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# Safety Section



This safety section covers information for: VMCs EMC, 5, 10, 15, 15XT, 2016L, 2216, 3016, 3016L, 3020, 4020, 4020A, 4525, 5020A, 6030, 6535 and 8030; Rotary Tables VH65, TR65, and V300 (400) MM; and VH5C Indexer.

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The information in this document is reviewed regularly and any necessary changes will be incorporated in the next revision. We welcome any suggestions for improvement.

Material is subject to change without notice.

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### **MODIFICATIONS, ALTERATIONS, AND CHANGES**

Do not modify or alter this equipment without the written approval of Fadal Machining Centers. Unauthorized changes may lead to hazardous conditions. Address any questions to Fadal's Service Department.

### SAFETY WARNINGS

1. **WARNING! WEAR ANSI or CE APPROVED SAFETY GLASSES AT ALL TIMES.** Everyday glasses are not designed for protection. Only ANSI or CE approved safety glasses have impact resistant lenses. Hearing protection must be worn when operations exceed 90 (85 CE) decibels.
2. **KEEP DOORS CLOSED WHILE MACHINING.**
3. **WEAR PROPER APPAREL.** Do not wear loose clothing, gloves, neckties, rings, bracelets, or other jewelry that might get caught in moving parts or areas of potential electric shock. Non-slip footwear is recommended.
4. **CONTAIN LONG HAIR.** Tie long hair back and wear protective hair covering to contain long hair.
5. **USE A NIOSH OR CE APPROVED DUST MASK OR RESPIRATOR.** Protection is recommended when cutting operations are dusty, or exceed the permissible exposure limit.
6. **KEEP WORK AREA CLEAN.** Good housekeeping practices encourage safety.
7. **Read SPINDLE, MANUALLY LOADING & UNLOADING A HOLDER** in the Operator's Manual.
8. **DO NOT OPERATE THE MACHINE UNDER THE INFLUENCE OF DRUGS OR ALCOHOL, PRESCRIBED OR OTHERWISE.**
9. **READ THE SAFETY WARNINGS SUPPLIED WITH ALL TOOLING.**
10. **MAINTAIN TOOLS WITH CARE.** Keep tools sharp and clean for best performance and to reduce the risk of injury. Follow instructions for lubrication and for changing accessories.
11. **REMOVE ADJUSTING KEYS AND WRENCHES.** Always check that keys and wrenches are removed from tools and tooling before starting the machine.
12. **DO NOT EXCEED THE MANUFACTURER'S RECOMMENDED MAXIMUM RPM FOR THE TOOL.** When tools are placed in the spindle, verify the current RPM commanded in the control before starting the spindle.
13. **SECURE TOOLS PROPERLY IN THEIR HOLDERS.**
14. **SECURE WORK.** Use common machining practices for holding (fixturing) material to be machined.
15. **REMOVE ALL TOOLS FROM THE SPINDLE AND TOOL CHANGER** before servicing and changing accessories such as tooling, fixtures, indexers, the tail stock of a fourth axis and any fourth axis or fourth-fifth axis combination, etc.
16. **ALWAYS DEBUG A NEW PROGRAM** before running it in the AUTO mode. (See DEBUG PROGRAM in the User's Manual.)
17. **The machine tool MUST be connected to a grounded, metal, permanent wiring system, or to a system having an equipment-grounding conductor.**

18. DO NOT OPERATE THE MACHINE IN AN UNSAFE ENVIRONMENT. Do not use the machine in damp or wet locations, or expose to rain. Keep the work area well lighted.
19. DO NOT FORCE TOOL. Tools are designed to perform properly and safely at proper rates. Keep tools sharp.
20. USE THE CORRECT TOOL. Do not attempt to use tools or attachments to perform a job for which they were not designed.
21. DON'T OVERREACH. Keep proper footing and balance at all times. Use a steady object for support when reaching over the machine.
22. REDUCE THE RISK OF UNINTENTIONAL STARTING. Power off the machine at the main disconnect switch and use the proper lockout/tagout procedures while working within the chip enclosure, or when there is potential for a release of energy.
23. POWER OFF THE MACHINE AT THE MAIN DISCONNECT SWITCH AND LOCK OUT WHEN WORKING INSIDE ANY OF THE ELECTRONIC CABINETS.
24. USE RECOMMENDED ACCESSORIES. Refer to the User's Manual for FADAL recommended accessories. Unapproved accessories increase the risk of injury.
25. NEVER STAND ON OR IN THE MACHINE. Besides the risk of slipping or falling, serious injury could occur if a tool is unintentionally contacted.
26. CHECK FOR DAMAGED PARTS. Always check all parts for binding, breakage, and any other condition that will affect the proper operation of the machine and/or increase the risk of injury. Damaged or missing parts must be repaired or replaced BEFORE operating the machine.
27. NEVER LEAVE THE MACHINE UNATTENDED. Turn the power off to the machine when leaving the machine unattended. Never leave the machine until it comes to a complete stop.
28. DO NOT DISCONNECT THE FRONT DOOR SAFETY SWITCHES.
29. WIPE UP SPILLS. Immediately cover with absorbent material and wipe up coolant and oil spills around the machine. Correct the cause of the leakage to prevent any hazards.
30. ELECTRICAL INSTALLATION OF THE MACHINE MUST BE DONE BY A QUALIFIED ELECTRICIAN.
31. ONLY FADAL OR FADAL DISTRIBUTOR FACTORY AUTHORIZED INDIVIDUALS MAY INSTALL THE MACHINE.
32. USE PROPER SAFETY GLOVES WHEN HANDLING SHARP OR JAGGED EDGES. Do not wear gloves around rotating machinery.

33. DO NOT USE AIR HOSES TO BLOW CHIPS OFF YOUR BODY OR CLOTHES. Serious injury to your eyes, hearing, and skin could result. Do not blow towards others.

### GENERAL

A carelessly or improperly operated VMC can cause serious injury or death as well as damage or destruction of equipment. The emergency and safety procedures in this manual are to help users operate the VMC in a safe manner. The warnings in this manual follow accepted industry safety practices. Tasks involving toxic materials must be reviewed and approved by an industrial hygienist or safety engineer.

Fadal has no control over the applications the operator may use the VMC for and is not responsible for injuries or equipment damage. Read and understand the *User's Manual*. The safe use and disposal of all hazardous materials processed or used by the VMC is the responsibility of the user. All safety warnings and procedures must be followed.

It is the sole responsibility of the user to comply with all local, state, national (Federal), and international and environmental safety laws and regulations applicable to the VMC and its use.

### **WARNINGS AND CAUTIONS**

This manual contains information that will assist qualified operators and maintenance personnel. Unqualified operators should never attempt to operate or perform maintenance on the VMC.

### **PICTORIALS**

Pictorials are used within warnings to rapidly communicate a hazard to the reader. The pictorials and their meaning are given in this section. A diagram of the locations and types of warnings that are physically attached to, or engraved on, the VMC is also included.

### **POTENTIAL HAZARDS TO PERSONNEL**

The most serious potential hazards associated with the VMC are:

- electric shock
- sharp edges on cutting tools
- rotating cutting tools
- noise
- compressed air

### **PHYSICAL ENVIRONMENT AND OPERATING CONDITIONS (CE SPECIFICATIONS)**

FADAL VMCs meet or exceed the environmental requirements stated in EN 60204-1:1992 section 4.4.

Electromagnetic Compatibility meets or exceeds the levels specified by EN 50081-2:1993 and EN 50082-2:1995.

Ambient air temperature conforms as specified in EN60204-1:1992 section 4.4.2 (+5 deg C to +40 deg C).

Humidity conforms as specified in EN60204-1:1992 section 4.4.3 (relative humidity 30% to 95% non-condensing).

Altitude conforms as specified in EN60204-1:1992 section 4.4.4 (maximum altitude without derating exceeds 1000 meters above sea level).

Contaminants conform as specified in EN60204-1:1992 section 4.4.5.

Equipment is not intended for use in a corrosive atmosphere. Equipment that will be used in an environment with excessive amounts of fine conductive particulate matter (e.g. graphite) must be ordered with the graphite restraint package.



### **ELECTRIC SHOCK**

The VMC has numerous subsystems powered by high voltage electricity. This electricity is not a hazard during most operations, however certain maintenance operations conducted by qualified individuals may require the defeat of interlocks so that power may be maintained during diagnostics or adjustments tasks. Under no circumstances should the operator defeat any interlock.

Read all applicable manuals and follow their warnings to prevent accidental electric shock. Operators must never remove shields or panels, nor should operators bypass or otherwise disable interlocks.

### **SHARP EDGES ON CUTTING TOOLS**

Cutting tools have sharp edges that could lead to a serious cut. The tools used on the VMC are stored in a tool tray when not being used. Under most circumstances they pose no threat to operator or maintenance personnel. It is possible for personnel to come into contact with stationary cutting tools during job setup or when replacing cutting tools for any reason. Extreme care must be taken to avoid coming into contact with the sharp edges on cutting tools.

### **ROTATING CUTTING TOOLS**

Rotating cutting tools used by the VMC create potential hazards of entanglement. A cutting hazard is also possible if the operator comes into contact with rotating cutting tools. The Polycarbonate shield is equipped with an interlock to prevent the VMC from operating when the shield is opened. Under no circumstances should operators disable or remove the interlocks.

If the interlock is not functioning properly, qualified maintenance personnel should be notified and the VMC must not be used until it is functioning properly.

Prior to starting any job, the operator on the VMC should inspect all of the cutting tools being used to ensure they are in good condition and free of defects such as cracks. The operator should also insure that only the appropriate cutting tools for the material being machined are present.

Using the wrong tool or using a damaged tool could result in the failure of the tool or material being machined. Failure of either could lead to pieces of either the tool or the material being ejected at extremely high speed. Ejection of either could lead to serious injury or death to personnel in the vicinity. Major equipment damage could also be sustained.

### NOISE

Exposure to occupational hazardous noise or prolonged exposure to noise above 90 decibels may cause permanent hearing damage. The amount of noise the VMC produces varies by the type of material, speed of the cut, and several other factors.

To prevent loss of hearing from the noise of an operating VMC, hearing protection must always be worn by personnel exposed to noise above 90 decibels or above. The level of protection required may vary because of variation in the amount of noise being produced by the VMC. To insure adequate hearing protection is attained, compliance with OSHA standards is required. Consult a qualified industrial hygienist or safety engineer to insure adequate protection prior to operating the VMC.

### NOISE (CE COMPLIANCE)

Exposure to occupational hazardous noise or prolonged exposure to noise above 85 decibels may cause permanent hearing damage. The amount of noise the VMC produces varies by the type of material, speed of the cut, and several other factors.

To prevent loss of hearing from the noise of an operating VMC, hearing protection must always be worn by personnel exposed to noise above 85 decibels or above. The level of protection required may vary because of variation in the amount of noise being produced by the VMC. To insure adequate hearing protection is attained, compliance with CE standards is required. Consult a qualified industrial hygienist or safety engineer to insure adequate protection prior to operating the VMC.

Continuous equivalent A-weighted sound pressure at workstation is 77dB(A) or less when tested according to Annex D of prEN 12417.

The figures quoted are emission levels and are not necessarily safe working levels. While there is a correlation between the emission and exposure levels, this cannot be used reliably to determine whether or not further precautions are required. Factors that influence the actual level of exposure of the workforce include characteristics of the work room, the other sources of noise, etc. i.e., the number of machines and other adjacent processes. Also the permissible exposure level can vary from country to country. This information, however, will enable the user of the machine to make a better evaluation of the hazard and risk.

### **COMPRESSED AIR (CE COMPLIANCE)**

Compressed air poses a potential hazard from flying debris. Under normal conditions the compressed air may not present a hazard to the operator. Failure of any component of a compressed air system may cause parts to be ejected at high speed. Operators and maintenance personnel must always wear eye protection that meets OSHA standards and ANSI standard Z87.1 (or CE standards) when working on systems that use compressed air.

The operator may also use their shop's compressed air to remove debris from material being machined. If shop air is used for this purpose, it must be done in accordance with OSHA or CE standards. Alternative means of debris removal, such as debris rakes, should be considered. **UNDER NO CIRCUMSTANCES SHOULD THE OPERATOR ATTEMPT TO REMOVE DEBRIS WHILE THE VMC IS RUNNING.** Consult a qualified industrial hygienist or safety engineer to insure debris removal is accomplished in a safe manner and in a manner that complies with local, state, national (Federal), and international regulations.

### ADDITIONAL SAFETY PRECAUTIONS

Compliance with the following safety practices is required to safely operate the VMC:


1. Never work alone on live electrical circuits. Another person qualified to turn off power to the VMC must be present when voltage is 600 or over. That person must also know CPR (cardiopulmonary resuscitation) and company emergency procedures.
2. Never wear jewelry or loose fitting clothing while working on the VMC. Long hair should be secured and under a cap.
3. .Wear eye protection when operating or maintaining this machine.
4. Never operate this machine without all guards, safety shields, and interlocks in place and functioning properly.
5. Report any unsafe conditions to the supervisor immediately. Do not operate this machine until the unsafe condition has been resolved. If the operator is not familiar with a condition, consult an industrial hygienist or safety engineer for approval prior to proceeding.
6. Comply with all local, state, national (Federal), and international (CE) regulations pertaining to the handling, processing or disposal of hazardous materials used in conjunction with VMC operations.
7. Do not leave electrical cords where they may be tripped over. Secure all electrical cords and compressed air lines connected to the VMC.
8. Keep a UL or CE approved fire extinguisher close to the VMC and make sure all personnel know the location of the fire extinguisher.
9. Do not turn the VMC on or try to operate it if there are explosive or flammable gases present.
10. Do not install substitute parts or modify the VMC without consulting a safety engineer. Contact FADAL or your local distributor for authorized repair parts and service.
11. The Polycarbonate viewing panels are an integral part of the safety enclosure for the VMC. They must be inspected at least monthly for any signs of reduced effectiveness (such as cracking or crazing) and replaced immediately if such signs or other indications of reduced effectiveness are noticed. Furthermore, tests have indicated that coolants can reduce the effectiveness of the panels over a period of time, therefore the panels should be replaced, regardless of condition, at least every two years.

12. The Polycarbonate shield is equipped with an interlock to prevent the VMC from operating when the shield is opened. Under no circumstances should the operator disable or remove the interlocks. If power is lost to the VMC, the spindle will free wheel for 30 seconds. Under no circumstances should the operator open the Polycarbonate shield before the spindle stops rotating completely.
13. The machine is not intended for use with flammable or harmful substances.
14. Take appropriate additional safety precautions and measures when working with magnesium, wood, or other combustible materials.
15. Dust removal equipment is needed when working with dust-producing materials or procedures.
16. Due to danger of slips or falls on a wet or oily surface, table and enclosure floor should be clean and dry before using them for maintenance access.
17. Do not enter enclosure area unless machine is off and power is locked out.

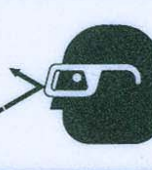




## SAFETY LABELS

LBL-0123

**SAFETY INSTRUCTIONS**

 **DANGER**

All milling machines contain hazards from rotating cutting tools, belts and pulleys, high voltage electricity, noise, and compressed air.



- Rotating cutting tools can severely injure you. NEVER place any part of your body near rotating cutting tools. Inspect cutting tools for damage before operating this machine. DO NOT operate this machine unless doors are closed. DO NOT operate this machine unless door interlocks are working properly.
- Rotating pulleys and belts can severely injure you. NEVER place any part of your body near rotating or moving parts. ALWAYS ensure guards are in place before operating this machine.
- High voltage electricity can severely injure or kill you. NEVER attempt to adjust or repair electrical circuits unless you are familiar with the circuits and are qualified to work safely on the electrical circuits. ALWAYS lock out electrical circuits before attempting to work on this machine.
- Exposure to loud or long term noise can lead to permanent hearing loss. DO NOT operate this machine without hearing protection. ALWAYS wear hearing protection that meets Occupational Safety and Health Administration (OSHA) standards for noise attenuation.
- Compressed air can injure you. DO NOT work on compressed air systems without first disconnecting the source of compressed air. ALWAYS wear eye protection when performing maintenance on compressed air systems. ONLY authorized qualified personnel familiar with the compressed air system should perform maintenance on the compressed air system.



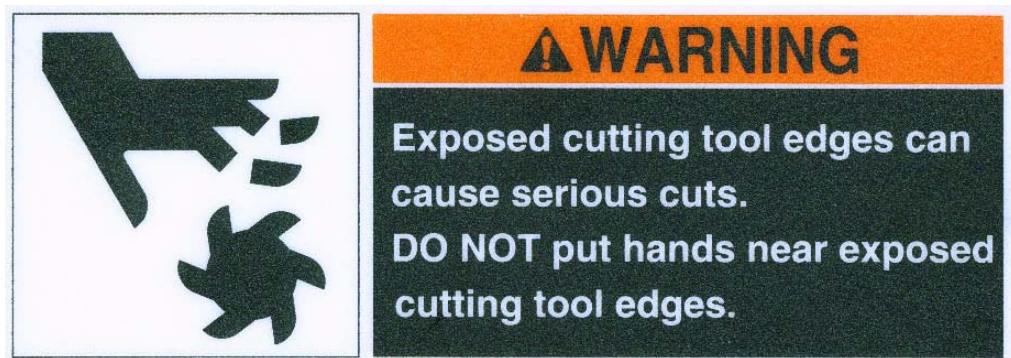
LBL-0129



LBL-0158



LBL-0127



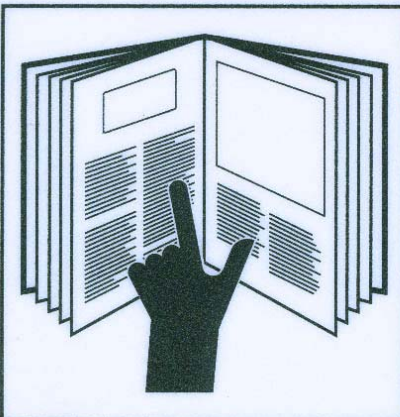
LBL-0130

**⚠ WARNING**



Flying objects from this machine may injure. **ALWAYS** wear safety glasses when operating this machine. Noise from this machine can damage hearing. **ALWAYS** wear ear protection when operating this machine. **DO NOT** operate this machine with the doors open or with enclosures removed. Lockout before servicing.

LBL-0163



**⚠ WARNING**

To avoid serious injury or death to you or others:

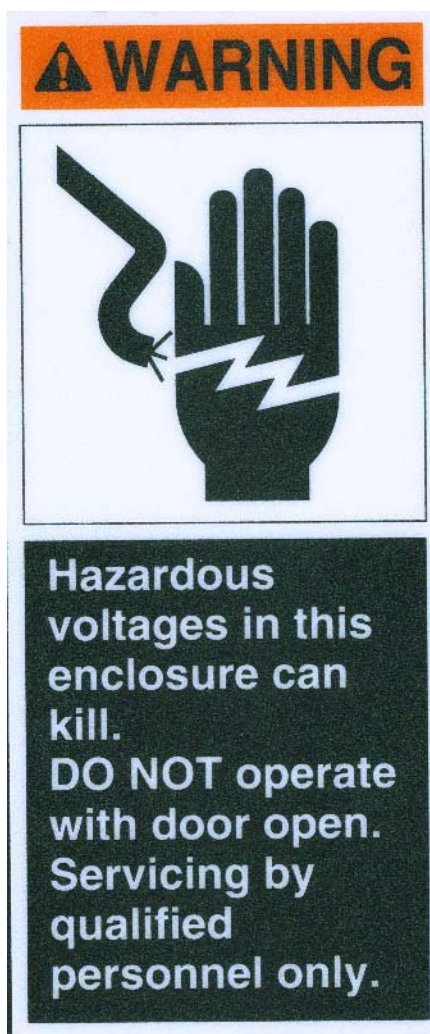
- This machine must be operated by qualified personnel only.
- Read and completely understand Operator's Manual before operating this machine.



LBL-0126



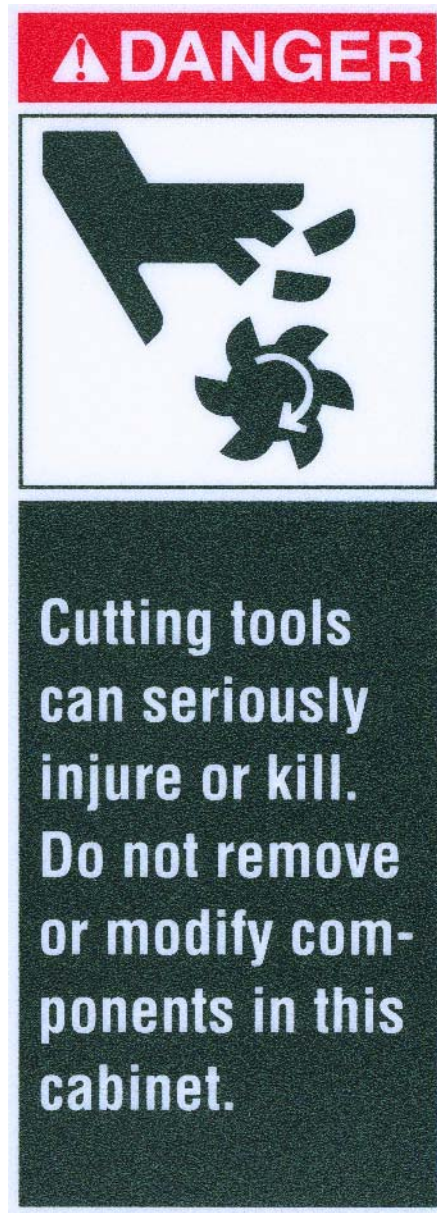
LBL-0128



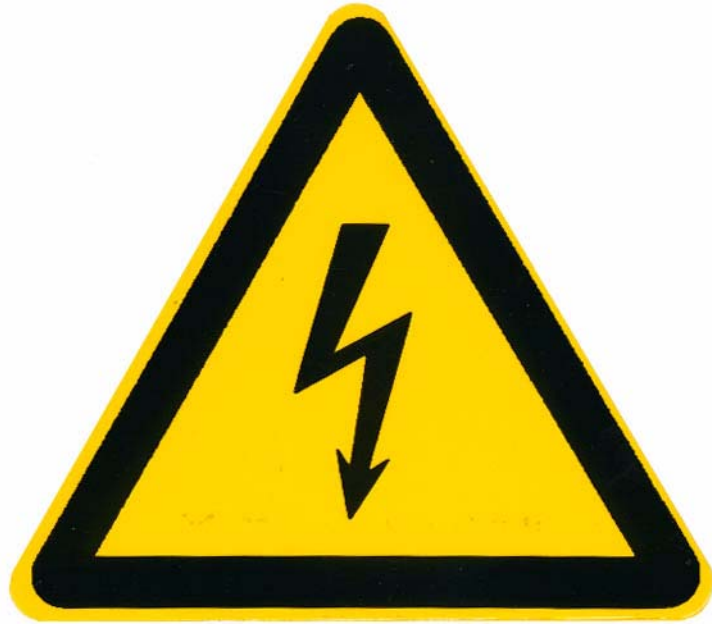
LBL-0125



LBL-0235



LBL-0131



LBL-0263





LBL-0187

**FADAL VMC GROUNDING REQUIREMENTS**

FADAL VMC machines shall be grounded by any of the methods listed in article 250 of the National Electric Code. (see installation chapter of the FADAL VMC Maintenance Manual for details) The minimum grounding method recommended by FADAL is as follows:

- Grounding wire must be one continuous conductor, solid or stranded, no splices.
- Grounding wire must be copper wire with green insulation or a copper wire having green insulation with a yellow stripe.
- Grounding wire must be a No. 8 AWG or larger conductor.
- One end of this wire is connected to the protective earth bar in the back cabinet of the FADAL metalworking machine. The other end of the wire is connected to an applicable grounding lug in the power distribution panel of the building.

LBL-0234



LBL-0124



LBL-0040

**MAINTENANCE AND RAIL LUBRICATION**

**DAILY**

1. CHECK AIR PRESSURE ( 80-90 PSI ).
2. WITH TOOL IN SPINDLE BLOW CHIPS FROM AROUND A.T.C. AND SLIDE. NEVER BLOW CHIPS FROM AROUND THESE AREA DURING AUTOMATIC TOOL CHANGE OR WITHOUT A TOOL IN THE SPINDLE.
3. REMOVE HEAVY CHIP BUILD UP FROM GUARDS AND WAY COVERS.
4. WASH A.T.C. AND MACHINE WORK AREA.

**WEEKLY**

1. CLEAN A.T.C. SLIDE.
2. CHECK AIR REGULATOR:  
A: DRAIN WATER SEPARATOR
3. INSPECT ALL COOLING FANS. CLEAN IF NECESSARY.

**EVERY 2 WEEKS**

1. TO LUBE THE RAILS AND BALL SCREWS, GREASE EVERY LUBRICATION PORT AT THE SADDLE, TABLE AND HEAD WITH 4 PUMPS OF THE GREASE GUN.  
A: USE MOBILTEMP SHC32 GREASE

LBL-0036

**MAINTENANCE AND LUBRICATION**

**DAILY**

1. CHECK AIR PRESSURE:  
A: RIGHT REGULATOR 120 PSI MAX. (TOOL OUT ONLY)  
B: LEFT REGULATOR 80-90 PSI
2. CHECK AIR FILTER:  
A: DRAIN AND CLEAN WATER SEPARATOR.
3. CHECK WAY LUBE LEVEL (USE CASTROL MAGNA BD68, SHELL TONNA 68V OR MOBIL VACTRA #2 ONLY).
4. CHECK WAY LUBE SYSTEM FOR ADEQUATE FLOW TO ALL WAYS.
5. WITH THE TOOL IN SPINDLE BLOW CHIPS FROM AROUND A.T.C. AND SLIDE. NEVER BLOW CHIPS FROM THE AREAS DURING AUTOMATIC TOOL CHANGE OR WITHOUT A TOOL IN THE SPINDLE.
6. REMOVE HEAVY CHIP BUILD UP FROM GUARDS AND WAY COVERS.
7. WASH A.T.C. AND MACHINE WORK AREA.

**WEEKLY**

1. CHECK SPINDLE COOLER PUMP AND REFRIGERATION UNIT FOR PROPER OPERATION.
2. CLEAN A.T.C. SLIDE.
3. ACTIVATE (OPTIONAL) THRU-TOOL COOLANT SYSTEM FOR 2-3 MINUTES.
4. LUBRICATE Y AXIS TELESCOPING BALLSCREW COVER WITH WAY LUBE.
5. INSPECT ALL COOLING FANS. CLEAN IF NECESSARY.
6. CLEAN REFRIGERANT PUMP FILTER.

**YEARLY**

1. SERVICE WAY LUBE FILTER:  
A: REPLACE BRONZE ELEMENT IN EXTERNAL FILTER.



### SAFETY LABEL LOCATIONS

4020S



LBL-0234

LBL-0123



LBL-0129



LBL-0234



LBL-0123

LBL-0163



LBL-0235



LBL-0125

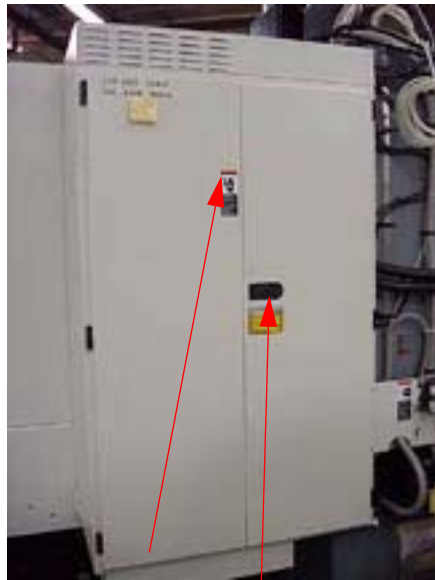


LBL-0128



LBL-0234

5020a, 4020a, 4020,  
3016L, 2216, 2016L,  
15, 15xt, EMC



LBL-0128

LBL-0263



LBL-0126



LBL-0128

LBL-0263



LBL-0235



LBL-0125



LBL-0125



LBL-0235



LBL-0127

6030, 8030



LBL-0123



LBL-0128



LBL-0263



LBL-0235



LBL-0128



LBL-0263





LBL-0235



LBL-0126



LBL-0129



LBL-0124





LBL-0235



LBL-0125



LBL-0123

LBL-0163



LBL-0128



LBL-0128

LBL-0263



LBL-0235



LBL-0128

LBL-0263



LBL-0235

6535, 4525, 3020



LBL-0126



LBL-0036



LBL-0123



LBL-0128

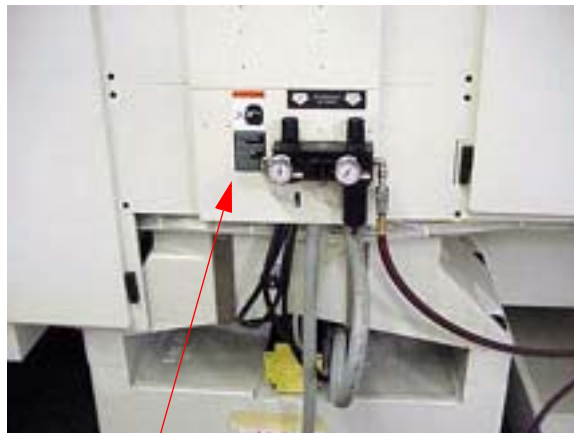


LBL-0123



LBL-0128

LBL-0263



LBL-0126



LBL-0128

LBL-0263



LBL-0036



LBL-0235



LBL-0125



LBL-0235



LBL-0125



## CE SAFETY LABELS

LBL-0431 small (CE)

LBL-0434 large (CE)

**Cutting of Fingers or Hand / Rotating Cutter**

Cutting tools can seriously injure. Never place any part of your body near rotating tools. Do not operate this machine unless the doors are closed and the door interlocks are working.

LBL-0432 (CE)

**Hand Entanglement / Belt Drive**

Rotating pulleys and belts can seriously injure. Never place any part of your body near rotating or moving parts. Always insure that guards are in place before operating this machine.

LBI-0132 (CE)

**Electric Shock / Electrocutation**

Hazardous voltages in this enclosure can kill. Do not operate with the door open. Servicing should be done by qualified personnel only. Lockout the power before servicing.

LBL-0435 (CE)

**Flying Debris and Loud Noise**

Flying objects from this machine may injure. Always wear safety glasses when operating this machine. Do not operate this machine with the doors open or the enclosures removed. Also, noise from this machine can damage hearing. Always wear ear protection when operating this machine.

LBL-0460 (CE)

**Flying Debris**

Flying debris and compressed air can cause eye injuries. Do not perform maintenance on pressurized systems. Disconnect the air source before performing maintenance. Always wear eye protection when performing maintenance on compressed air systems.

LBL-0430 (CE)

**Skin Puncture / Pressurized Air**

Compressed air can seriously injure. Do not perform maintenance on pressurized systems. Disconnect air source before performing maintenance. Always wear eye protection when performing maintenance on compressed air systems.

LBL-0436 (CE)

**Leg or Body Entanglement / Auger**

Auger can serious injure or kill. Keep body parts out of the auger system at all times. Turn off the machine and lockout the power before doing maintenance inside the enclosure.

LBL-0433 (CE)

**Hand Crush / Moving Parts**

Automatic pallet changer door will crush hands. Stand clear when the door is closing.

LBL-0443 (CE)

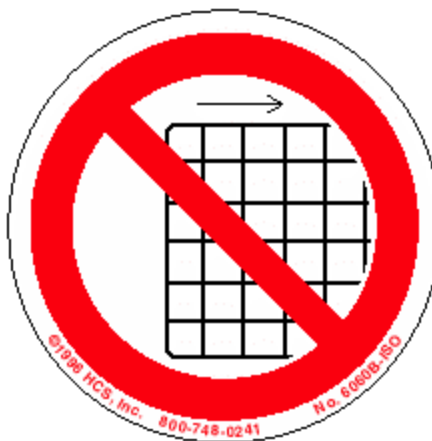


### **Hand Crush / Force from Side**

Automatic pallet changer can crush hands. Do not place hands or any part of the body in the path of a moving pallet.

## PROHIBITIONS

LBL-0441 (CE)

**Do Not Operate with Guard Removed**

Do not operate this machine with the doors open or the guards removed.  
Moving machinery and rotating cutters can seriously injure or kill.



## REQUIRED ACTIONS

LBL-0439 (CE)

**Wear Eye Protection**

Flying objects may injure. Always wear safety glasses when operating this machine.

LBL-0440 (CE)

**Wear Ear Protection**

Noise from this machine can damage hearing. Always wear ear protection when operating this machine.

LBL-0442 (CE)

**Consult Operator's Manual**

Read and understand the Operator's Manual before operating this machine.  
This machine must be operated by qualified personnel only,

LBL-0438 small (CE)

LBL-0437 large (CE)

**Lockout Electrical Power**

Whenever servicing the machine, turn the machine off and lockout the power.  
Turn off the machine and lockout the power before working in this cabinet.

## CE SAFETY LABEL LIST AND LOCATION

Location	Domestic or old Labels	CE Labels
ATC Slide Arm Plate	LBL-0129	LBL-0432 (1009B-ISO), LBL-0438 (6011B-ISO)
Spindle Belt Guide (inside spindle cover)	LBL-0129	LBL-0432 (1009B-ISO), LBL-0438 (6011B-ISO)
Front by Pendant	LBL-0123, LBL-0163	LBL-0435 (3002A-ISO), LBL-0439 (6040A-ISO), LBL-0440 (6041A-ISO), LBL-0442 (6126A-ISO)
Tool Turret Cover	LBL-0136	LBL-0136 (revised)
Tool Changer Cover	LBL-0127	LBL-0434 (1007A-ISO)
Head (Spindle) Cover	LBL-0130 LBL-0137,-0138, or -0139	LBL-0435 (3002A-ISO), LBL-0439 (6040A-ISO), LBL-0440 (6041A-ISO) LBL-0137,-0138, or -0139 (revised)
Right Front Door	LBL-0124 LBL-0140	LBL-0431 (1007B-ISO), LBL-0441 (6060B-ISO) (LBL-0140 deleted after doors locked)
On Control, Transformer, and Pendant Cabinet Doors	LBL-0128, LBL-0131	--- LBL-0131 (6010A-ISO)
Inside of Control, Transformer, and Pendant Cabinets	LBL-0125 LBL-0235	LBL-0131 (6010A-ISO), LBL-0437 (6011A-ISO) (B size labels used in Slant Control cabinet - LBL- 0461, LBL-0438)
Grounding Labels	LBL-0133 (chassis ground) LBL-0186 (Protective Earth input)	LBL-0133, LBL-0186 (same)
Flood, Mist, RS-232 Outlets	LBL-0192, LBL-0188, LBL-0189	LBL-0192, LBL-0188, LBL-0189 (same)
On Chiller Cabinet	LBL-0300	LBL-0300 (same, 3 languages)
Chiller Outlets	LBL-0191, LBL-0190	LBL-0191, LBL-0190 (same)
CNC Power Button	LBL-0038	LBL-0038 (same)
Air Regulator	LBL-0126 LBL-0146	LBL-0430 (1120B-ISO) LBL-0460 (3021B-ISO) keep LBL-0146
Maintenance & Pull Stud labels	LBL-0036, LBL-0037	LBL-0036, LBL-0037 (same) Translated versions must be used for non-English speaking countries.
CE	---	LBL-0141
Left Side	LBL-0123	----
On Control and Transformer Cabinet Doors	LBL-0263	----

Main Disconnect, Aux. Disconnect, and Motor Starter Enclosures	LBL-0132	LBL-0132 (6010C-ISO)
Main Disconnect	LBL-0134, LBL-0135	LBL-0134 (I5007a-D), LBL-0135 (I5008a-D)
Next to Main Disconnect (Inside)	LBL-0187	keep LBL-0187 Translated versions must be used.
Main Disconnect inputs (U,V,W)	LBL-0142, LBL-0143, LBL-0144	LBL-0142, LBL-0143, LBL-0144 (same)
Auger - by left and right access panels, lower left of front door	LBL-0234	LBL-0436 (5004A-ISO)
Pallet Changer Base (front & rear)	----	LBL-0443 (1042B-ISO)
Pallet Changer Door	LBL-0158	LBL-0433 (1099A-ISO)

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# Section 01: Specifications

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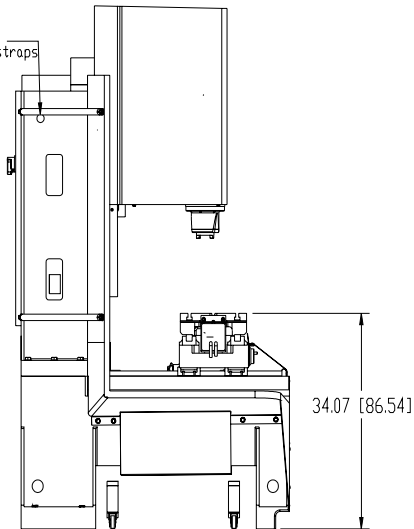
## Illustrations & Data for All VMC Models



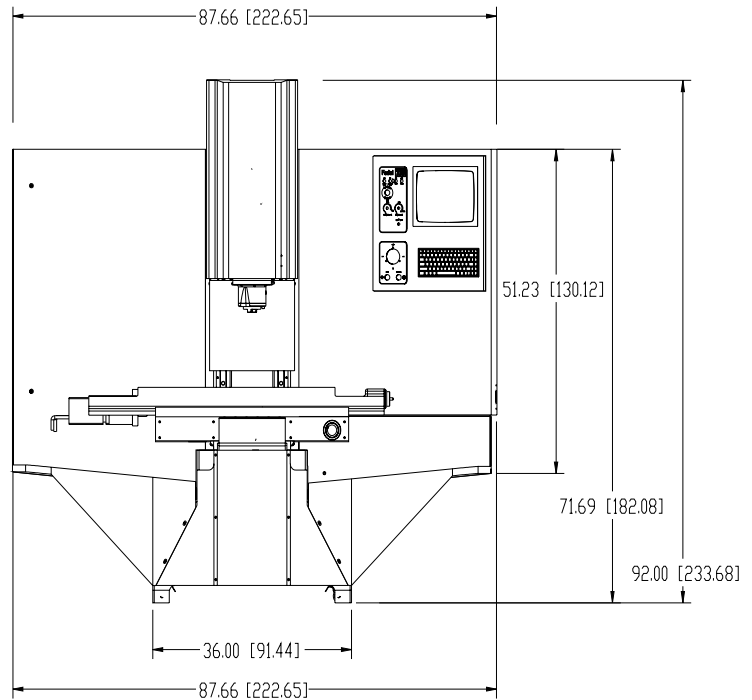
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## VMC TRM

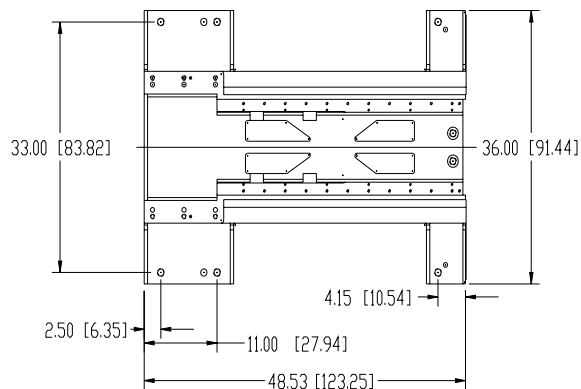
Use to lift by crane.  
Insert shipping bar  
attach to hook with lifting straps



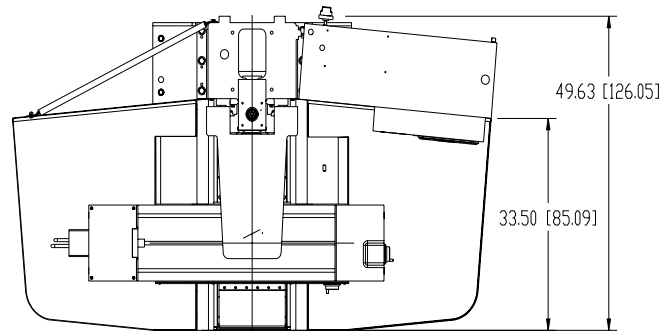
**SIDE VIEW**



**FRONT VIEW**



**TOP VIEW  
BASE**



**TOP VIEW**

**Note:** Dimensions represented in inches & [centimeters]

**Figure 1-1** VMC TRM

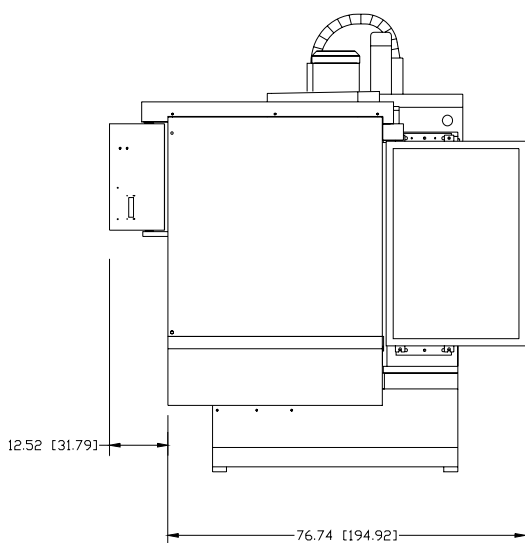
Table 1: VMC TRM Specifications

TRM Specifications	TRM Standard	TRM Metric
Table Size	35" x 12"	889mm x 304.8mm
Floor to Table	34.5"	876.3mm
T-Slots (No. x Width x Span)	3 x .562" x 4.375"	3 x 14.3mm x 111mm
Cutting Feed Rate	.01-200" ipm	.25-5080 mm/min
Rapid Feed Rate (X/Y/Z)	200 ipm	5080 mm/min
Max. Weight on Table	500 lbs	226.8 kg.
Axis Drive Motor (X/Y/Z)	DC, 2,000 lbs*	
Ball Screw Size	32mm	
Longitudinal (X Axis)	30"	762mm
Cross (Y Axis)	14"	355.6mm
Vertical (Z Axis)	14"	355.6mm
Spindle Nose to Table	4"-18"	101.6mm-457.2mm
Spindle Center to Column Ways	19"	482.6mm
Main Motor HP	5 HP*	
Opt. HT Motor - Automatic 2 Speed Vector	N/A	
Torque	28 ft-lbs*	38Nm
Accuracy, Axis Positioning	± .0004"***	.0102mm
Accuracy, Axis Repeatability	± .0002"***	.0050mm
Glass Scales (X/Y/Z)	N/A	
Spindle Speed	4,000 rpm	
Spindle Orientation	N/A	
Spindle Taper	No. 40	
Max. Tool Diameter	4.5"	114.3mm
Max. Tool Length	10"	254mm
Max. Tool Weight	15 lbs.	6.8kg
Machine Width and Depth	88" W x 50" D	2235mm x 1270mm
Machine Maximum Height	92"	2336.8mm
Machine Weight	3,500 lbs.	1587kg
Air Pressure Reqs. (Momentary)	80-120 psi, 15 scfm	
Power Reqs. (3-phase)	22 amps, 220 VAC	
Single Phase (Optional)	45 amps, 220 VAC	

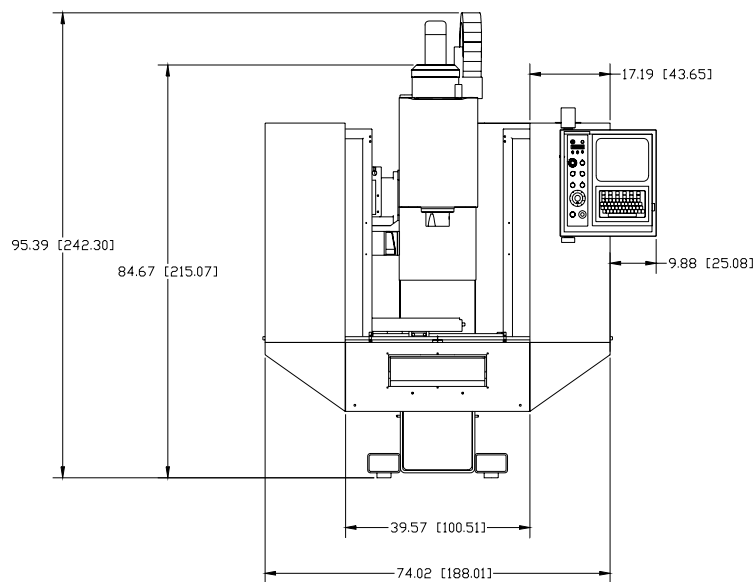
\* Rated Peak Value

\*\*All accuracies are quoted at 68 F

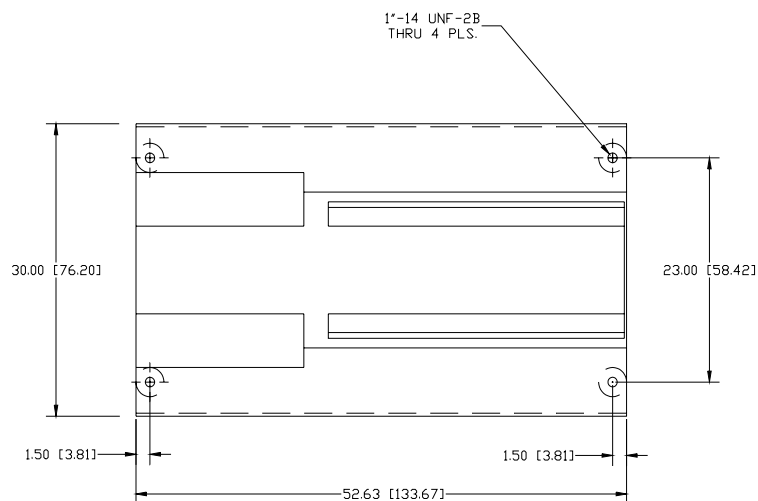
## VMC EMC



**SIDE VIEW**



**FRONT VIEW**



**Figure 1-2 VMC EMC**

**TOP VIEW  
BASE  
SCALE 2:1**

**Note:** Dimensions represented in inches & [centimeters]

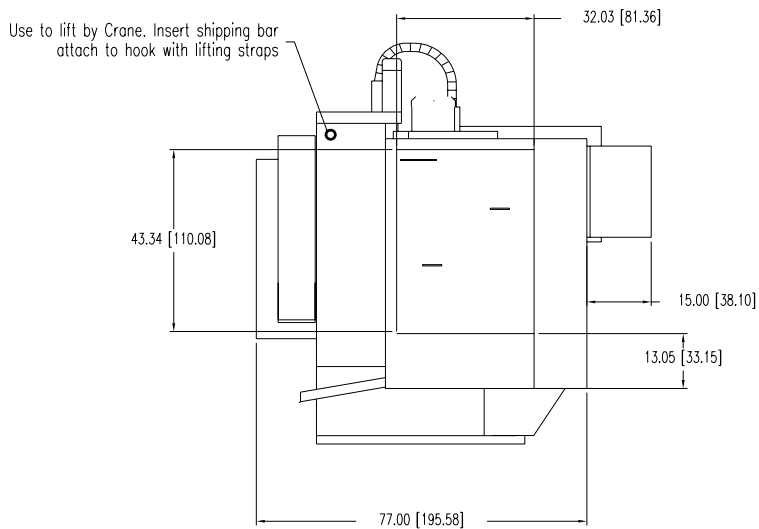
Table 2: VMC EMC Specifications

EMC Specifications	EMC Standard	EMC Metric
Table Size	29.5" x 16"	749mm x 406mm
Floor to Table	33.25"	845mm
T-Slots (No. x Width x Span)	3 x .562" x 4.33"	3 x 14mm x 110mm
Cutting Feed Rate	.01-250" ipm (375 @ 150%)	.25-6,350 (9,525 at 150%) mm/min
Rapid Feed Rate (X/Y/Z)	700 ipm	17.8 m/min
Max. Weight on Table	1,000 lbs	453.6 kg
Axis Drive Motor (X/Y/Z)	DC, 2,500 lbs	AC, 11,250 N*thrust
Ball Screw Size		32 mm
Longitudinal (X Axis)	20"	508mm
Cross (Y Axis)	16"	406mm
Vertical (Z Axis)	14"	356mm
Spindle Nose to Table	4"-18"	102mm-457mm
Spindle Center to Column Ways	17"	431mm
Main Motor - Automatic 2 Speed Vector	12 HP*	
Opt. HT Motor - Automatic 2 Speed Vector	N/A	
Torque	36 ft-lbs	102Nm
Accuracy, Axis Positioning	± .0002"	.0050mm
Accuracy, Axis Repeatability	± .0001"	.0025mm
Glass Scales (X/Y/Z)	N/A	
Spindle Speed	7,500 rpm	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	16	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3"	76mm
Max. Tool Length	10"	381mm
Max. Tool Weight	15 lbs.	6.8kg
Machine Width and Depth	75" W x 77" D	1.9mm x 2.0mm
Machine Maximum Height	92"	2.6m
Machine Weight	4,800 lbs.	2495kg
Air Pressure Reqs. (Momentary)	80-120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40 amps, 230 VAC	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	N/A	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)		

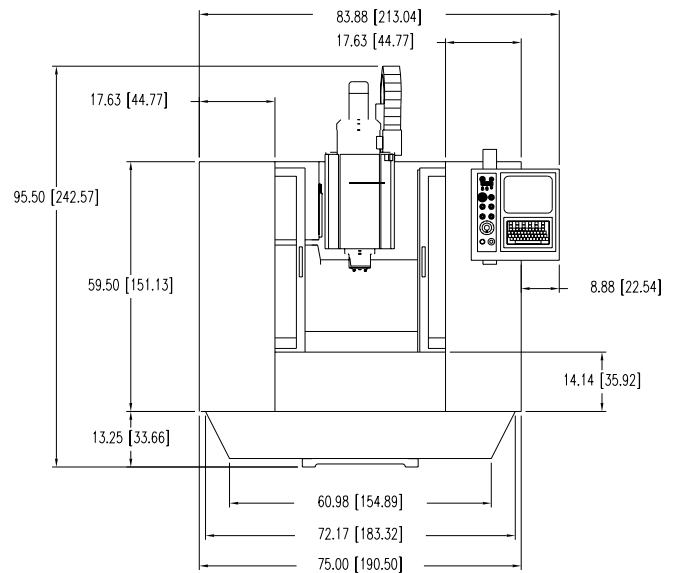
\*Rated Peak Value



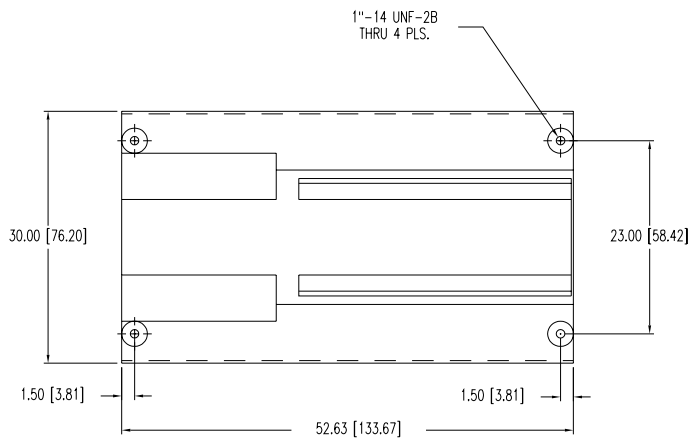
## VMC 15/15XT



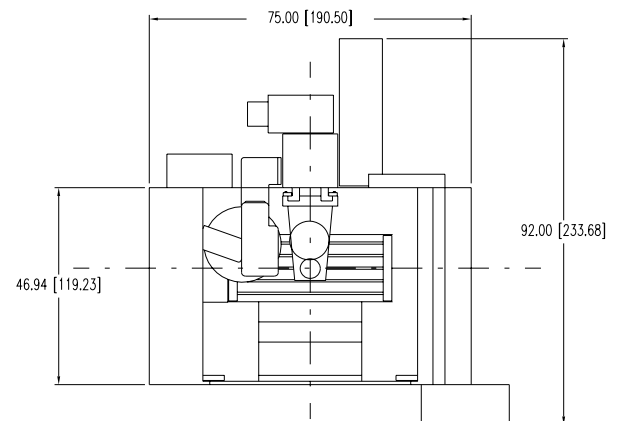
**SIDE VIEW**



**FRONT VIEW**



**TOP VIEW  
BASE  
SCALE 2:1**



**TOP VIEW**

**Note:** Dimensions represented in inches & [centimeters]

**Figure 1-3** VMC 15, 15XT

Table 1: VMC 15 Specifications

15 Specifications	15 Standard	15 Metric
Table Size	29.5" x 16"	749mm x 406mm
Floor to Table	30.5"	775mm
T-Slots (No. x Width x Span)	3 x .562" x 4.33"	3 x 14mm x 110mm
Cutting Feed Rate	.01-250" ipm (375 @ 150%)	.25-6,350 (9,525 at 150%) mm/min
Rapid Feed Rate (X/Y/Z)	400 ipm	10.1 m/min
Max. Weight on Table	1,500 lbs	680 kg
Axis Drive Motor (X/Y/Z)	DC, 3,500 lbs	AC, 15,900 N*thrust
Ball Screw Size	31.75mm Dia.	
Longitudinal (X Axis)	20"	508mm
Cross (Y Axis)	16"	406mm
Vertical (Z Axis)	20" (28" Opt.)	508mm (711mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102mm-610mm (102-813mm)
Spindle Center to Column Ways	17"	431mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	N/A	
Torque	75 ft-lbs	102Nm
Accuracy, Axis Positioning	± .0002"	.0050mm
Accuracy, Axis Repeatability	± .0001"	.0025mm
Glass Scales (X/Y/Z)	N/A	
Spindle Speed	10-7,500 rpm	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3"	76mm
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8kg
Machine Width and Depth	75" W x 77" D	1.9mm x 2.0mm
Machine Maximum Height	101"	2.6m
Machine Weight	5,500 lbs.	2495kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/45 amps, 230 VAC	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	N/A	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)		

\*Rated Peak Value

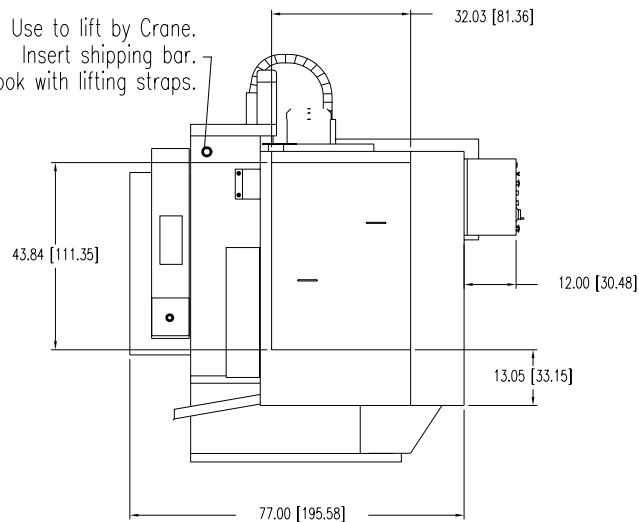
**Table 2: VMC 15XT Specifications**

15XT Specifications	15XT Standard	15XT Metric
Table Size	38" x 16 "	965mm x 406mm
Floor to Table	30.5"	775mm
T-Slots (No. x Width x Span)	3 x .562" x 4.33"	3 x 14mm x 110mm
Cutting Feed Rate	.01-250" ipm (375 @ 150%)	.25-6,350 (9,525 at 150%) mm/min
Rapid Feed Rate (X/Y/Z)	400 ipm	10.1 m/min
Max. Weight on Table	1,500 lbs	680 kg
Axis Drive Motor (X/Y/Z)	DC, 3,500 lbs	AC, 15,900 N*thrust
Ball Screw Size	31.75mm Dia.	
Longitudinal (X Axis)	30"	762mm
Cross (Y Axis)	16"	406mm
Vertical (Z Axis)	20" (28" Opt.)	508mm (711mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102mm-610mm (102-813mm)
Spindle Center to Column Ways	17"	431mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	N/A	
Torque	75 ft-lbs	102 Nm
Accuracy, Axis Positioning	± .0002"	.0050mm
Accuracy, Axis Repeatability	± .0001"	.0025mm
Glass Scales (X/Y/Z)	N/A	
Spindle Speed	10-7,500 rpm	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3"	76mm
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8kg
Machine Width and Depth	75" W x 77" D	1.9mm x 2mm
Machine Maximum Height	101"	2.6mm
Machine Weight	5,800 lbs.	2495kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/45 amps, 230 VAC	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	N/A	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)		

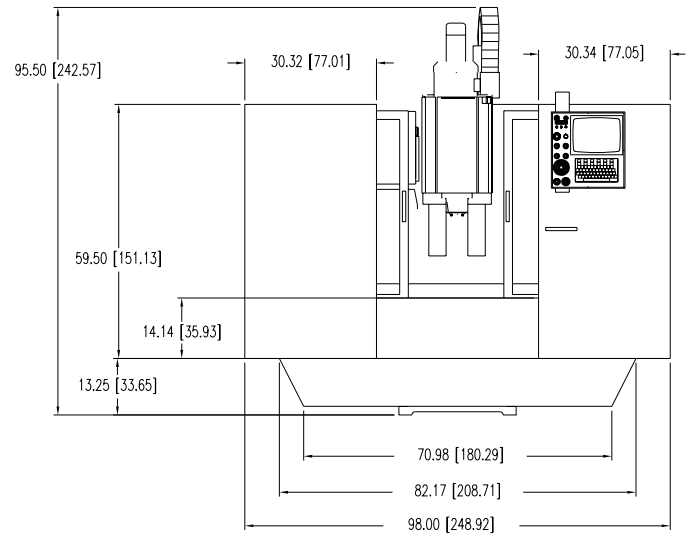
\*Rated Peak Value

## VMC 2216

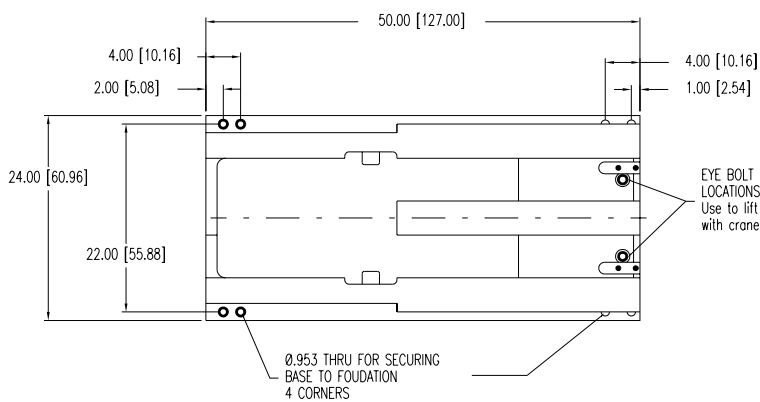
Use to lift by Crane.  
Insert shipping bar.  
Attach to hook with lifting straps.



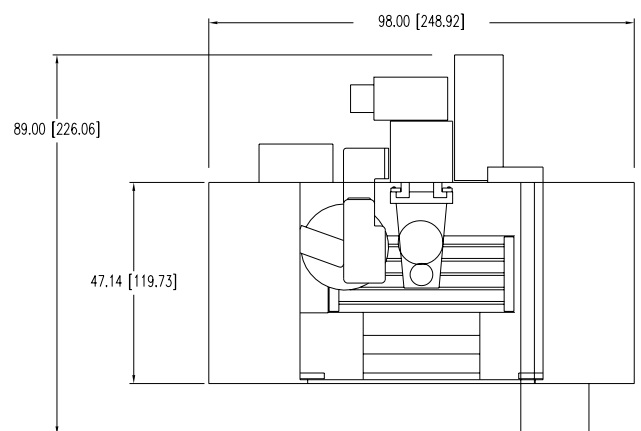
**SIDE VIEW**



**FRONT VIEW**



**TOP VIEW  
BASE  
SCALE 2:1**



**TOP VIEW**

**Figure 1-4 VMC 2216**

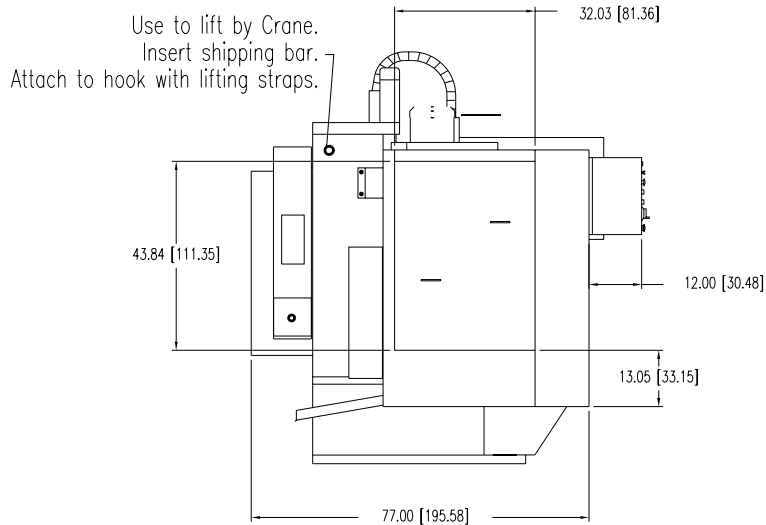
**Note:** Dimensions represented in inches & [centimeters]

Table 2: VMC 2216 Specifications

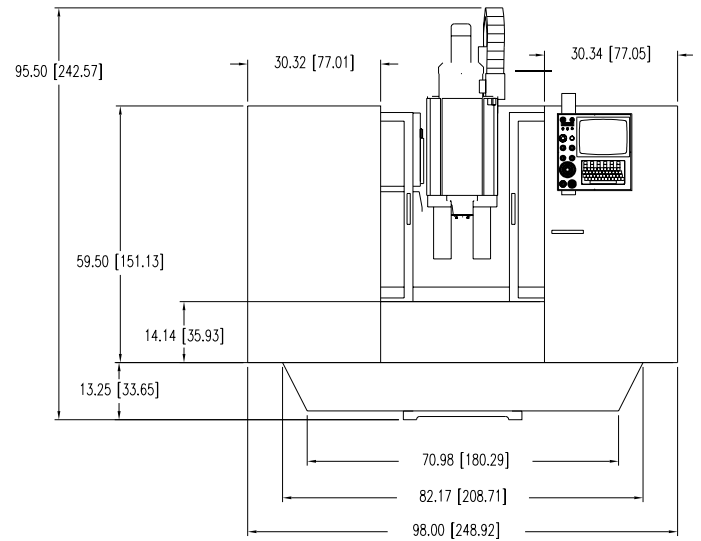
2216 Specifications	2216 Standard	2216 Metric
Table Size	39" x 16"	750mm x 406mm
Floor to Table	31"	787mm
T-Slots (No. x Width x Span)	3 x .562" x 4.33"	3 x 14mm x 110mm
Cutting Feed Rate	.01-400 ipm (600 @ 150%)	.25-10,160 (15,240 at 150%)mm/min.
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	22.8 m/min. (X,Y) 17.7 m/min (Z)
Max. Weight on Table	2,006 lbs.	991 kg.
Axis Drive Motor (X/Y/Z)*	AC, 3,800 lbs	AC, 16.900 N* thrust
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	22"	559mm
Cross (Y Axis)	16"	406mm
Vertical (Z Axis)	20" (28" Opt.)	508mm (711mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102mm-610mm (102mm-813mm)
Spindle Center to Column Ways	16"	406mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Torque	160 ft-lbs, 220 ft-lbs (HT)	220 Nm/300 Nm
Accuracy, Axis Positioning	± .0002"	.0050mm
Accuracy, Axis Repeatability	± .0001"	.0025mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76mm (114mm w/o adjacent tools)
Max. Tool Length	15"	381
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	98" W x 77" D	2.5m W x 2m D
Machine Maximum Height	103"	2.6m
Machine Weight	8,300 lbs.	3,765 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/45 amps, 230 VAC	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

\* Rated Peak Value

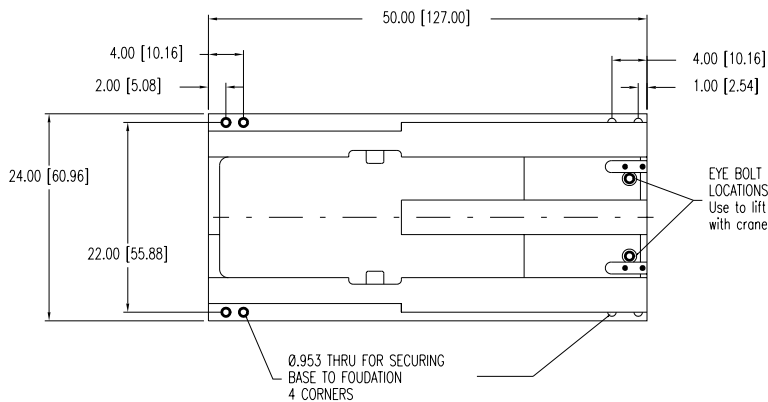
## VMC 3016



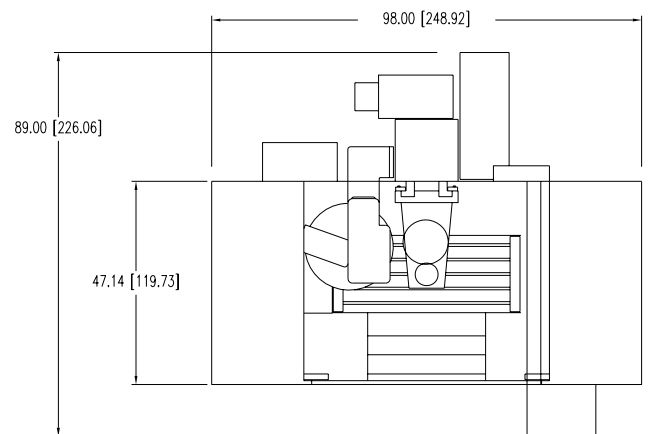
**SIDE VIEW**



**FRONT VIEW**



**TOP VIEW  
BASE  
SCALE 2:1**



**TOP VIEW**

**Figure 1-5 VMC 3016**

**Note:** Dimensions represented in inches & [centimeters]

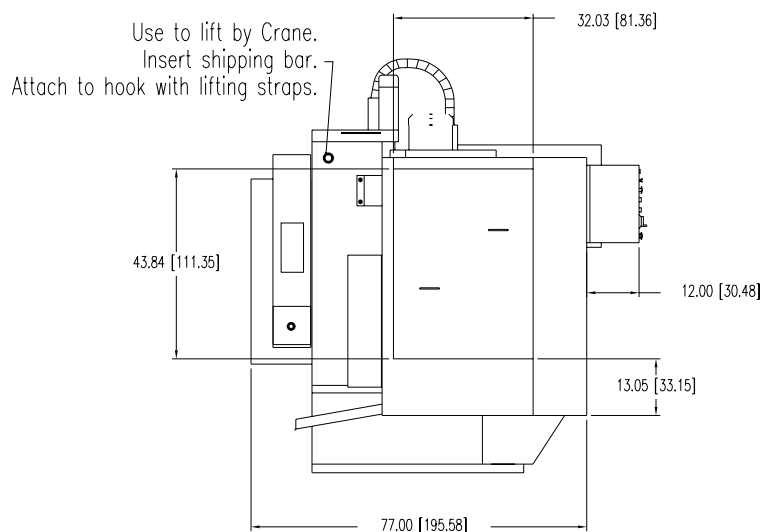
Table 3: VMC 3016 Specifications

3016 Specifications	3016 Standard	3016 Metric
Table Size	39" x 16"	750mm x 406mm
Floor to Table	31"	787mm
T-Slots (No. x Width x Span)	3 x .562" x 4.33"	3 x 14mm x 110mm
Cutting Feed Rate	.01-400 ipm (600 @ 150%)	.25-10,160 (15,240 at 150%)mm/min.
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	22.8 m/min. (X,Y) 17.7 m/min (Z)
Max. Weight on Table	2,736 lbs.	1,241 kg.
Axis Drive Motor (X/Y/Z)	AC, 3,800 lbs peak thrust	AC, 16.900 N* thrust
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	30"	762mm
Cross (Y Axis)	16"	406mm
Vertical (Z Axis)	20" (28" Opt.)	508mm (711mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102mm-610mm (102mm-813mm)
Spindle Center to Column Ways	16"	406mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Torque	160 ft-lbs, 220 ft-lbs (HT)	220 Nm/300 Nm
Accuracy, Axis Positioning	± .0002"	.0050mm
Accuracy, Axis Repeatability	± .0001"	.0025mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76mm (114mm w/o adjacent tools)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	98" W x 77" D	2.5m W x 2m D
Machine Maximum Height	103"	2.6m
Machine Weight	8,550 lbs.	3,878 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/45 amps, 230 VAC (20/25 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

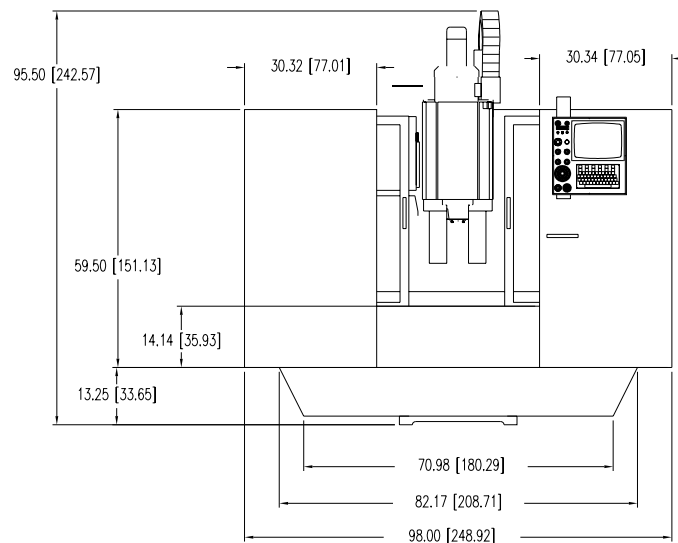
\* Rated Peak Value



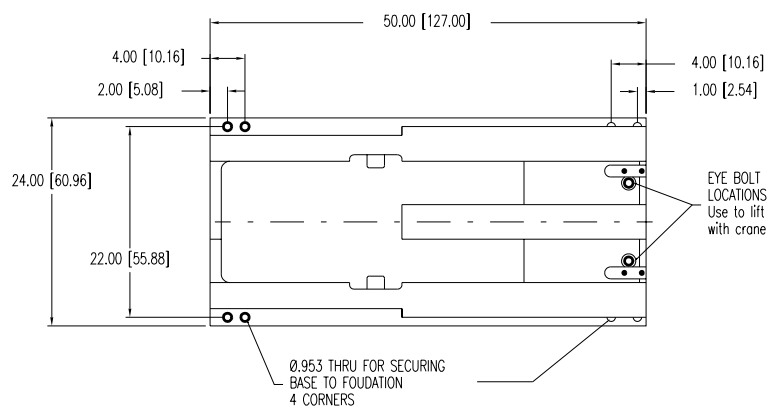
## VMC 2016L



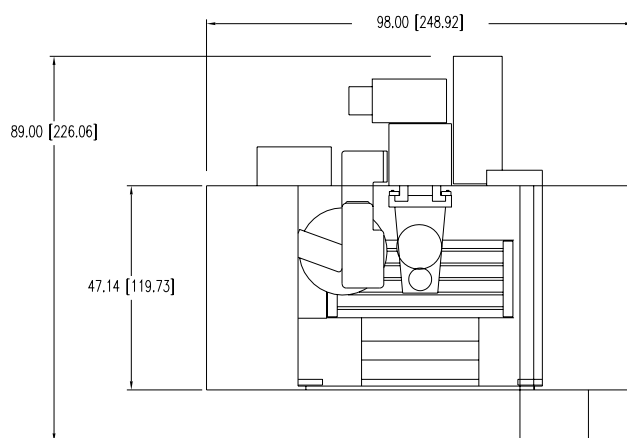
**SIDE VIEW**



**FRONT VIEW**



**TOP VIEW  
BASE  
SCALE 2:1**



**TOP VIEW**

**Figure 1-6 VMC 2016**

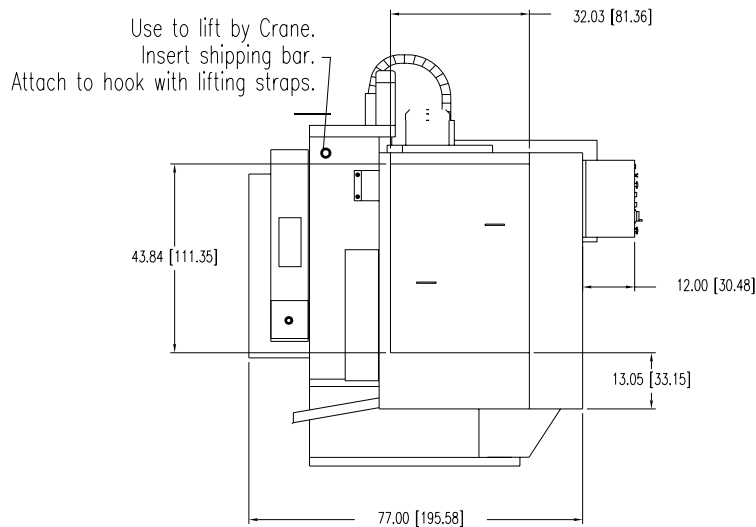
**Note:** Dimensions represented in inches & [centimeters]

Table 4: VMC 2016L Specifications

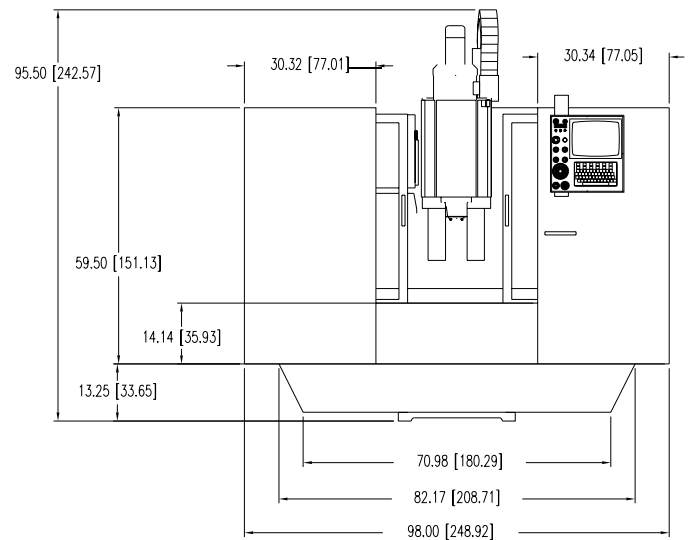
2016L Specifications	2016L Standard	2016L Metric
Table Size	29.5" x 16"	750mm x 406mm
Floor to Table	30.5"	775mm
T-Slots (No. x Width x Span)	3 x .562" x 4.33"	3 x 14mm x 110mm
Cutting Feed Rate	.01-250 ipm (375 @ 150%)	.25-6,350 (9,525 at 150%)mm/min.
Rapid Feed Rate (X/Y/Z)	500 ipm (X/Y/Z)	12.7 m/min (X,Y,Z)
Max. Weight on Table	2,000 lbs.	907 kg.
Axis Drive Motor (X/Y/Z)	DC 3,500 lbs peak thrust	AC, 15,900 N* thrust
Ball Screw Size	31.75mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	20"	508mm
Cross (Y Axis)	16"	406mm
Vertical (Z Axis)	20" (28" Opt.)	508mm (711mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102mm-610mm (102mm-813mm)
Spindle Center to Column Ways	17"	406mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	N/A	
Torque	75 ft-lbs	102 Nm
Accuracy, Axis Positioning	± .0002"	.0050mm
Accuracy, Axis Repeatability	± .0001"	.0025mm
Glass Scales (X/Y/Z)	N/A	
Spindle Speed	10-7,500 rpm	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76mm (114mm w/o adjacent tools)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	75" W x 77" D	1.91m W x 1.96m D
Machine Maximum Height	101"	2.6m
Machine Weight	5,800 lbs.	2,631 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/45 amps, 230 VAC (20/25, 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	N/A	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	N/A	

\* Rated Peak Value

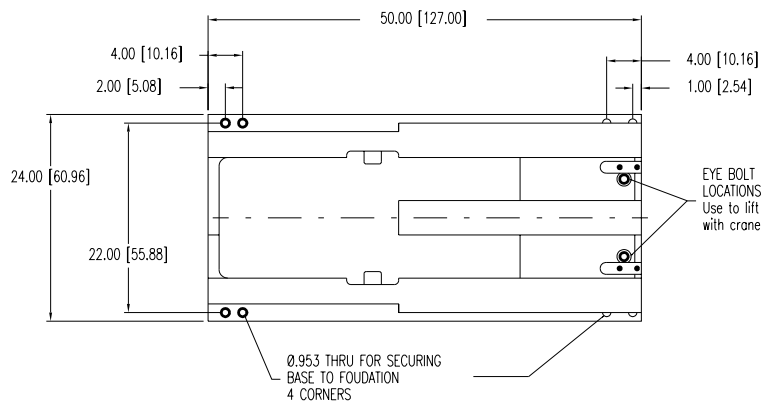
## VMC 3016L



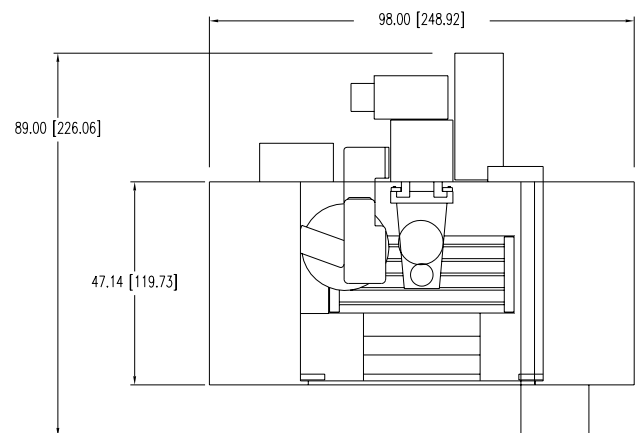
**SIDE VIEW**



**FRONT VIEW**



**TOP VIEW  
BASE  
SCALE 2:1**



**TOP VIEW**

**Figure 1-7 VMC 3016L**

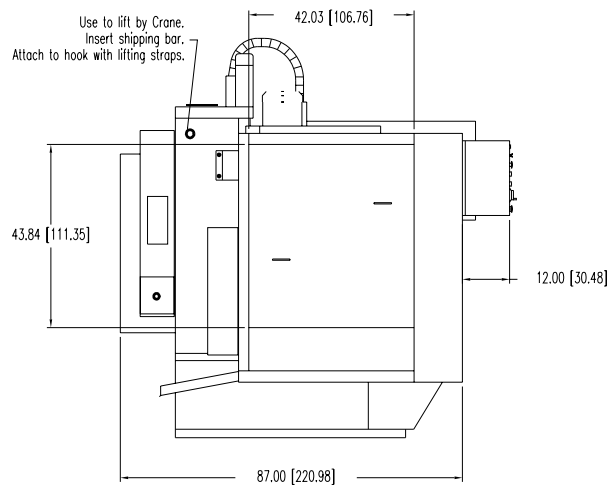
**Note:** Dimensions represented in inches & [centimeters]

Table 5: VMC 3016L Specifications

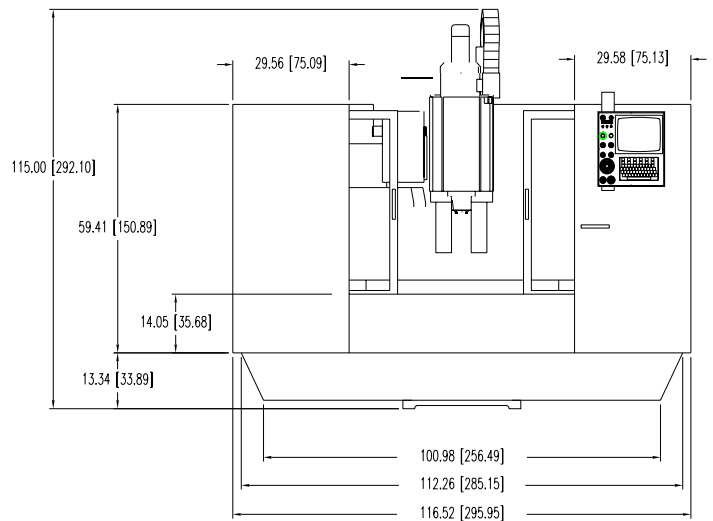
3016L Specifications	3016L Standard	3016L Metric
Table Size	38" x 16"	750mm x 406mm
Floor to Table	30.5"	775mm
T-Slots (No. x Width x Span)	3 x .562" x 4.33"	3 x 14mm x 110mm
Cutting Feed Rate	.01-250 ipm (375 @ 150%)	.25-6,350 (9,525 at 150%)mm/min.
Rapid Feed Rate (X/Y/Z)	500 ipm (X/Y/Z)	12.7 m/min (X,Y,Z)
Max. Weight on Table	2,000 lbs.	907 kg.
Axis Drive Motor (X/Y/Z)	DC 3,500 lbs peak thrust	AC, 15,900 N* thrust
Ball Screw Size	31.75mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	30"	762mm
Cross (Y Axis)	16"	406mm
Vertical (Z Axis)	20" (28" Opt.)	508mm (711mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102mm-610mm (102mm-813mm)
Spindle Center to Column Ways	17"	406mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	N/A	
Torque	75 ft-lbs	102 Nm
Accuracy, Axis Positioning	± .0002"	.0050mm
Accuracy, Axis Repeatability	± .0001"	.0025mm
Glass Scales (X/Y/Z)	N/A	
Spindle Speed	10-7,500 rpm	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76mm (114mm w/o adjacent tools)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	90" W x 77" D	2.3m W x 1.96m D
Machine Maximum Height	101"	2.6m
Machine Weight	6,200 lbs	2812 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/45 amps, 230 VAC (20/25, 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	N/A	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	N/A	

\* Rated Peak Value

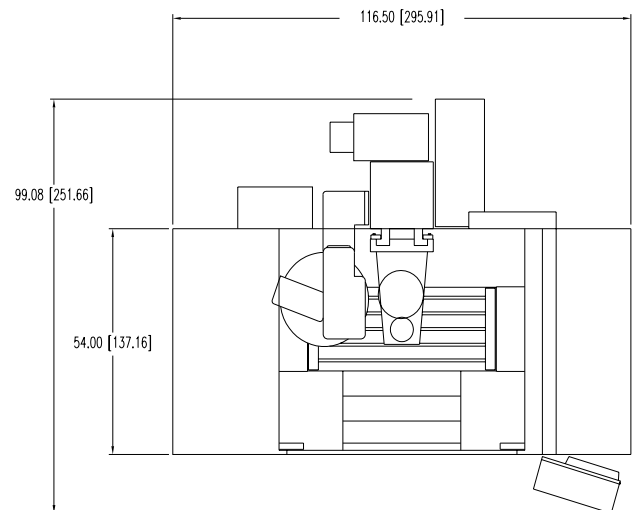
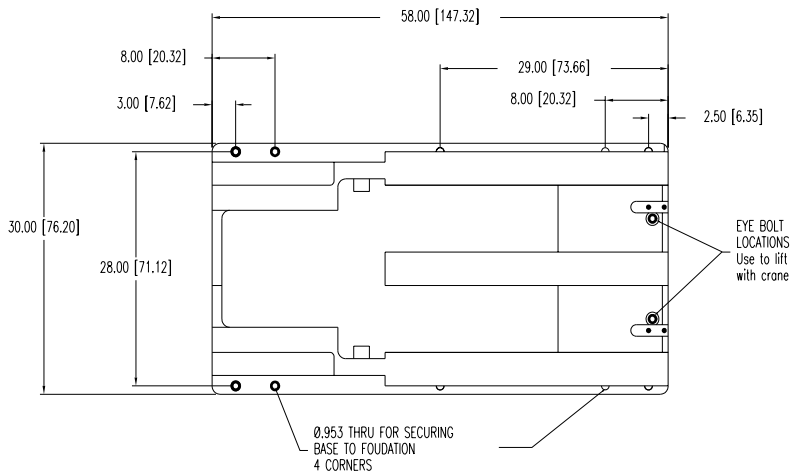
## VMC 4020



**SIDE VIEW**



**FRONT VIEW**



**TOP VIEW**

**TOP VIEW  
BASE  
SCALE 2:1**

**Figure 1-8 VMC 4020**

**Optional Very High Torque Motor** 30 Peak Horsepower, 32 Amps continuous current in WYE mode, 56 Amps continuous current in DELTA mode, Peak current may run as high as 70 Amps

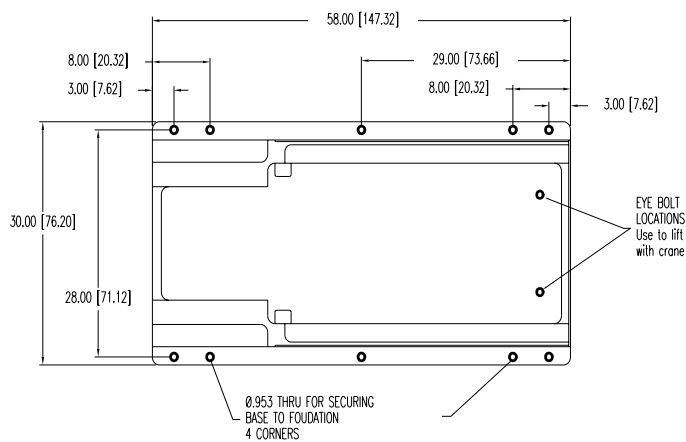
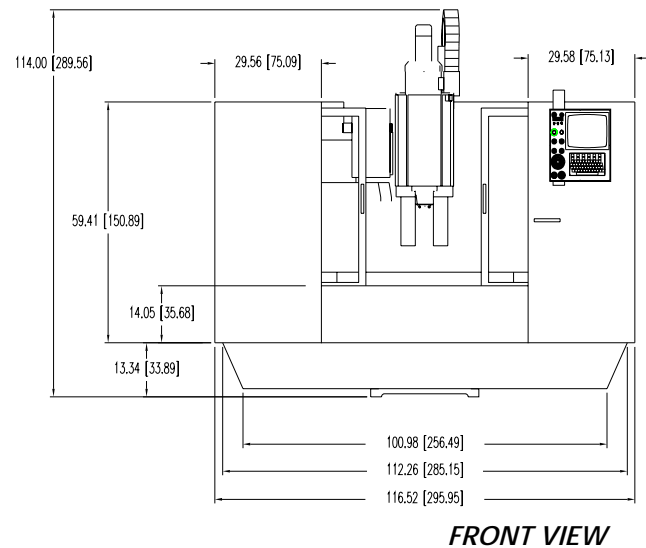
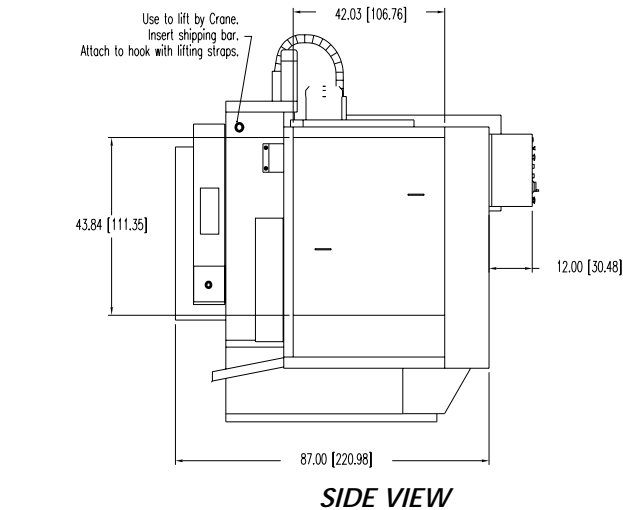
**Note:** Dimensions represented in inches & [centimeters]

Table 6: VMC 4020 Specifications

4020 Specifications	4020 Standard	4020 Metric
Table Size	48" x 20"	1,219mm x 508mm
Floor to Table	32"	813mm
T-Slots (No. x Width x Span)	5 x .687" x 3.75"	5 x 17.5mm x 95.3mm
Cutting Feed Rate	.01-400 ipm (600 @ 150%)	.25-10,160 (15,240 at 150%)mm/min.
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	22.8 m/min (X,Y,Z)
Max. Weight on Table	3,641 lbs.	1,652 kg.
Axis Drive Motor (X/Y/Z)	AC, 3,800 lbs peak thrust	AC, 16,900 N* thrust
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	40"	1,016mm
Cross (Y Axis)	20"	508mm
Vertical (Z Axis)	20" (28" Opt.)	508mm (711mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102mm-610mm (102mm-813mm)
Spindle Center to Column Ways	20"	406mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Torque	160 ft-lbs, 220 ft-lbs (Opt.)	220 Nm/300Nm/378Nm
Accuracy, Axis Positioning	± .0002"	.0050mm
Accuracy, Axis Repeatability	± .0001"	.0025mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21 (30 Opt.)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (6" w/o adjacent tools)	76mm (114mm w/o adjacent tools)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	116" W x 87" D	3m W x 2.21m D
Machine Maximum Height	104"	2.6m
Machine Weight	10,500 lbs.	4763 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/45 amps, 230 VAC (20/25 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

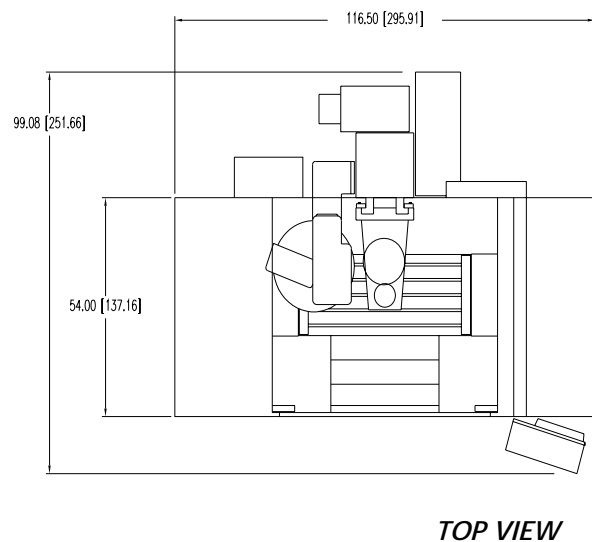
\* Rated Peak Value

## VMC 4020A



**TOP VIEW  
BASE  
SCALE 2:1**

**Figure 1-9 VMC 4020A**



**Note:** Dimensions represented in inches & [centimeters]

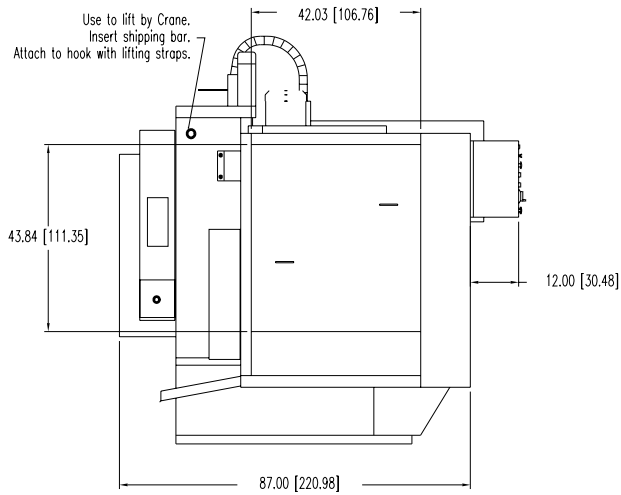


Table 7: VMC 4020A Specifications

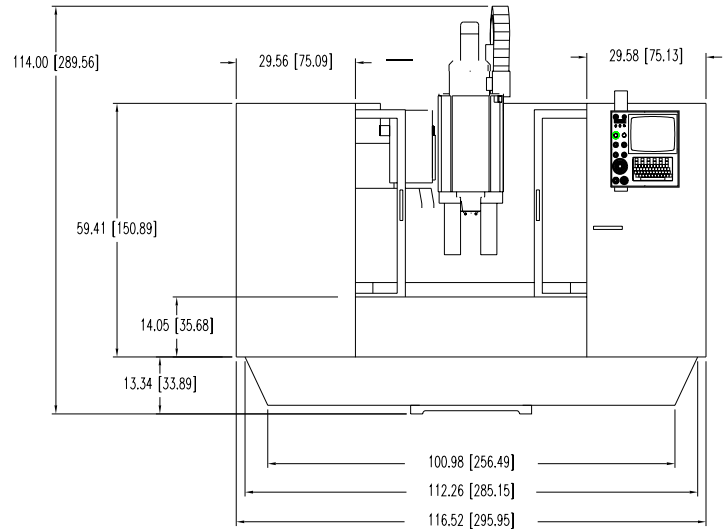
4020A Specifications	4020A Standard	4020A Metric
Table Size	48" x 20"	1,219mm x 508mm
Floor to Table	35"	889mm
T-Slots (No. x Width x Span)	5 x .687" x 3.75"	5 x 17.45mm x 95.25mm
Cutting Feed Rate	.01-400 ipm (600 ipm @ 150%)	.25-10,160 (15,240 at 150%)mm/min.
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	30.5(X,Y) 17.8(Z) m/min.
Max. Weight on Table	3,000 lbs.	1,361 kg.
Axis Drive Motor (X/Y/Z)	AC, 3, 800 lbs peak thrust	AC, 16,900 N* thrust
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	40"	1016mm
Cross (Y Axis)	20"	508mm
Vertical (Z Axis)	20" (28" Opt.)	508mm (711mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102mm-610mm (102mm-813mm)
Spindle Center to Column Ways	20"	406mm
Main Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Opt. HT Motor - Automatic 2 Speed Vector	N/A	
Torque	120 ft-lbs	220 Nm/300Nm/378Nm
Accuracy, Axis Positioning	± .0002"	.0050mm
Accuracy, Axis Repeatability	± .0001"	.0025mm
Glass Scales (X/Y/Z)	N/A	
Spindle Speed	10-7,500 rpm	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21 (30 Opt.)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76mm (114mm w/o adjacent tools)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	116" W x 87" D	3m W x 2.21m D
Machine Maximum Height	104"	2.6m
Machine Weight	11,000 lbs.	4990 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/45 amps, 230 VAC (20/25 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2 (Z)	

\* Rated Peak Value

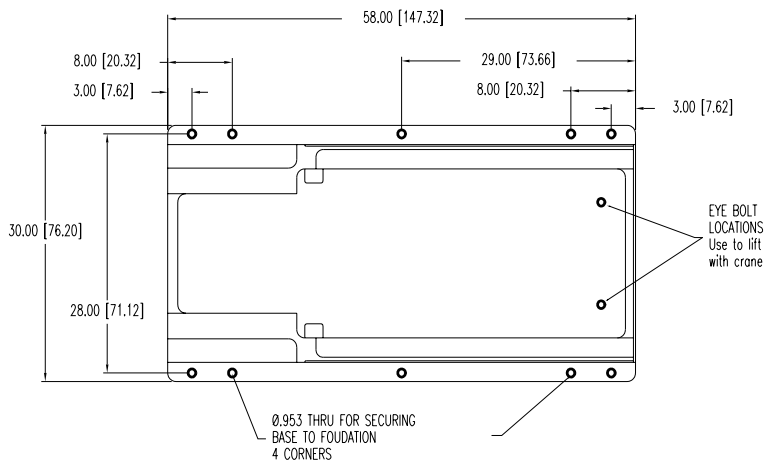
## VMC 5020A



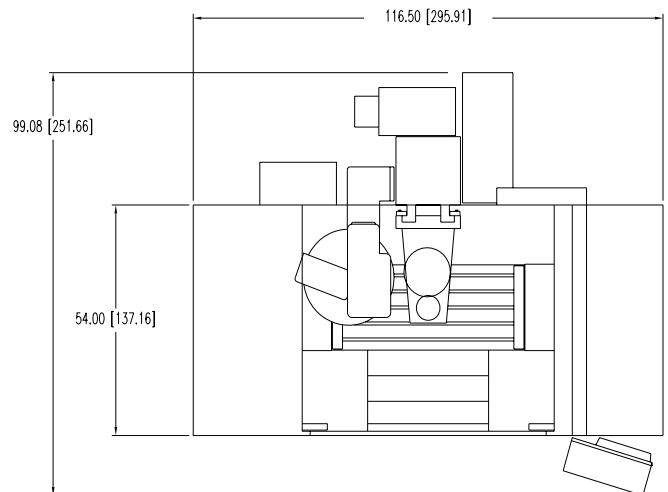
**SIDE VIEW**



**FRONT VIEW**



**TOP VIEW  
BASE  
SCALE 2:1**



**TOP VIEW**

**Figure 1-10 VMC 5020A**

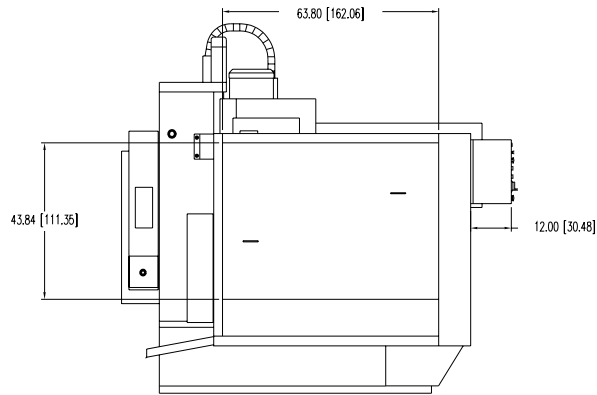
**Note:** Dimensions represented in inches & [centimeters]

Table 8: VMC 5020A Specifications

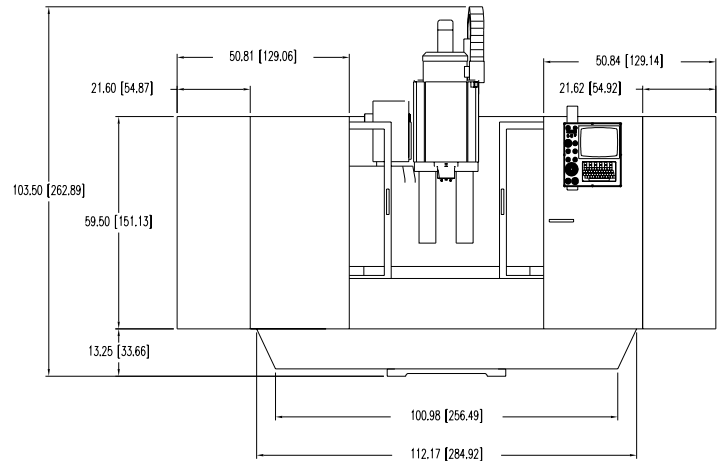
5020A Specifications	5020A Standard	5020A Metric
Table Size	58" x 20"	1,473mm x 508mm
Floor to Table	31"	787mm
T-Slots (No. x Width x Span)	3 x .687" x 3.75"	3 x 17.45mm x 95.25mm
Cutting Feed Rate	.01-400 ipm (600 @ 150%)	.25-10,160 (15,240 at 150%)mm/min.
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	22.8 m/min (X,Y,Z)
Max. Weight on Table	3,000 lbs.	1,361 kg.
Axis Drive Motor (X/Y/Z)	AC, 3,800 lbs peak thrust	AC, 16,900 N* thrust
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	50"	1,270 mm
Cross (Y Axis)	20"	508mm
Vertical (Z Axis)	20" (28" Opt.)	508mm (711mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102mm-610mm (102mm-813mm)
Spindle Center to Column Ways	20"	406mm
Main Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Opt. HT Motor - Automatic 2 Speed Vector	N/A	
Torque	120 ft-lbs	220 Nm/300Nm/378Nm
Accuracy, Axis Positioning	± .0002"	.0050mm
Accuracy, Axis Repeatability	± .0001"	.0025mm
Glass Scales (X/Y/Z)	N/A	
Spindle Speed	10-7,500 rpm	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21 (30 Opt.)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76mm (114mm w/o adjacent tools)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	116" W x 87" D	3m W x 2.21m D
Machine Maximum Height	103"	2.6m
Machine Weight	11,500 lbs.	4990 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/45 amps, 230 VAC (20/25, 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2 (Z)	

\* Rated Peak Value

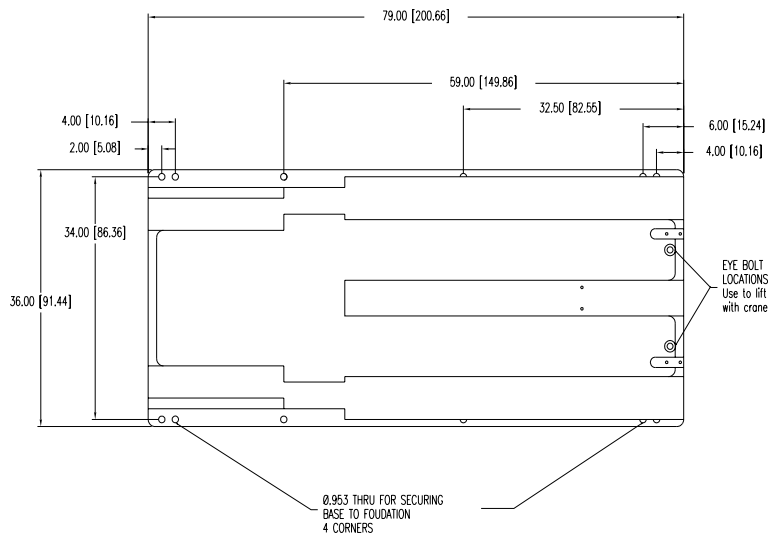
## VMC 6030



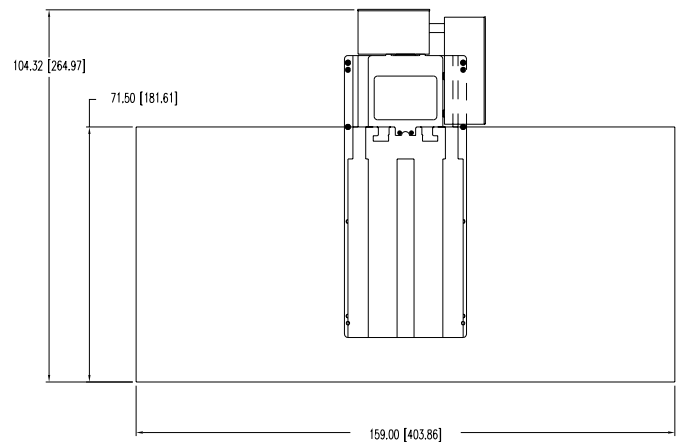
**SIDE VIEW**



**FRONT VIEW**



**TOP VIEW  
BASE  
SCALE 2:1**



**TOP VIEW**

*Figure 1-11 VMC 6030*

**Note:** Dimensions represented in inches & [centimeters]

**Optional Very High Torque Motor** 30 Peak Horsepower, 32 Amps continuous current in WYE mode, 56 Amps continuous current in DELTA mode, Peak current may run as high as 70 Amps.

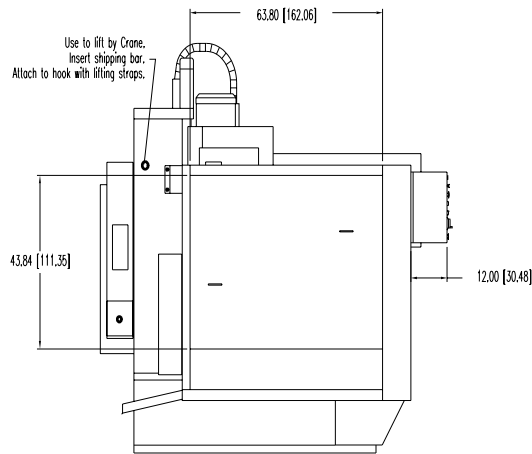


Table 9: VMC 6030 Specifications

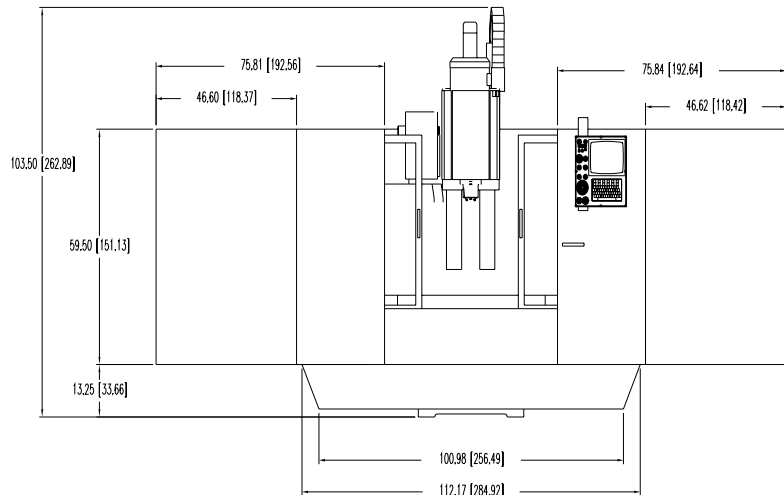
6030 Specifications	6030 Standard	6030 Metric
Table Size	62.5 x 30"	1,588mm x 762mm
Floor to Table	36"	914mm
T-Slots (No. x Width x Span)	5 x .687" x 5.5"	5 x 17.5mm x 139.7mm
Cutting Feed Rate	.01-250 ipm (375 @ 150%)	.25-6,350 (9,525 at 150%)mm/min.
Rapid Feed Rate (X/Y/Z)	400 ipm (X/Y/Z)	10.1 m/min (X,Y,Z)
Max. Weight on Table	4,120 lbs.	1,869 kg.
Axis Drive Motor (X/Y/Z)	AC, 5,000 lbs peak thrust	AC, 22,420 N* thrust
Ball Screw Size	1.75" Dia. (X/Y) 1.50" Dia. (Z)	44.45mm Dia (X,Y) 38.1mm Dia. (Z)
Longitudinal (X Axis)	60"	1,524 mm
Cross (Y Axis)	30"	762mm
Vertical (Z Axis)	30"	762mm
Spindle Nose to Table	5.5"-35.5"	140mm-902mm
Spindle Center to Column Ways	16"	406mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Torque	160 ft-lbs, 220 ft-lbs (Opt.)	300 Nm/375Nm
Accuracy, Axis Positioning	± .0004"	.0076mm
Accuracy, Axis Repeatability	± .0002"	.0038mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21 (30 Opt.)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76mm (114mm w/o adjacent tools)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	158" W x 103" D	4m W x 2.6m D
Machine Maximum Height	122"	3.1m
Machine Weight	17,000 lbs.	7,711 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/45, 230 VAC (20/25, 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	Spindle, Headstock, Ballscrew (Y)	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

\* Rated Peak Value

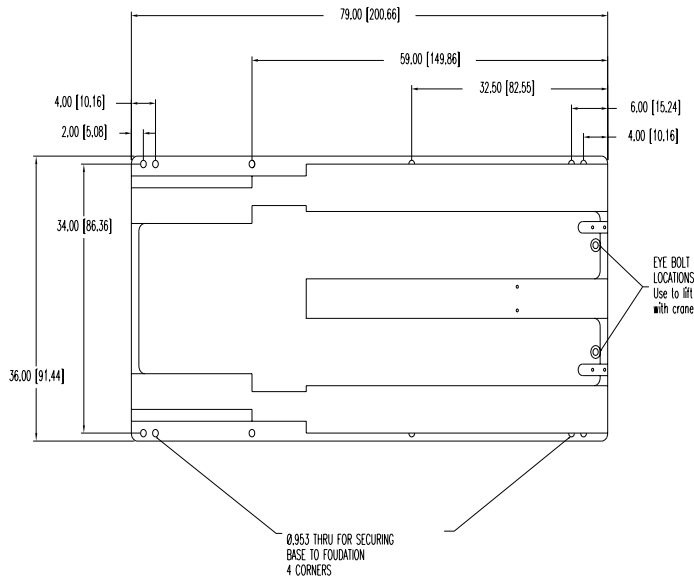
## VMC 8030



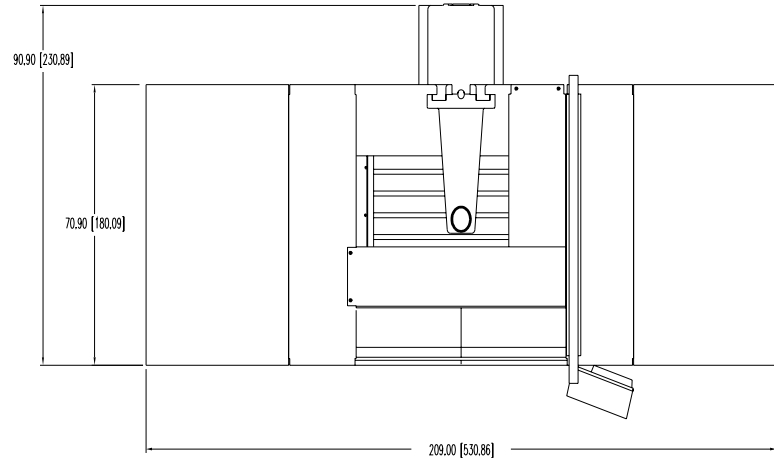
**SIDE VIEW**



**FRONT VIEW**



**TOP VIEW BASE  
SCALE 2:1**



**TOP VIEW**

*Figure 1-12 VMC 8030*

**Note:** Dimensions represented in inches & [centimeters]

**Optional Very High Torque Motor** 30 Peak Horsepower, 32 Amps continuous current in WYE mode, 56 Amps continuous current in DELTA mode, Peak current may run as high as 70 Amps.

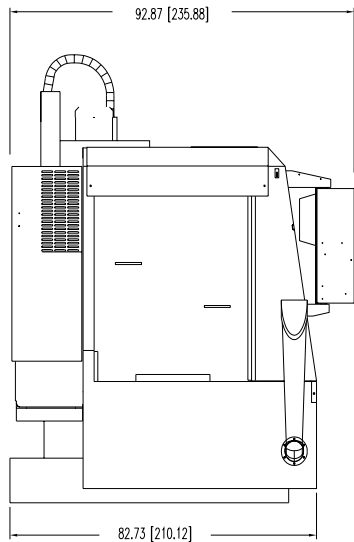
Table 10: VMC 8030 Specifications

8030 Specifications	8030 Standard	8030 Metric
Table Size	82.5" x 30"	2,096mm x 762mm
Floor to Table	36"	914mm
T-Slots (No. x Width x Span)	5 x .687" x 5.5"	5 x 17.5mm x 139.7mm
Cutting Feed Rate	.01-250 ipm (3765 @ 150%)	.25-6,350 (9,525 at 150%)mm/min.
Rapid Feed Rate (X/Y/Z)	400 ipm (X/Y/Z)	10.1 m/min (X,Y,Z)
Max. Weight on Table	3,751 lbs.	1,701 kg.
Axis Drive Motor (X/Y/Z)	AC, 5,000 lbs peak thrust	AC, 22,420 N* thrust
Ball Screw Size	1.75" Dia. (X/Y) 1.50" Dia. (Z)	44.45mm Dia (X,Y) 38.1mm Dia. (Z)
Longitudinal (X Axis)	80"	2,032 mm
Cross (Y Axis)	30"	762mm
Vertical (Z Axis)	30"	762mm
Spindle Nose to Table	5.5"-35.5"	140mm-902mm
Spindle Center to Column Ways	16"	406mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Torque	160 ft-lbs, 220 ft-lbs (Opt.)	300 Nm/375Nm
Accuracy, Axis Positioning	± .0004"	.0076mm
Accuracy, Axis Repeatability	± .0002"	.0038mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21 (30 Opt.)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	6"	152mm
Max. Tool Length	15"	381
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	209" W x 103" D	5.3m W x 2.6m D
Machine Maximum Height	119"	3m
Machine Weight	18,000 lbs.	8,165 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	45 amps, 230 VAC (20/25 amps, 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	Spindle, Headstock, Ballscrew (Y)	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

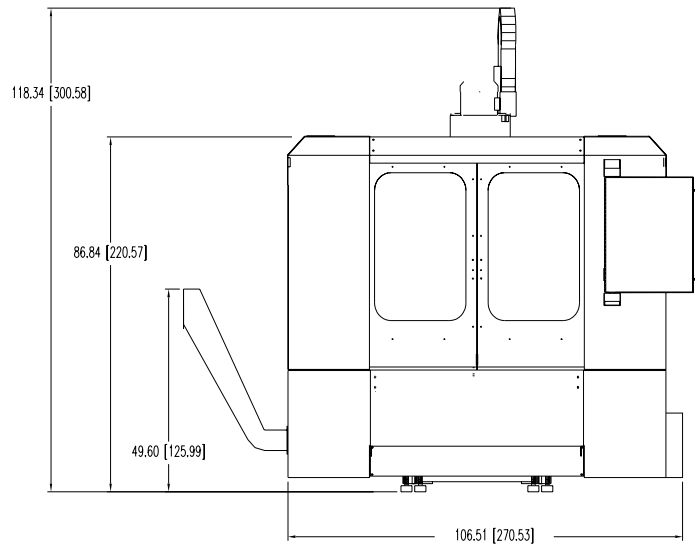
\* Rated Peak Value



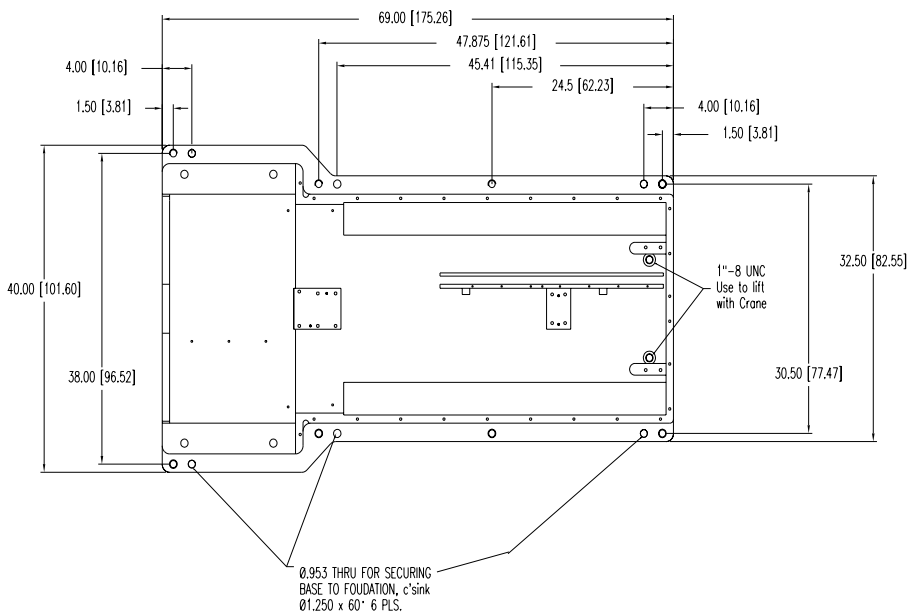
## VMC 3020



**SIDE VIEW**

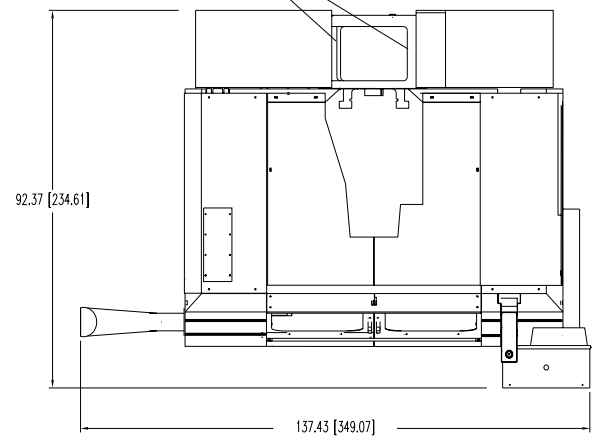


**FRONT VIEW**



**TOP VIEW  
BASE  
SCALE 2:1**

Use to lift with crane. Wrap sling around counterweight shipping bars.



**TOP VIEW**

*Figure 1-13 VMC 3020*

**Note:** Dimensions represented in inches & [centimeters]

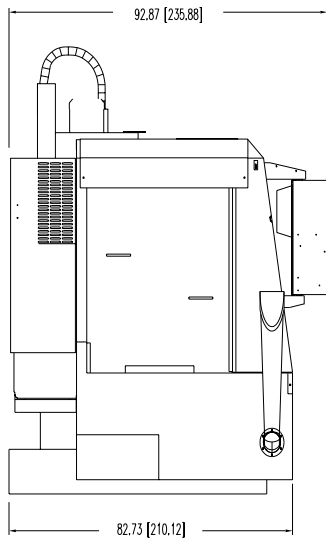
**Optional Very High Torque Motor** 30 Peak Horsepower, 32 Amps continuous current in WYE mode, 56 Amps continuous current in DELTA mode, Peak current may run as high as 70 Amps.

Table 11: VMC 3020 Specifications

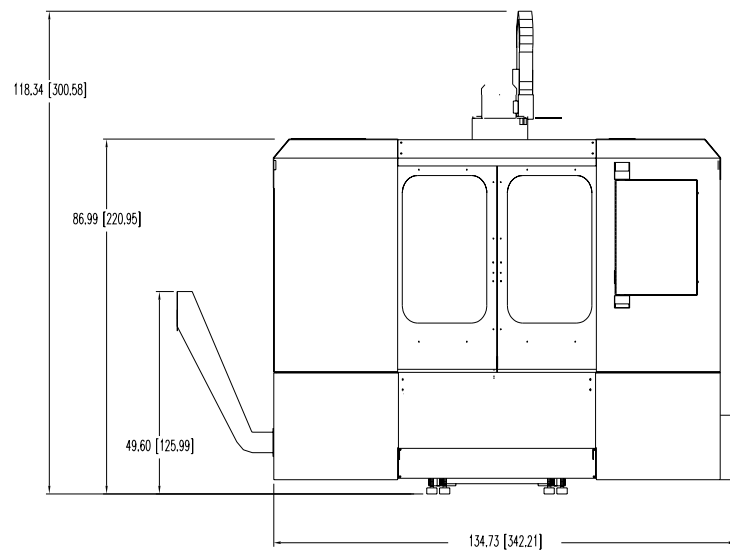
3020 Specifications	3020 Standard	3020 Metric
Table Size	40.5" x 20"	1,029mm x 508mm
Floor to Table	31"	787mm
T-Slots (No. x Width x Span)	5 x .709" x 3.75"	5 x 18mm x 95.3mm
Cutting Feed Rate	.01-400 ipm (600 ipm @ 150%)	.25-10,160 (15,240 at 150%)
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	30.5(X,Y) 17.8(Z) m/min
Max. Weight on Table	4,250 lbs.	1,928 kg.
Axis Drive Motor (X/Y/Z)	AC 3,800 lbs peak thrust	AC, 16,903 N*thrust.
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	30"	762 mm
Cross (Y Axis)	20"	508mm
Vertical (Z Axis)	20" (24" Opt.)	508mm (610mm)
Spindle Nose to Table	4"-24" (28" Opt.)	102mm-610mm-(711mm Opt.)
Spindle Center to Column Ways	22.875"	581mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Torque	160 ft-lbs, 290 ft-lbs (Opt.)	300 Nm/375Nm
Accuracy, Axis Positioning	± .0002"	±.004mm
Accuracy, Axis Repeatability	± .0001"	±.0015mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21 (30 Opt.)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76.2mm (114.3mm)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	106" W x 85" D	2.7m W x 2.16m D
Machine Maximum Height	96" (102" with 22.5 HP Opt.)	2.4m (2.6m with 22.5hp. Opt)
Machine Weight	12,400 lbs.	5,625 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	45 amps, 230 VAC (20/25 amps, 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

\* Rated Peak Value

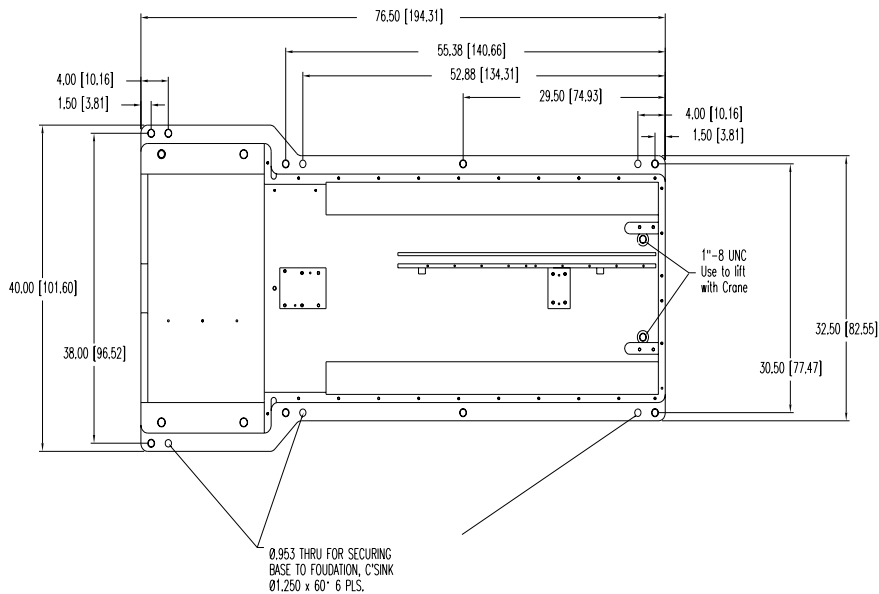
## VMC 4525



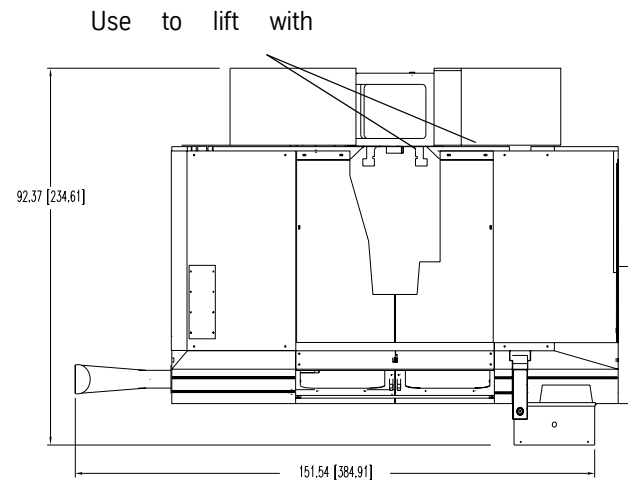
**SIDE VIEW**



**FRONT VIEW**



**TOP VIEW  
BASE  
SCALE 2:1**



**Figure 1-14 VMC 4525**

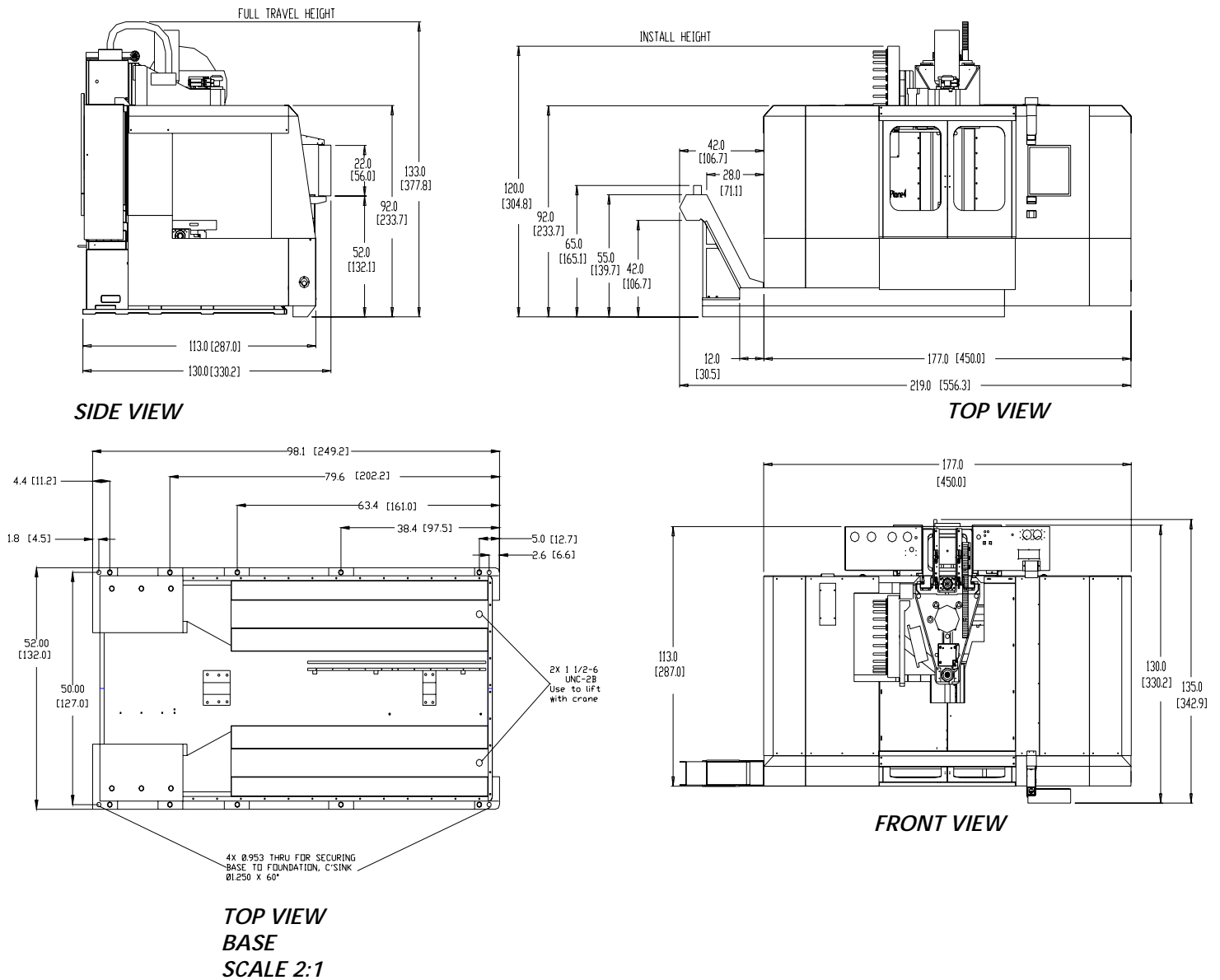
**Note:** Dimensions represented in inches & [centimeters]

Table 12: VMC 4525 Specifications

4525 Specifications	4525 Standard	4525 Metric
Table Size	53.5" x 25"	1,359mm x 635mm
Floor to Table	31"	787mm
T-Slots (No. x Width x Span)	5 x .709" x 4.92"	5 x 18mm x 125mm
Cutting Feed Rate	.01-400 ipm (600 ipm @ 150%)	.25-10,160 (15,240 at 150%)
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	30.5(X,Y) 17.8(Z) m/min
Max. Weight on Table	4,250 lbs.	1,928 kg.
Axis Drive Motor (X/Y/Z)	AC 3,800 lbs peak thrust	AC, 16,903 N*thrust.
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	45"	1,143 mm
Cross (Y Axis)	25"	635mm
Vertical (Z Axis)	24"	610
Spindle Nose to Table	4"-24"	102mm-610mm
Spindle Center to Column Ways	27.87"	708mm
Main Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Opt. HT Motor - Automatic 2 Speed Vector	30 HP*, 22.4 KW	
Torque	220 ft-lbs, 270 ft-lbs (Opt.)	300 Nm/375Nm
Accuracy, Axis Positioning	± .00016"	±.004mm
Accuracy, Axis Repeatability	± .00006"	±.0015mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	1.9 sec dual arm / 24 tools	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	4" (4.5" w/o adjacent tools)	101.6mm (114.3mm)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	128" W x90" D	3.25m W x 2.3m D
Machine Maximum Height	120"	3m
Machine Weight	13,600 lbs.	6,169 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/60 amps, 230 VAC (20/25 amps, 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

\* Rated Peak Value

## VMC 6535



**Figure 1-15** VMC 6535

**Note:** Dimensions represented in inches & [centimeters]

**Table 13: VMC 6535 Specifications**

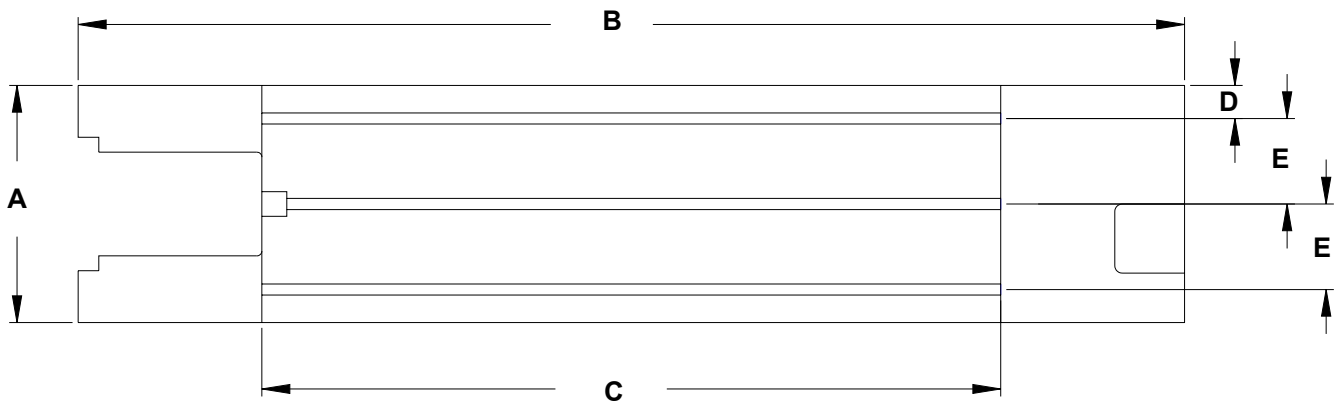
6535 Specifications	6535 Standard	6535 Metric
Table Size	74.8" x 26.5"	1,899mm x 673.1mm
Floor to Table	40.3"	1024mm
T-Slots (No. x Width x Span)	5 x .709" x 4.92"	5 x 18mm x 125mm
Cutting Feed Rate	.01-400 ipm (600 ipm @ 150%)	.25-10,160 (15,240 at 150%)
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	30.5(X,Y) 17.8(Z) m/min
Max. Weight on Table	4,250 lbs.	1,928 kg.
Axis Drive Motor (X/Y/Z)	AC 3,800 lbs peak thrust	AC, 16,903 N*thrust.
Ball Screw Size	62.2mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	65"	1,651mm
Cross (Y Axis)	35"	889mm
Vertical (Z Axis)	34"	864mm
Spindle Nose to Table	5"-39"	127mm-991mm
Spindle Center to Column Ways	37.4"	950mm
Main Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Opt. HT Motor - Automatic 2 Speed Vector	30 HP*, 22.4 KW	
Torque	220 ft-lbs, 270 ft-lbs (Opt.)	300 Nm/375Nm
Accuracy, Axis Positioning	± .00016"	±.004mm
Accuracy, Axis Repeatability	± .00006"	±.0015mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.), (7,500, 50 tpr. Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40 (50 Opt.)	
ATC, Number of Tools	1.9 sec dual arm / 24 tools (32, 50 tpr. Opt.)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	Ø9.85"	Ø250mm
Max. Tool Length	15.75"	400mm
Max. Tool Weight	40 lbs.	18 kg
Machine Width and Depth	219" W x 130" D	5.56m W x 3.3m D
Machine Maximum Height	133"	3.4m
Machine Weight	29,000 lbs.	6,169 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	40/60 amps, 230 VAC (20/25 amps, 480 VAC)	
Power Reqs. (3-phase) 50 taper	70 amps, 480 VAC	
Cool Power System	Spindle, Ballscrews	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

## Fadal Bolt Torque Specifications

**Table 14: Fadal Bolt Torque Specifications**

COLUMN	ALL	COLUMN TO BASE	5/8"-11 X X.50 HHB	175	FT-LBS
COLUMN	ALL	COUPLER SET SCREW	1/4"-20 X 0.50 SHSS	70	IN-LBS
COLUMN	ALL	Z B/S MOUNT IN BACK	3/8"-16 X X.XX HHB	45	FT-LBS
COLUMN	ALL	Z B/S MOUNT IN FRONT	1/2"-13 X 2.XX HHB	75	FT-LBS
COLUMN	ALL	Z B/S NUT	5/16"-18 X 1.25 HHB	30	FT-LBS
COLUMN	ALL	Z MOTOR	3/8"-16 X 1.25 SHCS	40	FT-LBS
COLUMN	ALL	Z XT B/S BEARING MOUNT	5/16"-18 X 1.50 HHB	25	FT-LBS
COLUMN	ALL	Z XT B/S BEARING SUPPORT (60/8030)	3/8"-18 X X.XX HHB	40	FT-LBS
COLUMN	ALL	Z XT B/S SUPPORT ADAPTER	5/16"-18 X 1.50 SHCS	15	FT-LBS
HEAD	ALL	SPINDLE	3/8"-16 X 1.00 SHCS	45	FT-LBS
HEAD	ALL	SPINDLE RETAINING RING	3/8"-16 X 1.00 HHB	25	FT-LBS
HEAD	7.5K RPM	DRAWBAR PISTON	1/4"-20 X 2.00 HHB	15	FT-LBS
HEAD	7.5K RPM	ORIENTATION BRIDGE (7.5K)	3/8"-16 X 6.00 SHCS	45	FT-LBS
HEAD	10K RPM	BACK BELT GUIDE	1/2"-13 X 4.00 HHB	70	FT-LBS
HEAD	10K RPM	HYDRAULIC PISTON	1/4"-20 X 2.00 HHB	15	FT-LBS
HEAD	10K RPM	ORIENTATION BRIDGE (10K)	5/16"-18 X 6.00 HHB	30	FT-LBS
HEAD	10K RPM	SPINDLE MOTOR	1/2"-13 X X.XX HHB	65	FT-LBS
HEAD	10K RPM	SPINDLE MOTOR MOUNT	1/2"-13 X X.XX SHCS	70	FT-LBS
HEAD	10K RPM	VIBRATION MOUNTS	1/2"-13 X 0.75 SHCS	70	FT-LBS
HEAD	10K RPM	Z STRAP	3/8"-16 X 1.75 HHB	45	FT-LBS
X-Y AXIS	ALL	SADDLE STRAP	3/8"-16 X 1.75 HHB	45	FT-LBS
X-Y AXIS	ALL	TABLE STRAP	3/8"-16 X 0.75 HHB	45	FT-LBS
X-Y AXIS	ALL	X B/S NUT	5/16"-18 X 1.XX HHB	25	FT-LBS
X-Y AXIS	ALL	X-Y MOTOR	3/8"-16 X 1.XX SHSC	40	FT-LBS
X-Y AXIS	ALL	Y B/S NUT	5/16"-18 X 1.XX SHCS	30	FT-LBS
X-Y AXIS	A MODEL	LOCATING SET SCREW	#10-32 X .50 SHSS	30	IN-LBS
X-Y AXIS	A MODEL	RAIL GUIDE MOUNT SCREW	1/2"-13 X 1.75 SHCS	70	FT-LBS
X-Y AXIS	A MODEL	TABLE B/S BLOCK MOUNT (4020/A)	3/8"-16 X 3.50 SHCS	40	FT-LBS
X-Y AXIS	A MODEL	X B/S SUPPORT MOUNT (A MODELS)	5/16"-18 X 1.50 SHCS	40	FT-LBS
X-Y AXIS	A MODEL	X-Y MOTOR MOUNT (A MODELS)	3/8"-16 X 1.25 SHCS	40	FT-LBS
X-Y AXIS	60/8030	TABLE B/S BLOCK MOUNT (60/8030)	3/8"-16 X 3.50 SHCS	40	FT-LBS
X-Y AXIS	60/8030	X B/S SUPPORT MOUNT (60/8030)	1/2"-13 X 4.50 HHB	80	FT-LBS
X-Y AXIS	60/8030	X MOTOR MOUNT (60/8030)	1/2"-13 X 3.50 HHB	80	FT-LBS
X-Y AXIS	60/8030	Y MOTOR MOUNT (60/8030)	3/8"-16 X 1.50 HHB	40	FT-LBS
X-Y AXIS	22/30/4020	TABLE B/S BLOCK MOUNT (22/3016)	5/16"-18 X 2.75 SHCS	25	FT-LBS
X-Y AXIS	22/30/4020	X B/S SUPPORT MOUNT (22/30/4020)	3/8"-16 X 1.75 HHB	40	FT-LBS
X-Y AXIS	22/30/4020	X-Y MOTOR MOUNT (22/30/4020)	1/2"-13 X 3.XX HHB	80	FT-LBS
X-Y AXIS	15/L	RAIL GUIDE MOUNT SCREW	5/16"-18 X 1.25 SHSC	25	FT-LBS
X-Y AXIS	15/L	RAIL LOCATING SET SCREW (A/L MODELS)	#10-32 X .50 SHSS	15	IN-LBS
X-Y AXIS	15/L	TABLE B/S BLOCK MOUNT	5/16"-18 X 2.00 SHCS	25	FT-LBS
X-Y AXIS	15/L	X B/S SUPPORT MOUNT	3/8"-16 X 1.75 HHB	40	FT-LBS
X-Y AXIS	15/L	X MOTOR MOUNT (15/L)	5/16"-18 X 2.00 SHSC	25	FT-LBS
X-Y AXIS	15/L	Y MOTOR MOUNT (15/L)	3/8"-16 X 1.75 HHB	40	FT-LBS

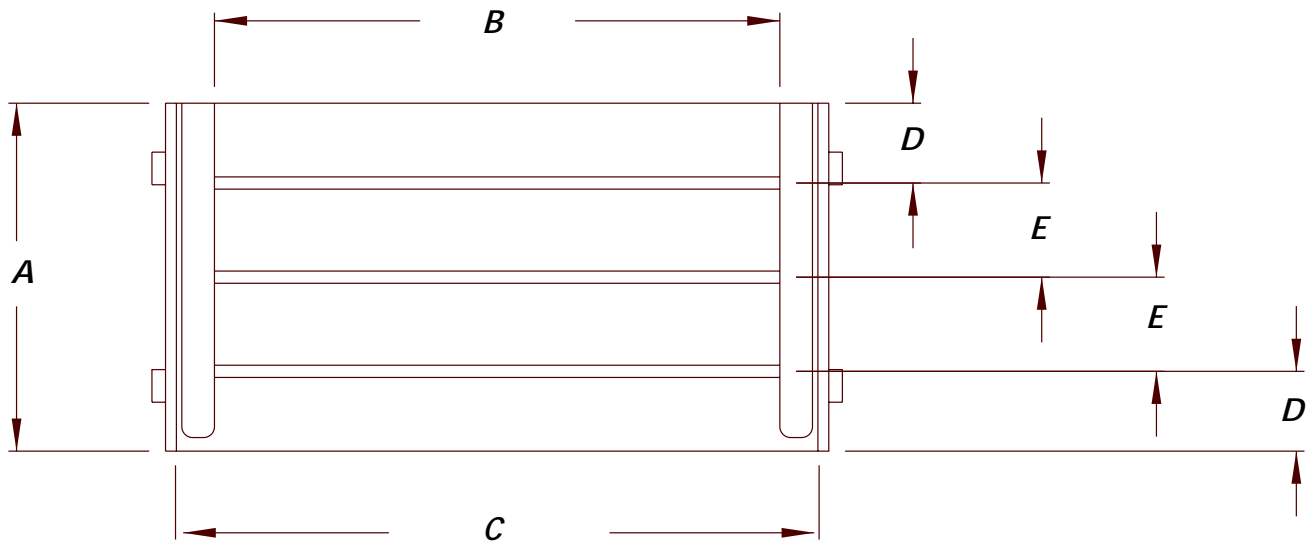
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**Table & T-Slot  
Dimensions****TRM Table***Figure 1-16* TRM Table

A = 12.00" (304.8mm)    B = 35.00" (889mm)    C = 35.72" (907.29)  
D = 1.625" (41.28mm)    E = 4.375" (111mm)



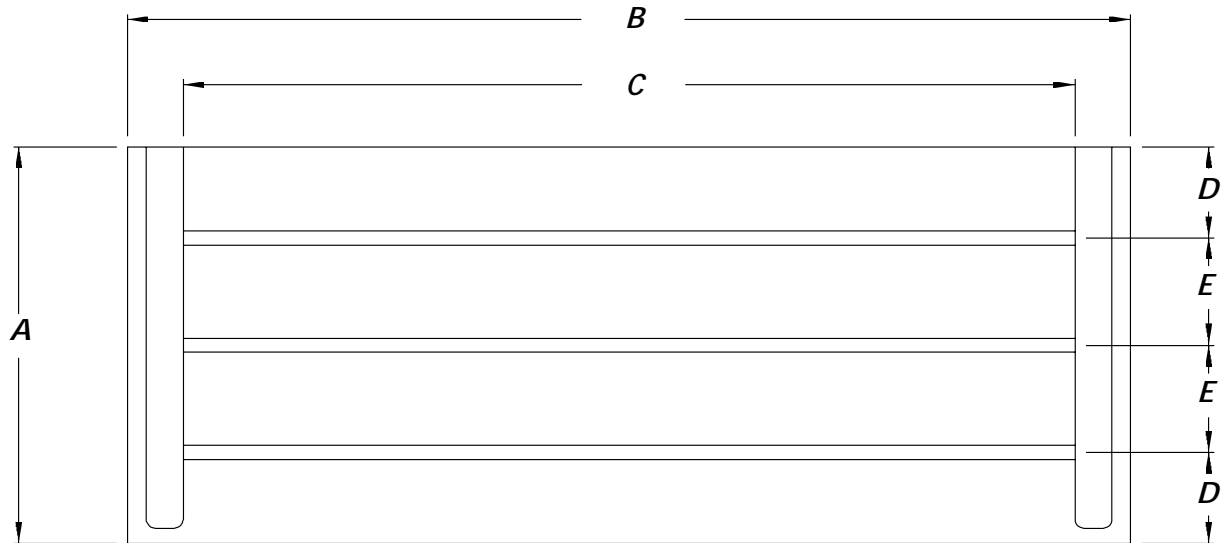
## EMC, 15 & 2016L Table



*Figure 1-17* EMC, 15 & 2016L Table

A = 16.00" (406.4mm)    B = 26.00" (660.4 mm)    C = 29.50" (749.3mm)  
D = 3.67" (93.22mm)    E = 4.33" (109.98mm)

## 2216 & 3016 Table



*Figure 1-18* 2216 & 3016 Table

A = 16.00" (40.64mm)    B = 40.50" (1028.7mm)    C = 36.00" (914.4mm)  
D = 3.67" (93.22mm)    E = 4.33" (109.98mm)

### EMC, 15XT & 3016L Table

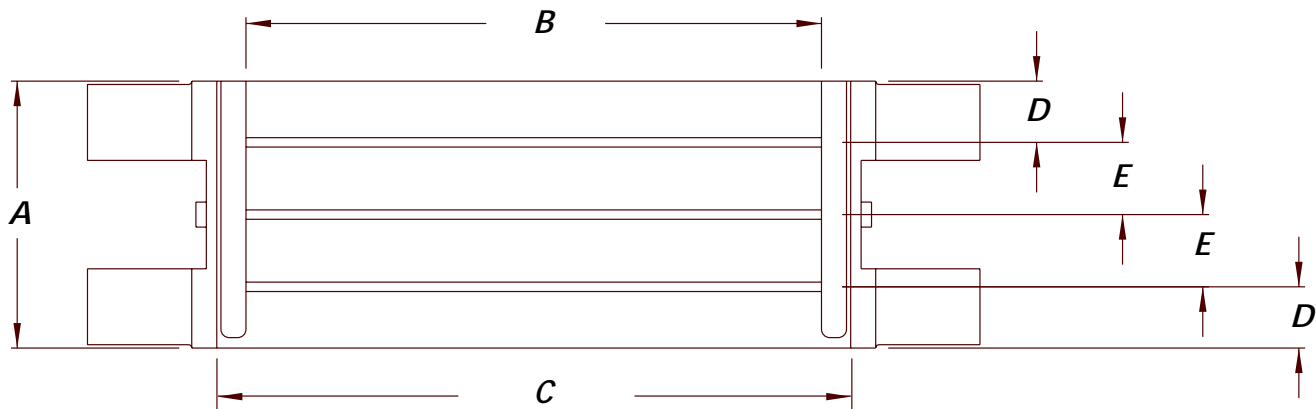


Figure 1-19 EMC, 15XT & 3016L Table

A = 16.00" (406.4mm)    B = 34.50" (876.3mm)    C = 39.00" (990.6mm)  
D = 3.67" (93.22mm)    E = 4.33" (109.98mm)

### EMC, 15, 15XT, 2216, 3016, 2016L & 3016L T-Slots

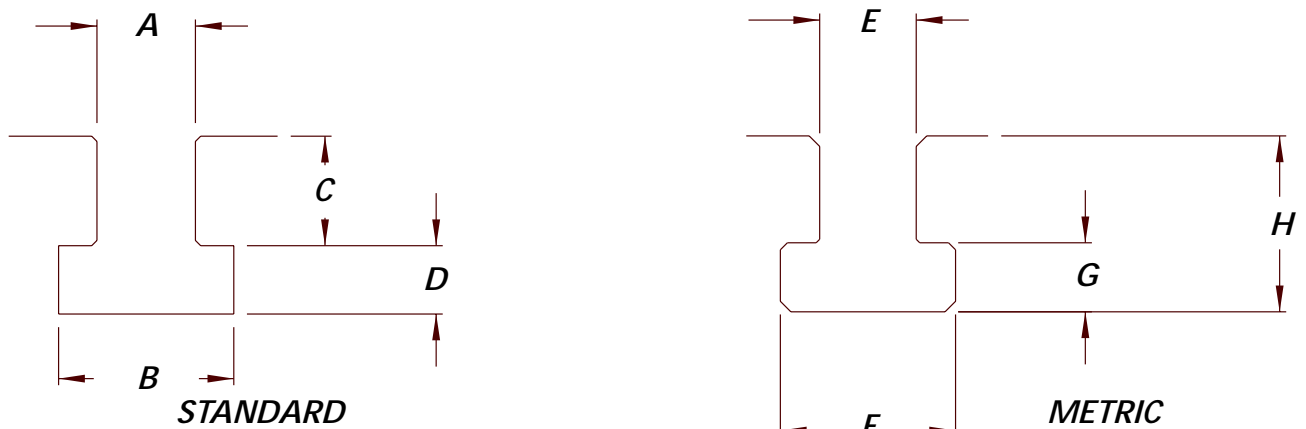


Figure 1-20 EMC, 15, 15XT, 2216, 3016, 2016L & 3016L T-Slots

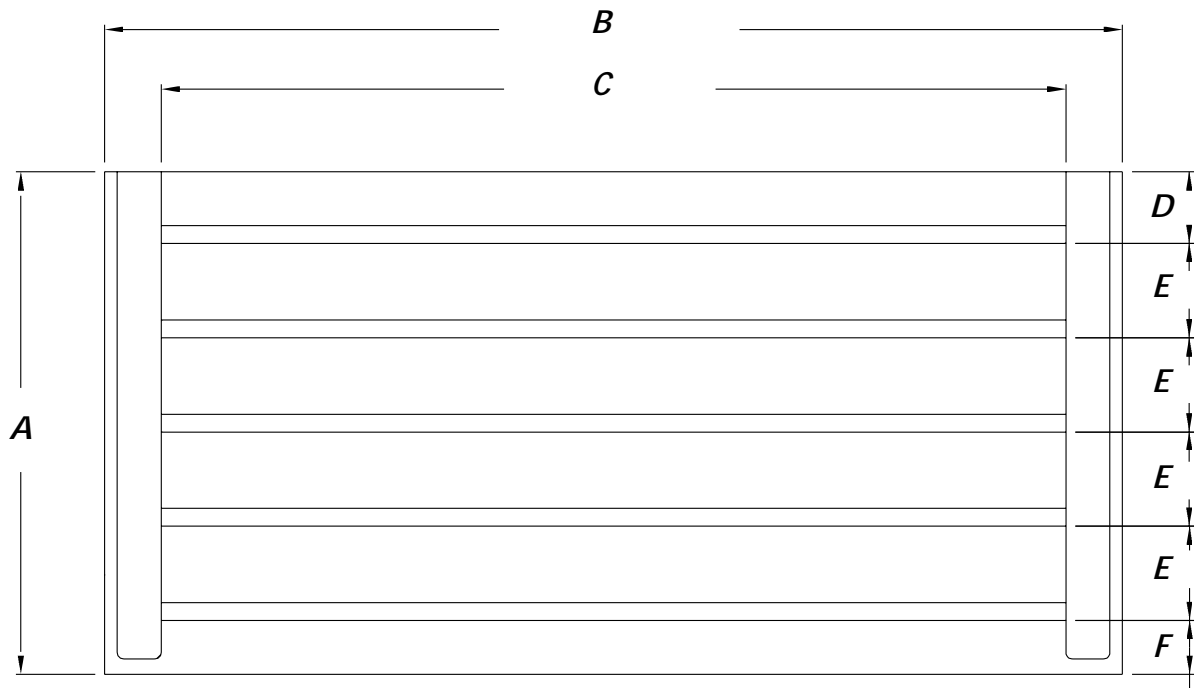
#### Standard T-Slot Dimensions:

A = .5625"-.5645" (14.26-14.34mm)    B = .970" (24.64mm)  
C = .625" (15.88mm)    D = .390" (9.91mm)

#### Metric T-Slot Dimensions:

E = .5510-.5525" (14-14.03mm)    F = .915-.975" (23.29-24.765mm)  
G = .364-.424" (9.25-10.77mm)    H = 1.004" (25.5mm)

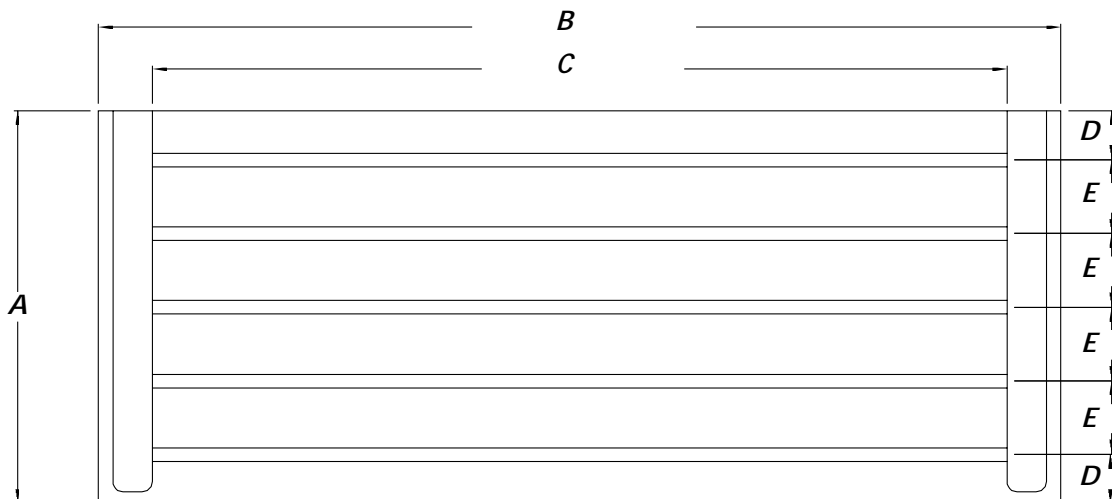
## 3020, 4525 Table & T-Slots



*Figure 1-21* 3020, 4525 Table & Slots

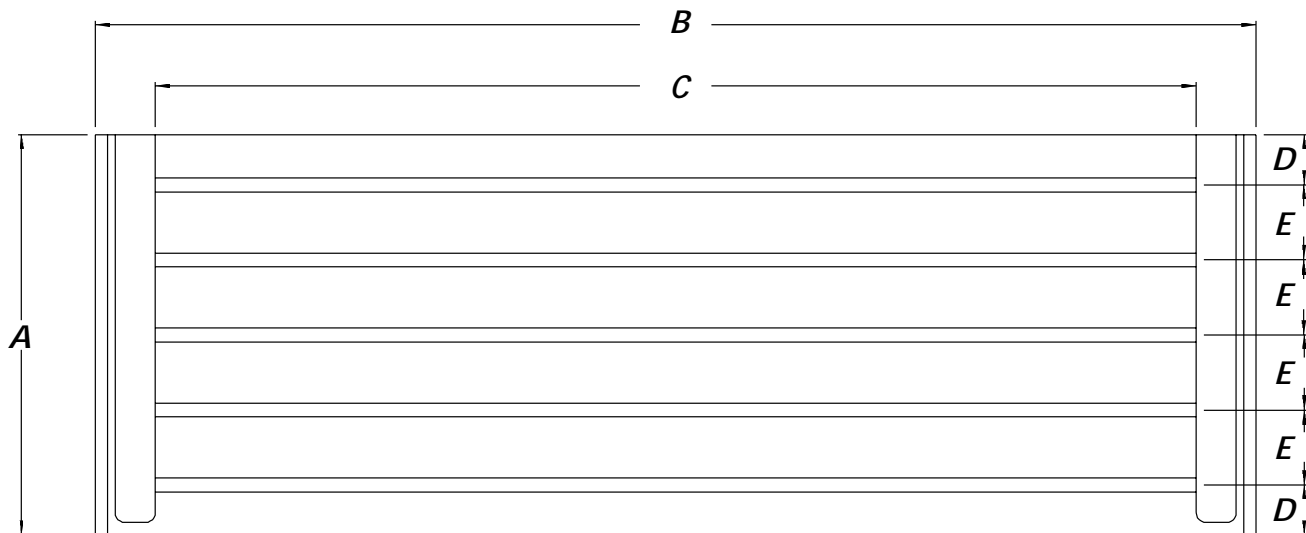
A = 20.0" (508mm)      B = 40.50" (1028.7mm)      C = 36.00" (990.6mm)  
 D = 2.885" (73.28mm)      E = 3.750" (95.25mm)      F = 2.145" (54.483mm)

## 4020 Table

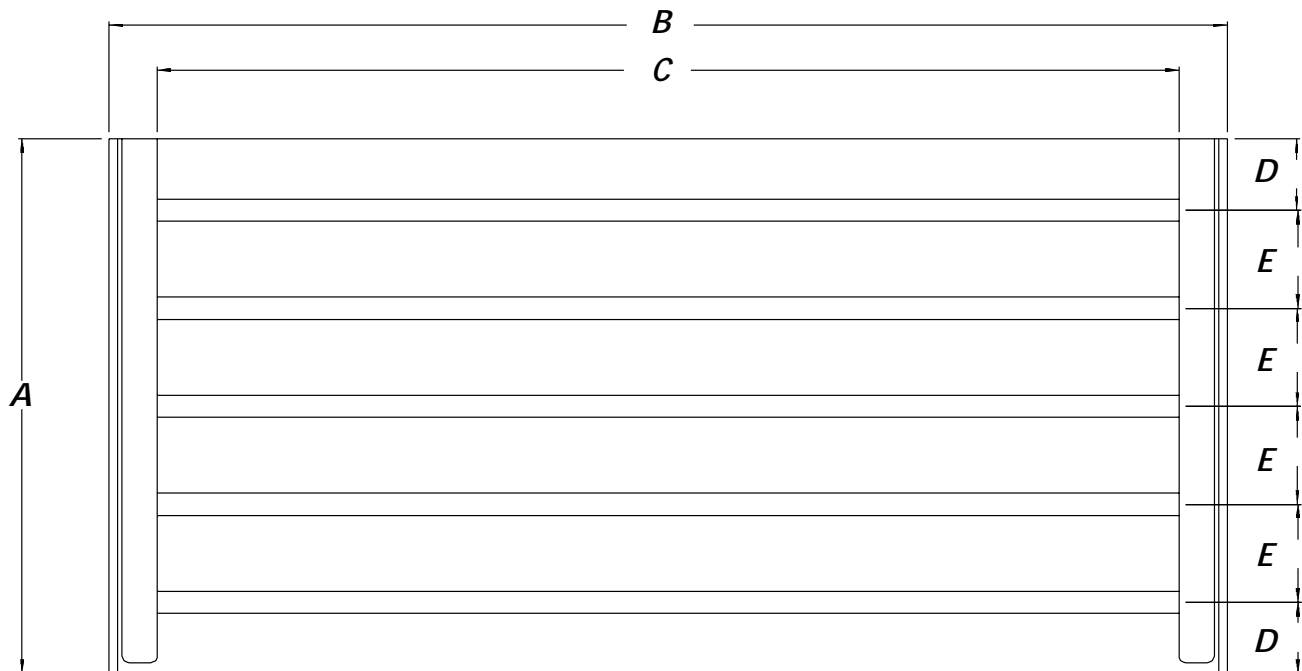


*Figure 1-22* 4020 Table

A = 20.00" (508mm)      B = 49.00" (1244.6mm)      C = 43.50" (1104.9mm)  
 D = 2.05" (63.5mm)      E = 3.75" (95.25mm)

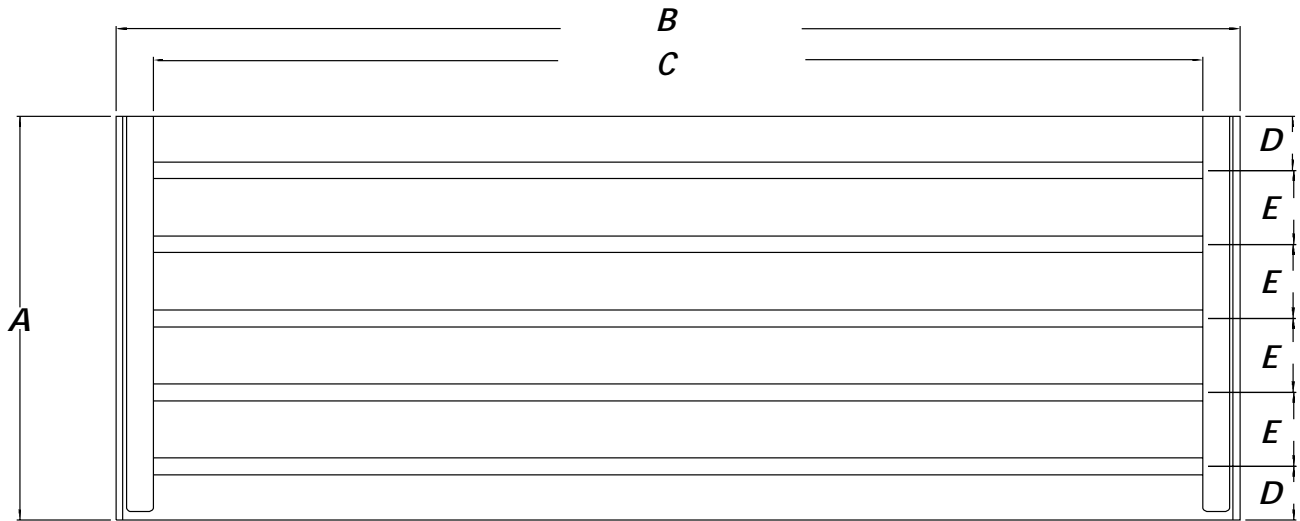
**4020A & 5020A  
Table***Figure 1-23* 4020A & 5020A Table

A = 20.00" (508mm)      B = 58.00" (1473.2mm)      C = 52.00" (1320.8mm)  
D = 2.50" (73.28mm)      E = 3.75" (95.25mm)

**6030 Table***Figure 1-24* 6030 Table

A = 30.00" (762mm)      B = 63.50" (1612.9mm)      C = 58.00" (1473.2mm)  
D = 4.00" (101.6mm)      E = 5.50" (139.7mm)

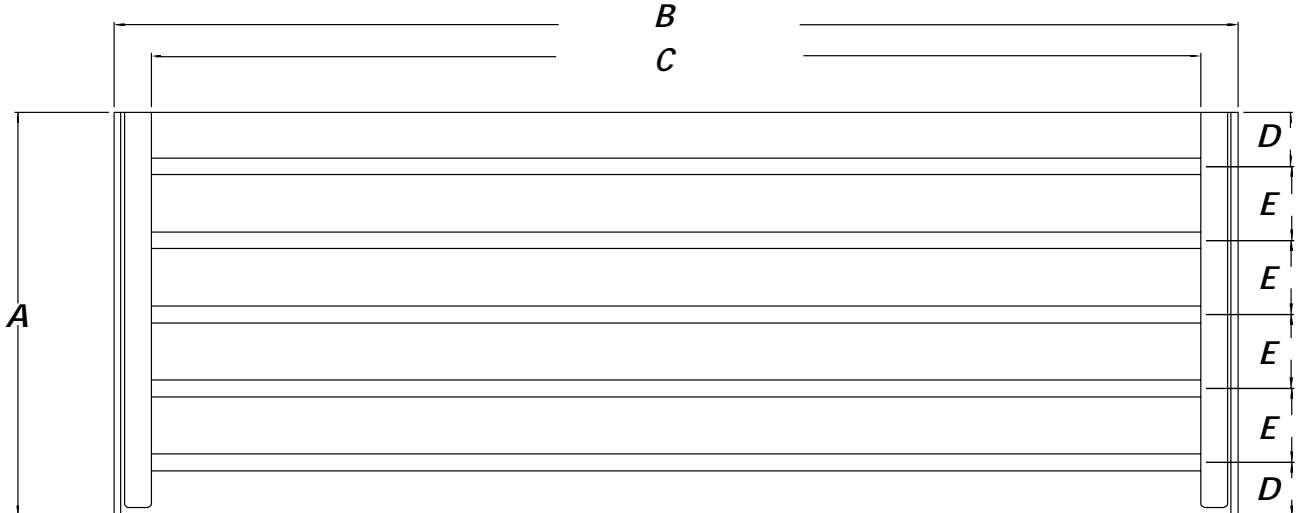
**8030 Table**



*Figure 1-25* 8030 Table

A = 30.00" (762mm)      B = 83.50" (2120.9mm)      C = 78.00" (1981.2mm)  
D = 4.00" (101.6mm)      E = 5.50" (139.7mm)

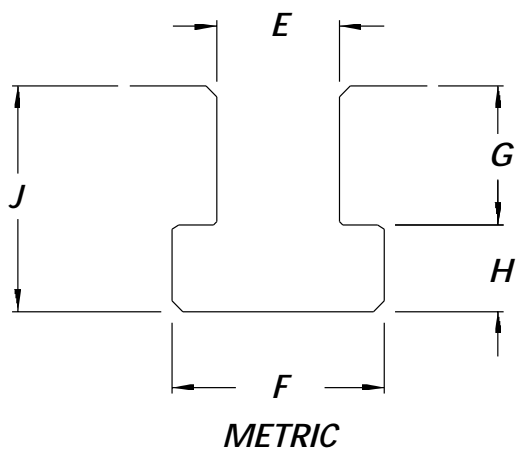
**6535 Table**



*Figure 1-26* 6535 Table

A = 35.00" (889mm)      B = 74.76" (1899mm)      C = 69.50" (1765mm)  
D = 2.74" (70mm)      E = 4.92" (125mm)

## TRM T-Slots

*Figure 1-27* TRM T-Slots**Metric T-Slots:**

E = 14.28-14.33mm

F = 24.6mm

H = 10mm

G = 15.9mm

J = 25.9mm

## 4020, 4020A, 5020A, 6030 & 8030 T-Slots

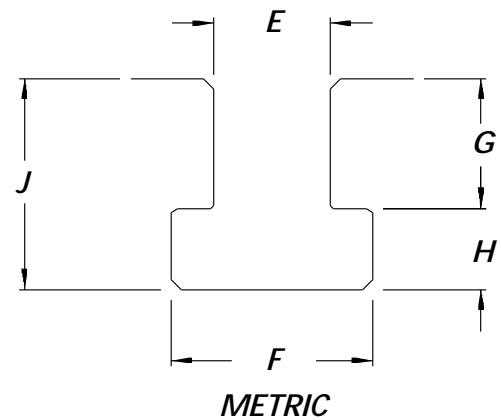
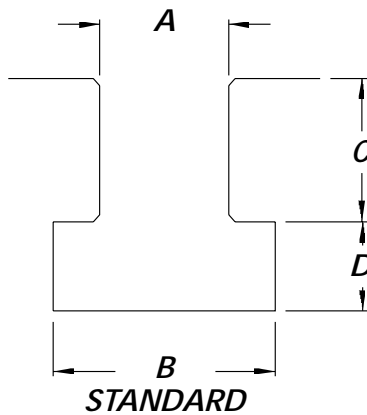


Figure 1-28 4020, 4020A, 5020A, 6030 & 8030 T-Slots

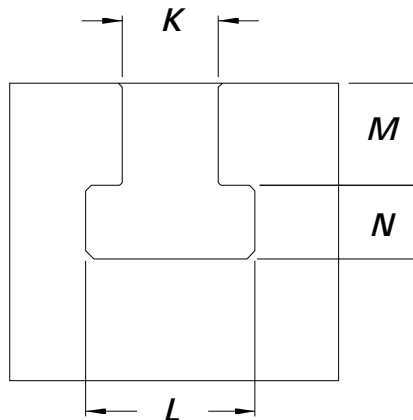
### Standard T-Slots:

A = .6875-.6895" (17.46-17.51mm)      B = 1.250" (31.75mm)  
C = .70" (17.78mm)      D = .485" (12.32mm)

### Metric T-Slots:

E = .7085-.7100" (17.996-18.034mm)  
F = 1.19-1.25" (30.23-31.75mm)      G = .787" (19.99mm)  
H = .482-.542" (12.24-13.77mm)      J = 1.299" (32.995mm)

## 3020, 4525, 6535 T-Slots



### 3020, 4525, 6535 T-Slots:

K = .7086-.7093" (17.998-18.016mm)      L = 1.19" (30.23mm)  
M = .817" (20.75mm)      N = .482" (12.24mm)

### Recommended Mainline Fuses / Circuit Breakers

**Table 15: Recommended Fuses**

Spindle Type	208 V 3 Phase	240 V 3 Phase	380-415 V 3 Phase	480 V 3 Phase	240 V Single Phase
5 HP	30A	30A	30A	30A	50A
10 HP	50A	50A	35A	25A	70A
HT	70A	70A	35A	35A	90A
VHT	N/A	90A	70A (SIEMENS)	N/A	N/A
50 Taper	N/A	N/A	70A	70A	N/A

**Table 16: Circuit Breakers for the New Sheet Metal**

Spindle Type	208 V 3 Phase	240 V 3 Phase	380-415 V 3 Phase	480 V 3 Phase	240 V Single Phase
5 HP	30A	30A	30A	30A	50A
10 HP	50A	50A	35A	25A	70A
HT	70A	70A	35A	35A	90A
VHT	N/A	90A	70A	N/A	N/A
50 Taper	N/A	N/A	70A	70 A	N/A
3 HP	N/A	30A	N/A	N/A	30A

**Table 17: Electrical Service Circuit Breaker**

Spindle Type	208 V 3 Phase	240 V 3 Phase	380-415 V 3 Phase	480 V 3 Phase	240 V Single Phase
5 HP	30 A	30 A	30 A	30 A	50 A
10 HP	50 A	40 A	25 A	25 A	60 A
HT	70 A	45 A	35 A	25 A	60 A
VHT	N/A	90 A	70 A	N/A	N/A
50-Taper	N/A	N/A	70 A	70 A	N/A

**Note:** VHT runs only on 220-240V. External transformer required for any other voltage.



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## Section 02: Pre-Installation Procedures

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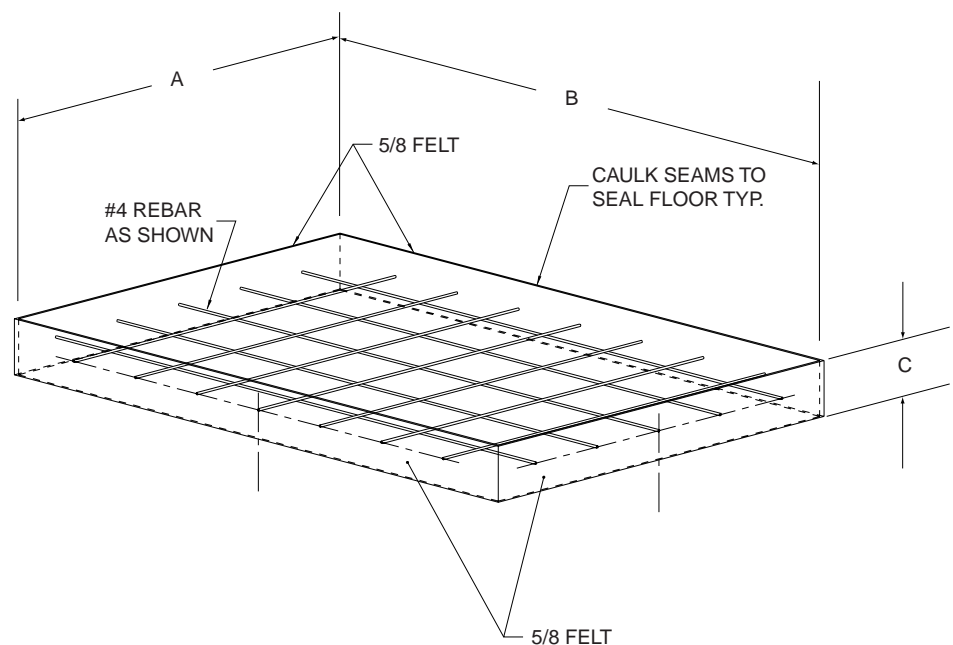
### Foundation



#### WARNING

The VMC *MUST* be placed on a surface that will support the combined weight of the VMC, options, fixtures, and tooling, etc. (refer to the VMC Specifications section at the beginning of this manual for VMC weights).

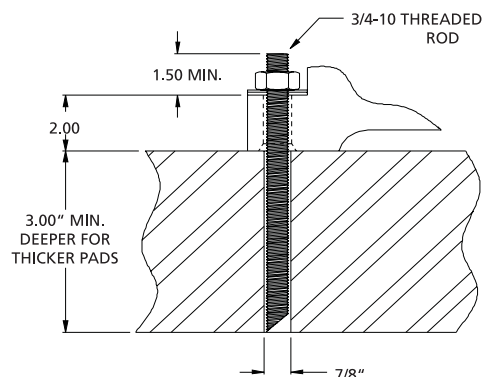
- 1) It is recommended that all models be placed on a isolated concrete pad 8-12 inches thick (Figure 2-1, Dimension C). For A and B dimensions, see Table 1.



**Figure 2-1** Typical Pad Construction

- 2) The VMC should be positioned on a single slab. Placing the VMC over an expansion joint may cause the VMC to shift when each individual slab moves.
- 3) The surface below the leveling pads should be free from cracks. Placing the VMC over a crack may cause the VMC to shift during use. *Inadequate flooring could result in mechanical degradation.*

- 4) Bolt the VMC directly to the pad through the .953" diameter holes that are provided in the base casting. The dimensions for the base mounting holes of all machines are in the VMC Specifications section. Anchors are to be installed as shown below in Figure 2-2. For high performance machines, the machine must be bolted to achieve maximum performance.



RECOMMENDED CURING TIME	
58°F TO 68°F	30 MIN
50°F TO 58°F	1 HR
41°F TO 50°F	2 HRS
32°F TO 41°F	4 HRS
23°F TO 32°F	8 HRS
14°F TO 23°F	24 HRS

#### ANCHOR STUD INSTALLATION:

1. WEAR SAFETY GOGGLES.
2. USE 7/8 CARBIDE TIPPED DRILL FOR THE ANCHOR YOU ARE USING.
3. USE A ROTARY-HAMMER DRILL AND DRILL THE BASE MATERIAL TO DEPTH.
4. **CAUTION! USE PROPER EYE AND HEARING PROTECTION WHILE PERFORMING THIS STEP.** REMOVE DUST AND RUBBLE FROM THE HOLE WITH COMPRESSED AIR, AND BRUSH.
5. INSERT CAPSULE IN THE HOLE, EITHER END FIRST.
6. SELECT PROPER 1/2" SQ. DRIVE SOCKET AND ATTACH TO SUP-R-SETTER.
7. JAM NUT ON STUD AS PER ILLUSTRATION.
8. USING A 1 1/8" SOCKET INSERT THE STUD INTO THE HOLE TO BREAK THE CAPSULE.
9. UNDER ROTARY POWER, PUSH THE STUD TO FULL DEPTH, MAINTAINING POWER FOR TWO OR THREE SECONDS AFTER THE STUD BOTTOMS.
10. PROMPTLY AND CAREFULLY RELEASE THE INSTALLATION TOOL FROM THE STUD, LEAVING IT UNDISTURBED RIGHT THROUGH THE PRESCRIBED CURING TIME CONSISTENT WITH ON-SITE TEMPERATURE.
11. INSTALL MACHINE.
12. LEVEL MACHINE.
13. ADD TWO FLAT WASHERS, ONE LOCK WASHER AND ONE NUT PER THREADED ROD.
14. TIGHTEN NUT, STOP WHEN WASHER GETS FLAT, DO NOT OVERTIGHTEN.
15. RECHECK LEVEL.

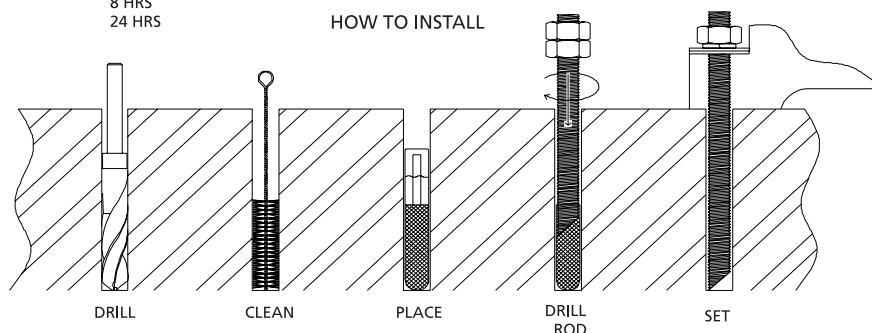


Figure 2-2 Anchor Stud Installation

Table 1: Isolation Pad Dimensions

Machine	A (depth)	B (width)
EMC/ 15/ 15XT/ 2016L	7 ft. 9 in.	7 ft. 7 in.
2216/ 3016	7ft 9in	9ft 6in
3016L	7ft 9in	9ft 10in
4020/ 4020A/ 5020A	8ft 7in	11ft
3020	8ft 5in	10ft 2in
4525	8ft 10in	12ft
6030	9ft 11in	14ft 6in
6535	9ft 11in	15ft 10in
8030	9ft 11in	18ft 9in
TRM	Not Required	Not Required

## Shipping Dimensions

**Table 2: VMC Shipping Dimensions**

VMC	LENGTH	WIDTH	HEIGHT	WEIGHT	Z MTR DWN
8030	17ft 8in	8ft 8in	10ft 2in	19,000lbs	8ft 8in
6535	14ft 9in	8ft 10in	11ft 3in	30,000lbs	11ft 3in
6030	13ft 2in	8ft 8in	10ft 2in	17,000lbs	8ft 8in
5020A	9ft 7in	7ft	8ft 3in	10,500lbs	6ft 8in
5020A	9ft 7in	7ft	9ft 1in ext column	10,500lbs	7ft 5in
4525	8ft 10in	7ft 10in	10ft	13,600lbs	8ft 5in
4020A	9ft 7in	7ft	8ft 3in	10,500lbs	6ft 8in
4020A	9ft 7in	7ft	9ft 1in ext column	10,500lbs	7ft 5in
4020	9ft 7in	7ft	8ft 3in	10,500lbs	6ft 8in
4020	9ft 7in	7ft	9ft 1in ext column	10,500lbs	7ft 5in
3020	8ft 10in	6ft 10in	10ft	12,400lbs	8ft 5in
3016	8ft 3in	6ft 5in	8ft 2in	9,500lbs	6ft 8in
3016	8ft 3in	6ft 5in	8ft 8in ext column	9,500lbs	7ft 4in
2216	8ft 3in	6ft 5in	8ft 2in	9,100lbs	6ft 8in
2216	8ft 3in	6ft 5in	8ft 8in ext column	9,100lbs	7ft 4in
3016L	7ft 5in	6ft 5in	7ft 7in	6,100lbs	6ft 6in
3016L	7ft 5in	6ft 5in	8ft 4in ext column	6,100lbs	7ft 3in
2016L	6ft 2in	6ft 5in	7ft 7in	5,800lbs	6ft 6in
2016L	6ft 2in	6ft 5in	8ft 4in ext column	5,800lbs	7ft 3in
15XT	7ft 5in	6ft 5in	7ft 7in	5,800lbs	6ft 6in
15XT	7ft 5in	6ft 5in	8ft 8in ext column	5,800lbs	7ft 3in
15	6ft 2in	6ft 5in	7ft 7in	5,500lbs	6ft 6in
15	6ft 2in	6ft 5in	8ft 4in ext column	5,500lbs	7ft 3in
EMC	6ft 2in	6ft 5in	7ft 7in	5,500lbs	6ft 6in
TRM					
HYDRO	8ft 5in	4ft 2in	5ft 3in	820lbs	
PALLET	7ft 2in	3ft 3in	3ft 8in	911lbs	

Table 3: VMC Crated Dimensions and Weights

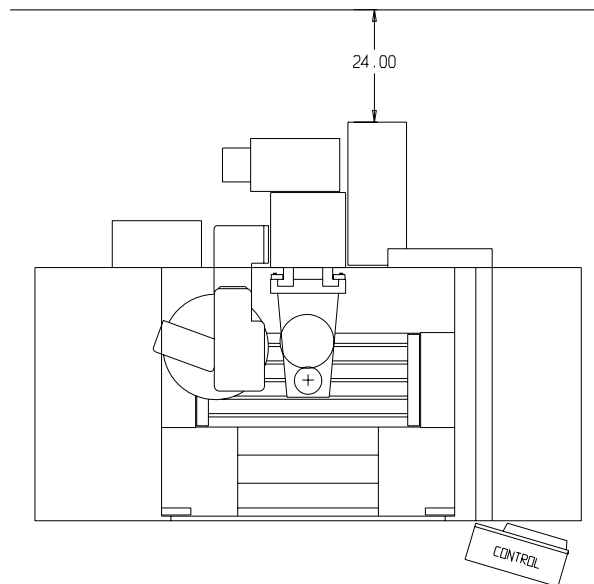
VMC	LENGTH	WIDTH	HEIGHT	WEIGHT
8030	17ft 8in	8ft 8in	10ft 2in	20,500lbs est
6535	17ft	8ft 10in	12ft 3in	32,000lbs est
6030	14ft	8ft 8in	10ft 2in	18,500lbs est
5020A	10ft 5in	8ft	8ft 7in	11,800lbs est
4525	10ft 5in	8ft	8ft 7in	12,000lbs est
4020A	10ft 5in	8ft	8ft 7in	11,800lbs est
4020	10ft 5in	8ft	8ft 7in	11,800lbs est
3020	9ft	8ft	8ft 7in	11,000lbs est
3016	9ft	7ft	8ft 7in	10,300lbs est
2216	9ft	7ft	8ft 7in	10,300lbs est
3016L	7ft 5in	6ft 5in	7ft 7in	7,000lbs est
2016L	6ft 2in	6ft 5in	7ft 7in	6,800lbs est
15XT	7ft 5in	6ft 5in	7ft 7in	6,300lbs est
15	6ft 2in	6ft 5in	7ft 7in	6,000lbs est
EMC	6ft 2in	6ft 5in	7ft 7in	6,000lbs est
HYDRO	9ft 3in	4ft 9in	6ft	1,420lbs est
PALLET	7ft 9in	4ft 9in	6ft	1,411lbs est

**Note:** VMC-TRM/15/15XT/2016L/3016L/6535 and 8030 do not get crated. They are placed on pallets and vacuum sealed.

## Positioning

- 1) Place the VMC so that skylights or air vents are NOT directly overhead. Do not expose the machine to direct sunlight, or any other heat source. Do not place the machine in an area that will expose the machine to moisture, standing water, liquid or rain.

- 2) Ensure there is adequate room behind the VMC to fully open the rear cabinet door. Minimum clearance behind the machine is two feet (24"/60.96 cm.) (See Figure 2-3).



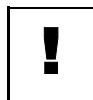
**Figure 2-3** 24" Minimum Clearance Behind VMC

- 3) Ensure adequate ceiling clearance for the Z axis conduit with the Z axis in the Z+4.0" position. VMCs with the Extended Travel option require an additional 8.0" vertical clearance. (See Table 4).

**Table 4: Minimum Ceiling Clearances (inches)**

	VMC EMC, 15, 15XT, TRM	VMC 2216, 3016	VMC 2016L, 3016L	VMC 4020, 4020A, 5020A	VMC 6030, 8030	VMC 3020, 4525	VMC 6535
Regular Column (Z+4.0")	95.00	97.00	97.00	98.00	126.00	127.00	140.00
Extended Column 28.0"	103.00	105.00	105.00	106.00	N/A	135.00	N/A

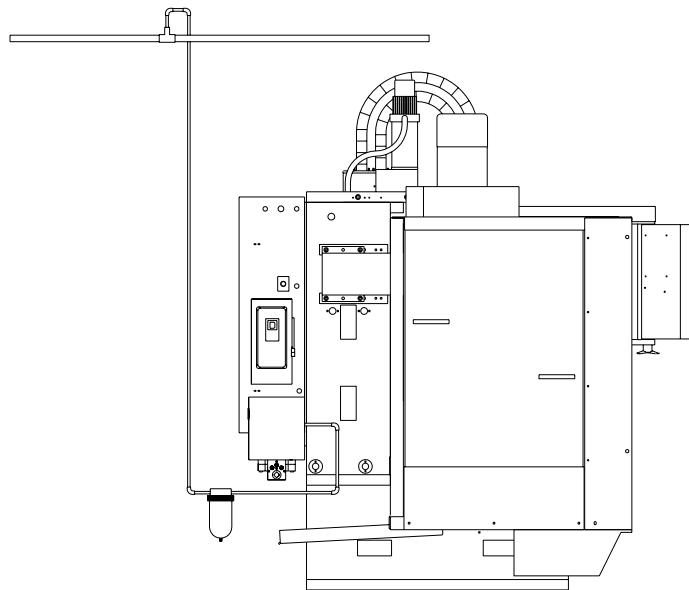
## Air Supply



## IMPORTANT

Air pressure required: 120psi before regulator, 80 psi after regulator, 15 scfm (standard cubic feet per minute) momentary.

- 1) From the main air supply line attach a 3/8" air supply line for the VMC. The distance from the air compressor and number of machines attached should be taken into consideration when determining the size of piping for the main air supply line.
- 2) Piping may consist of one or more of the following: galvanized pipe, PVC pipe or high pressure hose. Do not use quick disconnects; quick disconnects will restrict air flow.
- 3) A "T" riser should be used to connect the main air supply line with the air supply line to the VMC (see figure 4).
- 4) To prevent moisture from entering the VMC's air system, attach a drain to the lowest point of the air supply line. (See figure 2-4). The drain could be a self-relieving moisture separator, a simple petcock, or a gate valve opened occasionally to release the water build-up. An air dryer is preferred where higher moisture levels exist.
- 5) To help prevent contaminants from entering the air system on the VMC, place a filter in-line on the main air supply line.



*Figure 2-4* Attach Drain to Lowest Point of Air Supply Line

## Electrical Grounding



### IMPORTANT

The importance of proper grounding CANNOT be over-emphasized! Improper grounding will result in a wide range of hard-to-diagnose problems in communications, positioning, spindle motion, etc.

**Primary Grounding** (refer to NEC 1990 ARTICLE 250 SECTION 81)

- 1) The grounding conductor shall be of copper. The material selected shall be resistant to any corrosive condition existing at the installation or shall be suitably protected against corrosion.
- 2) The grounding conductor shall be a No. 8 AWG (10 mm<sup>2</sup>) or larger equipment ground conductor, and must be:
  - solid or stranded
  - insulated, covered, or bare
  - installed in one continuous length without a splice or joint.
- 3) Individually covered or insulated grounding conductors shall have a continuous outer finish that is either green, or green with one or more yellow stripes.
- 4) A No. 8 AWG (10 mm<sup>2</sup>) or larger equipment ground conductor and 3 phase conductors must be contained within one of the following:
  - rigid metal conduit
  - intermediate metal conduit
  - electrical metallic tubing
- 5) The ground conductor shall be connected between the VMC's ground bus and the approved ground bus contained within the voltage supply panel board or enclosure.
- 6) The VMC branch supply conduit, phase conductors and ground conductors must be dedicated to a single VMC. They cannot be used to supply any other loads.

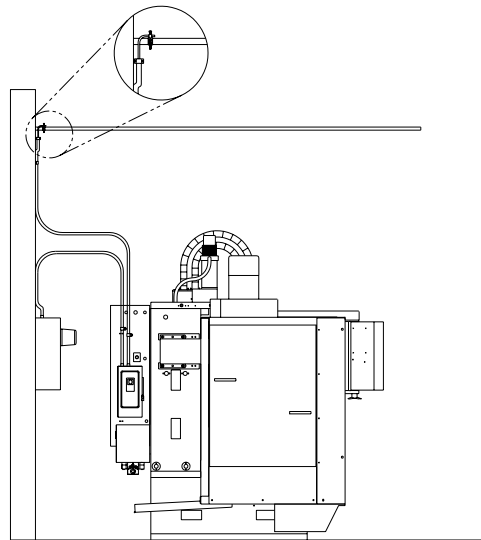
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**Supplemental Grounding**

(refer to NEC 1990 ARTICLE 250 SECTION 91)

- 1) Supplementary grounding electrodes shall be permitted to augment the equipment grounding conductor; however, the earth shall not be used as the sole equipment grounding conductor.
- 2) The supplemental grounding conductor shall be a No. 6 (16 mm<sup>2</sup>) or larger copper conductor in the form of a wire, and must be:
  - solid or stranded
  - insulated, covered or bare
  - installed in one continuous length without splice or joint

- 3) A No. 6 (16 mm<sup>2</sup>) or larger grounding conductor shall be run in one of the following:
  - rigid metal conduit
  - intermediate metal conduit
  - electrical metallic tubing or cable armor
- 4) One end of the supplemental grounding conductor shall be attached to the VMC's ground bus. The other end shall be effectively bonded to a copper cold water pipe that is in direct contact with the earth for 10 feet or more (see figure 2-5).
- 5) Connections shall be made so that they are electrically continuous.



*Figure 2-5* Bond Grounding Conductor to Copper Cold Water Pipe

Many problems that are difficult to diagnose can occur if the VMC is not properly grounded. Proper grounding cannot be overemphasized.

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### Checking Grounding Integrity of Fadal VMCs

#### Specification - Grounding for the Fadal machine:

- 1) MUST conform to NEC code as stated in the Maintenance Manual.
- 2) MUST be a continuous wire 8 AWG or larger between the VMC's ground bus and the building power distribution panel serving the VMC.



- 3) MUST be dedicated to a single VMC. (The ground and phase conductors cannot be shared with any other equipment.)
- 4) Ground rods and other supplemental grounding may be used in addition to the ground specified above but not instead of it.

**Inspection - Check  
ground wire coming  
into VMC:**

- 1) The ground wire coming into the VMC and going to the building power distribution panel must be 8AWG or larger.
- 2) The ground wire must be connected to the ground bar in the back cabinet of the VMC. (It does not go to a screw in the disconnect box.)
- 3) The ground wire is to be a continuous wire from the VMC to the building power distribution panel serving the VMC. The conduit is not to be used as the grounding conductor. Ground rods and other supplemental grounding may be used in addition to the ground specified above but not instead of it. Servicemen are not the appropriate people to be inspecting power distribution panels or building wiring. The serviceman is not expected to physically verify the routing of the ground conductor, but should look for any indications that grounding is not as specified.

**Verification - Check  
grounding integrity  
with Fluke meter:**

- 1) Measure the resistance (ohms) of a length of 16AWG or larger wire that is long enough to reach from the VMC to the building power distribution panel that supplies the VMC. Record reading.
- 2) Attach the wire of step 1 (test wire) to the ground bus of VMC. The other end will be used for measurement at the power distribution enclosure. (Do not open the enclosure. Use a bare screw or bare metal on the enclosure for measurements.)
- 3) Set meter to AC Volts; with VMC on, measure and record voltage between the test wire and the power distribution enclosure. Set meter to DC Volts; measure and record voltage. Voltages should be 0V with machine on but not operating, but up to .010V is OK.
- 4) Turn off the VMC and measure the ground voltages (AC and DC) again. Record these readings. Voltages should be 0V to .005V.
- 5) Voltages (AC or DC) across the ground wire will cause false resistance readings. If the ground voltages with VMC off are 0 (.005VAC max.), set meter to ohms and measure resistance between VMC ground bus and power distribution enclosure. Resistance measurement should be less than twice the resistance measured in step 1. (If resistance is negative (due to a ground current), reverse meter leads and average the two readings.)

**Electrical Service****IMPORTANT**

Electrical installation of machine must be done by a qualified electrician.

- 1) The total connected load should not exceed 75% of the panel rating, allowing for the VMC load. Refer to the Electrical Rating Plaque for full load current.
- 2) If other CNC equipment, motor controllers, motors or electric-discharge lighting (fluorescent, mercury vapor, metal-halide, high and low pressure sodium) are connected to the same panel, the connected load should not exceed 50% of the panels rated capacity.
- 3) Prior to the installation of the VMC, the panel should be measured for average and peak loads across the three phases.

**WARNING**

The VMC must NOT be installed on a panel where the measured surge demand current exceeds the panel's supply amplitude.

**Preferred Service**

The VMC should be supplied by a dedicated circuit connected directly to the Service Entrance panel.

**Alternate Service**

The VMC may be supplied by a dedicated circuit connected directly to the local branch panel.

**Circuit Breakers**

See Table 17 Section 1

**Wiring**

(refer to NEC 2002 ARTICLE 310 TABLE 310-16)

**Table 5: Wiring Requirements**

40 Taper	240 VAC 3 Ø	8 AWG (10 mm <sup>2</sup> ) stranded THHN copper within 100 ft. of panel. For VHT 4AWG	6 AWG (16 mm <sup>2</sup> ) stranded THHN copper 100 ft. or more from panel. For VHT 3 AWG
40 Taper	480 VAC 3 Ø	10 AWG (6 mm <sup>2</sup> ) stranded THHN copper within 100 ft. of panel. For VHT 6 AWG	8 AWG (10 mm <sup>2</sup> ) stranded THHN copper 100 ft. or more from panel. For VHT 4 AWG
40 Taper	240 VAC Single Ø	6 AWG (16 mm <sup>2</sup> ) stranded THHN copper within 50 ft. of panel.	4 AWG (25 mm <sup>2</sup> ) stranded THHN copper from 50 to 100 ft. from panel.
50 Taper	480 VAC 3 Ø	8 AWG (10 mm <sup>2</sup> ) stranded THHN copper within 100 ft. of panel. For VHT 4AWG	6 AWG (16 mm <sup>2</sup> ) stranded THHN copper 100 ft. or more from panel. For VHT 3 AWG

**Conduit**

(refer to NEC 2002 ARTICLE 300-17 and Annex C TABLE C1)

- 1) The number and size of conductors in any raceway shall not be more than will permit dissipation of the heat.
- 2) The conduit must allow ready installation or withdrawal of the conductors without damage to the conductors or to their insulation.

**Table 6: Conduit Selection**

# of Conductors	Conductor Size	Minimum Size of Conduit
4	10 AWG THHN (6 mm <sup>2</sup> )	1/2"
4	8 AWG THHN (10 mm <sup>2</sup> )	3/4"
4	6 AWG THHN (16 mm <sup>2</sup> )	3/4"
3	4 AWG THHN (25 mm <sup>2</sup> )	1.0"

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## Section 03: Installation Procedures

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### Machine Installation & Hook-Up

**IMPORTANT**

Before beginning the Machine Installation & Hook-Up it is important to review the entire Pre-Installation section.

**Unpacking****Tools Required**

Hammer, 15/16" socket or wrench and knife

- 1) Remove the crate and/or protective material from around the VMC.
- 2) Remove the strapping material from the front doors.
- 3) Unload the boxes from the inside and/or around the VMC.
- 4) Remove the 4 each 5/8" bolts and nuts between the base of the VMC and the pallet.

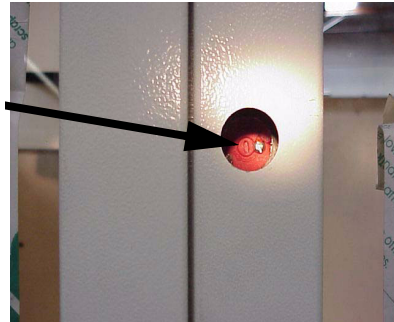
**Unlocking Front  
Doors with CE Door  
Locks****Tools Required**

Small screwdriver.

- 1) Remove cap on front door frame.



- 2) Release the screw.



- 3) Turn to override door lock.



### Moving the VMC: Fork Lift

(See Figure 3-2).

#### Tools Required

5/32" hex bit socket or Allen wrench.

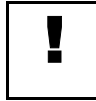
#### IMPORTANT



The head and the counterweight must be secured before lifting the VMC. Since the TRM doesn't have a counterweight, only secure the head on the TRM.

- 1) Remove the 4 each (per panel) 1/4-20 cap bolts from the access panel if not already removed.
- 2) Install the fork lift bars through the openings in the base casting. Fork lift bars may be obtained from FADAL if none are available.
- 3) FORK LIFT from the front of VMC.

**Note:** VMCs EMC, 5, 10, 15, and 15XT have fork lift access supports as part of the base. On the TRM it is recommended that the machine is picked up from the front or the back.

**Moving the VMC:  
Crane****IMPORTANT**

For the 6535 use a forklift with a 30,000 plus lifting capacity

(See Figure 3-2).

**Tools Required**

1/4" and 9/16" hex bit socket or Allen wrench.

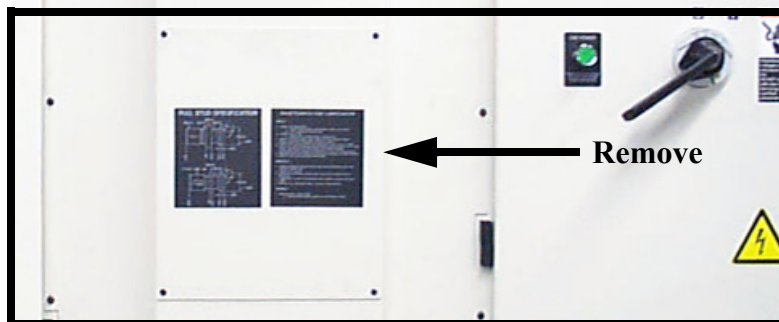
**IMPORTANT**

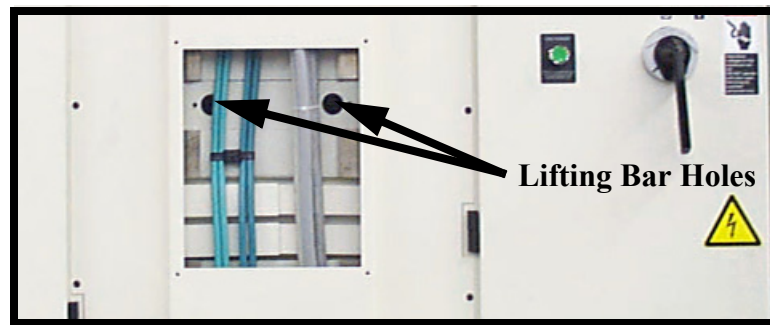
The head and the counterweight **MUST** be secured before lifting the VMC. Since the TRM doesn't have a counterweight, only secure the head on the TRM.

VMCs 5, 10, 15, and 15XT are NOT intended to be lifted by a crane.

- 1) Remove the 1/4-20 cap bolts to the axis scale cover, if installed.
- 2) Remove the 5/16-18 cap bolts securing the front Teleflex cover to the saddle.
- 3) Slide the Teleflex cover toward the front of the VMC.
- 4) Remove the 2 each 1-8 (1.5-6 for the 6535) set screws in the front of the base casting.
- 5) **STANDARD SHEETMETAL:** Install the 2 each 1-8 eye bolts. Place the 1 1/4" steel bar through the top rear hole in the column side. (See Figure 3-2). Use a properly rated lifting strap around bar and through eyebolts for lifting.

**SLANT SHEETMETAL:** Install the 2 each 1-8 eye bolts (1.5-6 eye bolts for the 6535). Remove upper cover from back of column. Place two 1 1/4" steel bars through the two top holes in the column rear. Use a properly rated lifting strap around bar and through eyebolts for lifting.





*Figure 3-1* Slant Sheetmetal Details

### Placing the VMC

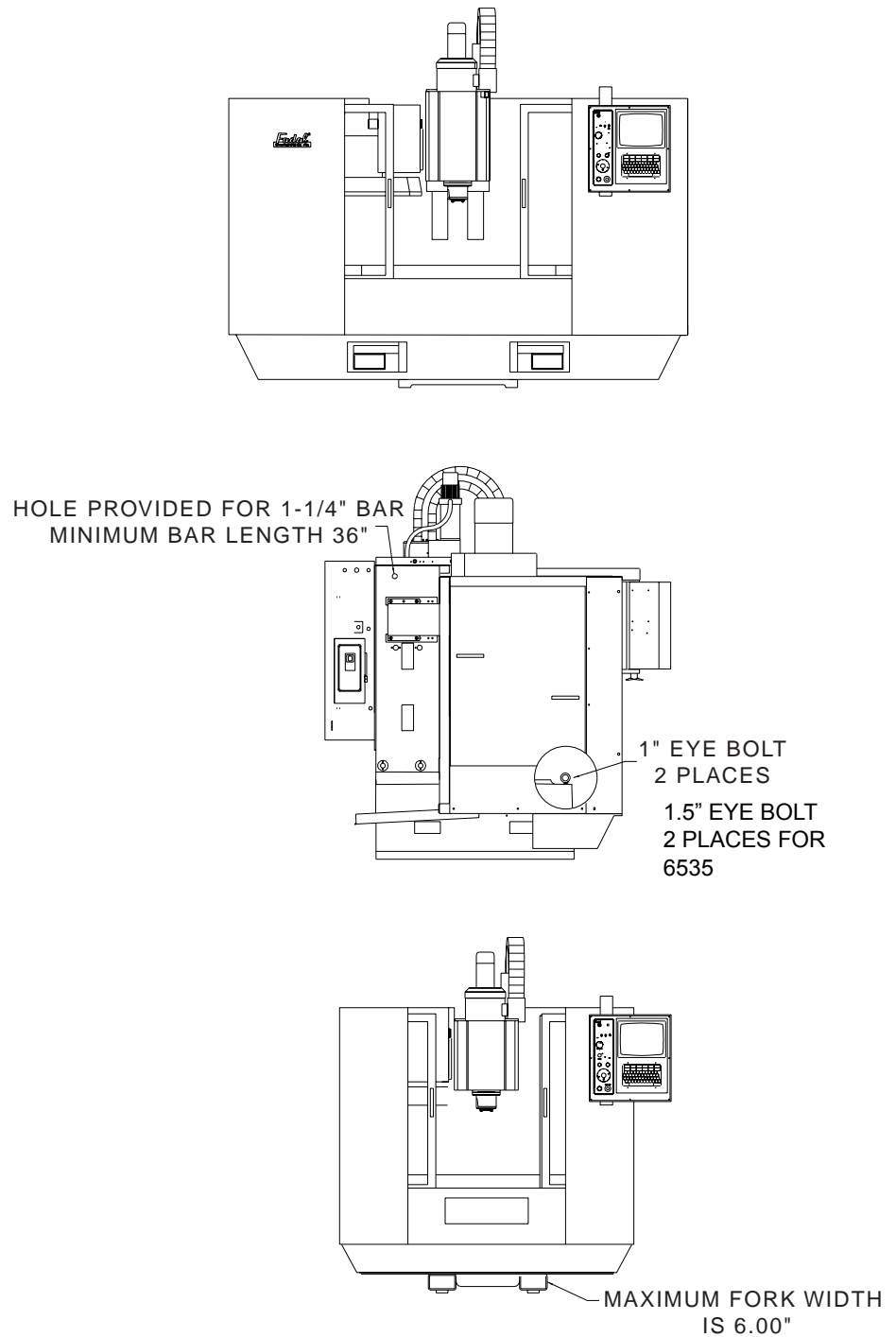
- 1) Place the leveling pads (countersink side up) under the leveling bolts. Be sure leveling bolts go into countersink on leveling pads.

**Note:** Use leveling pad (SHP-0002) (PLC-0063 for slant sheet metal machines, or machines equipped with the HydroSweep option) for placing the machine. Any other pad may cause damage to the machine.

- 2) Remove the fork lift bars or the eye bolts and the steel bar from the column.



- 3) At this point the VMC is ready for power and air connections.



*Figure 3-2* Moving the VMC

**Air Supply****IMPORTANT**

AIR PRESSURE REQUIRED: 120 psi before regulator, 80 psi after regulator, 15 scfm (standard cubic feet per minute) momentary.

- 1) Connect the 3/8" air hose to the VMC.
- 2) Check the pressure gauge for 120 psi and adjust the regulator on the VMC if necessary.
- 3) Check for air leaks at the fitting and around the air regulator.
- 4) It is important that the air compressor turns on when the pressure drops to approximately 120 PSI. This assures the VMC a constant 80 PSI.

**Power Check****WARNING**

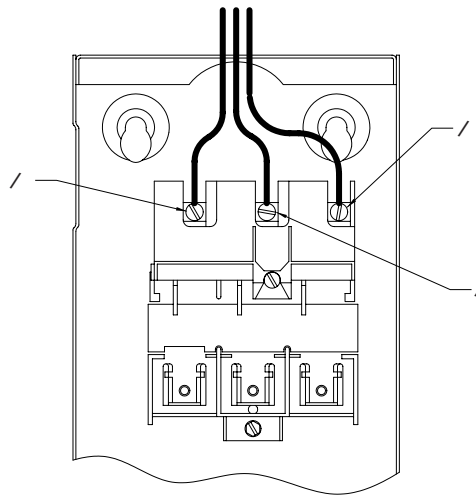
Do NOT power on the VMC before completing this section.

**Tools Required**

Fluke DMM, screwdriver or Wago tool 210-141 (ST-26), 5/16" hex bit socket and 3/4" open or box wrench.

**Verify the Main Power Fuses**

- 1) With the main disconnect switch in the off (down) position, open the cover to the main disconnect box.
- 2) Measure and record the incoming voltage across the terminal block of the main disconnect. (See Figure 3-3).

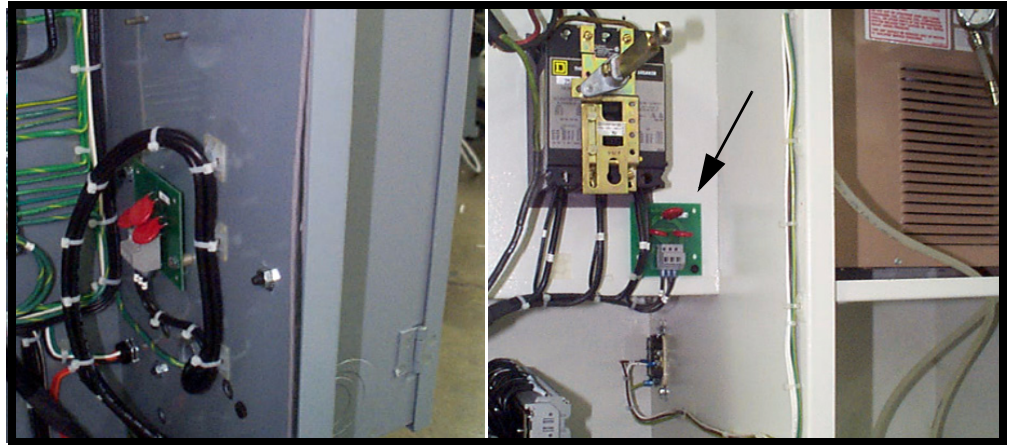


**Figure 3-3** Main Disconnect Terminal Block

- 3) Using table **B- 3 in Appendix B (MAIN POWER FUSES)**, verify that the fuses match the voltage and machine type, e.g. 4020HT, 240V, 60HZ, 3Ø = 45A.

**Verify the MOV Surge Suppressor Board**

- 1) Locate the MOV Surge Suppressor Board (see figure 3-4).



**Figure 3-4** MOV Surge Suppressor Board

- 2) Find the part number on the board.
  - a. If your incoming voltage is *under* 250 VAC, then an 1170-0 (PCB-0145) should be installed.
  - b. If your incoming voltage is *over* 250 VAC, then an 1170-1 (PCB-0146) should be installed.
- 3) Identify the jumper and AC input locations. Use **figures 3-10 through 3-14** for three phase and single phase transformers.
  - a. Where are the jumpers located?
  - b. Where are the AC inputs (L1, L2, L3) located?
- 4) With the jumper and AC input locations, locate the voltage setting of the transformer using the table in either **Figure 3-10 (3 phase)** or **Figure 3-11 (single phase)**.

**EXAMPLE:**

Jumper (Step 6a)	AC Input (Step 6b)	=	Voltage Setting
3-6	8	=	240VAC

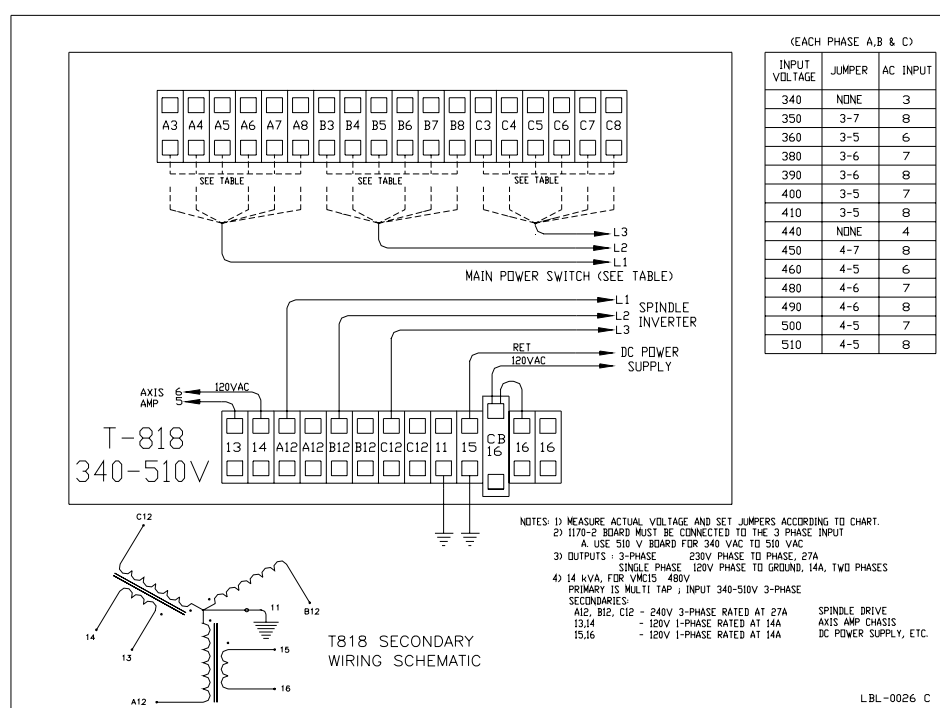


Figure 3-5

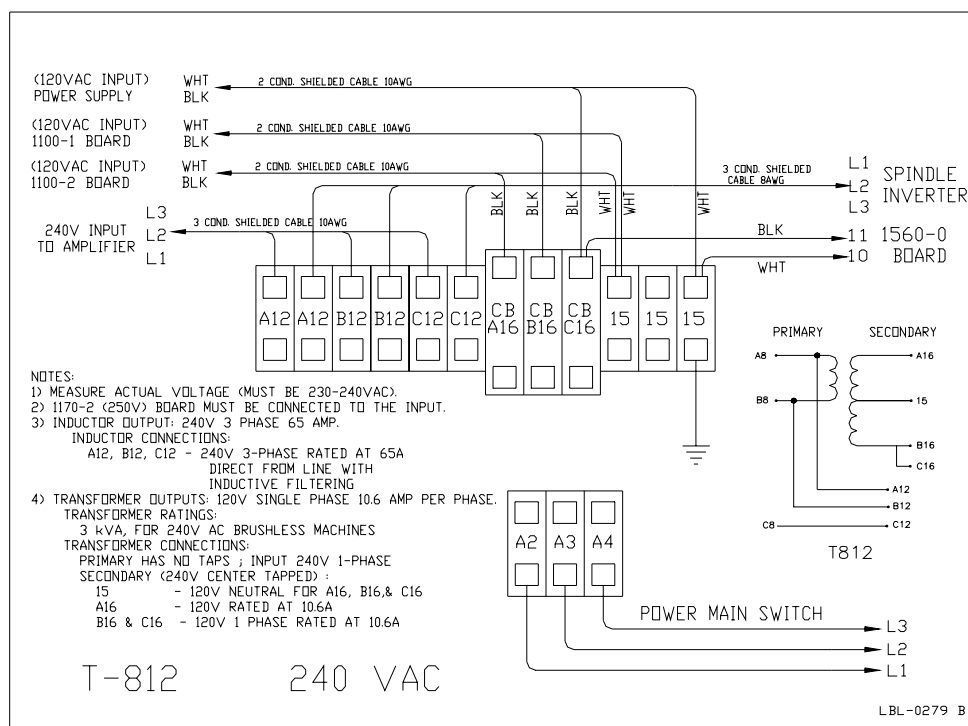


Figure 3-6

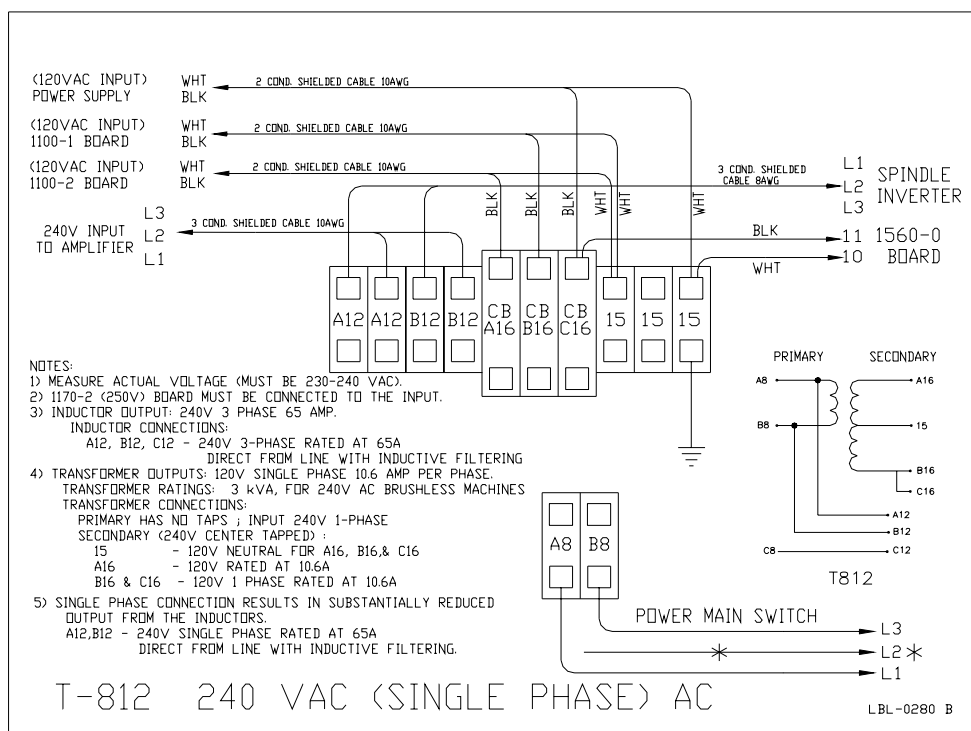


Figure 3-7

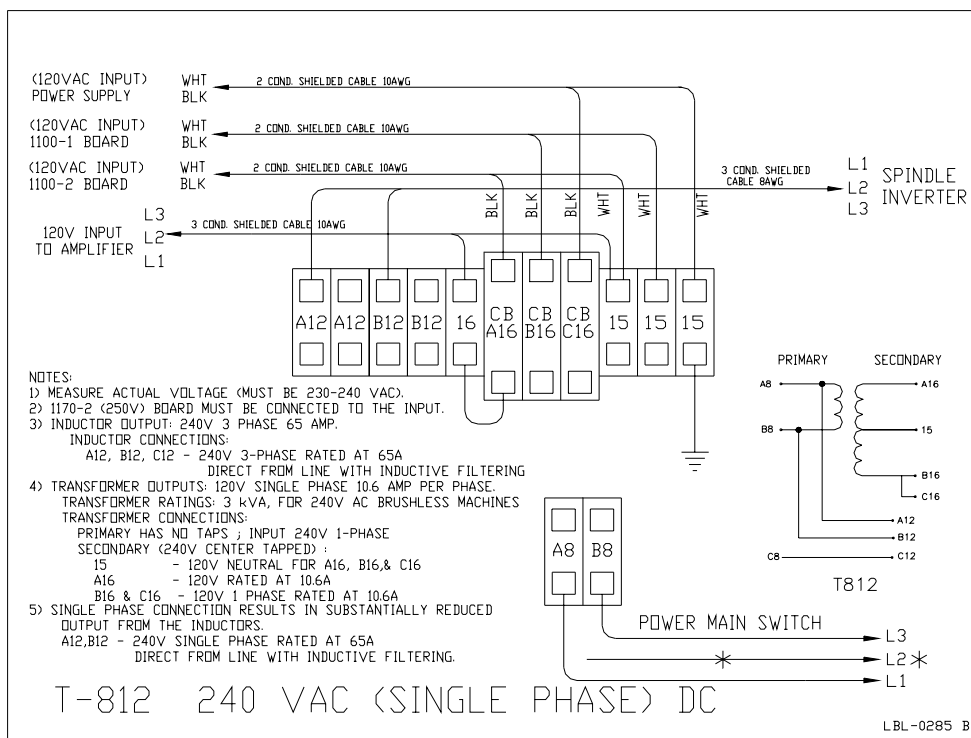


Figure 3-8

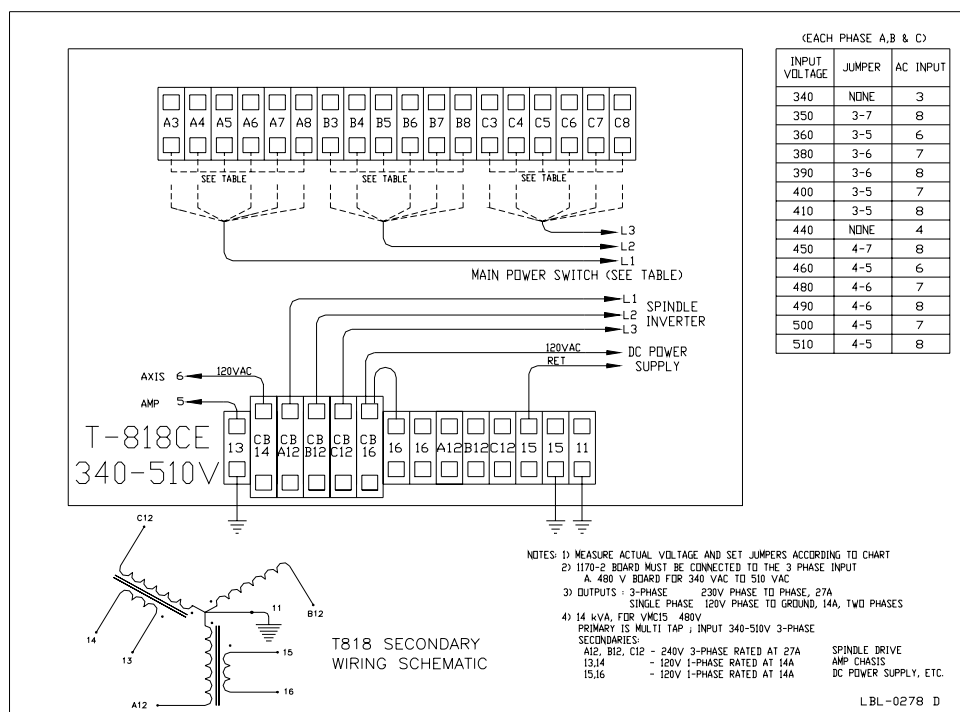


Figure 3-9

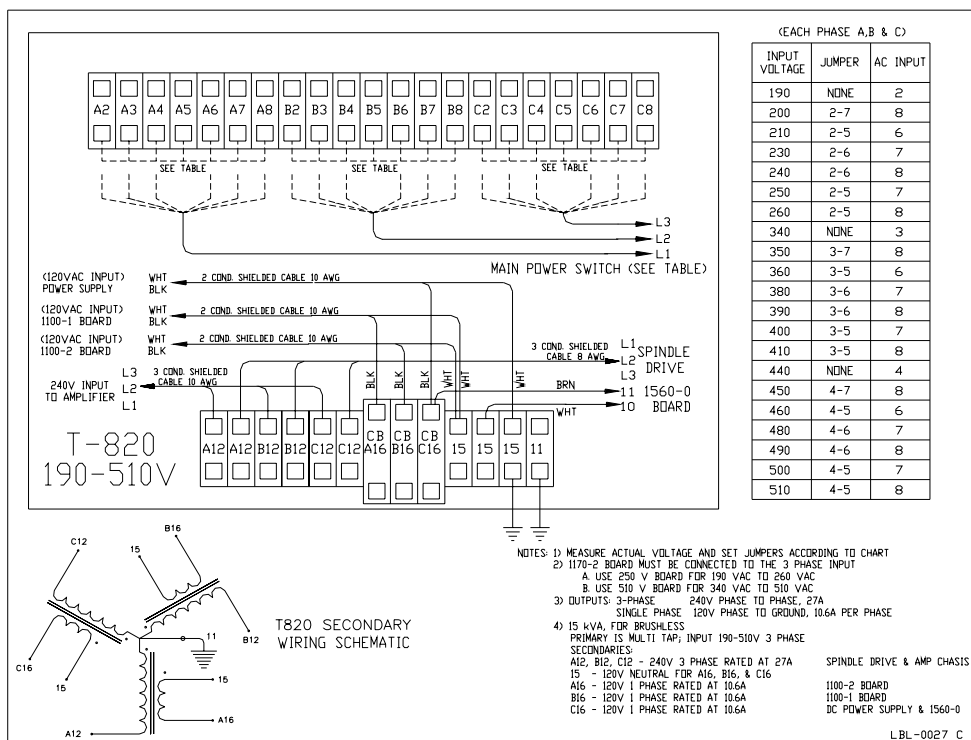


Figure 3-10

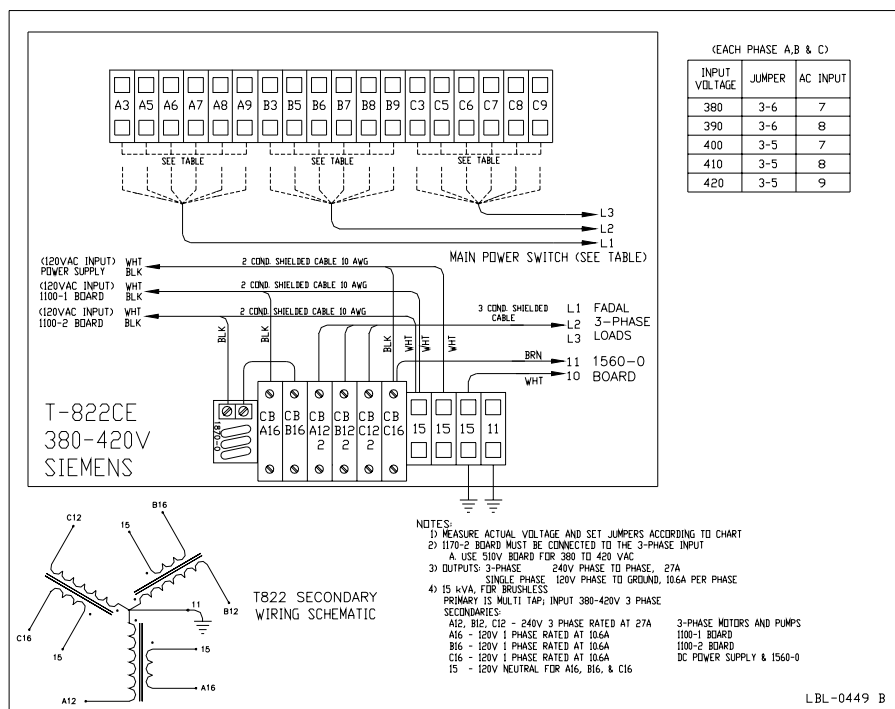


Figure 3-11

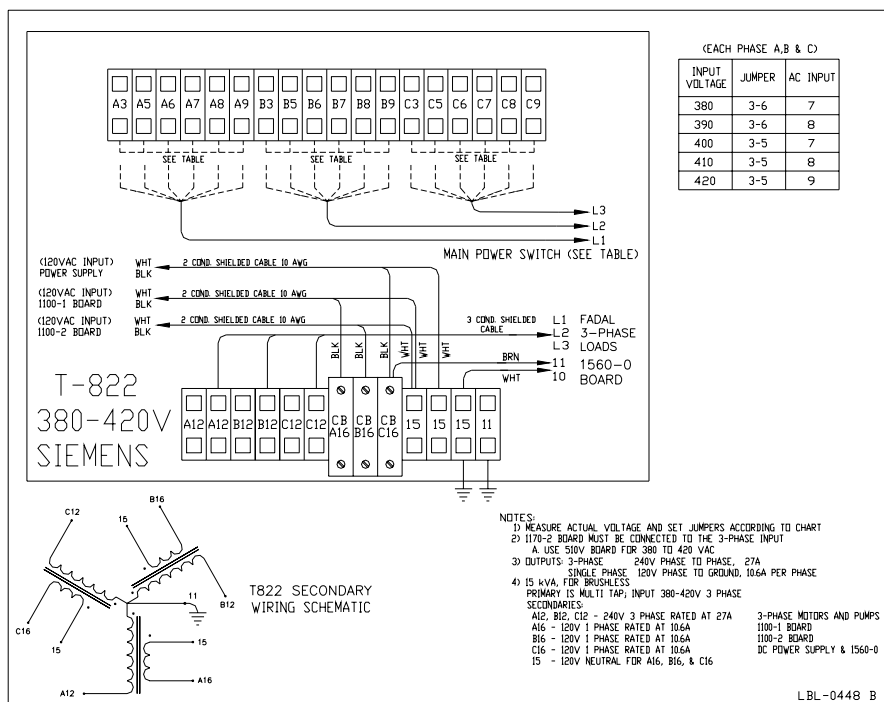


Figure 3-12

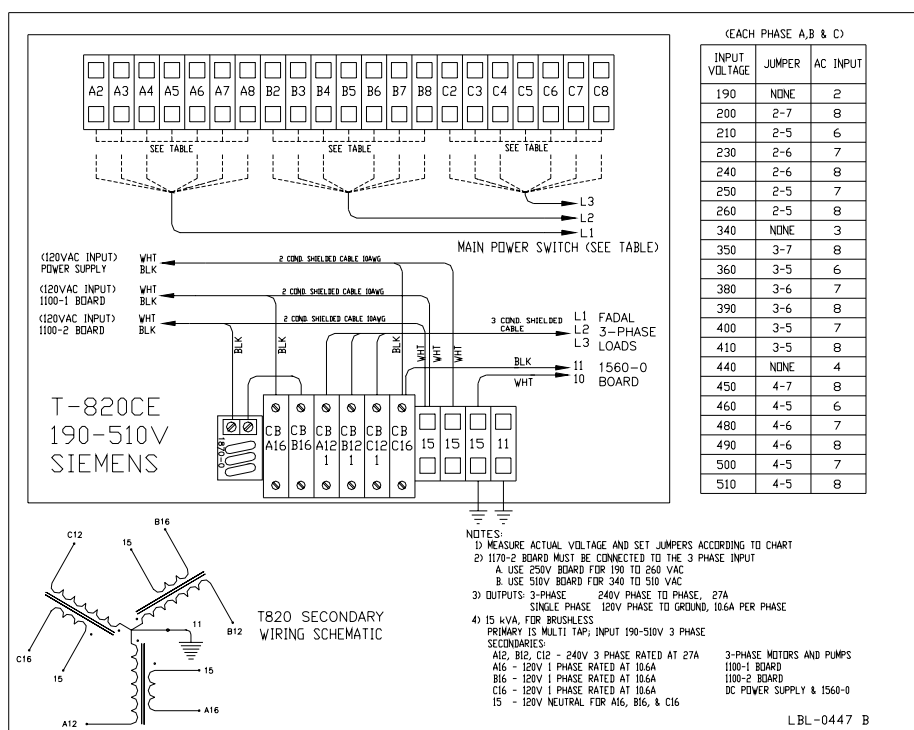


Figure 3-13

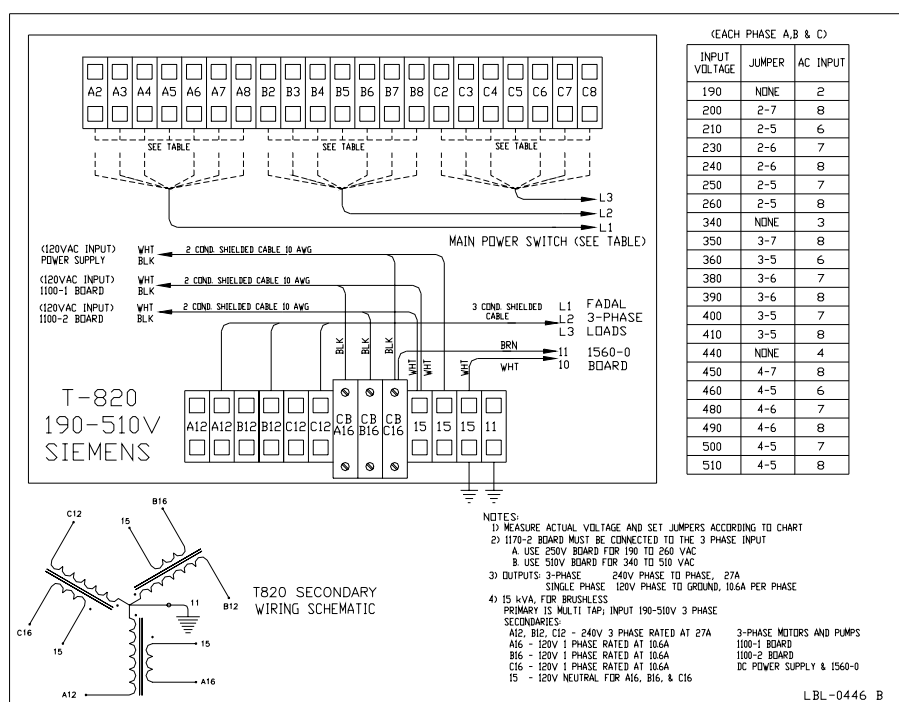


Figure 3-14



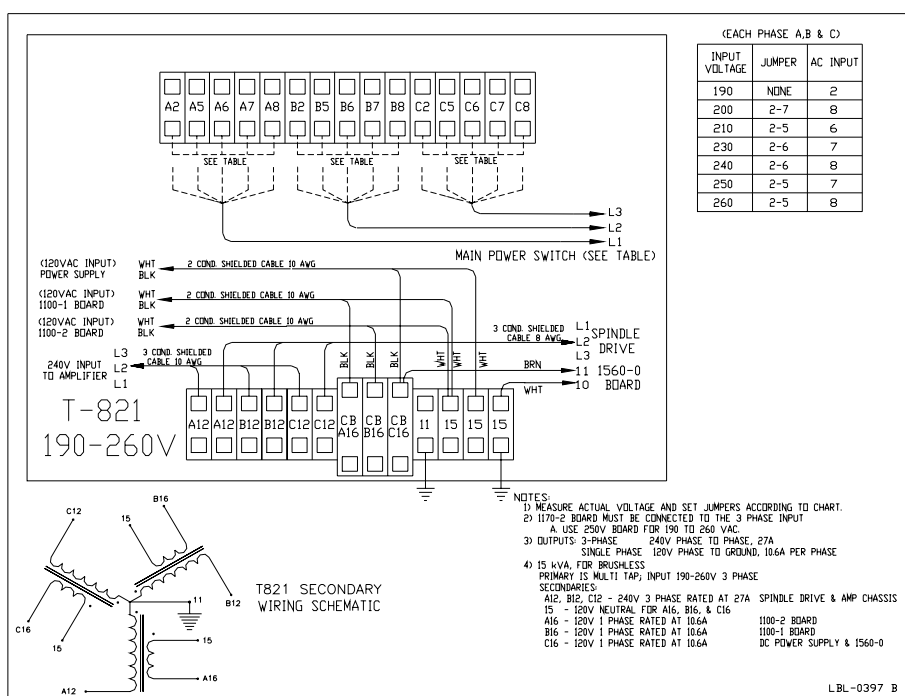


Figure 3-15

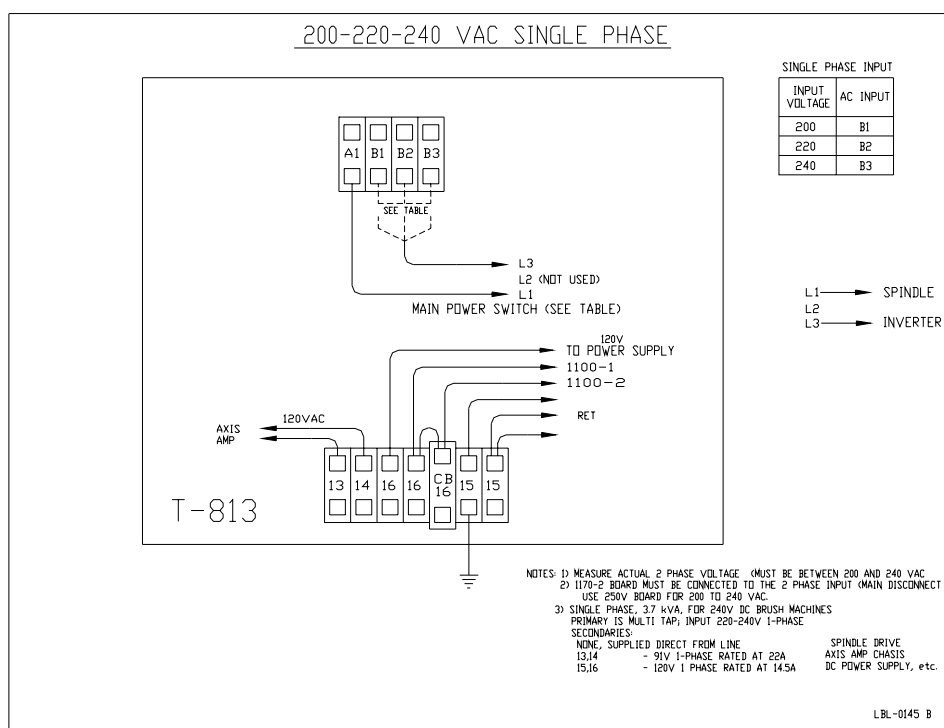


Figure 3-16

- 3) Subtract **step (A3.2.6-7)** from **step (A3.2.6-2)**.

**EXAMPLE:**

measure voltage=	240 L1-L2	245 L1-L3	242 L2-L3
voltage setting=	240 A	240 B	240 C
difference=	0	5	2

- a. If the difference is less than 10, continue.
- b. If the difference is greater than 10, adjust the voltage settings using either figure 9 (3 phase) or figure 10 (single phase) to match the measured voltage.

### The VMC is Ready for the Initial Power on Procedure

- 9) Move the main disconnect switch to the ON (up) position. DO NOT PRESS THE GREEN CNC POWER BUTTON.
- 10) Measure the voltage at the transformers secondary between A12-B12, A12-C12, B12-C12.
- 11) For single phase measure across A8-C8. The voltage should be between 230-240 VAC, correct if necessary.
- 12) Push the EMERGENCY STOP switch to disable the axes, then push the CNC POWER button.
- 13) Check the voltages on the D.C. power supply, i.e. 5, + 12, -12 VDC.
- 14) Reset the EMERGENCY STOP switch.
- 15) Unbolt and remove the support between the table and the head.
- 16) Unbolt and remove the counterweight bars from the column, located next to the main disconnect box.
- 17) Jog the axis to the cold start indicators and cold start the VMC.

---

### Transformer Tapping

- 1) With the machine main power switch turned OFF, verify that the chart on the door of the cabinet is the one for the transformer in the machine.
- 2) Measure the input voltage to the machine on the chart (Measure leg to leg the input power lines to the machine.).
- 3) Next to the voltage on the chart will be a "jumper" number such as 3-6 and a "AC Input" number such as 7.

- 4) Each phase has a group of terminals such as A3 to A8 for phase 1 and B3 to B8 for phase 2. Place a jumper between the two terminals listed on the chart for each phase. Using the same example place jumper from A3 to A6 for phase 1, B3 to B6 for phase 2 and one from C3 to C6 for phase 3.
- 5) Place the input tap wire in the proper terminal, as in example A7 for phase 1, B7 for phase 2 and C7 for phase 3.
- 6) Turn ON the main power switch.
- 7) Measure the input voltage to the spindle drive, usually labeled L1, L2 & L3, leg to leg. Should be about 230 VAC with the range being from 220 to 240 VAC. If the difference between 230 and the measured voltage is greater than ten (10) volts then power down. If the voltage is too high then select the next higher voltage on the chart and change the jumper and / or input tap and recheck. If the voltage is too low then select the next lower voltage and change and check.

**Note:** It is acceptable to have the legs tapped differently by one voltage tap position. There should be no more than one position.

---

### Single Phase Input Power

The Fadal VMC line is designed for three phase input power. However, three-phase power is not always available. If this is the case, Fadal offers a single-phase input power option. All Fadal machines are capable of operating on single-phase line input. The torque ratings will be at 60% of the published performance. The rapid traverse rate is reduced to not more than 700 IPM for machines with higher speed capability. This is because as the DC bus capacitors are drained and the bus voltage drops, the single-phase input can not recharge the capacitors as fast as the three-phase. Lower bus voltage equals lower speed and more current. Single-phase requires 73% more current to maintain the same performance (square root of 3). The main limitation is the spindle drive. It will not draw more than its rated current. The current rise is steeper in single-phase and will therefore trip sooner.

Fadal does not recommend single-phase power for the High torque or the 6535, 6030 and 8030 machines and cannot be used with VHT. This option can be ordered on a new machine and can be installed in the field. Some wiring changes are also necessary. Please see the single-phase transformer charts and wiring instructions.

---

### Phase Converter Rotary

The Normal Fadal VMC requires three phase-input power. The machines are also configured in a single-phase power configuration when requested. Some customers prefer to use rotary phase converters, however Fadal does not recommend the use of rotary phase converters.

Rotary phase converters input single-phase 208 to 230 VAC and output three phase 230 VAC. For a VMC close to a 5% voltage balance between legs would be desired, in reference to the voltage differences of each phase. Most CNC machines would require the output power to be 1-1/2 to 2 times larger than the spindle motor (for a Fadal output must be at or higher than the minimum of the required input; see specifications). A Voltage Stabilizer may also be required. The stabilizer's function is to maintain a consistent voltage level of the three phases during light or no load conditions.

---

### Transformer Sensor

An improvement to transformer design has been developed and it can be retrofitted to existing machines originally fitted with T820, T821, or T822 transformers. This improvement is designed to interrupt the Emergency Stop circuit when the machine is used beyond its designed peak performance for an extended period of time, and transformer temperature approaches its rated limits.



*Figure 3-17* Transformer sensor kit

To determine if the machine has this circuit, look on the left side of the transformer connector rail for a mechanical relay. If the transformer sensor circuit is installed and an Emergency Stop occurs, check the mechanical relay. If the relay is activated (LED lit) then this circuit is not involved but if the relay is not activated then the transformer is overheated. In this case power down the machine and allow the transformer to cool. If the condition persists, then there is a problem that requires investigation.

---

**Leveling**

Leveling is an important first step in setting up the VMC. All calibration and squareness performed on the assembly line is done with the machine leveled. It is important to follow the sequence below precisely to ensure proper results.

**Tools Required**

Precision Level, such as the Starrett 12", P/N 199Z

**IMPORTANT**

Verify that the scale reads the same when rotated 180 degrees.

If using a flashlight to see the bubble, do not place the flashlight on the level, as it will warm the bubble and give an incorrect reading.

**For All VMCs**

- 1) The VMC should be positioned on one solid concrete slab (see PRE-INSTALLATION section). Do not straddle any cracks or seams.
- 2) Center the leveling pads under the leveling screws.

**Note:** Use leveling pad SHP-0002 (PLC-0063 for slant sheet metal machines, or machines equipped with the HydroSweep option) for placing the machine.

- 3) Level the VMC as close as possible to the leveling pads. The leveling screws should be extended as little as possible to reduce vibration through the sheet metal.

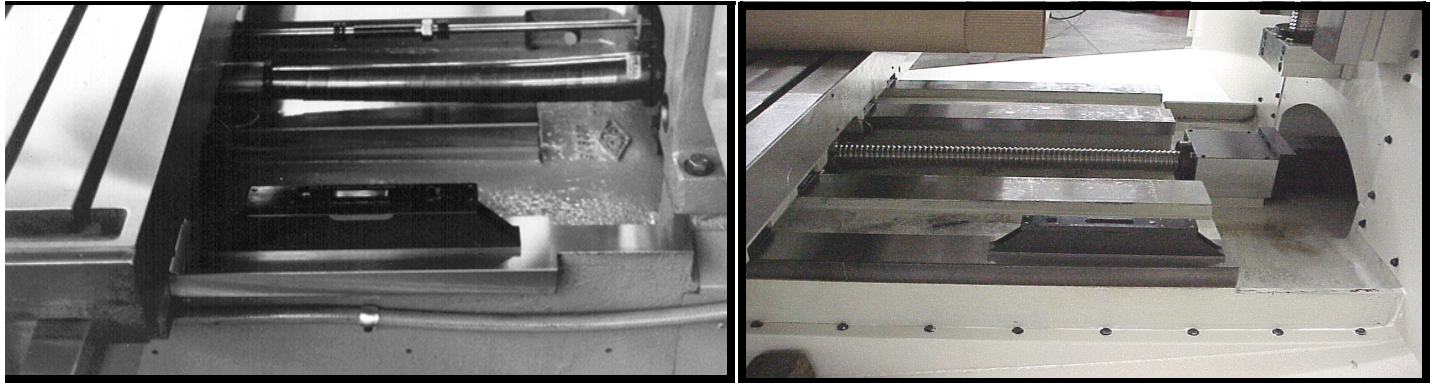
**IMPORTANT**

Make sure that machines with the chip conveyor option are raised high enough so that the chip conveyor tank fits under the sheet metal of the VMC. See section 13 for more information on installing the chip conveyor.

- 4) Verify the Cold Start indicators, then cold start the VMC.
- 5) Clean the level with alcohol.

**Box Way VMCs**

- 1) Jog the Y axis to the Y+ limit.
- 2) Clean the outer base ways with alcohol.
- 3) Place the level on the right hand way (the outer right hand way on the 6535) of the base with the small bubble towards the column. Take an accurate reading. See figure 3-18.



**Figure 3-18** Leveling Box Way (6535 on right).

- 4) Now put the level on the left hand way (the outer left hand way on the 6535) of the base with the level pointing in the same direction as on the right hand way.
- 5) Adjust the leveling screws on the machine until the left hand way and the right hand way are level and even.
- 6) The level will have a front to back bubble and a side to side bubble. Level the machine from front to back first and then from side to side. When adjusting the side to side, adjust both leveling screws of one side only.
- 7) If leveling larger machines, such as the 6535, 6030 or 8030 models, the center four leveling screws must not be touching the leveling pads during the leveling procedure. After the machine has been leveled, lower the four screws to the pad, then check the level and tram readings to ensure they have not changed.
- 8) Verify the spindle tram and, if necessary, adjust by slightly changing *only* the two front leveling screws.

#### **Linear Way VMCs**

- 1) Place leveling pads beneath the six leveling screws.

**Note:** Use only leveling pad (SHP-0002) (PLC-0063 for machines equipped with the HydroSweep option) for placing the machine. Any other pad may cause damage to the machine.

- 2) Drive down the four corner leveling screws to create a minimum of 1/2" gap between the bottom of the base and the top of the leveling pads.



*Figure 3-19* Drive Down Corner Leveling Screws

**Note:** Verify that the leveling pads are seated properly on the pad center depressions.

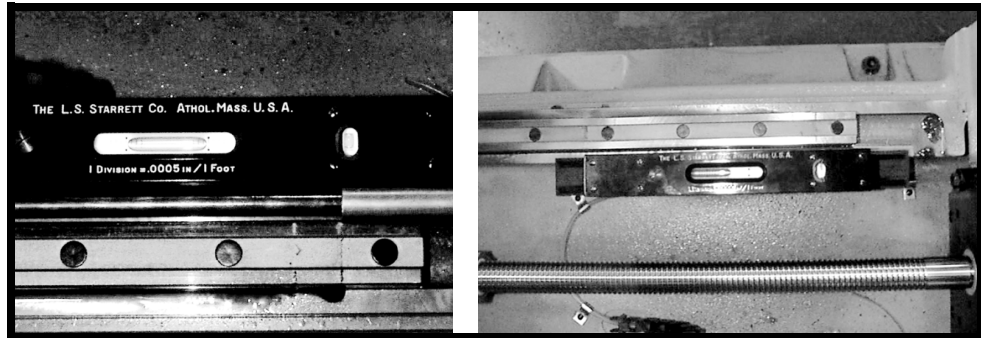
- 3) Jog the saddle to its maximum positive Y position. Disconnect the rear Y axis way cover from the saddle and slide it back to the vertical column.
- 4) Using a clean lint free rag and solvent, wipe the four level tabs and the way base clean of oil and grime. Wipe the bottom of the level clean. Feel for burrs after cleaning the base; remove them with a flat stone if needed.



*Figure 3-20* Clean the Ways



- 5) Place the level on the leveling tabs.500” away from the linear guide way. Situate the level so that the small level gauge is towards the column. All leveling measurements will be taken with the level in this orientation.



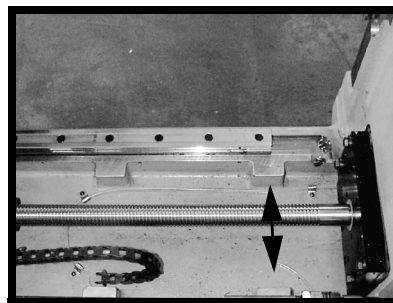
*Figure 3-21* Take Leveling Measurements (6535 on right).

**Note:** Verify that the level is firmly seated by trying to rock it from side to side. Rough in the level by applying pressure to the screws until the level on both gauges is even.

- 6) Allow approximately three minutes before adjusting the level to ensure that the level is at the same temperature as the machine. Adjust the base using the leveling screws. Adjust the screws until the bubble is at the center of the large leveling gauge. Use care to avoid shining the flashlight onto the bubble or otherwise adding heat to the bubble fluid which will distort the results.
- 7) Repeat the above steps for the opposite way.

**Note:** Maintaining the same orientation is important when setting the level on a base way.

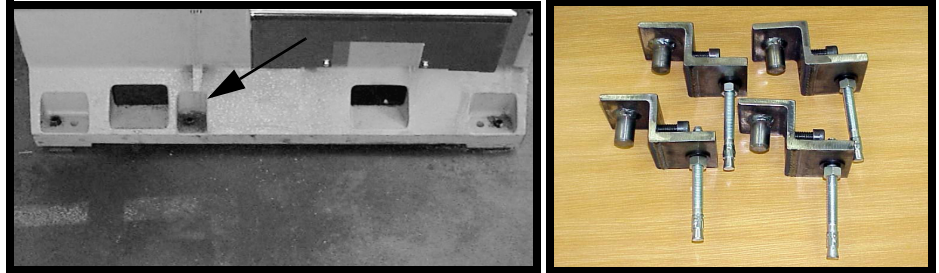
- 8) After the large bubble is centered on both ways, level the small bubble on both ways using both leveling screws on one side only.
- 9) Both ways will have the same reading when the machine is leveled.





*Figure 3-22* Ways Have Same Reading When Leveled

- 10) After the base leveling is completed, seat the two middle leveling screws on the leveling pads.



*Figure 3-23* Left: Seat Middle Leveling Screws on Leveling Pads. Right: Hold Down Clamps.

- 11) Recheck the level of the base to verify that it has not been disturbed, after the middle screws are seated.

**IMPORTANT**



The level of the machine should be checked periodically until the concrete supporting the machine has settled.

---

**Hold Down Clamps**

Larger machines may vibrate, bump on reversals, and degrade floor finish. This may indicate that the base casting needs to be clamped to floor.

Larger machines need to be clamped to the floor to prevent movement between the machine and the floor, and clamping holes are provided on all base castings for this purpose. In the Parts Manuals, there are drawings indicating the locations of these holes so that machines may be moved, studs installed in the concrete floor, and machines reinstalled onto them.

The kit SHP-0116 (see figure 3-23) has been developed to mount the machine to the floor without moving it.

- 1) The Clamp is first mounted into the clamping hole in the base.
- 2) The position is marked on the floor for drilling a ½" hole into the concrete.
- 3) The RedHead stud is mounted in the floor with one nut and washer on it.
- 4) The Clamp is mounted over the stud and then the two ½ inch Socket Cap screws are tightened, pinching the flange of the base casting.
- 5) The second washer and nut are tightened onto the stud, inhibiting any flexing up or down of the base casting.
- 6) Recheck machine level.

Hilti (mfg in Liechtenstein) makes a Right-Angle Hammer Drill, model TE-5, with a model TE-AC Right Angle Head attachment, that works very well in this application.

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## Section 04: Machine Maintenance

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### Scheduled Maintenance

#### Maintenance & Lubrication Schedule

##### Daily

- 1) Check air pressure: Right regulator 120 PSI. max. (Tool Out Only). Left Regulator 80-90 PSI.
- 2) Check way lube level. Use Castrol Magna BD68, Shell Tonna 68V or Mobil Vactra #2 ONLY. (Not applicable to TRM)
- 3) Check way lube system for adequate oil flow to all way surfaces.
- 4) With tool in spindle blow chips from around A.T.C. and slide. NEVER blow chips from around these areas during automatic tool change or without a tool in the spindle.
- 5) Remove heavy chip build up from guards and way covers.
- 6) Wash A.T.C. and machine work area.
- 7) Check coolant level. (Not applicable to TRM)
- 8) Clean coolant screen. (Not applicable to TRM)
- 9) Clean the area around the machine.
- 10) Immediately clean any spills in the area.

##### Weekly

- 1) Check spindle cooler pump and refrigeration unit for proper operation. (Not applicable to TRM)
- 2) Check fluid level of chiller tank and refill, if needed, with a 50/50 mix of Dowfrost clear and de-ionized water. If de-ionized water is not available, sodium-free distilled water can be substituted. *Do not accept any substitutes for DOWFROST CLEAR!* (Not applicable to TRM)
- 3) Clean A.T.C. slide. (Not applicable to TRM)
- 4) Check air regulator.

- 5) Drain and clean water separator.
- 6) Fill oiler if needed. (Not applicable to TRM)
- 7) Activate Thru-Tool coolant system for 2-3 minutes (if machine has this option). (Not applicable to TRM)
- 8) Lubricate Y axis telescoping ball screw cover with way lube. (Not applicable to TRM)
- 9) Grease axis way cover using molygraph. (Not applicable to TRM)
- 10) Grease retention rings using molygraph. (Not applicable to TRM)
- 11) Grease Geneva wheel and gear using Kopr-Kote. (Not applicable to TRM)
- 12) For high torque machines, check fluid level in the hydraulic actuator reservoir. Refill, if needed, with Mobil DTE Heavy Medium.
- 13) Inspect all cooling fans, clean screens if necessary.

**Every 4 months**

Service way lube filter. Machines with an external filter require less frequent replacement; however, do not exceed 4 months. When replacing the external filter, fill the new filter with way lube prior to installation.

**EMC & TRM  
Lubrication of the  
ballscrews****Every 6 months**

To keep the EMC & TRM running smoothly, it is crucial that the ballscrews are lubricated with MOBIL SHC #32 grease at least every 6 months depending on use. Fadal recommends that a Fadal certified service person lubricate the ballscrews.

- 1) Remove the way axis covers.
- 2) Locate the ZERK fittings on the ballscrew ballnut.
- 3) Insert the hose of the grease gun (TLC-0285) onto the ZERK fitting.
- 4) Pump MOBIL SHC #32 grease (CHM-0083) into each ballscrew ballnut. Pump until grease begins to come out of the ballscrew ballnut.
- 5) Remove the grease gun.
- 6) RE-install the axis covers.

**TRM Lubrication of  
the Ways****Every 3 months**

To keep the TRM running smoothly, it is crucial that the ways are lubricated with bearing grease at least every 3 months depending on use.

- 1) Locate the ZERK fittings on the ways on the linear way truck.

- 2) Insert the hose of the grease gun (TLC-0285) onto the ZERK fitting.
- 3) Pump MOBIL SHC #32 grease (CHM-0083) into each linear way truck. Pump until grease begins to come out of the linear way truck.
- 4) Remove the grease gun.

### Lubrication of the Ways

#### Waylube System

USE WAYLUBE TYPE Castrol Magna BD68, Shell Tonna 68V or Mobil Vactra Oil #2.

The Positive Displacement Injection (PDI) lube system is a solenoid-controlled pneumatic system. When the solenoid is activated, the pump sends oil to the junction block assemblies, which may contain several different size valves, at a pressure ratio of 5:1. The pump is activated for 10 seconds, within a 4 minute cycle, during which oil is distributed to all of the valves on the junction block assemblies. When the solenoid is deactivated the oil flow stops and creates back pressure which escapes through a relief valve. When the pressure on the valve drops below 50 psi, a spring inside the valve is then able to inject oil into the lines.

The CNC has direct control of the automatic lube system. The cycle is activated by executing an axis motion in a CNC program, commanding an axis move in MDI mode or pressing the JOG key. Once activated it monitors the oil level to be sure the reservoir is above the minimum level. In addition, it shuts the oil system down if the machine sits idle longer than one cycle of the lube system.

Frequently clogging filters indicate that the wrong waylube is being used. *Use Castrol Magna BD68, Shell Tonna 68V or Mobil Vactra Oil #2 ONLY.*

#### Procedure for Flushing a Contaminated Waylube System

This procedure is necessary when the waylube that was being used in the machine was incorrect. Other waylubes may contain paraffin wax or silicone.

- 1) Replace the 10-port way lube junction block that is located at the left side of the saddle.
- 2) Replace the External filter on the BIJUR PDI way lube pump (Part # LUB-0049).
- 3) Remove the oil line that is between the way lube pump and the three port junction T that is located near the pump mount.
- 4) Verify that the flush pump air regulator is fully counterclockwise.
- 5) Attach an air line to the flush pump.

**WARNING**

Verify that the air regulator is closed.

- 6) Insert the 3/8" hose from the flush pump into a container of grade A kerosene.
- 7) Slowly open the air regulator clockwise to start the flush pump.
- 8) Increase the air pressure being careful that the output pressure does not exceed 180 PSI at the gauge.
- 9) The pump is 4:1 ratio, 45 PSI input air pressure is 180 PSI output.
- 10) Enter a program that will exercise all axes to their limits. Start the program running.
- 11) The flow of kerosene through the way lube system should be steady.
- 12) If the kerosene is dripping slowly down the column from underneath the Z axis head the manifold filters are probably clogged. Replace the 8 port junction block located on the Z axis head. Start over at step D.
- 13) Remove the 3/8" hose from the kerosene and place the hose in a can of clean fresh waylube.
- 14) Slowly open the regulator clockwise on the flush pump. Pump waylube through the lines until the system is well lubricated.
- 15) Stop the machine and return it to the COLD START position.
- 16) Turn the flush pump air regulator fully counterclockwise and remove the air line.
- 17) Remove the flush pump and reattach the oil line from the Bijur pump to the 3 port junction.

**Cooling Fans****WARNING**

Power off the machine at the main disconnect switch and lockout/tagout the main disconnect.

There are numerous cooling fans on the VMC that require periodic inspection. Located in the CNC box and the junction box.

**WARNING**

Wear safety glasses!



If the fan is turning slowly or not at all it may require cleaning or replacement. The fan on the bottom of the junction box has a screen that requires periodic inspection and removal for cleaning.

### **Spindle & Ballscrew Cooling System**

The spindle and ballscrew cooling system is made up of a motor pump assembly, ambient-liquid temperature sensor assembly and a DP5P chiller. As long as there is power to the machine the chiller pump is circulating Dowfrost through the system. The ambient sensor is used to measure casting/air temperature and the liquid sensor to measure Dowfrost temperature in the return line. When there is a one degree temperature differential between the two sensors the chiller is then powered on.

### **Pump Filter**

There is a small filter and pressure gauge located on the pump head assembly. Normal pressure is 3-5 pounds, cooled ball screws are 10 to 30 pounds. If the pressure gauge shows a pressure above normal the filter should be inspected and cleaned.



*Figure 4-1* Pump Filter

### **Tank Reservoir**

The tank reservoir is located next to the motor pump assembly in the chiller cabinet. The tank has a 2 1/2 gallon capacity. Visually check the fluid level with the machine powered on. If the fluid level is less than 1/2 of the tank, mix the

Dowfrost to a 50:50 solution, with deionized water, or sodium free distilled water and fill to no more than 3/4 full.



*Figure 4-2* Tank Reservoir

**Source for Dowfrost:**

GOLDENWEST LUBRICANTS  
1816 POTRERO AVE.  
SOUTH EL MONTE, CA 91733  
(626) 443 - 3441  
(800) 540 - 5823

*Do not accept any substitutes for DOWFROST!*

**Pressure**

The cooling system should maintain a constant pressure of 3 to 5 psi on machines with 400 I.P.M. rapid or 10 to 30 psi with 700 I.P.M. rapid.

If the pressure rises, the following conditions may exist:

- clogged pump filter;
- pinched oil lines;
- clogged cross tubes (only on 400 I.P.M. machines equipped with cooled ball screws).

If the machine is losing pressure and the Dowfrost level keeps dropping, the following conditions may exist:

- the O-ring that seals the ball screw cross tubes is leaking;
- there is a hole in one of the lines.



## Fuses, Heaters, & Relays

SEE SECTION 18: Fuses, Heaters, Parameters

## Fluids

**Table 1: Fluids**

RESERVOIR	FILL WITH
Waylube	CASTROL MAGNA BD68 SHELL TONNA 68V or MOBIL VACTRA #2
Spindle Cooling System	DOWFROST CLEAR (Mixed 50/50 with de-ionized water or sodium free distilled water)
Rotary Tables	MOBIL GEAR 626
Hydraulic Hi/Low	MOBIL DTE HEAVY MEDIUM
Hydraulic Brake	HYDRAULIC OIL 32

## Auger **Cleaning and Freeing Chips from the Auger Chip Removal System**

Prior to cleaning or removing jammed material from the Auger or its exit tube.

- 1) Shut down the VMC by disconnecting the main switch in the back. It is imperative to use OSHA approved Lock Out – Tag Out procedures to power down the VMC.



*Figure 4-3* Lock Out-Tag Out



### **WARNING**

Chips from the machining process are extremely sharp. Do not attempt to remove these materials with bare hands.

**WARNING**

Do not remove material while the machine is operating or in the Emergency Stop mode.

**Chip Removal from the Machine Interior**

Remove the side panels, open front doors, and remove the material from the Auger. Wear heavy leather gloves and use a tool, such as pliers, when removing material between the sheet metal and the auger.

Do not climb inside the machine to clean the auger. As shown below, all portions of the auger are easily accessible from the front and side panel doors.

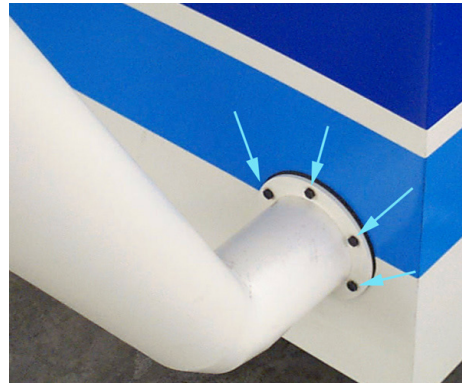


*Figure 4-4* Auger Accessibility from Front and Side Panel Doors

**Chip Removal from the Exit Tube**

- 1) Removal of the tube may be necessary for material jammed in the exit tube.

- 2) Remove 6 hex bolts and washers from auger exit tube connection to the sheetmetal housing.



*Figure 4-5* Remove Hex Bolts and Washers from Auger Exit Tube

- 3) Wear heavy leather gloves and use a tool such as pliers when removing jammed material from the auger exit tube. Remove using a heavy steel rod (for hard to reach area in the mid-section of the tube) or pliers.
- 4) Reattach the auger exit tube to the sheet metal housing.

#### **Dual Arm Tool Changer**

The causes of abnormal wear and fractures will be apparent when the tool changer is used without lubricant. It is very important to grease all moving parts of the tool changer at least once a week.

#### **Lubricant**

The lubricant should be changed annually, or when it has become visibly deteriorated. The recommended lubricant is SAE 90-140, approximately 1.3 gallons.

#### **Grease**

Grease should be spread once a week in the following locations:

- 1) The claws of the tool changing arm unit.
- 2) The tip of the release pin of the tool changing arm unit.

#### **Cleaning**

- 1) Remove the chip powder from around the proximity switch inducing box.
- 2) Remove the chip powder from around the inverted moving body of the tool pot.
- 3) The tool changing mechanism must be cleaned frequently to prevent excess build up of chip powder.

**Scheduled  
Maintenance  
for Dual Arm Tool  
Changer****Inspection**

Check the parts of the tool falling mechanism regularly and, check for grease on the sliding base of the tool falling mechanism and the sliding base of the pull rod. Check the parts of the tool pots and tool discs for tightness and overall condition.

The maintenance schedule is based on machine usage of eight hours a day, five days a week.

**Daily Maintenance**

Perform the following daily:

**1) Cleaning**

- a. Remove the chips and debris surrounding the proximity switch inducing block.
- b. Remove the chips and debris that have accumulated on the inverted moving body of the tool pot.
- c. Clear the tool changing mechanism of all debris before any operation.

**2) Inspection:**

- a. Check the parts of the tool falling mechanism for damage and wear. Add grease to the sliding base of the tool falling mechanism and the pull rod.
- b. Check the parts of the tool pots, tool discs, and snap rings for damage and tightness.

**Weekly Maintenance**

Perform the following weekly:

**1) Greasing:**

- a. Grease the claws of the tool changing arm unit.
- b. Grease the tip of the release pin of the tool changing unit.

**Miscellaneous Maintenance**

Perform the following as necessary:

Change the lubricant annually or as needed. The recommended lubricant is SAE 90-140. The Dual Arm Tool Changer uses approximately 5 liters (1.3 gallons).

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**Calibration of VMCs  
using the Renishaw  
laser**

<b>Scope</b>	This qualification procedure applies to all Fadal VMCs calibrated using the Renishaw Laser and software.
<b>Reference Documentation</b>	Renishaw Laser Measurement System – Current Version – User Manual
<b>Materials and Equipment</b>	<ul style="list-style-type: none"><li>• PC Loaded with Renishaw Software and PC10 Plug-in card.</li><li>• Renishaw ML10 Laser</li><li>• Renishaw Interferometer</li><li>• Renishaw Reflector</li><li>• Temperature Sensor ‘Magnetic’</li><li>• Temperature Sensor ‘Mechanical’</li><li>• Laser Tripod</li></ul>
<b>Safety and Environmental</b>	<p>Always use caution when working around machinery. Wear proper protective clothing and wear safety glasses at all times.</p> <p>Although the laser used for this measurement is safe to use, it is never a good idea to look at a “Laser beam” with an unprotected eye. Take care to avoid an unmanaged or unshielded beam, which could strike a bystander.</p>
<b>Definitions</b>	<p>Laser Calibration process – The process of obtaining deviations from a standard and using these values to correct a standard via software.</p> <p>Calibration Measurement – the final calibration measurement after the survey compensation data has been entered into the controller. This is verification that the survey compensation data has corrected the axis to the laser standard.</p> <p>Survey – Laser measurement to obtain deviation data “to survey” which will be used to enter compensation values into the controller.</p>
<b>Responsibilities</b>	Fadal Machining Centers and Quality have responsibility for the test procedure. Managers and Supervisors have responsibility for following this test procedure where its use is required.
<b>Procedure</b>	This procedure will measure unidirectional axis travel in reference to a calibrated laser. Deviations are generated which are loaded into the VMC controller software. The software will correct for the mechanical deviations improving the accuracy of axis travel. This procedure is designed as a production qualification and machine calibration procedure. It covers only one type of laser measurement. Refer to the current Renishaw manual for other

laser methods if required. It may be used for re-calibration of a machine after service or re-build. It may also be used for re-calibration of a machine after service or re-build

The procedure is written for a technician that has had training both with the Renishaw manual and on the job... Therefore, only trained technicians should be performing this calibration procedure.

For further detail on Laser set-up, refer to the set-up section of the current Renishaw manual.

**CAUTION:**

Laser could cause severe eye damage, do not point laser outside or mirror range nor look directly into.

**Standard Fadal  
Cnc88hs**

Axis to be Calibrated and Configuration

There are three axis (X, Y and Z) which may be calibrated using this procedure and two configurations one using the motor encoder the other using the optional scale box. The table below directs which axis and configuration to use during production testing:

	No Scale Option	X/Y Scale Option	Z Scale Option
Survey at Encoder	X Y Z*	X Y	X Y Z
Survey with Scale		X Y	X Y Z
Calibrate with Encoder	X Y	X Y	X Y Z
Calibrate with Scale		X Y	X Y Z

\* ONLY if Z-Calibrate Option is ordered.

The reason both Encoder and Scale calibration measurements are completed, when the scale option is purchased, is to provide a backup calibration to the customer in the event the scales need to be disabled.

**Documentation**

Place copies of **all** axis surveys and calibrations in the Fadal Machine Assembly Checkout Record.

Place copies of the final axis surveys in customer documentation pocket of the VMC.

### Calibration Requirements and Limits

VMCs over compensated via software...this is not considered calibrated. The limits for proper calibration are (100%pas).

Maximum Target to Target Compensation < 0.0003"

Maximum Range of Compensation (Max delta from lowest value to highest) < See Table Below.

VMC Model	X	Y
TRM	15	30
EMC	15	30
15, 15XT	15	10
2216, 2016L, 3016L	15	10
4020, 4020S	20	10
4020A	30	10
5020A	40	10
6030	50	20
8030	110	20
3020	20	10
4525	50	20
6535	110	20

X and Y values above are Compensation Values they represent 0.0001" units.

### Laser Setup

To perform a VMC calibration the VMC must be in good working order and have the table free of fixtures and parts.

- With the machine powered up and in HOME position clear out old survey data.
- Set up and level out the tripod so that the leveling bubble is in the middle of the target circle on the tripod legs at their base, set laser on the tripod.
- The front two feet on the bottom of the laser fit into the two holes on the top of the tripod.
- Aim the laser towards the middle T-slot of the machine.
- Plug the laser cable into the small port on the back of the laser unit.
- Plug the power cord into the back of the laser unit and plug in the computer power source.
- Power on the computer and the laser.

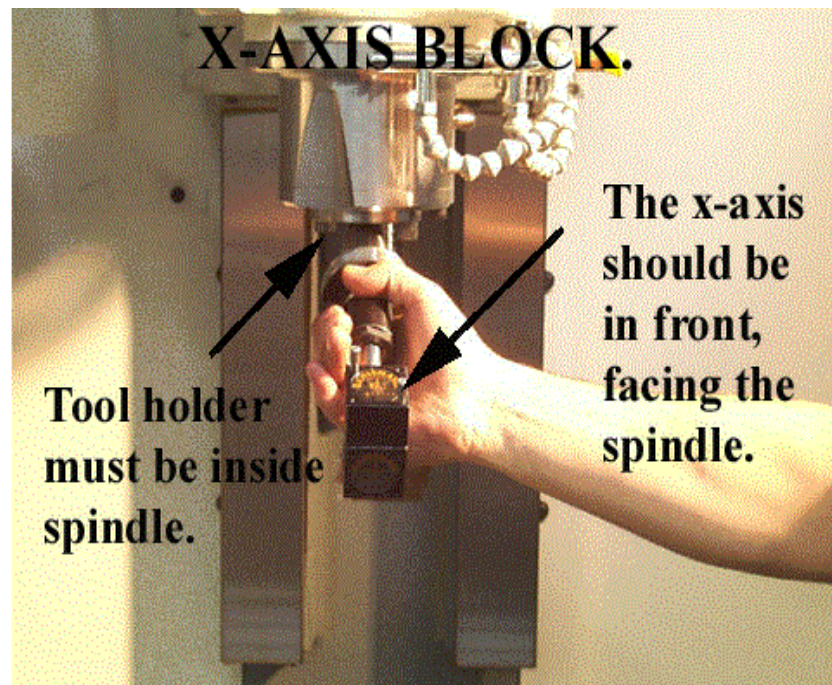
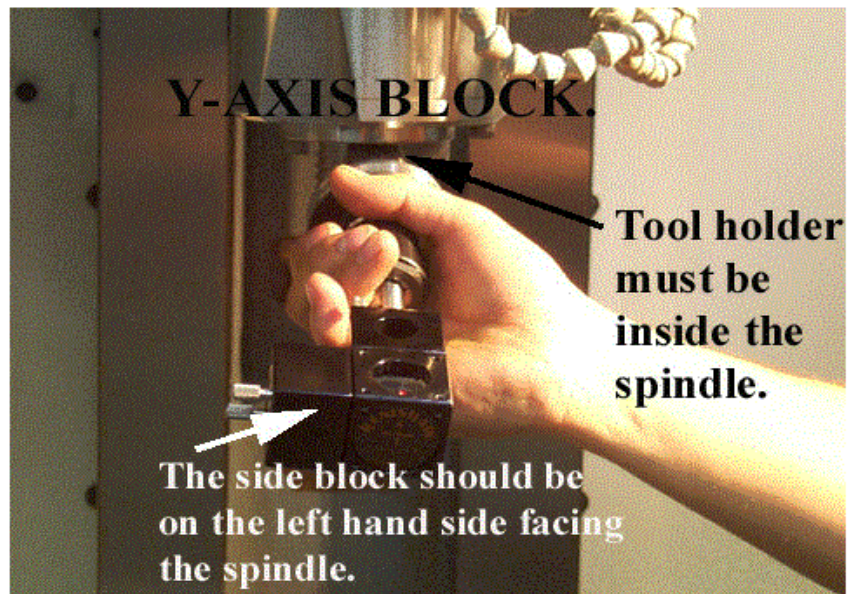
### CAUTION:

Laser could cause severe eye damage, do not point laser outside of mirror range, nor look directly into beam.



**Note:** The laser will require 15 minutes to warm up.

- Plug the RS232 cable into the RS232 serial port on the back of the side wiring cabinet of the VMC.
- Plug the laser cable into the small port on the back of the laser unit.





- Install beam splitter into spindle. There are two arrows on the beam splitter for calibrating the X-axis, the arrows should be pointing down the X-axis and away from the column. The mirror “must be attached” to the front of the beam splitter. For calibrating the Y-axis, the arrows go in the same direction as the X-axis, but attach the mirror to the left of the beam splitter.
- Install mirror unit in the middle T-slot on the table.
- Jog Z-axis head down so the bottom of the beam splitter and the mirror on the table are horizontally even.
- Tighten down the mirror on the table.
- Install the first temperature sensor on the inside of the door away from any draft, the second sensor, which is a magnetic temperature sensor is to be placed in the middle T- Slot, middle of the table.

### **Aligning the laser**

- When lining up the laser beam the beam must go into the beam splitter from the laser at 3:00 and come out of the splitter at 9:00 for X-axis.
- With the X-axis at its negative end, line up the beams superimposed on each other. Do this by jogging the head and adjusting the mirrors from side to side. Be sure that the mirror and the beam splitter are completely parallel with each other.
- Once the beams superimpose, jog the X-axis to its positive limit.
- Line up the beams on the target of the laser superimposed. (This may take a while with a lot of adjusting.)
- Use the three adjusters to correct the lasers position, always level first, then rotate (unit turning CW or CCW), and last translate (laser up and down). This is the proper way for fast and accurate alignment of the laser.
- Once the beams superimpose, then turn the dial on the front of the laser one turn in the clockwise direction. This should leave the target position to open, to let the laser receive the beam.
- After laser set up check the computer screen to see if the signal meter is completely green, if so then you are ready to go. (If the signal meter is not green, then adjust using steps above).

**Download Survey** For Fadal Control use the following survey downloading procedure:

- § Run Survey Download off computer desktop [REN2FAD.EXE]
- § On Fadal Control and at Enter Next Command, type CD,6
- § Follow program instructions and enter appropriate data.

**Note:** Program will move into axis calibration.

**Axis Calibration** Data Capture  
 Target Sequence – Linear  
 Number of runs – 1 for survey 2 for calibration  
 Select Direction – Unidirectional

**Amend Title Information** – (Do as Prompted)  
 VMC Type  
 Serial Number  
 Location – (Same as “Auto Target Generate” Target)  
 Title – Encoder or Scale, and Survey or Calibration

## Escape

ALT P = Changes the Datum  
 F2 = Datum's the Laser  
 Alt – = Changes the sign from negative to positive and vice versa.

**Run program on CPU** Select axis (x, y, or z)  
 Select length of axis  
 Agree or disagree

**Push F2** to datum the computer

## Start Data Capture

**Push Auto** and run the rest of the program on the VMC  
 When prompted, hit **enter** and slidehold the program – **SETCS** and send axis to home position

**Save data** – Save and Name Computer files as follows:  
 [Axis] [E,S or C] [The last 6 serial number digits]  
 E = Encoder Survey, S = Scale Survey, C = Calibration Axis = X, Y  
 or Z

For a SN: 01200010111, an example is: XE010111 or YS010111

**Analyze**

Surveys – (Error Comp Table)

Absolute Value

Produce Error Comp Table

Graph – (Renishaw Analysis)

Copies of survey and calibration placed in machine (electrical cabinet pocket) and document book or jacket.

**Exit** Application

**Sample output from  
a laser measurement  
system.**

RENISHAW CALIBRATION INTERFEROMETER SYSTEM  
ERROR COMPENSATION TABLE

MACHINE VMC 3020

SERIAL No: XXXX

DATE: XXXXX

By:

Axis: Y AXIS

Location: -9

Title: Type

Combined table with backlash

value

Compensation type

Absolute

Compensation resolution

0.0001 in

Reference position

-9.0000 in

Compensation start

-9.0000 in

Compensation end

10.0000 in

Compensation spacing

1.0000 in

Backlash value

0.0000 in

Compensation values

No.

Axis position  
(in)

Combined  
(0.0001 in)

1	-9.00000	0
2	-8.00000	-1
3	-7.00000	-2
4	-6.00000	-2
5	-5.00000	-3
6	-4.00000	-3
7	-3.00000	-4
8	-2.00000	-4
9	-1.00000	-4
10	0.00000	-4
11	1.00000	-4
12	2.00000	-4
13	3.00000	-4
14	4.00000	-5
15	5.00000	-4
16	6.00000	-5
17	7.00000	-5
18	8.00000	-6
19	9.00000	-6
20	10.00000	-7

This partial view of COMP\_VALUES\_y shows the survey values from the above file. Notice that there are three pointers in the brackets. Out of those three, the middle number has the same meaning as the position No. in the file above.

N50 \$AA\_ENC\_COMP[\_ENC\_NR, 1, AX2] = - 0.0000 corresponds to No. 1  
and N75 \$AA\_ENC\_COMP[\_ENC\_NR, 6, AX2] = - 0.0003 corresponds to No. 6 in the table.

N75 \$AA\_ENC\_COMP[\_ENC\_NR, 6, AX2] = - 0.0003  
N35 \$MA\_ENC\_COMP\_ENABLE[\_ENC\_NR, AX2] = 0  
N40 NEWCONF  
stopre  
;-----BEGINNING—OF—SURVEY-----

N45 \$AA\_ENC\_COMP[\_ENC\_NR,0,AX2]=-0.0000  
N50 \$AA\_ENC\_COMP[\_ENC\_NR,1,AX2]=-0.0000  
N55 \$AA\_ENC\_COMP[\_ENC\_NR,2,AX2]=-0.0001  
N60 \$AA\_ENC\_COMP[\_ENC\_NR,3,AX2]=-0.0002  
N65 \$AA\_ENC\_COMP[\_ENC\_NR,4,AX2]=-0.0002  
N70 \$AA\_ENC\_COMP[\_ENC\_NR,5,AX2]=-0.0003  
N75 \$AA\_ENC\_COMP[\_ENC\_NR,6,AX2]=-0.0003  
N80 \$AA\_ENC\_COMP[\_ENC\_NR,7,AX2]=-0.0004  
N85 \$AA\_ENC\_COMP[\_ENC\_NR,8,AX2]=-0.0004  
N90 \$AA\_ENC\_COMP[\_ENC\_NR,9,AX2]=-0.0004  
N95 \$AA\_ENC\_COMP[\_ENC\_NR,10,AX2]=-0.0004  
N100 \$AA\_ENC\_COMP[\_ENC\_NR,11,AX2]=-0.0004  
N105 \$AA\_ENC\_COMP[\_ENC\_NR,12,AX2]=-0.0004  
N110 \$AA\_ENC\_COMP[\_ENC\_NR,13,AX2]=-0.0004  
N115 \$AA\_ENC\_COMP[\_ENC\_NR,14,AX2]=-0.0005  
N120 \$AA\_ENC\_COMP[\_ENC\_NR,15,AX2]=-0.0004  
N125 \$AA\_ENC\_COMP[\_ENC\_NR,16,AX2]=-0.0005  
N130 \$AA\_ENC\_COMP[\_ENC\_NR,17,AX2]=-0.0005  
N135 \$AA\_ENC\_COMP[\_ENC\_NR,18,AX2]=-0.0006  
N140 \$AA\_ENC\_COMP[\_ENC\_NR,19,AX2]=-0.0006  
N145 \$AA\_ENC\_COMP[\_ENC\_NR,20,AX2]=-0.0007

;-----END--OF--SURVEY-----

N150 \$AA\_ENC\_COMP\_STEP[\_ENC\_NR,AX2]=1

**Laser Shut Down**

- When finished with entire calibration procedure for all axes Press F5 and exit application, then exit to DOS.
- Turn off laser and move dial one notch until target shows.
- Unplug laser cable and RS232 cable.
- Power down and Unplug computer.
- Store all equipment and clean up workstation.

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**Pallet Changer/  
Hydro Sweep™****Each Part Cycle**

- 1) Make certain that HydroSweep unit is cycled before every Pallet Exchange. Use an M20 in the program to make it automatic. Frequent washing out of chips prevents them from building up into difficult-to-remove piles.
- 2) Blow away any chips that may lodge underneath Pallet in Hydraulic Arm groove.

**Daily Maintenance**

- 1) Put both Pallets away onto stand. Put tool in spindle. Wash down interior with coolant hose nozzle, using care to keep splash away from Automatic Tool Changer, Head assembly, or any wiring connections.
- 2) Wash out HydroSweep drum, clearing any chips from inside. Inspect behind HydroSweep Ram for any stray chips blocking return slot.
- 3) Clean chips from trough behind Table and Saddle, and on Sliding Doors.
- 4) Guard, and inspect between front Y-axis way cover and front of machine for chip buildup.
- 5) Remove screen/tank cover over fluid tank, and clean screen protecting pumps.
- 6) Using tool, check for any chip buildup in tank ahead of screen.
- 7) Check tank reservoir fluid level, and refill as necessary.
- 8) Check Waylube level, refill with Castrol Magna BD68, Shell Tonna V68, or Mobil Vactra #2.
- 9) Check for air pressure. Single regulators should be set for 80PSI. Dual regulators should be set at 80PSI on the left gauge, and 90-100PSI maximum on the right gauge.
- 10) Move X-axis to either side, and flip over outer X-axis way cover. Inspect for chip buildup, and clean. Check for waylube presence on both X-axis ways. Inspect Z-axis and Y-axis as well.
- 11) Check pressures/vacuum on Coolant-Thru pump filter and replace filter, if necessary.

**Weekly Maintenance**

- 1) Check Hydraulic Fluid level for Pallet Clamp on top of machine. Use Mobil DTE Heavy Medium.
- 2) Remove Hydraulic Arm pump cover, and inspect Hydraulic Arm system, refilling fluid if necessary.

- 3) Check Hydraulic Arm chain tension by push/pull on arm.
- 4) Remove Head Cover, and inspect fluid lines for Hi/Lo Idler assembly, refilling, if necessary.
- 5) Remove all tools from tool changer, and clean out any chip buildup. When returning tools to ATC, inspect retention ring tension on tool holders for excessive looseness, replacing rings, if necessary.
- 6) Disconnect front Y-axis way cover from saddle, and check for chip buildup.
- 7) Inspect under Y-axis motor for chips, and clear out drain ports under Y-axis ways nearest the column.

**Monthly Maintenance**

- 1) Carefully remove pallets, and grease rail bearings, using care not to damage lip seals.
- 2) Remove spindle motor top filter cover, and inspect filter. Replace, if necessary.
- 3) Inspect Pallet Roller latch system for both Pallets on stand.
- 4) Inspect all HydroSweep nozzles for chip clogging.
- 5) Check Pallet Lift Door for smooth operation.
- 6) Inspect Chiller cabinet for low fluid in container, should be 1/2 to 3/4 full.
- 7) Inspect Chiller recirculation pump filter, and clean as needed.
- 8) Blow air into top of Chiller louvers to clear out dirt collecting on condenser.
- 9) At bottom of rear cabinet, remove fan filter screen and clean.
- 10) Inspect front door rollers, tightening as necessary.
- 11) Check door interlock system for proper operation.
- 12) Remove head cover and inspect belts, and check for any Coolant-thru system leaks.
- 13) Inspect all cables, hoses, and tubing for looseness, or damage.



**HydroSweep™ Only****Each Part Cycle**

- 1) Make certain that HydroSweep unit is cycled before every part change, or run at least 20 minutes per hour run time. Use an M20 in the program to make it automatic. Frequent washing out of chips prevents them from building up into difficult-to-remove piles, and clears drum from chip buildup.
- 2) Clean away any chips that may lodge in rear trough at bottom of Y-axis sliding tray.

**Daily Maintenance**

- 1) Wash down interior with coolant hose nozzle, using care to keep splash away from Automatic Tool Changer, Head assembly, or any wiring connections.
- 2) Wash out HydroSweep drum, clearing any chips from inside. Inspect behind HydroSweep Ram for any stray chips blocking return slot.
- 3) Clean chips from trough behind Table and Saddle, and on Sliding Guard, and behind Sliding Guard near Y-axis ballscrew, and inspect between front Y-axis way cover and front of machine for chip buildup.
- 4) Remove screen/tank cover over fluid tank, and clean screen protecting pumps.
- 5) Using shovel, check for any chip buildup in tank ahead of screen.
- 6) Check tank reservoir fluid level, and refill as necessary, using only coolant with anti-foam inhibitors.
- 7) Check Waylube level, refill with Castrol Magna BD68, Shell Tonna V68, or Mobil Vactra #2.
- 8) Check for air pressure. Single regulators should be set for 80PSI. Dual regulators should be set at 80PSI on the left gauge, and 90-100PSI maximum on the right gauge.
- 9) Move X-axis to either side, and flip over outer X-axis way cover. Inspect for chip buildup, and clean. Check for waylube presence on both X-axis ways. Inspect Z-axis and Y-axis as well.
- 10) Check pressures/vacuum on Coolant-Thru pump filter and replace filter, if necessary.

**Weekly Maintenance**

- 1) Remove Head Cover, and inspect fluid lines for Hi/Lo Idler assembly, refilling, if necessary.
- 2) Remove all tools from tool changer, and clean out any chip buildup found. When returning tools to ATC, inspect retention ring tension on tool holders for excessive looseness, replacing rings, if necessary.
- 3) Disconnect front Y-axis way cover from saddle, and check for chip buildup.
- 4) Inspect under Y-axis motor for chips, and clear out drain ports under Y-axis ways nearest the column.

**Monthly Maintenance**

- 1) Remove spindle motor top filter cover, and inspect filter. Replace, if necessary.
- 2) Inspect all HydroSweep nozzles for chip clogging.
- 3) Inspect Chiller cabinet for low fluid in container, should be 1/2 to 3/4 full.
- 4) Inspect Chiller recirculation pump filter, and clean as needed.
- 5) Blow air into top of Chiller louvers to clear out dirt collecting on condenser.
- 6) At bottom of rear cabinet, remove fan filter screen and clean.
- 7) Inspect front door rollers, tightening as necessary.
- 8) Check door interlock system for proper operation.
- 9) Remove head cover and inspect belts, and check for any Coolant-thru system leaks.
- 10) Inspect all cables, hoses, and tubing for looseness, or damage.

The above maintenance procedures may be performed by customer's maintenance crew.

**6-Month Planned Maintenance**

This should be performed by the Fadal Planned Maintenance Crew semi-annually.

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**Tests for CE  
Safeguards on Fadal  
Machines**

These tests should be done when machine is first installed and after servicing when any components are replaced.

1) Power on machine but do not cold start.

Start spindle. (Press Shift-Spindle on)

- Spindle will not start OR
- Press Emergency Stop; spindle must stop.
- Immediately release Emergency Stop; spindle does not start.

2) Cold start machine.

Start spindle. (Press Shift-Spindle on)

- Press Emergency Stop; spindle must stop.
- Immediately release Emergency Stop; spindle shall not start, VMC remains in emergency stop.
- Repeat test in Auto, MDI, and Jog modes.

3) Start spindle. (Press Shift-Spindle on)

- Open front door; spindle must stop.
- Try to restart spindle; spindle does not start with doors open.
- Check LED on 2000-1 board; it should be on.
- Check contactor for spindle; contacts should be out. (There may be a 5 to 10 second delay between the opening of the door and the release of the contactor. This allows a controlled stop).

4) Close doors.

- Repeat test with left side panel.
- Repeat test with right side panel.

5) Do a TC,1 with doors open.

- Z-axis does not rise if doors are open.
- close doors and execute TC,1.

6) With doors open press manual (ending TC,1).

- Z-axis does not move unless doors are closed.

**Daily & Weekly Safety Tests for CE Safety Circuits**

To ensure proper functioning of safety circuits, the following tests should be performed on a regular basis.

**Daily**

The Door Interlock Monitor will be on the 1310-0C board if the machine has an auger, or on the 2000-1A board.

If the machine does not have an auger and is not CE, there will be no Door Interlock Monitor.

**Door Interlock Monitor Daily Test for 2000-1A or 1310-0C**

- 1) Close all doors. Make sure VMC is not in emergency stop.
- 2) Start spindle at slow speed.
- 3) Open front door.

Spindle should stop immediately (fully stopped from any speed in less than 5 seconds). Five to ten seconds after the door is opened you should hear the spindle contactor open. (The five to ten second delay allows the spindle to come to a controlled stop.)

- 4) Close front door. Spindle contactor will immediately reenergize.

**Daily****Front Door Lock Daily Test for 2030-0A**

- 1) Close all doors. Make sure machine is not in emergency stop.
- 2) Open front door. You may be able to hear the spindle contactor open, if not a second person will be needed to watch the contactor.
- 3) Close front door. You may be able to hear the contactor close, if not see 2 above.
- 4) Start spindle. Attempt to open front door. Front door should be locked.
- 5) Stop spindle. There should be a delay of 1 to 5 seconds after the spindle comes to a complete stop before the door unlocks. (This delay can be adjusted from 1 to 5 seconds with R22.)
- 6) In either automatic or manual mode command a tool change. Attempt to open the door. Front door should be locked while turret is moving toward spindle or while dual arm tool changer arm is in motion.

**Dual Arm Tool Changer (1330) Daily Test**

No daily test.

**Pallet Changer (1100-3A) Daily Test**

No daily test.

**Weekly**

The Door Interlock Monitor will be on the 1310-0C board if the machine has an auger, or on the 2000-1A board.

If the machine does not have an auger and is not CE, there will be no Door Interlock Monitor.

**Door Interlock Monitor (2000-1A) Weekly Test**

- 1) Close all doors. Make sure VMC is not in emergency stop.
- 2) Open cabinet containing Door Interlock Board (2000-1A) and examine LEDs and relays on the 2000-1A board.
  - Red door LEDs should be off.
  - Green door LEDs should be on.
  - Estop relay (K3) should be on (LED lit).
  - Output relay for spindle contactor (K2) should be on (LED lit).
- 3) Press Emergency Stop switch.
  - Estop relay should go off immediately.
  - Output relay should go off after 5 to 10 seconds.
- 4) Release Emergency Stop switch and clear emergency stop condition by pressing Jog.
- 5) Open front door.
  - Front door red LED should be on.
  - Green door LEDs should be off.
  - Spindle contactor should release after 5 to 10 seconds.
- 6) Close front door and open left side door.
  - Left door red LED should be on.
  - Green door LEDs should be off.
  - Spindle contactor should release after 5 to 10 seconds.
- 7) Close left side door and open right side door.
  - Right door red LED should be on.
  - Green door LEDs should be off.
  - Spindle contactor should release after 5 to 10 seconds.

**Weekly****Door Interlock Monitor Weekly Test for 2000-1 B or -1 C**

- 1) Close all doors. Make sure VMC is not in emergency stop.
- 2) Open cabinet containing Door Interlock Board (2000-1 B or -1 C) and examine LEDs and relays on the 2000-1 B or -1 C board.
  - Red door LEDs should be off.
  - Yellow door LEDs should be off. Green "Doors Closed" LED should be on.
  - Red Slidehold LEDs should be off.
  - Estop relay (K3) should be on (LED lit).
  - Green "Spindle Enable" LED should be on.
  - "Spindle" relay for spindle contactor (K2) should be on (LED lit).
- 3) Press Emergency Stop switch.
  - Estop relay should go off immediately.
  - Spindle Enable LED and Spindle relay should go off after 5 to 10 seconds.
  - Spindle contactor should then release.
- 4) Release Emergency Stop switch and clear emergency stop condition by pressing Jog.
- 5) Open front door.
  - Front door red LEDs should be on.
  - Green "Doors Closed" LED should be off.
  - The yellow LED for the front door should flash at the instant the door is opened.
  - Spindle Enable LED and Spindle relay should go off and Spindle contactor should release after 5 to 10 seconds.
- 6) Close front door and open left side door.
  - Left door red LEDs should be on.
  - Green "Doors Closed" LED should be off.
  - Yellow door LED should flash at the instant the one door is closed and when the other door is opened.
  - Spindle Enable LED and Spindle relay should go off and Spindle contactor should release after 5 to 10 seconds.
- 7) Close left side door and open right side door.
  - Right door red LEDs should be on.

- Green "Doors Closed" LED should be off.
- Yellow door LED should flash at the instants the one door is closed and when the other door is opened.
- Spindle Enable LED and Spindle relay should go off and Spindle contactor should release after 5 to 10 seconds.

**Door Interlock Monitor on Auger Board (1310-0C) Weekly Test**

- 1) Close all doors. Make sure VMC is not in emergency stop.
- 2) Open cabinet containing Auger Board (1310-0A) and examine LEDs and relays on the 1310-0A board.
  - Red door LEDs should be off.
  - Green door LEDs should be on.
  - Estop relay (K7) should be on (LED lit).
  - Spindle relay for spindle contactor (K5) should be on (LED lit).
  - Heart LED should be blinking.
- 3) Press Emergency Stop switch.
  - Estop relay should go off immediately.
  - Heart LED should be off.
  - Spindle relay should go off after 5 to 10 seconds.
- 4) Release Emergency Stop switch and clear emergency stop condition by pressing Jog.
- 5) Open front door.
  - Front door red LED should be on.
  - Green door LEDs should be off.
  - Heart LED should be off.
  - Spindle contactor should release after 5 to 10 seconds.
- 6) Close front door and open left side door.
  - Left door red LED should be on.
  - Green door LEDs should be off.
  - Spindle contactor should release after 5 to 10 seconds.
- 7) Close left side door and open right side door.
  - Right door red LED should be on.
  - Green door LEDs should be off.
  - Heart LED should be off.
  - Spindle contactor should release after 5 to 10 seconds.

**Weekly:****Front Door Lock Weekly Test for 2030-OA**

- 1) Close all doors.
- 2) Open cabinet containing Front Door Lock Board (2030-OA) and examine LEDs and relays on the 2030-OA board.
  - Power LED should be on.
  - Green "Unlock Door" LED should be on.
  - Green "Doors Closed" LED should be on.
  - LED on K6 and K7 should be on.
  - No other LEDs should be on.
- 3) Open front door.
  - Green "Doors Closed" LED should be off.
  - LED on K7 should be off.
  - Other LEDs should be unchanged.
- 4) Close front door and start spindle.
  - Attempt to open front door.
  - Front door should be locked.
  - "Spindle Rotating", "Spindle ON", "VMC Motion", and "Unlock Delay" LEDs should be on.
  - "Unlock Door" LED should be off.
  - LED on K6 should be off.
- 5) Stop SPINDLE.
  - There should be a delay of 1 to 5 seconds after the spindle comes to a complete stop before the door unlocks.
- 6) If there is a pallet changer start a pallet change.
  - Attempt to open front door. Front door should be locked.
  - "Pallet Motion", "VMC Motion", and "Unlock Delay" LEDs should be on.
  - "Unlock LED" should be off.
  - LED on K6 should be off.

**Dual Arm Tool Changer (1330) Weekly Test**

- 1) Make sure the VMC is not in emergency stop, that the spindle is off, and that no tool change is in progress.
- 2) Open cabinet containing the Dual Arm Tool Changer Control Board 1330-0 and examine the LEDs and relays.



- The LED (D16) for the contactor SSR should be off.
  - The E-stop relay (K5) should be energized (LED on, contact indicator showing).
  - The E-stop Signal relay (K6) should be energized (LED on, contact indicator showing).
  - The Drawbar and Arm Interlock relay (K7) should be energized (LED on, contact indicator showing).
  - The Arm Power relay (K8) should be energized (LED on, contact indicator showing).
- 3) Start spindle and examine LEDs and relays on 1330-0.
- The Drawbar and Arm Interlock relay (K7) should not be energized (LED off, contact indicator not showing).
  - The Arm Power relay (K8) should not be energized (LED off, contact indicator not showing).
- 4) Stop spindle. Press Emergency Stop. Examine LEDs on 1330-0.
- The E-stop relay (K5) should not be energized (LED off, contact indicator not showing).
  - The Drawbar and Arm Interlock relay (K7) should not be energized (LED off, contact indicator not showing).
  - The Arm Power relay (K8) should not be energized (LED off, contact indicator not showing).

### **Pallet Changer (1100-3A) Weekly Test**

- 1) Make sure there are no obstructions to the light curtain.
- The green LED on the Light Curtain receiver should be on.
  - The red LED on the Light Curtain receiver should be off.
- 2) Break the light curtain path with your hand.
- The green LED on the Light Curtain receiver should be off.
  - The red LED on the Light Curtain receiver should be on.
  - Red LEDs on the receiver will also show the beams that are being obstructed.
- 3) Make sure there are no obstructions to the light curtain. Open the cabinet containing Pallet Change Power Distribution board (1100-3A) and examine the LEDs on the 1100-3A.
- The green LEDs (D8 and D9) on the 1100-3A board should be on.
  - The red LED (D7) on the 1100-3A board should be off.

- 4) Obstruct the light curtain (a towel over one of the mirrors will do this) and observe the LEDs on the 1100-3A.
  - The green LEDs (D8 and D9) on the 1100-3A board will be off.
  - The red LED (D7) on the 1100-3A board will be on.
- 5) Start a pallet change and while the pallet is in motion obstruct the light curtain. The pallet change should stop immediately and a message should appear on the monitor requiring Start to be pressed to continue.

### Zero-Out Memory Procedure

**Note: Everything in memory will be erased! Store desired programs & data to disk**

- 1) Send machine to COLD START:
  - Type SETCS < ENTER >.
  - Type HO <ENTER>.
  - Press START.
- 2) Display and record the BACKLASH settings on the second page of this instruction sheet (Settings) in the spaces provided:
  - Type BL <ENTER>. Record the displayed values.
- 3) Display and record the PARAMETER settings on the second page of this instruction sheet (Settings) in the spaces provided:

**NOTE:** Some parameters appear ONLY in Format 1 or in Format 2, but NOT IN BOTH FORMATS.

- Type SETP <ENTER>. Record the displayed values.
  - Type P <ENTER> to display the second page of settings. Record the displayed values.
  - Type P <ENTER> to display the third, page of settings. Record the displayed values.
- 4) After all BACKLASH and PARAMETER settings have been recorded, zero memory:
    - Press <MANUAL> to get to ENTER NEXT COMMAND.
    - Type DI < ENTER >.

- Type GOA3000 <ENTER> to display the Diagnostics Menu.
- Press spacebar to get to Page 2 of the Diagnostic Menu, and select option 5 - ZERO MEMORY.
- Answer "Y" (type Y) to both questions the control asks. Memory is reset.

**NOTE:** If you are replacing a module(s), now is the time to power down the machine,  
replace the module(s), and power up ---- then proceed directly to STEP 5 below.

- Select option 2 - START CNC. This will take the control back to ENTER NEXT COMMAND.

5) Restore PARAMETER values as needed:

**NOTE:** The control will ask for BACKLASH values, but the PARAMETER values must be checked first.

- Type SETP <ENTER> to check and, if needed, re-enter PARAMETER settings - page 1.
- Type P <ENTER> to check and, if needed, re-enter PARAMETER settings - page 2.
- Type P <ENTER> to check and, if needed, re-enter PARAMETER settings - page 3.

6) Restore BACKLASH values:

- Power off the machine, wait 15 seconds, power on the machine, COLD START.
- Enter the BACKLASH values previously recorded as follows:

for X axis	BL,1,value 1, value2, value3 < ENTER >
for Y axis	BL,2,value1,value2,value3 <ENTER>
for Z axis	BL,3,value < ENTER >
for A axis	BL,4,value <ENTER>
for B axis	BL,S,value <ENTER>

7) Load the programs and offsets back into the machine. This procedure is now complete.

**Zero-Out Memory  
Settings**

Last Home Position X \_\_\_\_\_ Y \_\_\_\_\_ Z \_\_\_\_\_

## Backlash Settings

X-axis Backlash \_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_

Y-axis Backlash \_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_

Z-axis Backlash \_\_\_\_\_

A-axis Backlash \_\_\_\_\_

B-axis Backlash \_\_\_\_\_

## Parameter Settings

Format: \_\_\_\_\_ Baud Rate: \_\_\_\_\_ Spindle After M6: \_\_\_\_\_

Axes: \_\_\_\_\_ Travel: \_\_\_\_\_ Pendant: \_\_\_\_\_

Default: \_\_\_\_\_ A-AxisRatio: \_\_\_\_\_ M60/A-Axis Brake: \_\_\_\_\_

Default: \_\_\_\_\_ B-AxisRatio: \_\_\_\_\_ M60B-AxisBrake: \_\_\_\_\_

Default:Tool Changer Cap:IMM Fixed Cycle:

RPM Factor:Spindle Type:Orientation Factor:

## Parameter settings - Page 2

Default: \_\_\_\_\_ M3: \_\_\_\_\_ M7: \_\_\_\_\_ 3 Phase&gt;5%Low: \_\_\_\_\_

Pu Format: \_\_\_\_\_ N-words Ordered: \_\_\_\_\_ Tool Table: \_\_\_\_\_

Crc Mode: \_\_\_\_\_ Binary Buffers: \_\_\_\_\_ High Torque: \_\_\_\_\_

Spindle Off: \_\_\_\_\_ Turret Factor: \_\_\_\_\_ CMD Menu: \_\_\_\_\_

Pallet: \_\_\_\_\_ Gain: \_\_\_\_\_ Ramp: \_\_\_\_\_

Aspect: \_\_\_\_\_ Tilers: \_\_\_\_\_ Overload: \_\_\_\_\_

## Parameter Settings - Page 3

Screw: \_\_\_\_\_ Imp: \_\_\_\_\_ Xyz Ramp: \_\_\_\_\_

Z Tap Gain: \_\_\_\_\_ Vector: \_\_\_\_\_ Axis Display: \_\_\_\_\_

Auto Brake: \_\_\_\_\_ A-pallet: \_\_\_\_\_ B-pallet: \_\_\_\_\_

5-Axis Head: \_\_\_\_\_ GO Detail: \_\_\_\_\_ Feedback: \_\_\_\_\_

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## Section 05: Automatic Tool Changers

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Fadal's EMC model comes standard with a 16 tool capacity (21 tool capacity is optional) Geneva drive tool changer. The VMC 3020, 4525, 6535 come standard with the Dual Arm Tool Changer. The VMC TRM has no automatic tool changers. All other VMC models come standard with a 21 tool capacity (30 tool capacity optional) Geneva drive tool changer. An optional servo drive tool changer is available with 21 or 30 tool capacity.

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### Operation

#### Programming

To make an automatic tool change, an *M6* code is used. This code can be used in a program or in Manual Data Input (MDI) mode.

##### In a Program

When another tool is needed, an M6 followed by a tool location. (T\_) is entered and the tool changer will make the appropriate tool change and then continue on with the program.

##### In MDI

The operator can make a tool change with out running a program. If the operator is testing the tool changer or setting tool lengths, the M6 code followed by the tool location will command the tool changer to make the necessary tool change.

#### Electrical Operation

The ATC has two circuits; one is for the Turret (changes tool positions) and the other is for the Slide (moves ATC to the spindle and back) motor circuit. Both of these circuits are basically the same with the only differences being the motor gear ratios (Turret motor is 28:1 and Slide motor 58:1) and the K33 contacts in the turret circuit. This description will be for both circuits, with parts from the turret and slide parts in parentheses ( ). Negative logic is used meaning that to pull a line low or to about ground (Gnd) is considered on or active. The output leads on the solid state relays will be referred to as contacts for ease of explanation. The word "direction" used in this section refers to motor direction not machine direction.

The Turret Motor (Slide Motor) is activated when the Mill Interface PCBA (1040) pulls the line low (to Gnd), pin 16 (57), which goes through the following connections:

1060/J7-25 (1060/J7-24)  
to 1100-1/J1-25 (1100-1/J1-24)  
to 1100-1/J2-5 (1100-1/J2-14)  
to 1100-2/J1-5 (1100-2/J1-14)

to Solid State Relay K12 (K14) on one side of the control with the other side connected to 5 VDC. This activates the relay, closing the contacts (output leads) and allowing the 120VAC to flow to F6 (F8), CB2 (CB1) and to the contacts of mechanical relay K5 (K6) and from TB1-6 (TB1-2) to the motor windings. The other side of the motor windings is connected to TB1-8 (TB1-4) and to the RET (AC Return). This provides the power to the motor windings.

The 120 VAC power for the start winding flows to the 3 & 4 pins of K5 (K6) to TB1-7 (TB1-3) to the Start winding with the other side of the Start winding connecting to TB1-5 (TB1-1) to pins 9 & 10 of K5 (K6) and then to C2 (C1). This causes a phase shift in the Start winding current and the motor starts in the forward direction caused by the phase shift.

When reverse direction is required both the reverse and motor signal have to be activated. The turret (slide) motor reverse is activated when the Mill Interface PCBA (1040) pulls the line low on pin 5 (9) which goes through the following connections:

1060/J7-6 (1060/J7-1)  
to 1100-1/J1-6 (1100-1/J1-1)  
to 1100-1/J2-12 (1100-1/J2-1)  
to 1100-2/J1-12 (1100-1/J1-1)

to Solid State Relay K11 (K13) on one side of the primary with the other side connected to 5 VDC. This activates the relay, closing the contacts and allows the 120 VAC to flow to F5 (F7), to the coil of the Mechanical Relay K5 (K6), opening the normally closed contacts and closing the normally open contacts.

The power to the motor windings is the same as for the forward direction. The power to the start windings now flows to pins 5 & 6 of K-5 (K6), to TB1-5 (TB1-1), to the Start winding, returning to TB1-7 (TB1-3), to pins 11 & 12 of K5 (K6), and to C2 (C1). This causes the phase shift to be in the other direction. The motor runs in reverse.

The motor braking for this turret motor is provided by the gear box and the gear box grease for the Bodine brand motors and by a wavy washer for the Bison brand motors. If the grease breaks down the turret will overshoot. Repack grease in gear box to resolve.

The K33 contacts are controlled by the E-Stop circuit on the coil side of the relay. The contacts will open when an E-Stop condition exists and will stop the operation of the turret.

The K3 relay has two sets of normally closed contacts (3,4 to 11,12), which provide a path for the 120 VAC for the drawbar and slide motor reverse circuits. This performs two functions: One is the removal of power during an E-Stop condition and the other is the removal of power when the spindle is running in the forward direction.

**Tool Change  
Sequence**

The following is the order of operations for the CNC when making a tool change (Geneva driven and Servo Turret):

- 1) Move the Z axis to the machine home (cold start) position.
- 2) Turn the spindle slowly while looking for the Orientation Sensor signal.
- 3) When orientation signal is received, stop the spindle.
- 4) Activate the orientation arm.
- 5) Move the ATC turret to the tool position of the tool in the spindle.
- 6) Verify the orientation sensor.
- 7) Check the ATC Home sensor and verify that the ATC is at the home position.
- 8) Activate the ATC slide reverse circuit.
- 9) Activate the ATC slide motor circuit (air cylinder circuit for the EMC).
- 10) Watch for the ATC extended sensor signal.
- 11) Stop the slide motor (air cylinder for the EMC) when the extended position sensor is read.
- 12) Activate the draw bar.
- 13) Watch for the drawbar sensor detection (air feed parameter).
- 14) Check for the ATC fault switch.
- 15) Move the Z axis up to 3.8" above the cold start position.

- 16) Activate the turret motor and the turret reverse (if the reverse direction is required) circuit(s).
- 17) Count the turret sensor signals, with a dwell time for coasting as set by the turret factor, until the requested tool position is reached.
- 18) Stop the turret motor.
- 19) Move the Z axis downward to the machine home position.
- 20) Check for the ATC fault switch.
- 21) Release the drawbar circuit.
- 22) Activate the ATC slide motor.
- 23) Watch for the ATC Home sensor, to determine the ATC home position.
- 24) Stop the ATC slide motor (air cylinder for the EMC).
- 25) Release the orientation arm.

**Note:** The hall effect sensors have three wires. One for 5vdc, one for ground, and one for the signal. The signal will be about 5vdc until a magnet is over it, then it will become active, and the signal will be about zero.

#### ATC Sensors & Switch

The ATC Slide Home sensor is active when the ATC is in the home position. The connections are 1060/J12 pin 4 for Gnd, pin 6 for 5 VDC, pin 5 for the signal connecting to the 1040 PCBA at pin 72.

The ATC Slide Extended sensor is active when the ATC is at the extended position under the spindle. The connections are 1060/J12 pin 1 for Gnd, pin 3 for 5 VDC, pin 2 for the signal connecting to the 1040 PCBA at pin 70.

The ATC Turret Motion sensor is active when the turret is moving to the next tool position and it is half way to the next tool position. The connections are 1060/J12 pin 7 for Gnd, pin 9 for 5 VDC, pin 8 for the signal connecting to the 1040 PCBA at pin 74.

The ATC Fault switch is closed if the ATC spindle is moved out of position. The connections are 1060/J11 pin 7 for Gnd and pin 8 is the signal to the 1040 PCBA at pin 66.

#### ATC Fault Messages

**ATC FAILURE:** The machine is receiving a signal from the ATC fault switch. This would indicate that the ATC spindle is out of position. Check the position of the ATC spindle. If it is in the proper position, check the switch, the switch wiring, and the mill interface card.



**ATC TURRET FAILURE:** The machine did not receive a signal from the ATC Turret Sensor, when the tool position change was commanded. If the turret moved to the next position, then the sensor is not operating. This could be caused by a bad sensor, wiring problem, Mill Interface (1040), sensor to magnet spacing, or chips on the sensor or magnet. If the turret does not move, then the turret motor circuit is not operating. This may be caused by a mechanical bind, K12, F6, CB2, K33, turret motor, wiring problem or mill interface (1040).

**ATC WILL NOT MOVE TO POSITION:** When the ATC is commanded to move to either the extended or home positions and the appropriate sensor does not send a signal within the allotted time, this fault is displayed. The possible causes for this fault are mechanical problems including chips in the track area preventing the rollers from rolling, misalignment of the ATC or spindle position, bad sensor or gap setting, wiring problem, motor, or the mill interface board (1040).

**ATC WILL NOT MOVE TO SPINDLE:** Same as the ATC WILL NOT MOVE INTO POSITION except the direction (reverse) is known.

#### **ATC Servo Turret Operation**

The turret Motor is activated when the Mill Interface PCBA (1040) pulls the line low (to Gnd) pin 16 which goes through the following connections:

1060/J7-25  
to 1100-1/J1-25  
to 1100-1/J2-5  
to 1100-2/J1-5

to Solid State Relay K12 on one side of the control with the other side connected to 5 VDC. This activates the relay, closing the contacts (output leads) and allowing the 120 VAC to flow to F6 to CB2 to the contacts of mechanical relay K33 and to 1100-2/TB1 pins 6 (black wire), which is connected to the Servo Turret Control board (1860) at J3-1. This signal tells the Servo Turret Control board to turn turret motor on. Pin 8 (white wire) the RET (AC Return) is connected to the Servo Turret Control board (1860) at J3-4.

The Turret start motor connection at 1100-2/TB1 pin 7 is connected to the Servo Turret Control board at J3-2 (red wire) and pin 5 is not connected. A wire is added from the 1100-2/TB1-31 (120 VAC) to Control board J3-3 (blue wire). The servo turret requires that jumper be placed across CB7, a AGC2 fuse be added to F4, K12 Black relay be replaced with a Green relay (ELE-0101). Also the inside lead (connects to K5) of C2 be moved to the outside connection (return side) on the 1100-2 PCBA to remove the capacitor from the circuit, if this is not done the control may never get the off signal and turret would continue to run.

When reverse direction is required both the reverse and motor signal have to be activated. The turret motor reverse is activated by the Mill Interface PCBA (1040) pulls the line low on pin 5 which goes through the following connections:  
1060/J7-6  
to 1100-1/J1-6  
to 1100-1/J2-12  
to 1100-2/J1-12

to Solid State Relay K11 on one side of the primary with the other side connected to 5 VDC. This activates the relay, closing the contacts and allows the 120 VAC to flow to F5 to the coil of Mechanical Relay K5 opening the normally closed contacts and closing the normally open contacts. Resulting in 1100-2 TB1-7 to 1860 J3-2 line having 120VAC for forward and 0 VAC for reverse when the motor line is active.

For the Turret Motion sensor, the Hall effect switch for ATC turret connects to J6 on the Servo turret control board (1860). Pin 1 is 5 VDC, pin 2 is the signal and pin 3 is Gnd. The sensor connections from the motherboard (1060) J12 connect to the control board at J5, signal connecting J12-8 to J5-4, Gnd J12-7 to J5-3 and J12-9 5 VDC not connected.

For an AC Brushless machine, a Power Supply (PCB-0173) is required because the DC motor amp chassis outputs about 130 VDC on the axis amplifier chassis capacitor and the AC motor chassis outputs about 320 VDC. The servo turret amplifier does not operate correctly with the excess voltage. If the machine requires a power supply, then the wiring connections are pins 1 & 2 on the power supply. Connect to TB1-9 & TB1-8 respectively on the 1100-1 board, which is the control signal input. Pins 3 & 4 on the power supply connect to the 120 RET and VAC terminals on the 1100-2 PCBA. Pin 5 on the power supply connects to pin 3 on J2 (black wire) of the servo turret amp PCBA (1810). Pin 6 on the power supply connects to pin 4 on J2 (red wire) on servo turret amp. This is the amp's power.

K33 contacts are controlled by the E-Stop circuit on the coil side of the relay. Contacts will open when E-Stop condition exists and stop operation of the turret.

K3 has two sets of normally closed contacts (3,4 to 11,12) which provide a path for the 120 VAC for the drawbar and slide motor reverse circuits. This performs two functions: One is the removal of power during the E-Stop condition and the other is removal of power when the spindle is running in the forward direction.

### Servo Turret Controller and Amplifier Boards (PCB-0108)

The Servo Turret Amplifier Assembly (PCB-0108) consists of a mounting plate, Controller board 1860 and a Amplifier board 1810.

The Amplifier board has an input of about 130VDC and the motor output at J2. Two motor circuit fuses are AGC10A. J1 and J3 provide communication between the Amplifier and the Controller boards. The Amp also has an LED to indicate over temperature and for over current.

The Controller board has J1 and J4 for communication between the boards. The controller receives feedback (1860/J2) from an encoder on the motor with a 1:1 ratio to worm gear and three revolutions for one tool position change. The encoder is a 1000 line per revolution encoder. J3 is the input connection for the command signal from the 1100-2 board. 5 VDC and ground are provided on pins 1 and 2 of J5 and output the Turret Motion signal to the Motherboard (1060/J12 pins 7 & 8) from pins 3 and 4. The Turret Motion Hall Effect Sensor is connected to J6. The Controller has an LED for the Turret Motion sensor active and a pulse LED flashes indicating the board is active. S1 is a reset switch for the board.

The only adjustments on the Servo Turret board are by means of the four dip switches.

SPEED	SW1	SW2	MOTOR RPM
Slow	0 Closed	0 Closed	550
Medslow	1 Open	0 Closed	600
Medfast	0 Closed	1 Open	650
*Fast	1 open	1 open	750

MOTOR	SW3	SW4
Reserved	0 Closed	0 Closed
Reserved	1 Open	0 Closed
Reserved	0 Closed	1 Open
*Owisso/Bodine	1 Open	1 Open

\*Factory Setting

Random servo amp faults may occur, often with either heavy tools and/or the 30 tool ATC. Lowering the motor speed selection has been successful at eliminating these servo amp faults. However, this is not recommended because of the possibility of the Z axis coming down prior to the ATC turret reaching its position.

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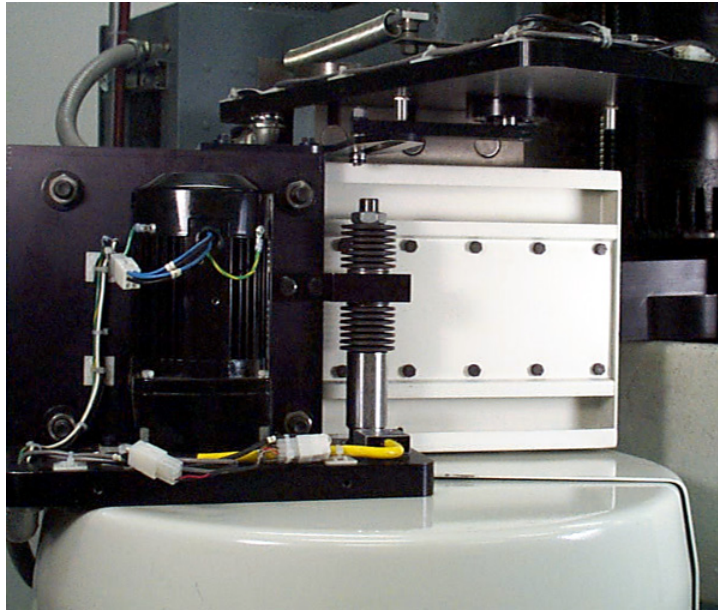
**Adjustments**

There are four motions that influence the automatic tool changer alignment. These motions are:

- Z-axis up & down.
- Spindle orientation.
- Turret in & out.
- Turret rotation.

**Z Axis Cold Start Adjustment**

- 1) Remove the ATC upper cover.

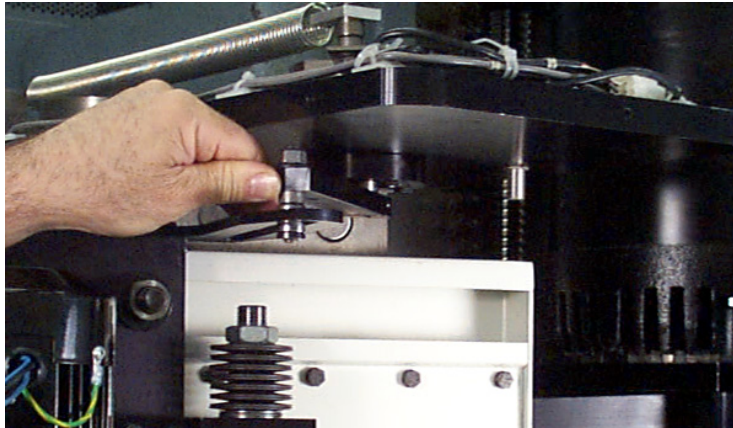


*Figure 5-1* Remove ATC Upper Cover

- 2) Position the Z-axis head to the machine zero position (CS).
- 3) Orientate Spindle (M19).
- 4) Manually move the ATC slide in toward the spindle

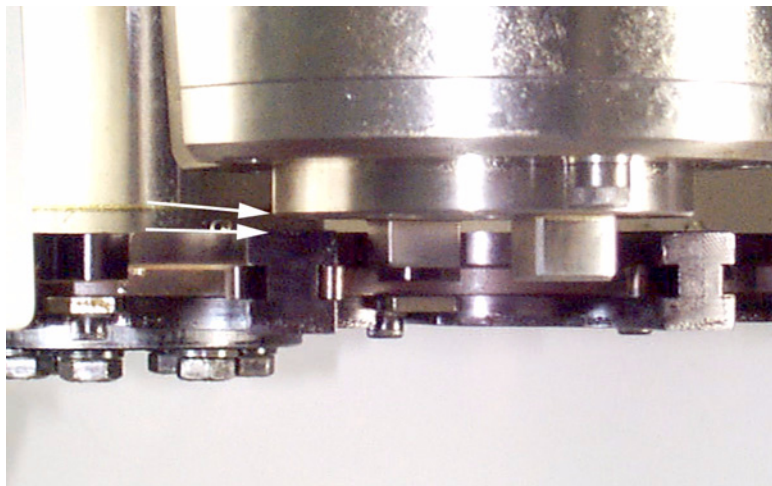
Note: The EMC machine uses an air cylinder for the turret movement. To manually move the ATC as suggested in step (4) several steps must be taken:

- Disconnect the air to the machine.
- Manually move the ATC slide towards the spindle.
- Re-connect the air to the machine for added pressure against the spindle.



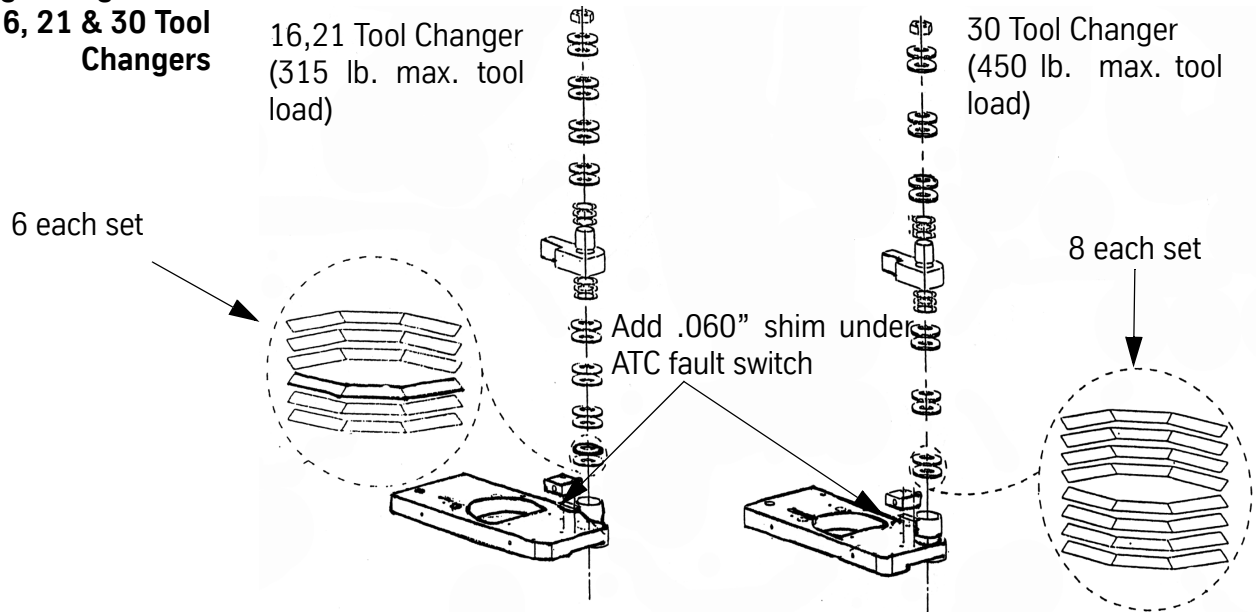
**Figure 5-2** Move ATC Slide Toward Spindle

- 5) Measure the distance from the ATC carriage to the nose of the spindle with a thickness gauge. Adjust the Z axis until the nose of the spindle is .050" [1.27mm] above the turret carriage for CAT taper, .250" [6.35mm] for BT tooling.



**Figure 5-3** Measure Distance from ATC Carriage to Spindle

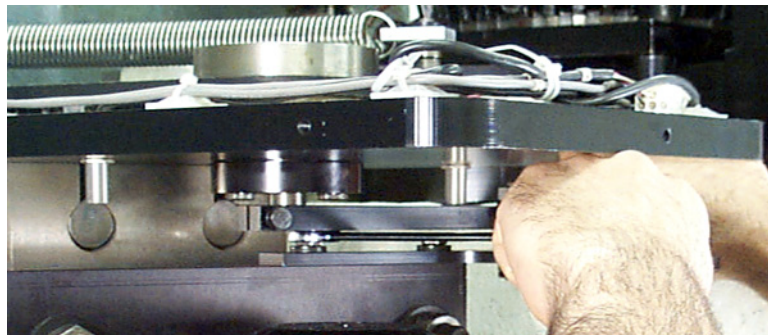
- 6) To adjust DC machines, loosen the screw holding the resolver and rotate the resolver. When the Z axis is in the correct position, tighten the screws. For AC machines, determine their offset by cold starting the machine then jogging the Z axis. Enter the value in SV.
- 7) Cold Start the machine and recheck the position.

**Spring Configuration  
16, 21 & 30 Tool  
Changers****ATC Turret Slide  
Adjustment**

- 1) Position the Z-axis to the machine zero.
- 2) Orient the spindle using M19 from MDI mode.
- 3) Insert a tool holder in the spindle.
- 4) Manually move the slide to the spindle until fully engaged. Loosen the 2 each 1/4" hex bolts to the upper Geneva slot

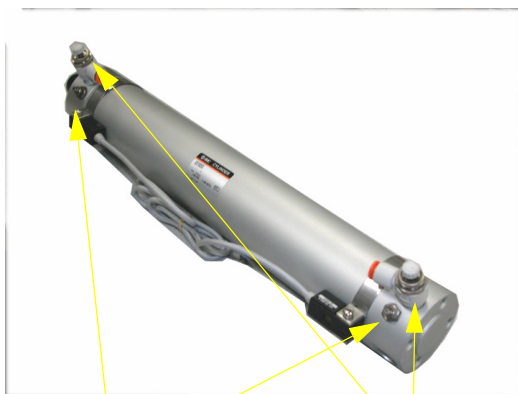
**Note:** The EMC machine uses an air cylinder for the turret movement. To manually move the ATC as suggested in step (4) several steps must be taken:

- Disconnect the air to the machine.
- Switch the air lines connected to the air cylinder (see figure 5-5)
- Manually move the ATC slide towards the spindle.
- Re-connect the air to the machine for added pressure against the spindle.



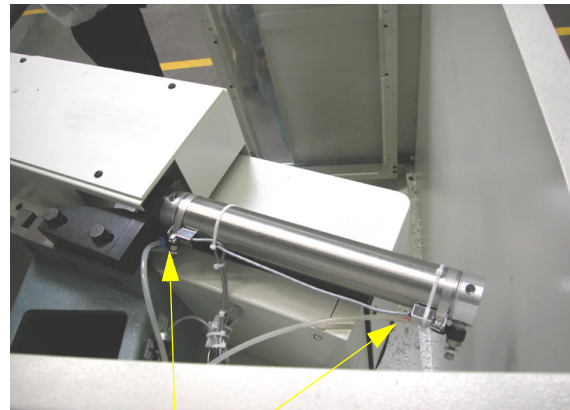
*Figure 5-4* Move Slide to Spindle Until Engaged





Adjust the cushion

Adjust the air flow



Air lines to switch for ATC adjustment

*Figure 5-5* EMC ATC Cylinder

- 5) Give the slide a firm push toward the spindle. Retighten the 2 bolts.
- 6) If the slide does not fully engage, loosen each of the six 3/8" hex bolts holding the tool carrier. This will allow the slide to fully engage.



*Figure 5-6* Loosen Hex Bolts Holding Tool Carrier

- 7) Tighten all bolts on tool carrier and upper Geneva slot. If the slide still does not engage, check the spindle orientation.

**Note:** continue with step (8) through (12) only if your machine is an EMC model VMC. (see Figure 5-5)

- 8) Disconnect the air to the machine.
- 9) Move the ATC slide back.
- 10) Switch the air lines connected to the air cylinder.
- 11) Re-connect the air to the machine.

12) Adjust the air flow. Make sure that the ATC doesn't move too quickly or too slowly on a tool change.

13) Adjust the cushion. Make sure that during the tool change the ATC doesn't "bang" at either end of its travel.

#### Tool Turret Rotational Adjustment

- 1) Position the Z-axis to the machine zero.
- 2) Orient the spindle using M19 from MDI mode.

#### IMPORTANT

For Servo Turret, do not adjust the rotation until the turret has been moved by pressing TURRET CW, and then pressing TURRET CCW.

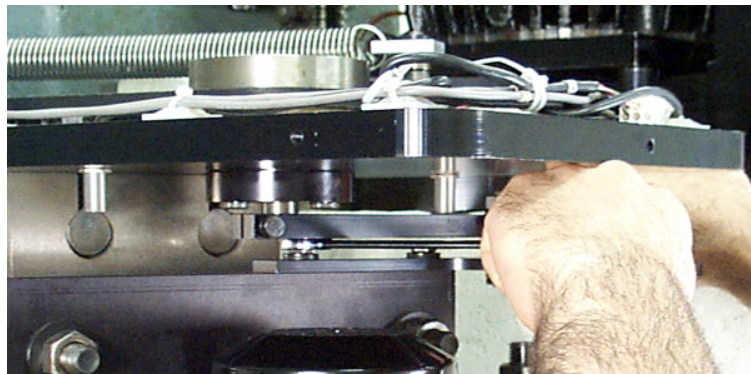


- 3) Loosen each of the six 3/8" hex bolts on the under side of the tool carrier.



**Figure 5-7** Loosen Hex Bolts on Under Side of Tool Carrier

- 4) With the tool in the spindle, manually move the slide into the spindle, until fully engaged.



**Figure 5-8** Manually Move Slide Into Spindle

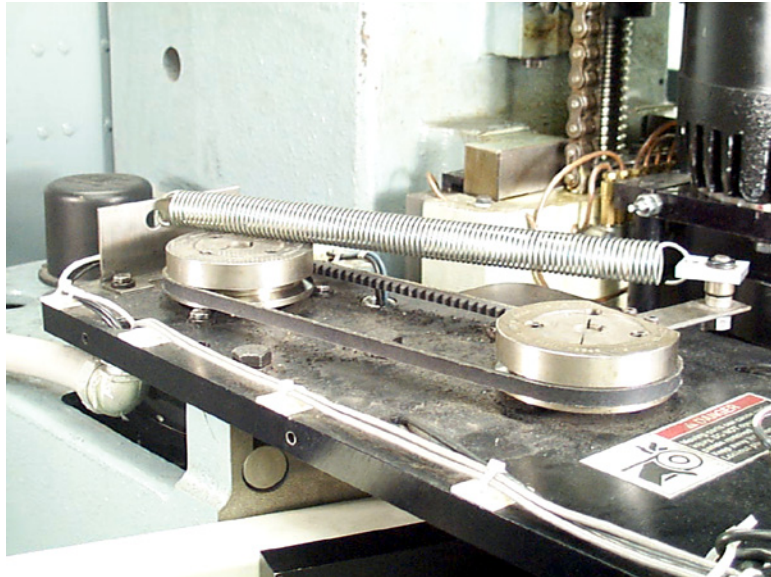
- 5) Tighten the 6 each 3/8" hex bolts.

If the tool carrier does not engage smoothly with the tool in the spindle there may be a misalignment with orientation assembly.



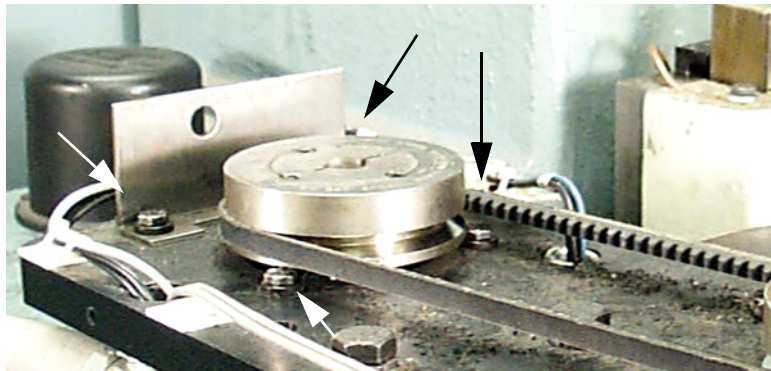
**ATC Slide Belt  
Replacement &  
Adjustment**

- 1) Remove ATC upper cover.



*Figure 5-9* Remove ATC Upper Cover

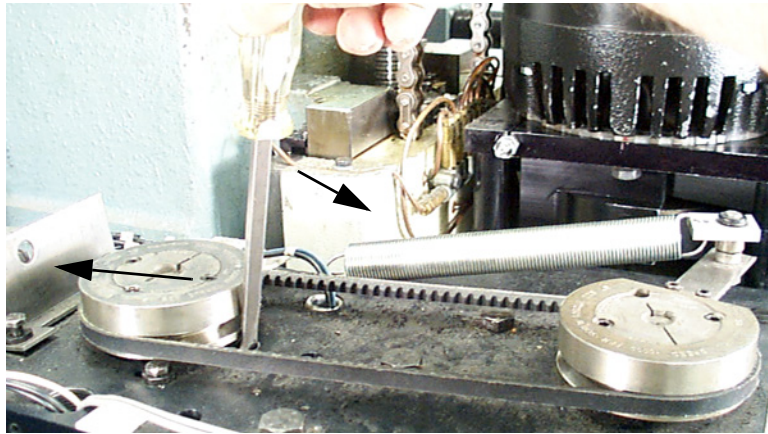
- 2) Remove tension spring.
- 3) Loosen 4 screws holding motor.



*Figure 5-10* Loosen Screw that Hold Motor

- 4) Remove belt. Install motor mounting screws.

- 5) Install the new belt. Using a screwdriver or small pry bar, apply force to move the motor back, then tighten the motor mount bolts.



*Figure 5-11* Install New Belt

**Note:** When the belt tension is correct you should have .250" (6.35mm) belt reflection with a 6lb. pull. If the belt is too tight or too loose the ATC will slam at one end of its travel. The belt is designed to slip at each end of the travel. If you do not have a pull gauge, squeeze the belt with your thumb and index finger in its center. If the inside of the belt is about even with the large mounting bolt, the belt tension is about right.

- 6) Reinstall the tension spring. Reinstall the cover.

---

### ATC Motor Replacement Procedure

#### Replacing the Turret Motor on a Geneva Wheel ATC

- 1) Remove the ATC cover.
- 2) Remove the Motor cover.
- 3) Disconnect the Molex connector with the motor wires.
- 4) Disconnect the ground wire.
- 5) Remove the four bolts holding the motor down.
- 6) Remove the motor.
- 7) Measure the distance from the bottom of the motor to the top of the Geneva gear.
- 8) Remove the Geneva gear.

- 9) Install Geneva gear on replacement motor at same position as on old motor.
- 10) Place motor in ATC and slide it firmly toward the Head.
- 11) Tighten motor mounting bolts.
- 12) Connect ground wire and Molex connector.
- 13) Perform alignment procedures.
- 14) Replace the covers.

**Replacing the Turret  
Motor on a Servo  
Turret ATC**

- 1) Remove the ATC cover.
- 2) Remove the motor cover.
- 3) Disconnect both the encoder and the motor Molex connectors.
- 4) Remove the four motor mounting bolts.
- 5) Remove the belt from the pulley and remove the motor.
- 6) Place the replacement motor (MTR-0144) in mount and replace the belt.
- 7) Install the four mounting bolts.
- 8) Pull motor upward so the belt is snug and tighten the mounting bolts.
- 9) Connect the encoder and motor connectors.
- 10) Perform alignment procedures.
- 11) Replace covers.

**Replacing the Slide  
Motor**

- 1) Remove the ATC cover.
- 2) Remove the large tension spring.
- 3) Disconnect the Molex connector for the slide motor.
- 4) Loosen the four motor mount bolts so motor can move to release belt tension.
- 5) Remove the belt.
- 6) Remove the three large bolts holding the slide motor mounting plate.
- 7) Pull the motor mounting plate up and lay it on its side.

- 8) Remove slide motor.
- 9) Install replacement slide motor.
- 10) Re-install motor mounting plate.
- 11) Connect the Molex motor connector.
- 12) Install belt. (see belt replacement procedure)
- 13) Install tension spring.
- 14) Perform alignment procedures.
- 15) Replace covers.

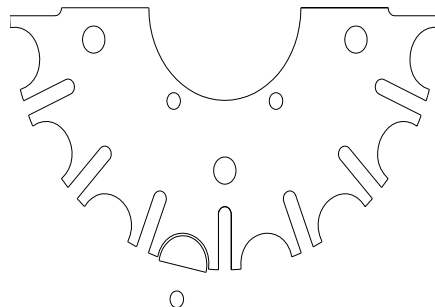
### Turret Factor Setting

This parameter is set at the factory. This parameter should not be changed unless the turret motor has been replaced or the tool turret rotation is over or under shooting.

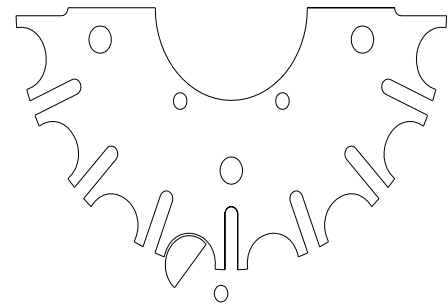
**Note:** VMCs equipped with the Servo Turret ATC, instead of the Geneva-driven ATC, must ALWAYS have a turret factor of 1.

A proper turret factor will have the Geneva driver positioned as in Figure 5-11-a.

An incorrect turret factor will have the Geneva driver positioned approximately as shown in Figure 5-11-b



**Figure 5-12 -a** Correct Geneva adjustment



**Figure 5-11-b** Incorrect Geneva adjustment

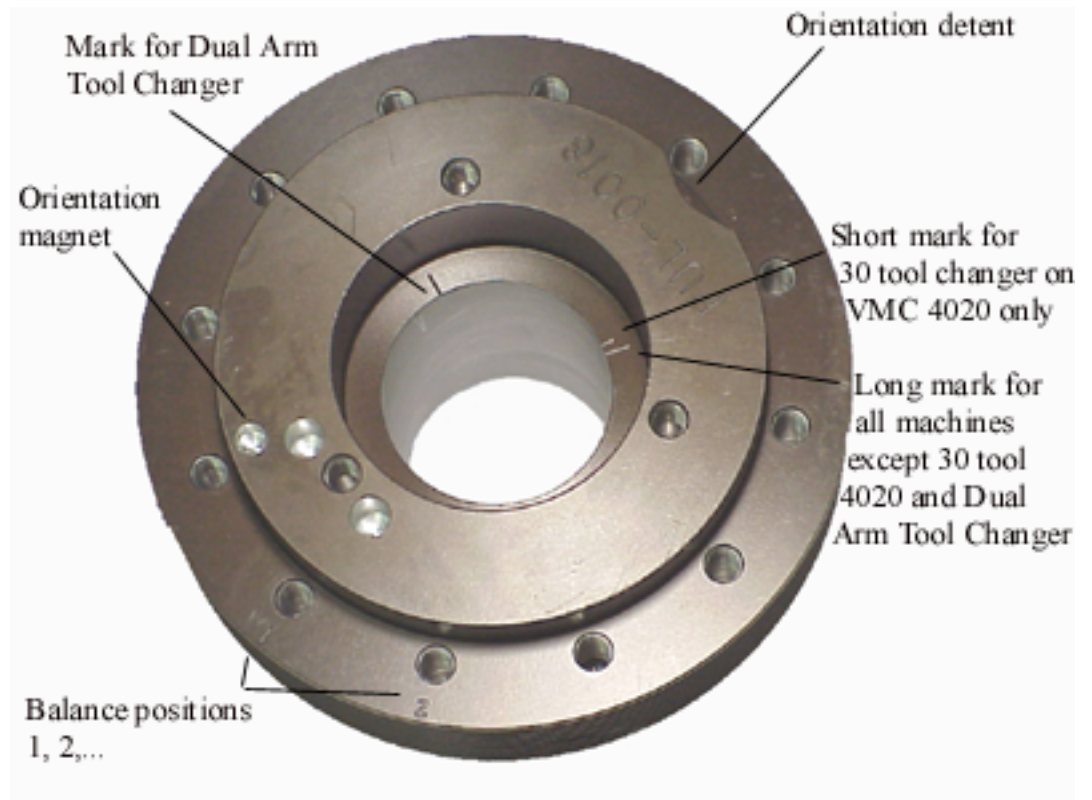
### Pulley Alignment

Fadal Spindle Pulleys have lines for the orientation alignment of the spindle. To achieve proper alignment, the line on the top of the spindle must be aligned with one of the three lines on the spindle pulley.

- The **Long Line**, which is for all Machines except for VMC 4020 with 30 tool ATC, and the Dual Arm ATC.
- The **Short Line**, which is for VMC 4020 machines with 30 tool ATC.

The Long and Short Lines are next to one another.

- The new pulleys will also have a **Third Line**, which is for the Dual Arm ATC.



*Figure 5-13* Fadal Spindle Pulleys

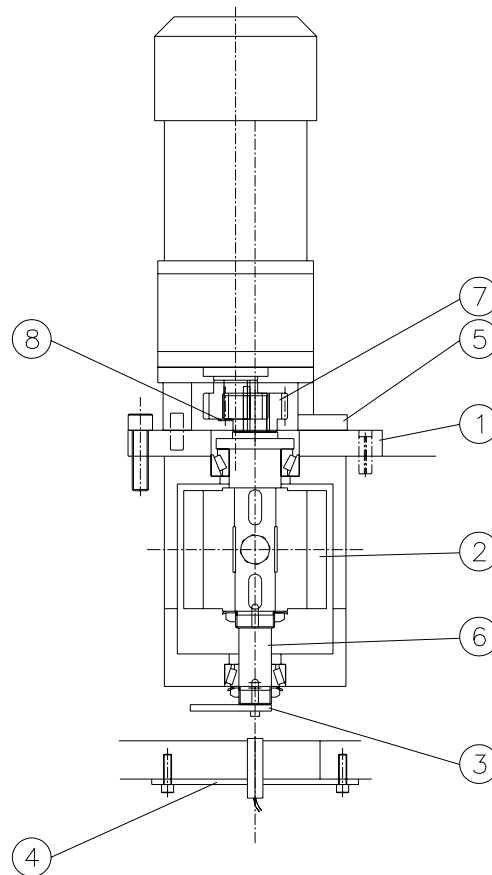
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**Dual Arm Tool  
Changer****Tool Changer  
Specifications**

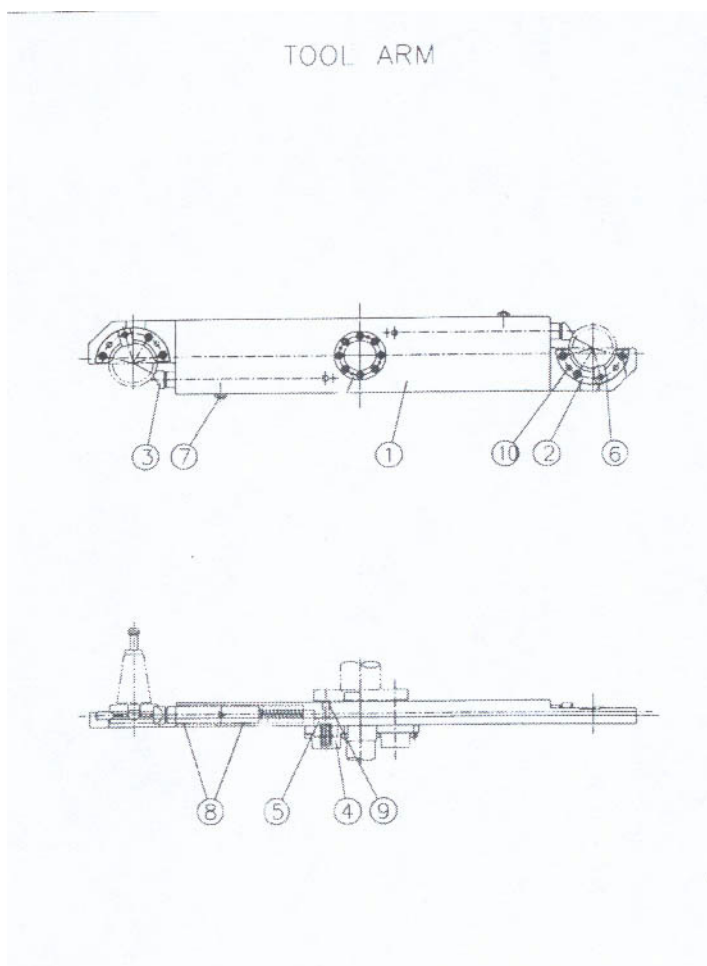
<b>Type of Tool</b>		CAT-40/BT-40
<b>Number of Tools</b>		24
<b>Maximum Tool Diameter</b>		
	All Pockets Full	100mm (4in.)
	Adjacent Pockets Empty	180mm (7.2in.)
<b>Maximum Tool Length</b>		350mm (13.8)
<b>Tool Weight</b>		
	Maximum	6.5kg (14.3lbs.)
	Average	5.0kg (11lbs.)
<b>Tool Magazine Drive Source</b>		
	Motor Voltage	220VAC, 3 Phase
	Air Pressure	5.7kg/sqcm (12.5psi)

## Sub-Assemblies

## INDEX MECHANISM

*Figure 5-14* Index Mechanism

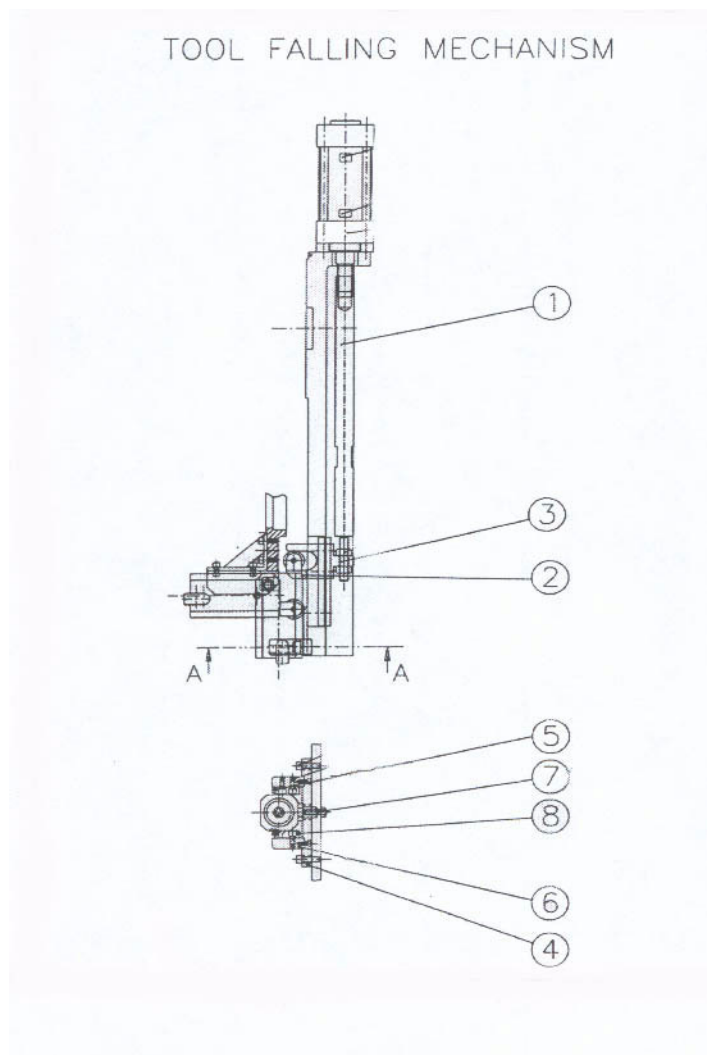
No.	Part Description
1	Cam Base
2	Cylindrical Cam
3	Sensor Block
4	Proximity Switch Bracket
5	Motor Base
6	Driving Shaft
7	Gear
8	Gear Plate



**Figure 5-15** Tool Arm

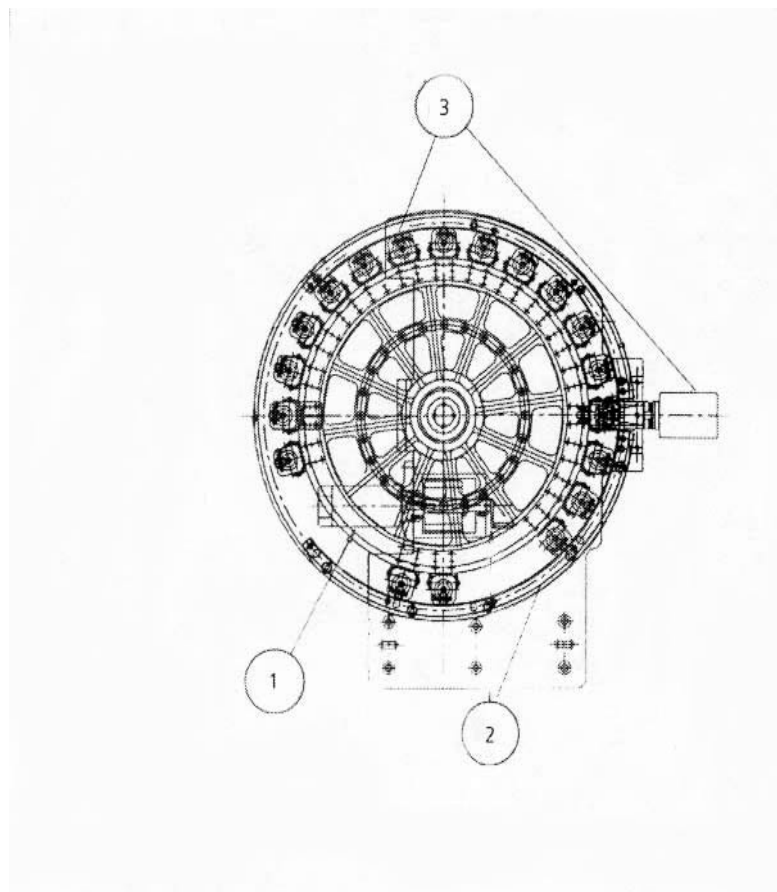
No.	Part Description
1	Tool Arm
2	Tool Draw
3	Tool Holding Rod
4	Spring Cover
5	Plunger
6	Positioning Key
7	Positioning Screw
8	Self Lubricating Bearing
9	Self Lubricating Bearing
10	Spring Pin





**Figure 5-16** Tool Falling Mechanism

No.	Part Description
1	Tool Rod
2	Sliding Block
3	Sliding Block Cover Plate
4	Positioning Block Stand
5	Positioning Sliding Block (1)
6	Positioning Sliding Block (2)
7	Fixing Base of Tool Pot
8	Positioning Sliding Block (3)



*Figure 5-17* Tool Turret

No.	Part Description
1	Tool Magazine Motor
2	Tool Magazine
3	Tool Buckets

**Installation &  
Testing****Dual Arm ATC Installation and Alignment:**

- 1) Verify that all bolts are properly tightened.
- 2) Remove the main cover surrounding the ATC arm and falling mechanism.
- 3) Remove the oil inlet plug and fill the ATC oil reservoir with lubricant (MOBIL DTE OIL HEAVY MEDIUM) to approximately 1-1/2 gallons or 5 liters. Observe the sight glass to verify that the oil reservoir does not over fill (see Figure 5-18, positions 1 and 2). The alternative way to fill the oil reservoir is by utilizing the plugged air vent on top and to the rear of the main ATC casting. This does not require the removal of the main cover.

**Note:** Use caution during installation. Check all of the control elements for damage (sensors and wires).

- 4) Install the ATC onto the machine using: 8 1/2 – 13 X 1 3/4 inch UNC-2B HHC hex cap screws with eight split lock washers.
- 5) Do not tighten the mount bolts completely. They will need to remain loose to allow for the front to back and side to side alignments to be made.
- 6) Using a crane or forklift, position the ATC as needed to assist in the adjustments.
- 7) Install the alignment fixture to the spindle mount surface using two 3/8-16X1” bolts. Verify that the fixture is centered. Slowly tighten the fixture. Keep the fixture centered throughout the procedure.

**Note:** Before proceeding to the next step, review the applicable job sheet to confirm that the ATC is set-up for the specified tool holder configuration (CAT-40 or BT-40). The tool grippers and tool orientation (or positioning) keys may need to be changed if the tool holder configuration needs to be changed.

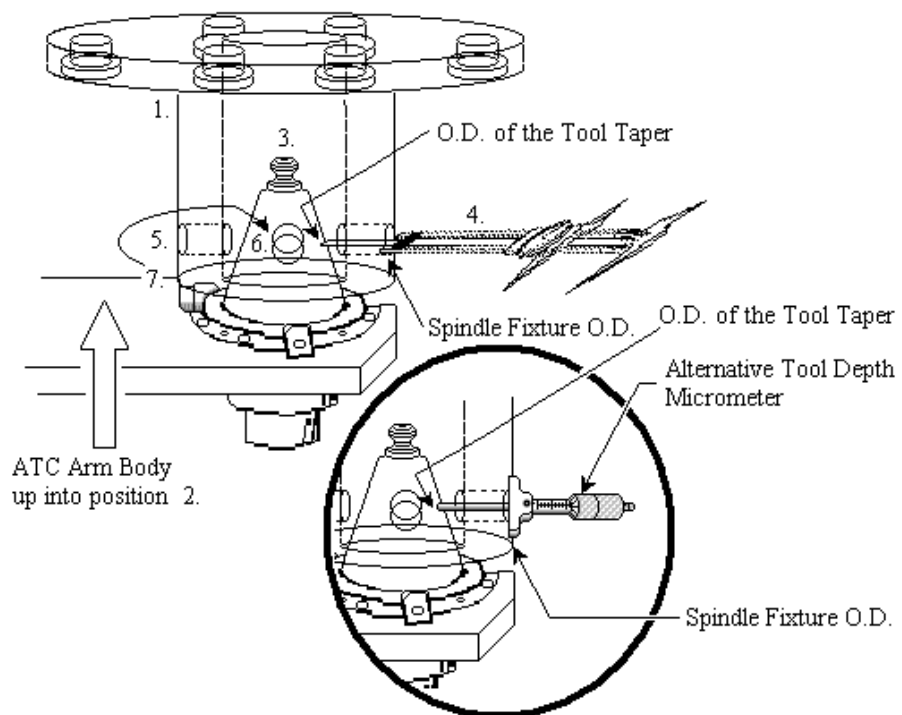
- 8) Remove the socket head cap screws plus the 2-8mm Roll pins mounting the gripper onto the ATC arm body (the gripper has 3 bolts for the 4525 and 4 for the 3020 and 6535).
- 9) Install and tighten the gripper with the proper tool orientation (or position) key. See Figure 5-17, positions 1, 6, and 7.
- 10) When manually rotating the tool arm, use the proper socket on top of the tool changing mechanism motor shaft. The drill motor should turn forward or CW.
- 11) While rotating the ATC arm, pull the motor brake switch up. This is the electromagnetic brake that will be holding the motor back from turning

smoothly. The switch is located on top and to the front of the ATC motor (the switch must be held up). See Figure 5-17, position 3.

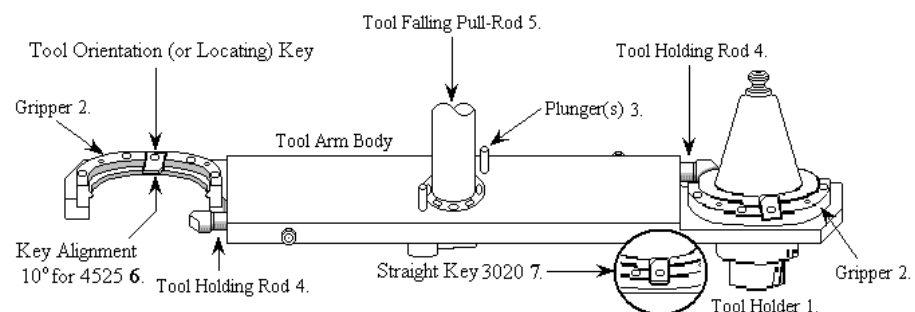
- 12) The ATC arm body will turn 80 degrees for the 3020, 65 degrees for the 4525 and 35 degrees for the 6535. The tool falling mechanism will engage. The arm will then move down and turn 180 degrees, for both the 3020 and 4525, to exchange gripper positions. Stop turning the motor when the arm reaches the down position.
- 13) With the falling mechanism in the down position, put the proper tool holder type in the forward tool gripper and orient the tool so that it goes into the arm gripper with the deepest relief engaging the gripper key way.
- 14) To install the tool holder manually, it will be necessary to push the plunger mechanism down, to release the pressure of the tool holding rod. See Figure 5-17, positions 2 and 3.
- 15) Begin manually turning the motor of the ATC. The falling mechanism will start moving back up. Stop turning the motor when the arm reaches the top most position or has reached the dead spot, before changing direction.
- 16) JOG the Z-axis down and position the head and spindle fixture at or near the normal Z-axis cold start position. this will put the tool holder up inside the fixture. Do not allow the sides of the tool holder to touch the Inner Diameter (I.D.) of the spindle fixture. For the Siemens Control, perform the following steps: Press the JOG hard key, then the MPG hard key, and use the MPG hand wheel to job the Z-axis into position.
- 17) If the ATC is off alignment, adjust the front to back and side to side as needed, until the tool can be inserted into the spindle fixture to a minimum of 1".
- 18) Put a small level on the ATC arm body to check the level. Typically, this would be the same level adjustment as the base casting. Check the base way, with the small level, as the reference position.
- 19) With a dial-caliper (Veiner-Caliper) or a depth micrometer, check the distance from the outer diameter (O.D.) of the tool holder to the O.D. of the spindle fixture using the fixture through holes. Split the difference between the front to back readings.
- 20) Check the distance between the O.D. of the tool holder to the O.D. of the spindle fixture, using the through holes, and split the difference between the side to side readings. See Figure 5-16, positions 4, 5, 6 and 7.
- 21) The reading that was obtained in step #20 will be the shim size required.

- 22) If required, install the shims in groups of twos, one along the top the row of the ATC mount bolts and one underneath the bottom row of mount bolts. See Figure 5-18, positions 4,5, and 6.
- 23) With a forklift or crane still connected to the ATC, loosen the support bolts to reposition the ATC. Using a rubber mallet, shift the tool changer forward or backward, or bring the front up or down. The forward and backward movement of the ATC is used to adjust the horizontal straightness. The front of the tool changer being moved up or down is used to adjust the level.
- 24) To properly adjust the side to side position of the ATC, use one of the following methods:
- Remove one of the shims from in between the main casting and the extended mount bracket. These items were used to compensate for dimension tolerances that resulted from the manufacturing process. Shims may or may not be present.
  - Remove the ATC extension mount bracket and mill it down to the proper dimension and then reassemble the part to the machine (This is only in the case of not having shims present between the ATC and extension bracket).
  - Manufacture shims that will be inserted between the extended mount bracket and the column casting of the machine. Loosen the support bolts to allow the shims to be inserted in along the top and bottom rows of the ATC mount bracket, at the column.
- 25) Recheck the level and alignment of the ATC for front to back and side to side. If necessary, re-adjust the alignment and tighten the ATC into position. See Figure 5-19.
- 26) Repeat above steps for the opposite tool gripper to ensure consistent alignment before pinning the ATC into its final position.
- 27) Drill and ream the four dowel-pin holes to accept tapered pins. The drill size is 5.953mm. The tapered Reamer size is: #5.
- Note:** When reaming the holes for the dowel pins, observe that the pins do not extend past the edge of the hole by more than 6.35mm (1/4 in.).
- 28) Install four #5 tapered dowel-pins into the ATC arm mount at the column. See Figure 5-18, position 4.
- 29) Switch to the reverse direction on the drill motor to manually rotate the tool arm back, so the tool holder can be removed.

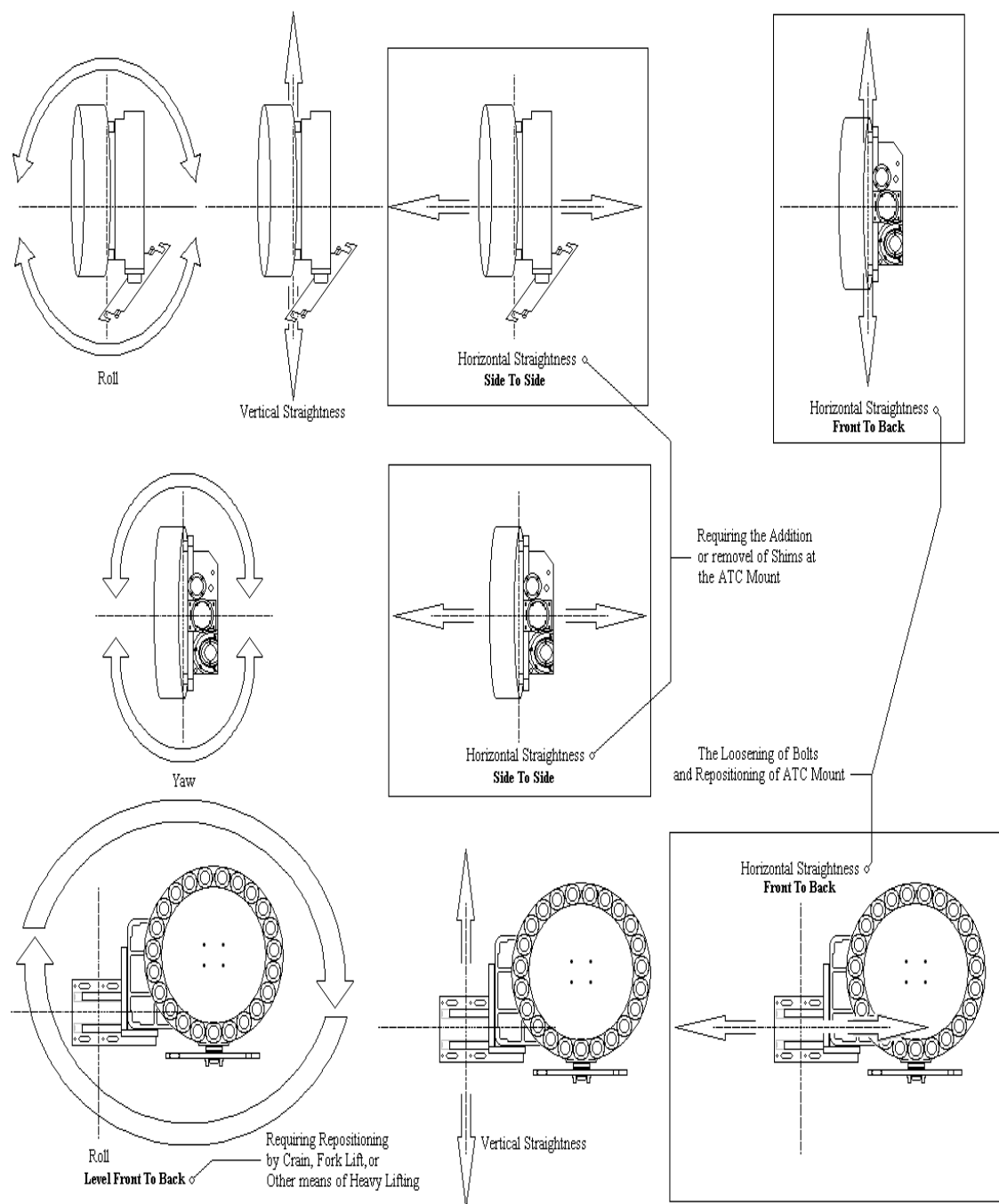
- 30) While rotating the ATC arm, pull the motor brake switch up. This is the electromagnetic brake that will be holding the motor back from turning smoothly. The switch is located on top and to the front of the ATC motor (the switch must be held up). See Figure 5-18, position 3. When the motor has reached the lowest position, press the plunger and remove the tool holder.
- 31) Start turning the ATC motor again, in the same direction as in step #30. The falling mechanism will reverse, sending the arm back up. At the highest position, the arm body will turn back (80 degrees for the 3020, 65 degrees for the 4525 and 35 degrees for the 6535) to the stand by position 1 (ATC Home Position).
- 32) Remove the spindle fixture from the head.



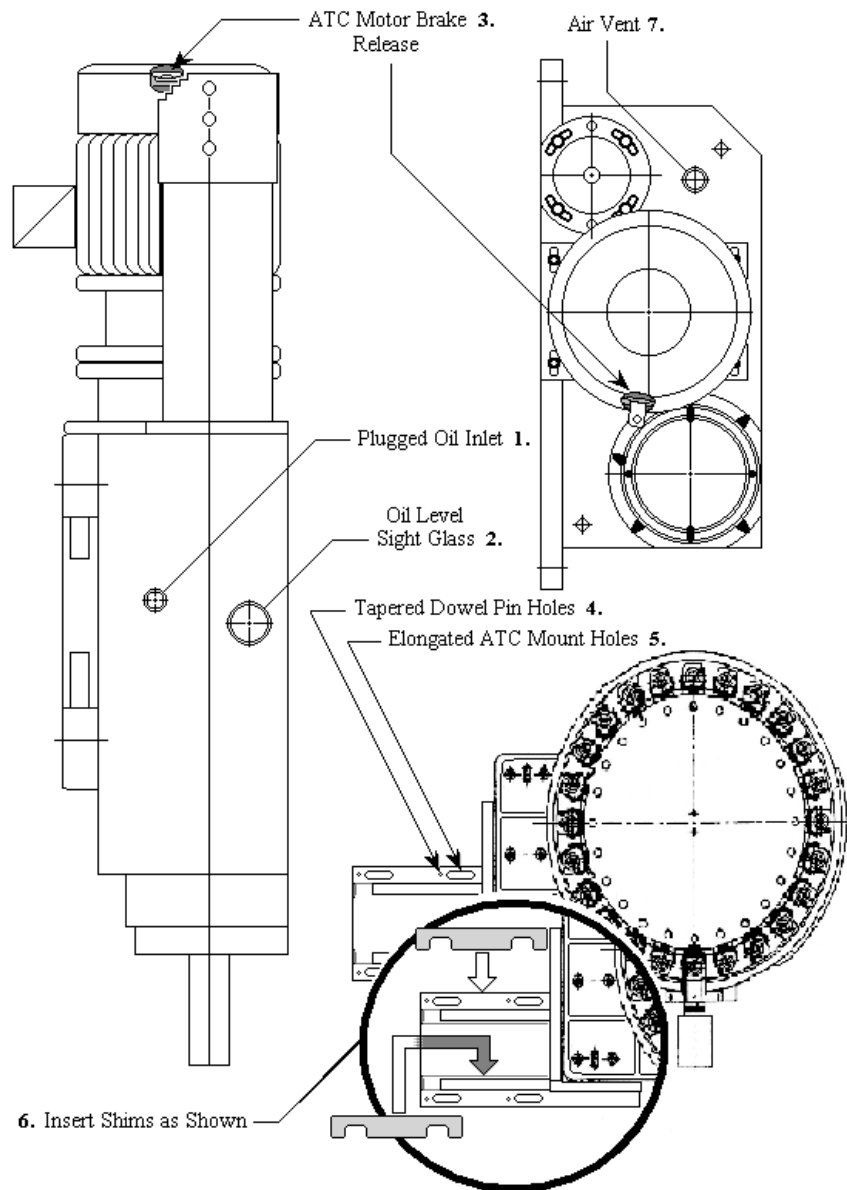
**Figure 5-18** Manual Rotation of Tool Arm



**Figure 5-19** Pull Motor Brake Switch



**Figure 5-20** ATC Movement



*Figure 5-21 Engage Gripper Key Way*

**Software &  
Mechanical Test**

Perform all of the following actions at the pendant keypad. Align all of the axes to the cold start marks.

- 1) Press the MANUAL button until ENTER NEXT COMMAND is displayed.
- 2) Type SETTO, and press the ENTER button. This will set the tool position to tool number 1.
- 3) Type CS, and press the ENTER button to Cold Start the VMC.



- 4) Type MD, and press the ENTER button. This will enter the VMC into the Manual Data Input (MDI) mode.
- 5) Type M6 T2, and press the ENTER and the START buttons.
- 6) Verify the following:
  - a. The proper tool number is displayed on the monitor.
  - b. A proper tool change was made (proper tool and position).
  - c. The Z-axis returns to Z0, cold start position.
- 7) Press the MANUAL key.
- 8) To test the high speed tool change, enter and run the following program:  
Type MD, and press the ENTER button.

Enter:

T-2

M6 T2

T-3

G4 P5000

M6 T3

T-5

G4 P5000

M6T2

Press the SPACE BAR to toggle user menu on.

Press the AUTO button, and then press the START button.

Verify the following:

- a. The proper tool number is displayed on the monitor.
- b. A proper tool change was made (proper tool and position).
- c. The Z-axis returns to Z0, cold start position.

Press the MANUAL button to return to the ENTER NEXT COMMAND screen.

### Set-Up

#### CNC Set-Up

The VMC is shipped with the parameters set for Dual Arm Tool Changer. Check the TOOL CAPACITY parameter on the PARAMETERS page. On the CNC control, type SETP and then press the ENTER button. The parameter for the Dual Arm is 4.

#### Orientation Set-Up

When installing the pulley on the spindle, use the third orientation mark to properly line up the spindle with the tool changing arm. The third orientation mark is located approximately 100 degrees from the standard orientation marks.

#### Cold Start Set-Up

- 1) Verify that the VMC has been cold started. Type M19, to orient the spindle, and press the ENTER button.
- 2) Press the JOG button, to enter the JOG mode, and slowly move the Z-axis all the way up.
- 3) Press the MANUAL button, to enter the ENTER NEXT COMMAND mode.
- 4) Type DI, press the ENTER button, type DD, and press the ENTER button (this is the diagnostic mode for the Dual Arm Tool changer).
- 5) Use the 3 button on the pendant keypad to index the tool arm over to the spindle.
- 6) Press the MANUAL button to return to the ENTER NEXT COMMAND mode, and press the JOG button.
- 7) Move the Z axis down until the front key of the spindle is in the key-way of the tool.
- 8) Measure a distance of .020" - .030" from the bottom of the spindle key to the bottom of the tool arm key-way.
- 9) Cold start the machine from this point.
- 10) Enter the Diagnostic Mode again, and use the 4 button on the pendant keypad to move the tool arm back to the center position.
- 11) Press the MANUAL button and type SV. Press the ENTER button (this is the Survey table). Press the D button, to move the cursor down, until the ZERO OFFSET is selected. Type the number 0 and press the ENTER button. The Zero Offset is now 0. Press the MANUAL button, to enter the ENTER NEXT COMMAND mode.
- 12) Using an extended base, place an indicator on the table and touch the indicator to the bottom of the spindle. Zero the indicator.
- 13) Type CS, and press the ENTER button, to Cold Start the machine. Press the JOG button and jog the Z axis up. Slide the indicator back under the spindle and jog the head down until the zero reading is obtained on the indicator. Move the indicator .020" - .030" above the zero reading. Look on the monitor and note the Z axis value on a sheet of paper.

- 14) Enter the Survey Table and select the ZERO OFFSET. Type the number that was recorded from the monitor. Press the ENTER button. Press the MANUAL button, to return to the ENTER NEXT COMMAND screen and press the JOG button, to enter the JOG mode.

**Note:** If the VMC is equipped with a Siemens Control, stop after step number 14.

- 15) Jog the Z axis down 3.25 inches and type SETCS. Cold start the machine. Jog the Z axis up 3.25". Enter the Diagnostics Mode for the Dual Arm Tool Changer, and use the 3 key on the keypad to move the tool arm in to the spindle. Verify the .020" - .030" gap between the bottom of the spindle key and bottom of the tool arm key way.

- 16) Use the 4 key on the keypad to move the tool arm back to the center position. Press the MANUAL button, then the JOG button and jog the Z axis back to the cold start position.

#### Tool Loading Procedures

- 1) Press the MANUAL button to enter the MANUAL DATA INPUT mode.
- 2) Type M19 and press the ENTER button, to orient the spindle.
- 3) Press the MANUAL button, to return to ENTER NEXT COMMAND. Press and hold the TOOL IN/OUT button and insert tool number one into the spindle (If the tool is a CAT-40, then the tool should be inserted with the shallow key slot facing the back of the spindle and the deep key slot facing the operator. If the tool is a BT-40, then insert the tool with the set screws facing the back of the spindle).
- 4) Use the Clockwise (CW) and Counterclockwise (CCW) buttons, located on the pendant, to position the tool turret. Type SETTO to establish tool position for the control.
- 5) Press the MANUAL button, to return to the MANUAL DATA INPUT and type M6T2. Press the ENTER button, then the START button. This will put tool number one in the tool carrier and leave the spindle open for tool number two to be inserted (M is the programming code for a tool change and T2 is for tool number 2).
- 6) Repeat step number 5, substituting the appropriate tool number, until all of the desired tools have been loaded.

#### Operation

##### Programming

The Dual Arm Tool Changer uses the same programming codes as the Geneva driven and Servo Turret tool changers. To optimize the tool to tool change time,

a T minus (T-) command is used to pre-stage the next tool. The following program is an example of the programming for this tool changer, and can be used in the *Auto Mode* or the *Manual Data Input (MDI) Mode*.

**Sample Program:**

```
01
M6T1 (make a tool change to tool number 1)
S1000M3
T-4 (pre-stage tool number 4). This is different from the T minus command that
is used with the Geneva type tool changer, which positions the tool changer at
slot number 4 to give adequate tool clearance.
```

```
-----
program
-----
```

```
M6T4 (Tool change to tool number 4)
S1000M3
T-1 (pre-stage tool number 1):
```

**Note:** Separate the M6T# line and the T-# line with at least one line of different coding.

**Manual Operation**

The tool changer can be manually operated in the Diagnostic Mode. This mode will be used to service the tool changer or complete a systems check.

- 1) On the keypad, type DI, and press the ENTER button. Then type DD and press the ENTER button. This will put the machine in the diagnostic mode for the Dual Arm Tool Changer.
- 2) Use the menu to operate the desired function.

**WARNING**

Verify that the head is 3.25" or more above the machine cold start position before moving the tool arm in the forward or reverse direction.



1	Bucket Up
2	Bucket Down
3	Move Arm Forward
4	Move Arm Reverse
6	Reset 1330 Card
0	Sensor Status
' _ _	Pocket Status

- 3) Pressing the "0" button will display the sensor status at the bottom of the diagnostics page. This is where the status of each sensor can be monitored during manual operation.

### Sensors

Home Position Bucket Up Drawbar Down  
Tool Arm Stop Bucket Down Emergency Stop  
Tool Change Pos Tool Count Interlock

If the tool changer arm or bucket are out of position, the DI/DD mode must be used to move any component.

Using the DD Command

To view the tool positions, use the ENTER NEXT COMMAND screen and type DD. While viewing the tool positions, the operator can:

- 1) Press the CW/CCW buttons, on the pendant, to change the slot that is lined up with the spindle. This change will be highlighted by an asterisk (\*), placed next to the appropriate number.
- 2) Choose option number 1, SWAP TOOLS, which will change the tool in the spindle with the tool in the bucket that is lined up with the spindle. When the tools are switched, the monitor will display the tool that is in the spindle.
- 3) Choose option number 2, SORT TOOLS, which will sort all of the tools automatically, placing each tool with its respective slot number. When the tool changer has finished sorting the tools, tool number 1 will be in the spindle.

### Sys 101.4 Software Update.

A recovery procedure has been developed for the case where the Turret on Dual Arm Tool Changers has been commanded to rotate, and E-Stop has been implemented prior to completion of the rotational move, possibly interrupting the Tool Count and mislocating the bucket at "Ready" position.

Should this case occur and the Turret is mislocated between buckets, the error message, "AMBIGUOUS BUCKET POSITION, VERIFY POCKET # WITH SETTO, #" will appear.

- 1) 1. From the command line, type "DD".
- 2) 2. This will display the Tool Bucket and Tool Number table, and identify with an asterisk which Bucket is expected to be at the "Ready" position.

- 3) 3.If the Turret is mis-positioned, and the tools are NOT out of sequence, then press TURRET CW or CCW until BUCKET #1 (not TOOL #1) has been rotated to the "Ready" position at the bottom.
- 4) 4.Type "SETTO,1" at the command line to reset Bucket #1 to the "Ready" position, and move the , ' asterisk in "DD" to Bucket 1. This command can be used as "SETTO,xx" where "xx" is the BUCKET number at the "Ready" position. It does NOT reset Tool Numbers.
- 5) 5.If the tool sequence is still incorrect, then remove the tools from the Tool Changer, move Bucket #1 to the "Ready" position with TURRET CW or CCW, type "SETTO" from the command line, and reload all of the tools. "SETTO" resets all of the Tool Numbers to that of the Bucket Numbers.

#### Versions

SYS 101.4 is available in English non-CE only.

#### Troubleshooting

Symptom	Possible Problem	Corrective Action
Tool disc does not stop at the locating position	1) The brake is not working. 2) The distance between the proximity switch and sensor point is too long.	1) Verify that the wiring of the electronic brake is correct and that the brake is in proper working condition. 2) Close the distance between the proximity switch and the sensor point.
The tool disc keeps rotating	1) The proximity switch is faulty. 2) The distance between the proximity switch and the sensor point is too long.	1) Install a new proximity switch. 2) Close the distance between the proximity switch and the sensor point.
The bracket of the tool pot is deformed	1) The tool disc is rotating while the tool is falling.	1) Install and adjust a new set of brackets. Insert a dowel pin into the tool disc.
The tool disc has jammed while rotating.	1) The C snap ring is loose or the parts of the tool pot fixing base are broken. 2) The cylinder is moving while the tool disc is rotating. As a result, the tool pot is stuck at the tool falling position.	1) Remove and replace the snap ring or the tool pot bracket. 2) Verify that the bracket is not deformed. If the sliding block of the tool falling and roller are broken, repair or replace them.

#### Sequence of Events for Dual Arm-ATC Operation—Fadal Control

- 1) Feedback.

- 2) Tool Up sensor (Magnetic reed switch mounted at Bottom of Air Cylinder- normally open – “Tool Up” LED).
- 3) Tool Down sensor (Magnetic reed switch mounted at Top of Air Cylinder- normally open -“Tool Down” LED).
- 4) Above sensors have a LED mounted into the sensor and 1330-0 card that is lit when switch is closed.
- 5) Arm Stop (Proximity current sensor #1 mounted at Top on Arm – “Stopping Sensor” LED).
- 6) Arm Tool (Proximity current sensor #2 mounted at Center on Arm – “Arm at Spindle” LED).
- 7) Arm Home (Proximity current sensor #3 mounted at Bottom on Arm – “Arm at Home” LED).
- 8) Tool Count sensor (Proximity current sensor mounted under Turret Motor – “Tool Count” LED).
- 9) Drawbar sensor (Hall Effect sensor mounted under Drawbar Cylinder – “Drawbar” LED).

Above sensors have an LED mounted on the 1330-0 card that is lit when switch is closed.

## Errors

#	Error Message	Description
1	CAROUSEL SOLENOID FAILURE (OR SENSOR)	
2	DRAWBAR SOLENOID FAILURE (OR NO AIR)	The Drawbar Cylinder could not be moved down to extract tool. Check Air Supply. Check Tool.
3	DRAWBAR SENSOR FAILURE	The Drawbar Cylinder piston could not return home.
4	ATC ARM IS NOT IN HOME POSITION	The ATC Arm did not arrive at ATC Home.
5	ATC BUCKET UP SOLENOID/SENSOR FAILURE	The ATC Bucket Cylinder did not arrive at TOP.
6	ATC BUCKET DOWN SOLENOID/SENSOR FAILURE	The ATC Bucket Cylinder did not arrive at BOTTOM.
7	ATC ARM SOLENOID SENSOR/HOME SENSOR FAILURE	The ATC Arm could not move away from HOME.
8	ATC TOOL ARM OBSTRUCTED	The ATC Arm did not arrive at Spindle.
9	ATC TOOL SENSOR FAILURE	The ATC Arm TOOL Sensor was not seen.

#	Error Message	Description
10	ATC TOOL CLAMPING FAILURE	The ATC Arm could not move down from Spindle.
11	ATC TOOL UNCLAMPING FAILURE	The ATC Arm could not leave Tool Holders.
12	ATC INTERLOCK IS ON	
13	ATC COMMUNICATION ERROR WITH 1330-CARD	Can't communicate between the 1330 and 1400.
14	ATC AMBIGUOUS BUCKET POSITION	ATC Bucket is neither UP nor DOWN. Neither reed switch is seen.
15	ATC AMBIGUOUS TURRET POSITION	ATC Turret is in-between Buckets. Turret Sensor is not seen.

#### DA-ATC Tool Change Cycle—Fadal Control

- 1) Initiate Tool Change -- M6.
- 2) Spindle OFF (M5). Orient Spindle (M19). Check for Orient Switch feedback.
- 3) If feedback from Spindle Orientation Hall Effect switch, then Spindle is Oriented, STOP Spindle. K7 and K9, K3 and K4 OFF.
- 4) Begin a new one second timer to initiate "Bucket DOWN" cycle.
- 5) Enable 1330/K2 to power Air Valve to move Bucket DOWN.
- 6) If Air Cylinder top reed switch is OPEN and the bottom reed switch is CLOSED, then stop the timer. Proceed to 4.
- 7) If timer times out, the Bucket did not move down, and if top reed switch is CLOSED and bottom reed switch is OPEN, then get message #6—ATC BUCKET DOWN SOLENOID/SENSOR FAILURE. Halt system.
- 8) Or, if timer times out, the Bucket did not move down, and if top reed switch is OPEN and bottom reed switch is OPEN, then get message #14—AMBIGUOUS BUCKET POSITION. Halt system.
- 9) Begin a new one second timer for "Arm to Spindle" cycle, and activate Triacs for Arm Motor to move.
- 10) Enable 1330/K4 relay to CLOSE 3-phase contactor.
- 11) Stop the timer as soon as the Arm moves away from its home position, and the ARM STOP and ARM HOME sensors report that Arm is away. This verifies that the ARM STOP and ARM HOME signals are working properly. Then proceed to 5.



- 12) If the timer times out, and therefore the arm has not moved from the ARM HOME position, then get message #7, ATC ARM SOLENOID SENSOR/HOME SENSOR FAILURE. Halt system. Check Overload LED on 1330, Arm Motor Drive Belt, Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, and fuses ahead of Contactor.
- 13) Begin a new one-second timer to initiate “Arm Approaching Spindle/Bucket” cycle.
- 14) As soon as the ARM STOP and ARM TOOL signals are seen, stop the timer, disable 1330/K4 relay to disconnect Contactor to power OFF Arm Motor. Proceed to 6.
- 15) If the timer times out, the arm has not arrived at Spindle and Turret Bucket. Get message # 8—ATC TOOL ARM OBSTRUCTED or if ARM STOP sensor was seen and ARM TOOL was not, get # 9--ATC TOOL SENSOR FAILURE. Halt system. Check Overload LED on 1330, Arm Motor Drive Belt, Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, and fuses ahead of Contactor.
- 16) Begin a new one-second timer to initiate “Drawbar Down” cycle.
- 17) Enable the 1330/K1 relay to power Air Solenoid to Drawbar Cylinder.
- 18) As soon as Drawbar Cylinder Hall Effects switch is seen, stop the timer. Proceed to 7.
- 19) If timer times out, then Tool could not be extracted from Spindle. Get message #2—DRAWBAR SOLENOID FAILURE (OR NO AIR). Halt system. Check Drawbar Cylinder Hall Effects switch and its adjustment, air supply, check for broken Drawbar Cylinder piston, Drawbar Cylinder leaks, Drawbar/Belleville spring problems, and Tool Holder/Pull Stud problems.
- 20) Begin a new one second timer to initiate “Arm DOWN” cycle.
- 21) Enable 1330/K4 relay to CLOSE 3-phase contactor.
- 22) Stop the timer as soon as the Arm moves away from its Spindle position, and the ARM STOP and ARM TOOL sensors report that Arm is away. This verifies that the ARM STOP and ARM TOOL signals are working properly. Then rotate Arm 180 degrees and proceed to 8.
- 23) If the timer times out, and therefore the arm has not moved from the ARM TOOL position, then get message #10, ATC TOOL CLAMPING FAILURE. Halt system. *(This message is incorrect as the control cannot tell if the tool has been clamped or not.)* Check Overload LED on 1330, Arm Motor Drive Belt,

Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, and fuses ahead of Contactor.

- 24) Begin a new one-second timer to re-initiate “Arm Approaching Spindle/ Bucket” cycle.
- 25) As soon as the ARM STOP and ARM TOOL signals are seen, stop the timer, disable 1330/K4 relay to disconnect Contactor to power OFF Arm Motor. Proceed to 9.
- 26) If the timer times out, the arm has not arrived at Spindle and Turret Bucket. Get message # 8—ATC TOOL ARM OBSTRUCTED or if ARM STOP sensor was seen and ARM TOOL was not, get # 9--ATC TOOL SENSOR FAILURE. Halt system. Check Overload LED on 1330, Arm Motor Drive Belt, Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, and fuses ahead of Contactor.
- 27) Begin a new one second timer for “Clamp Tool” cycle.
- 28) Disable 1330/K1 relay to stop Air Valve to Drawbar Cylinder.
- 29) If Drawbar Hall Effect Switch signal is OFF, then Tool is clamped. Stop the timer. Proceed to 10.
- 30) If the timer times out, tool is NOT clamped. Get message #3—DRAWBAR SENSOR FAILURE. Halt system. (*This error message is incorrect.*) Check for fluid buildup in Drawbar Cylinder, broken return spring, or misadjusted Hall Effect Switch.
- 31) Begin a new one second timer for the “Arm Return to Home” cycle.
- 32) Enable 1330/K4 relay to CLOSE 3-phase contactor.
- 33) Stop the timer as soon as the Arm moves away from its Spindle position, and the ARM STOP and ARM TOOL sensors report that Arm is away. This verifies that the ARM STOP and ARM TOOL signals are working properly. Then rotate arm to ATC HOME position. Proceed to 11.
- 34) If the timer times out, and therefore the arm has not moved from the ARM TOOL position, then get message #11—ATC TOOL UNCLAMPING FAILURE. Halt system. (*This message is incorrect as tool is not unclamped here.*) Check Overload LED on 1330, Arm Motor Drive Belt, Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, and fuses ahead of Contactor.

- 35) Begin a new one-second timer to initiate “Arm Approaching ATC Home” cycle.
- 36) As soon as the ARM STOP and ARM HOME signals are seen, stop the timer, disable 1330/K4 relay to disconnect Contactor to power OFF Arm Motor. Disable Triacs to Arm Motor. Proceed to 12.
- 37) If the timer times out, the arm has not arrived at Spindle and Turret Bucket. Get message # 8—ATC TOOL ARM OBSTRUCTED. Halt system. Check Overload LED on 1330, Arm Motor Drive Belt, Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, and fuses ahead of Contactor.
- 38) Begin a new one second timer to initiate “Bucket UP” cycle.
- 39) Enable 1330/K3 to power Air Valve to move Bucket UP.
- 40) If Air Cylinder top reed switch is CLOSED and the bottom reed switch is open, then stop the timer. Proceed to 13.
- 41) If timer times out, the Bucket did not move up, and if top reed switch is OPEN and bottom reed switch is CLOSED, then get message #5—ATC BUCKET UP SOLENOID/SENSOR FAILURE. Halt system.
- 42) Or, if timer times out, the Bucket did not move up, and if top reed switch is OPEN and bottom reed switch is OPEN, then get message #14—AMBIGUOUS BUCKET POSITION. Halt system.

Tool change cycle is completed.

#### PCB-0213 Dual Arm ATC Controller Card

##### Description and Explanation of Operation of PCB-0213 (1330-0A)

The 1330-0A is identical to the 1330-0 in terms of connections and operation with the following exceptions: a LED indicator has been added for the drawbar position sensor input, the overload sensing threshold for turret motor has been changed, and a spindle head position sensor has been added to interlock arm movement. This last change is the most significant; if the Z-axis is not at the tool change position, relays K9 and K8 will not allow the arm to move.

The 1330-0A is used on both Fadal and Siemens controls. However, the software is different for Siemens control from the Fadal control and is ordered separately from the PCB-0213.

#### Inputs

8-bit data port with strobe and ask for commands (bi-directional) - J4

**6 Sensors - J1 and J2:**

- Tool Count - proximity sensor, Namur PNP, active source
- Home position - proximity sensor, Namur PNP, active source
- Tool Change Position - proximity sensor, Namur PNP, active source
- Stopping Position - proximity sensor, Namur PNP, active source
- Drawbar down sensor - Hall Sensor, active low
- Tool Down - reed sensor, NPN, normally open
- Tool Up - reed sensor, NPN, normally open

(All sensor inputs except for drawbar can be configured for different sensors than those shown).

All sensor inputs have LEDs indicating their status. These inputs cannot be checked with a volt meter because the sensors are current devices.

+5V, +12V, GND - J5

120 VAC (J6 pin 1)

RET (J6 pin 2)

**E-Stop (120 VAC) - J6 pin 3 (from 1100-1 TB1 pin 10)**

Disables all 120V and 230V outputs from the 1330 when VMC is in E-Stop.

**Drawbar and Arm Interlock**

J6 pins 5 and 6 (from 1100-2 TB1 23 & 24) Disables arm and drawbar when spindle is on. Drawbar SSR on 1100-2 must be jumpered or arm and drawbar will not work.

Door Interlock (120 VAC) - J6 pin 7

**(from 2000-1A J2 pin 3 or 1310-1C J1 pin 9)**

Disables arm when doors are open. (If there is no 1310 or 2000 board, J6 pin 7 must be jumpered to J6 pin 8.)

**Head Position Sensor- J11 (Hall sensor or magnetic reed switch)** Disables arm movement (K9) if the Z-axis is not at tool change position. If no tool change position sensor is installed, then J11 pins 2 and 3 must be jumpered.

**OutPuts****2 Motors:**

- Motor for turret - 3-phase, bi-directional (5 triacs) (Interlocked with E-Stop)
- Motor for arm - 3-phase, bi-directional (5 triacs) (Interlocked with E-Stop, doors, spindle, and head position)

**3 Valves:**

- Drawbar (interlocked with E-Stop, spindle, and head position)
- Tool Down (interlocked with Tool Up and E-Stop)
- Tool Up (interlocked with Tool Down and E-Stop)

Contactor supplying 230 V 3-phase to 1330 (interlocked with E-Stop and overcurrent)

LED Indicators:

Sensor Inputs (Green):

- Tool Count - On at each tool position, off between tool positions.
- Arm at Home - On when arm is in home (or idle) position.
- Arm at Spindle - On when the arm is at the spindle.
- Stopping - On when arm is at home or at the spindle.
- Drawbar - On when drawbar is down.
- Tool Down - On when tool bucket is down.
- Tool Up - On when tool bucket is up.
- ATC Fault (Red) - On when there is a tool change fault.
- Heartbeat (Green) - Blinks indicating CPU is alive and functioning.
- Overload (Yellow) - Indicates a motor overload is occurring (flashes at 50/60 Hz).
- (Turret overload  $\geq 4$  A, Arm overload  $\geq 7.5$  A)
- Overcurrent (Red) - On after there has been an overcurrent
- (Turret overcurrent  $\geq 13$  A, Arm overcurrent  $\geq 30$  A)
- Output Indicators (Yellow):
- Turret FWDOn when turret moving forward. (Turret CCW)
- Turret REVOn when turret moving reverse. (Turret CW)
- Arm FWDOn when arm moving.
- Arm REVOn when arm commanded in reverse by Dual Arm menu
- Drawbar On while drawbar solenoid is commanded on (K1)
- Tool Down On while tool down solenoid is commanded on (K2)
- Tool Up On while tool up solenoid is commanded on (K3)
- Contactor On while 3-phase contactor is commanded on (K4)

Currents:

*Peak current* of the turret motor measures 4-6 A. Continuous current of the turret motor measures 0.8-1.2 A.

*Peak current* of the arm motor measures at 8-13 A. Continuous current of the arm motor measures at 2-3 A. (Since the arm movement is limited, this continuous current is less than 1 second).

**Current Sensing:**

There are two different values of current sensed for each motor: "overload" (current larger than allowable continuous value) and "overcurrent" (current well beyond allowable peak value). Overload will occur when the motor stalls. Overcurrent would occur when there is a short circuit or motor windings short.

The overload signal is returned to the microcontroller which checks its duration and shuts down the motor if it lasts beyond normal startup current. The overcurrent signal shut down the triacs through hardware and is returned to the microcontroller with the overload signal. Overloads will occur whenever the motor is started because starting current is greater than locked rotor current. Therefore it is normal to see the Overload LED flash when the motor starts.

**Functional Explanations:**

For board to have 120V for the SSRs:

- VMC must not be in E-Stop (E-Stop relay (K5) passes 120V through CB1 to SSRs).
- CB1 must not be tripped.

For board to have 3-phase power:

- Board must have 120V power (see above).
- There must not be an overcurrent (D17 lit).
- Contactor SSR (K4) must be energized.

For board to have 3 phase power to Arm triacs:

- Board must have 120V power (see above).
- Board must have 3-phase power (see above).
- Spindle must not be on (and Drawbar relay on 1100-2 must be jumpered); this energizes the Drawbar Interlock relay (K7).
- If CE machine, 120V output from 2000 (J2 pin 3) or 1310 (J1 pin 9) board must go to J6 pin 7 (doors must be closed);
- If not CE, J6 pin 7 must be jumpered to J6 pin 3
- (CNC should not allow arm movement with doors open).
- Once all of the above conditions are met, Arm Power relay will be energized.

For drawbar to be energized:

- Board must have 120V power.
- Spindle must be off (Drawbar Interlock relay energized; this passes 120V power to Drawbar SSR and floats Drawbar enable to AND gate).
- Drawbar SSR must be energized.

For Tool Up or Tool Down solenoid to be energized:

- Board must have 120V power (see above).

- SSR for Tool Up or Tool Down must be energized.
- (Logic on the 1330 will disable Arm Up if Arm down is on and vice versa).

For Turret Fwd or Turret Rev to be active (turret in motion):

- Board must have 120V power (see above).
- Board must have 3-phase power (see above).
- (Spindle may be on. Turret motion with the spindle on is allowable but not arm motion.)
- Overcurrent latch must be reset by microcontroller.
- Turret Fwd or Turret Rev (not both) must be active (low).

For Arm Fwd or Arm Rev to be active (arm in motion):

- Board must have 120V power (see above).
- Board must have 3-phase power (see above).
- Spindle must be off (Drawbar Interlock relay energized; this pulls arm enable to OR gates low).
- Z-axis must be at tool change position (LED D20). If head is not at tool change position, K9 will not be energized which will disable K8. (If there is no head position sensor (J11) then J11 pins 2 and 3 must be jumpered. Shunt ELE-0088 is recommended for this.)
- If CE machine, 120V output from 2000 or 1310 board must go to J6 pin 7 (doors must be closed); if not CE, J6 pin 7 must be jumpered to J6 pin 3. (CNC should not allow arm movement with doors open).

Once all of the above conditions are met, the Arm Power relay will be energized:

- Overcurrent latch must be reset by microcontroller.
- Arm Fwd or Arm Rev (not both) must be active (low).

**Scheduled  
Maintenance**

The maintenance schedule is based on machine usage of eight hours a day, five days a week.

**Daily Maintenance**

Perform the following daily:

**1) Cleaning**

- a. Remove the chips and debris surrounding the proximity switch inducing block.
- b. Remove the chips and debris that have accumulated on the inverted moving body of the tool pot.
- c. Clear the tool changing mechanism of all debris before any operation.

**2) Inspection:**

- a. Check the parts of the tool falling mechanism for damage and wear. Add grease to the sliding base of the tool falling mechanism and the pull rod.
- b. Check the parts of the tool pots, tool discs, and snap rings for damage and tightness.

**Weekly Maintenance**

Perform the following weekly:

**1) Greasing:**

- a. Grease the claws of the tool changing arm unit.
- b. Grease the tip of the release pin of the tool changing unit.

**Miscellaneous Maintenance**

Perform the following as necessary:

- 1) Change the lubricant annually or as needed. The recommended lubricant is SAE 90-140. The Dual Arm Tool Changer uses approximately 5 liters (1.3 gallons).

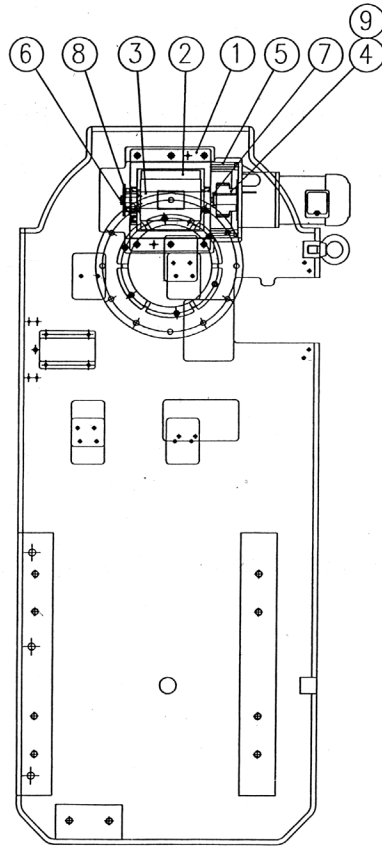


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**50 Taper Dual Arm  
Tool Changer****Tool Changer  
Specifications**

<b>Type of Tool</b>		CAT-50/BT-50
<b>Number of Tools</b>		32
<b>Maximum Tool Diameter</b>		
	All Pockets Full	Ø125mm (4.92in.)
	Adjacent Pockets Empty	Ø250 (9.85in.)
<b>Maximum Tool Length</b>	Maximum	400mm (15.75in.)
<b>Tool Weight</b>	Maximum	18kg. (40lb.)
<b>Tool Magazine Drive Source</b>		
	Motor Voltage	AC 220 V, 3 Phases
	Air Pressure	5~7kg/Cm (70-100 psi)

## Sub-Assemblies

*Figure 5-22* Index Mechanism

No.	Part Description
1	Cam Base
2	Cylindrical Cam
3	Driving Spindle
4	Gear
5	Motor Base
6	Proximity Switch Base
7	Gear's Locking Basket
8	Proximity Switch Block
9	Gear

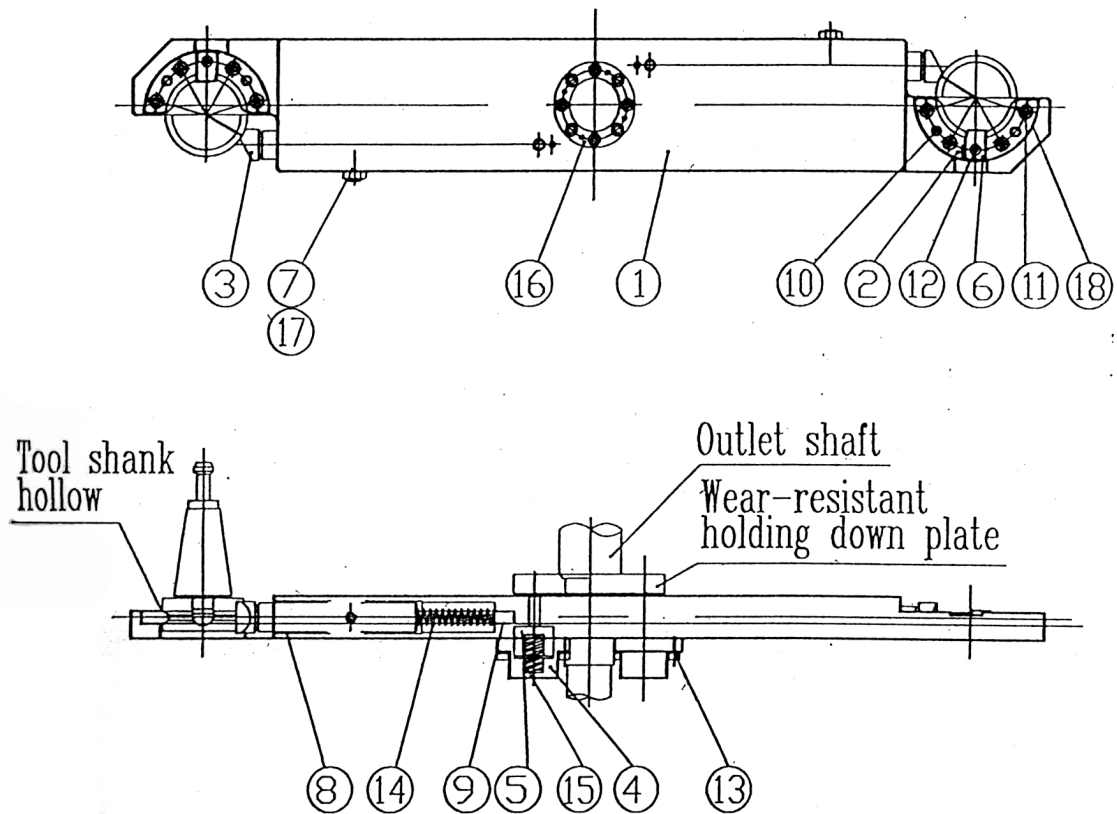
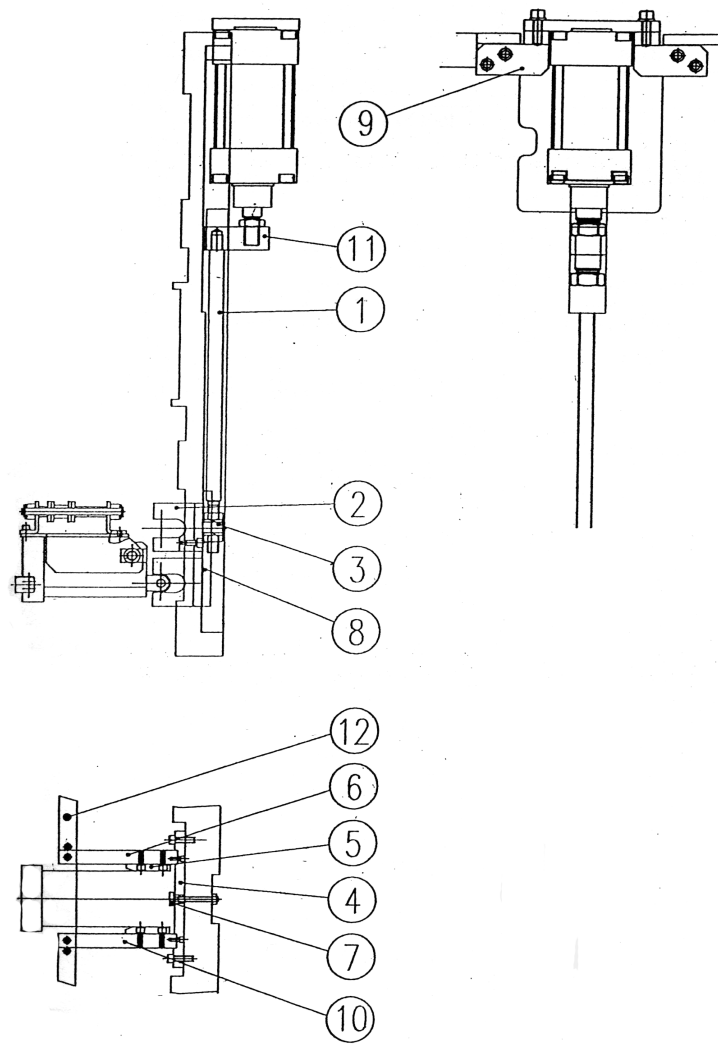


Figure 5-23 50 Taper Tool Arm

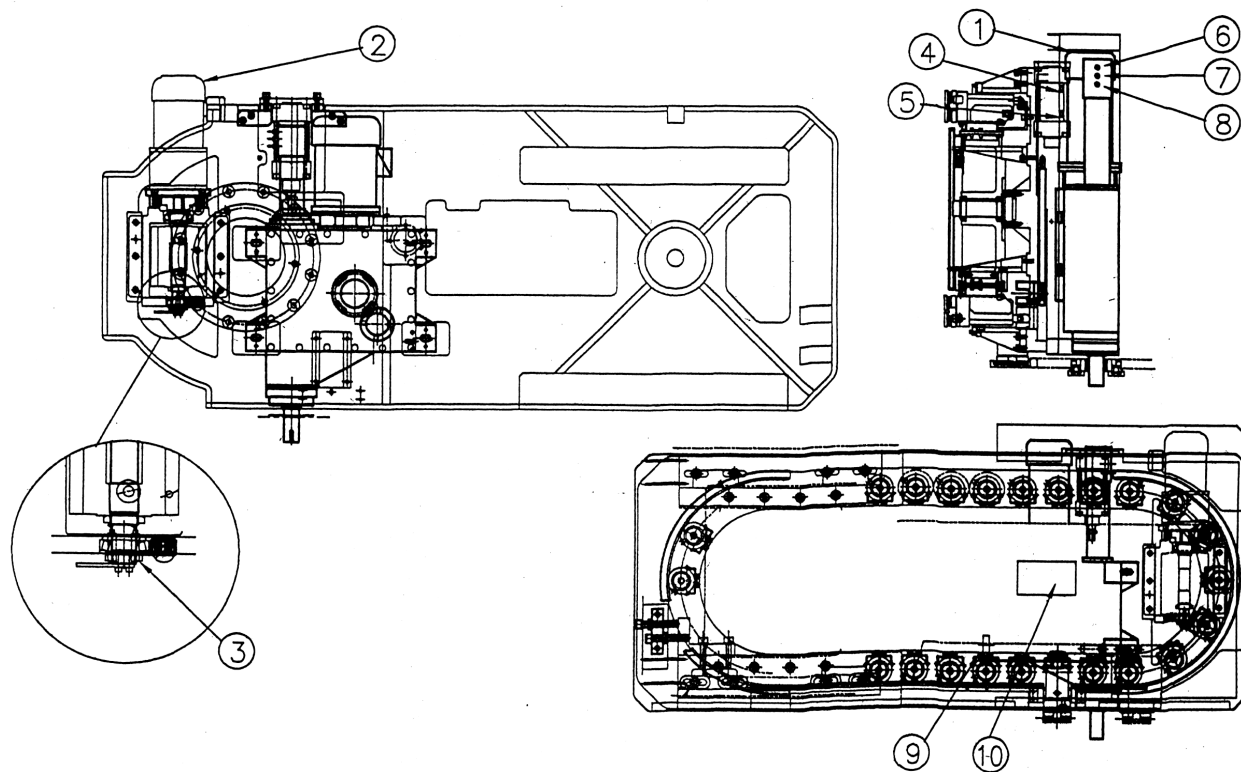
No.	Part Description	No.	Part Description
1	Tool Arm Body	12	Counter Sunk Screw
2	Gripper	13	Female Hexagon Bolt
3	Tool Holding Rod	14	Spring(2)
4	Spring Cover	15	Spring(1)
5	Fixing Rod	16	Locking Ring
6	Positioning Key	17	Hexagon Nut
7	Positioning Bolt	18	Catching Claw Pad
8	Self Lubricating Bearing		
9	Self Lubricating Bearing		
10	Pin		
11	Female Hexagon Bolt		



**Figure 5-24** Tool Falling Mechanism

No.	Part Description	No.	Part Description
1	Tool Falling Pull Rod	9	Cylinder Base
2	Sliding Block	10	Positioning Slide Block
3	Sliding Block Cover Plate	11	Connecting Block
4	Positioning Block	12	R-Fixing Plate
5	Positioning Sliding Block (1)		
6	Positioning Sliding Block (2)		
7	Pot Fixing Base		
8	Positioning Block		

## CONTROL ELEMENTS

*Figure 5-25* Control Elements

No.	Part Description
1	Tool Changing Mechanism Motor
2	Index Mechanism Motor
3	Proximity Switch 1
4	Reed Switch 2
5	Reed Switch 1
6	Proximity Switch 2
7	Proximity Switch 3
8	Proximity Switch 4
9	Proximity Switch 4
10	Control Box

- Installation**
- 1) Check if all the bolts and parts are affixed tightly (they might be loose during transportation). If not; fasten them tightly.
  - 2) Check if the automatic tool changer has any interference with the column of machining center or other area while connecting to the interface.
  - 3) Check voltage specification of motors, sensors and wiring condition to see if they are all compatible with the control system of the machining center.
  - 4) Insure that the conducting wire of control elements during installation is not damaged.
  - 5) Install the automatic tool changer with the machining center, adjusting the relative position between the tool arm and spindle.
    - a. When manually rotating the tool arm for the proper angle, put the wrench on the top of the tool changing mechanism motor shaft to rotate the arm.
    - b. While rotating the arm, pull rod of the motor brake must be released for smooth rotation.
    - c. Adjust the shaft of the arm and spindle in the vertical direction so that they are parallel.
  - 6) Connect each control element according to the diagrams with the relative points of the machining center.
  - 7) When programming the automatic tool changer, note the protection programming between each single action and refer to 'SEQUENCE OF ELECTRIC ACTIONS' and 'INSTALLATION NOTICE'.
  - 8) Check all the wiring and the relative connections to see if they are accurate before trial running.
  - 9) When performing the trial running, take single action in the beginning, then go for successive actions.
  - 10) If the trial running of single action is not smooth, stop running to check, in order to avoid any damage.
  - 11) If it is necessary, prolong the time between each related action.
  - 12) When performing the successive running, be careful not to miss any interlock protection programming between all the relative actions.

**Installation Notice**

- 1) Make the necessary interlock protection programming for all the relative connections. The following chart is for reference.

Relay Control	Tool Disk Rotation	Tool Falling	Tool Returning	Tool Changing Mechanism Action
Tool Disc Starting		Off	Off	Off
Reed switch of tool returning (protruding of cylinder)	On			
Reed switch of tool returning (protruding of cylinder)				On
Proximity switch of tool counting and positioning of tool disk		On	On	On
Relay of tool changing mechanism motor starting	Off	Off		
Proximity switch of origin of tool changing mechanism	On	On		

- 2) After the tool falling of the tool pot is completed, there must be little prolonged time (0.10.25 seconds) before the tool catching of arm. The purpose is to have sufficient air pressure inside the cylinder to avoid shaking of the tool pot while tool catching.
- 3) After the sensor of the tool unclamping or the tool clamping of the spindle claw is sensed, there could be some prolonged time if necessary. If the tool arm is proceeding the next action before the tool has been unclamped or clamped completely from spindle claw, tool might be forced to be pulled out or the tool might be falling.
- 4) Adjust the pressure of cylinder to be 5-7 kg/c m<sup>2</sup>.

## Troubleshooting

Symptom	Possible Reasons	Solution
Tool disk is not rotating while tool selecting	<ol style="list-style-type: none"> <li>1. Proximity switch of tool counting and positioning of tool disc is not sensed</li> <li>2. Proximity switch is out of order</li> <li>3. Index mechanism motor is out of order</li> <li>4. Motor brake is out of order</li> <li>5. Reed switch of tool returning (protruding of cylinder) is not at the proper position</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust the proximity switch to the proper position</li> <li>2. Change a new proximity switch</li> <li>3. Repair the motor or change a new one</li> <li>4. Check the wiring or change its parts</li> <li>5. Adjust it to the proper position</li> </ol>
Tool disc does not stop at locating position	<ol style="list-style-type: none"> <li>1. Brake of index mechanism motor is not working</li> <li>2. Distance between proximity switch of tool counting &amp; positioning of tool disc and inducing block is too long</li> <li>3. Proximity switch is out of order</li> </ol>	<ol style="list-style-type: none"> <li>1. Check if wiring of brake is correct or if its parts are out of order</li> <li>2. Adjust the distance between proximity switch and inducing block to be closer</li> <li>3. Change a new proximity switch</li> </ol>
Tool disc keeps Rotating	<ol style="list-style-type: none"> <li>1. Distance between proximity switch of tool counting &amp; positioning of tool disc and inducing block is too long</li> <li>2. Proximity switch is out of order</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust the distance between proximity switch and inducing block to be closer</li> <li>2. Change a new proximity switch</li> </ol>
Fixing base of tool pot is deformed	Tool disc rotates while tool pot is falling	Change a new set of fixing base, and adjust, then put spring in
Tool disc is stuck while rotating	<ol style="list-style-type: none"> <li>1. "C" snap ring is loose, or parts of tool pot fixing base are falling apart</li> <li>2. Cylinder works while tool disc is rotating, so tool pot is stuck at tool falling position</li> </ol>	<ol style="list-style-type: none"> <li>1. Disassemble the scattered fixing base and check each part if they are all workable of change a new set of fixing base</li> <li>2. Check if the tool pot fixing base is deformed. Put sliding block of tool falling and roller back if they are falling apart</li> </ol>



Symptom	Possible Reasons	Solution
Tool pot is shaking while tool returning or tool falling	1. Sliding base of tool falling is not lubricated enough 2. Speed of cylinder is not even	1. Apply grease 2. Adjust intake pressure and speed adjusting device of cylinder
Tool pot is not at locating position while tool falling or tool returning	Bolts of pull rod of tool falling are loose	Adjust bolts of pull rod of tool falling to be normal and tighten them
Cylinder is not acting	1. Reed switch of tool falling (contracting of cylinder) is out of order 2. Reed switch of tool returning (protruding of cylinder) is out of order 3. Tool disc is not at locating position 4. No intake pressure in cylinder	1. Change a new reed switch 2. Change a new reed switch 3. Set tool disc to the locating position 4. Check if air resource has air and if solenoid valve is working
Arm is not rotating while tool changing	1. Inducing block of origin of tool changing mechanism is not at the proper position 2. Proximity switch is out of order 3. Reed switch of tool falling (contracting of cylinder) is not at the proper position	1. Adjust it to the proper position 2. Change a new proximity switch 3. Adjust it to the proper position
Arm is not rotating after tool catching	1. Inducing block of tool catching of tool changing mechanism is not at the proper position 2. Proximity switch is out of order	1. Adjust it to the proper position 2. Change a new proximity switch
Tool catching of arm is not accurate	The relative position between arm and spindle is not correct	How to Adjust Arm: 1. Pull the pull rod of clutch downwards. 2. Use hexagon handle to turn motor and make the arm rotate to the angle of tool catching. 3. Adjust the arm until the arm sticks to the caught tool. 4. Tighten the fixing bolt of the arm.

Symptom	Possible Reasons	Solution
Arm is not rotating after 180° tool changing	1. Inducing block of tool catching of tool changing mechanism is not at the proper position 2. Proximity switch is out of order	1. Adjust it to the proper position 2. Change a new proximity switch
Arm stops at origin position but proximity switch of origin is not sensed	1. Inducing block of origin is not at the proper position 2. Proximity switch is out of order	1. Adjust it to proper position 2. Change new proximity switch
Arm is supposed to stop at origin position but is not accurate	Inducing blocks are not at the proper position	Turn the 3 inducing blocks simultaneously to the proper angle
Motor is too hot	1. Brake is not released 2. Brake is out of order 3. Commutator is out of order	1. Check commutator is with electricity or not 2. Repair the brake or change to a new one 3. Change a new commutator
Timing belt of tool changing mechanism is sliding from pulley	1. The timing belt is too loose 2. The timing belt is worn	1. Adjust timing belt tight 2. Change a new timing belt

- Maintenance**
- 1) The lubricant inside the lubricant container of the tool changing mechanism should be changed after working for 2400 hours.

When the cam, rollers and the bevel gear are in use without lubricant, abnormal wear and fractures will occur. Appropriate quantity of lubricant should be a little more than half of the lubricant container.

- 2) Change of lubricant

The lubricant should be changed annually or when the lubricant becomes worse. Recommended lubricants viscosity: SAE 90140. Amount of lubricant: 5L.

- 3) Apply grease weekly
  - a. On the grippers of tool arm
  - b. On the tip of tool holding rod of tool arm
  - c. On the sliding block of tool falling, fixing base of pull rod of tool falling
- 4) Cleaning
  - a. Remove the chips around all the proximity switches and reed switches.
  - b. Remove the chips inside the tool pot.
  - c. The tool changing mechanism parts should be cleaned frequently so that the chips will not stick to it.
- 5) Check the tool falling mechanism parts regularly.
- 6) Check the parts of tool pots & tool disc and also check if "C" snap rings are tight regularly. If not, fasten them tightly or change new parts.

#### **Dual Arm Tool Changer - Arm Installation**

#### **CAUTION!**

**The arm of the dual arm tool changer moves suddenly and with great force. Make sure that while performing the following procedure you and others are out of range of the arm.**

#### **Sending the Tool Changer Spindle to Home Position**

- 7) Type DI and press ENTER.
- 8) Type DD and press ENTER.

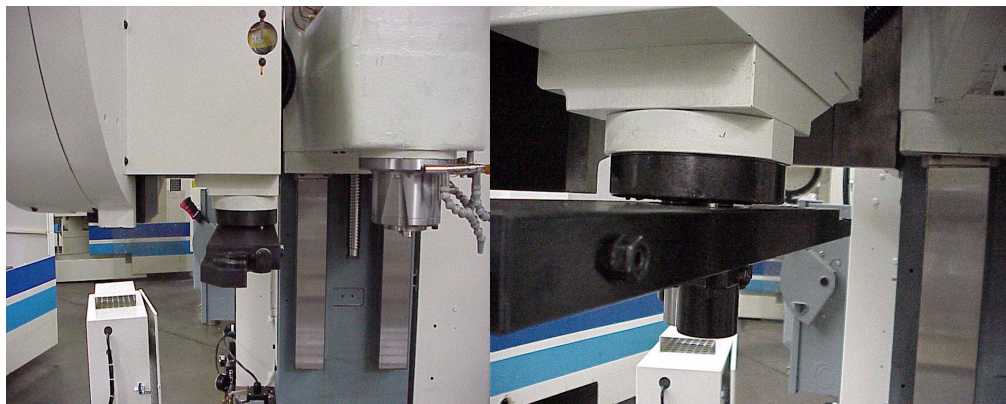
- 9) In the Dual Arm Tool Changer Menu, select number 4 (Move Arm Reverse) or 3 (Move Arm Forward) to bring the tool changer spindle to its home position.

**NOTE:** While pressing 3 or 4, you will notice the tool changer spindle pause for a brief moment before it begins its tool changing procedure again. It is during that pause that the tool changer spindle is at its home position.

### Inserting the Arm Assembly

**NOTE:** It is recommended that two people perform the following procedure.

- 1) Place the taper lock and arm assembly into the tool changer spindle. It is recommended that the side of the arm is parallel with side sheet metal wall of the tool changer. Make sure that there is a 3 to 4 mm space between the tool changer arm and the top of the tool changer spindle (see picture below).



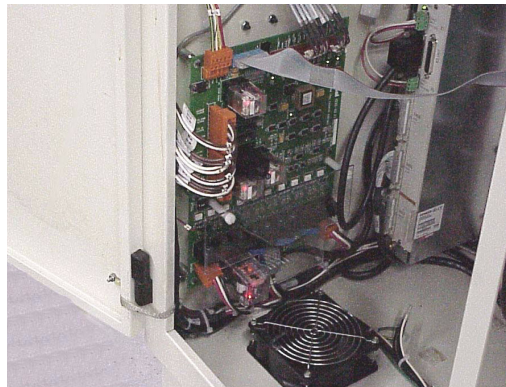
- 2) While holding the arm assembly, insert the installation tool (SVT-0149) and tighten with the 12mm bolt.



- 3) Snugly fasten (do not tighten!) the eight taper lock bolts at the bottom of the tool changer in a typical eight bolt crossing pattern.
- 4) Lower the tool pot to the tool change position.
- 5) Insert a tool holder into the spindle and the lowered tool pot.
- 6) Jog the Z axis to correct tool change position.
- 7) Lock the spindle with the M19 command.
- 8) Again enter the Dual Arm Tool Changer Menu and select number 4 (Move Arm Reverse) or 3 (Move Arm Forward) to slowly bring the arm into both tool holders.
- 9) Use your hands to push the tool changer arm into both tool holders making sure that both tool holders are gripped entirely by the tool changer arm.
- 10) Tighten the eight taper lock bolts at the bottom of the tool changer in a typical eight bolt crossing pattern.
- 11) Remove the installation tool (SVT-0149).

#### **Dual Arm Tool Changer Alignment**

- 1) Remove the dual arm head position sensor and replace with Jumper ELE-0088. (See pictures below).



- 2) Lock the spindle with the M19 command.
- 3) Jog the Z axis up.

#### **Entering the Dual Arm Tool Changer Menu**

- 1) Type DI and press ENTER.
- 2) Type DD and press ENTER.



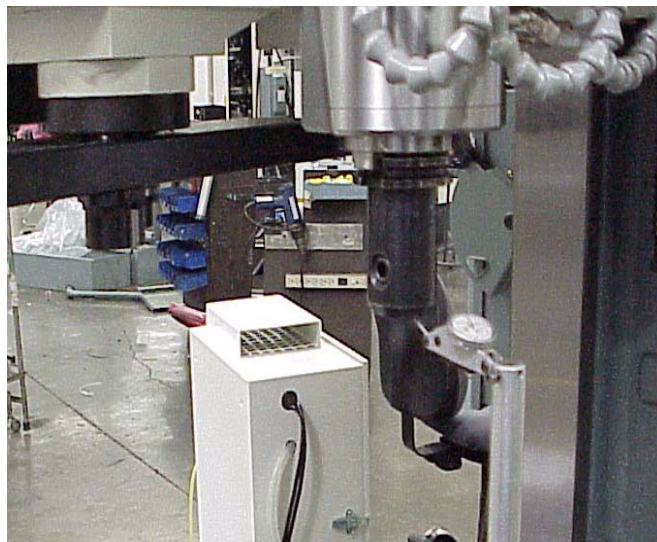
**CAUTION!**

The arm of the dual arm tool changer moves suddenly and with great force. Make sure that while performing the following procedure you and others are out of range of the arm.

- 3) In the Dual Arm Tool Changer Menu select number 4 (Move Arm Reverse) or 3 (Move Arm Forward) to bring the tool changer arm as close as possible to the spindle.
- 4) Place a tool in the arm of the tool changer.
- 5) Touch a flat surface of the tool with a .005 indicator and set to Ø. (See the picture below).

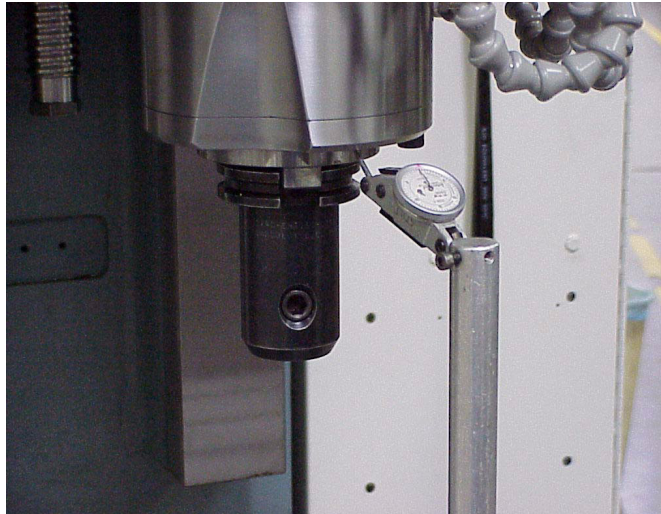


- 6) Carefully slide the indicator away from the tool, and remove the tool.
- 7) In the Dual Arm Tool Changer Menu select number 4 (Move Arm Reverse) or 3 (Move Arm Forward) to move the arm back to its standby position.
- 8) Place the tool in the spindle and lower the Z axis 3" approx.
- 9) Slide the indicator in, and place the needle in the same spot where the Ø was set in the arm.
- 10) Lower the Z axis until the indicator is Ø. (See the picture below).



- 11) Carefully slide the indicator away and Cold Start the machine.
- 12) Slide the indicator back in, under the tool and adjust the Z axis until the indicator is Ø. Write or remember the distance traveled to reach Ø (example: -.994).
- 13) Press MANUAL.
- 14) Type SV, press ENTER.
- 15) Select Z.
- 16) Use the letter U or D to select [zero offset] Ø.
- 17) Enter the distance traveled to reach Ø (example: -.994).
- 18) Press ENTER.
- 19) Press MANUAL.
- 20) Cold start the machine.
- 21) After the machine has finished the cold start procedure, verify with the indicator to make sure that it is Ø.
- 22) Remove the indicator.
- 23) Lower the Z axis 3.25".

24) Select a flat surface on the spindle and set the indicator to Ø. (see below).



25) Carefully slide the indicator out of the way.

26) Type SV press ENTER.

27) Select Z.

28) Use the letter U or D to select [zero offset].

29) Enter Ø.

30) Press MANUAL.

31) Cold start the machine. (The Z axis should still be 3.25" down).

32) After the machine has finished the cold start procedure, carefully slide the indicator under the spindle and lower the Z axis until it reads Ø.

33) Write down or remember the distance traveled to reach Ø.

34) Type SV, and press ENTER.

35) Select "Z".

36) Use the letter "U" or "D" to select [zero offset].

37) Enter Ø.

38) Press MANUAL.

39) Cold start the machine.

40) Slide the indicator under the spindle to double check Ø.



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**PCB-0213 Dual Arm  
ATC Controller Card****Description and  
Explanation of  
Operation of PCB-  
0213 (1330-0A)**

The 1330-0A is identical to the 1330-0 in terms of connections and operation with the following exceptions: an LED indicator has been added for the drawbar position sensor input, the overload sensing threshold for turret motor has been changed, and a spindle head position sensor has been added to interlock arm movement. This last change is the most significant; if the Z-axis is not at the tool change position, relays K9 and K8 will not allow the arm to move.

The 1330-0A is used on both Fadal and Siemens controls. However, the software is different for Siemens control from the Fadal control and is ordered separately from the PCB-0213.

**Inputs** 8-bit data port with strobe and ack for commands (bi-directional) - J4

6 sensors - J1 and J2:

Tool Count - proximity sensor, Namur PNP, active source

Home position - proximity sensor, Namur PNP, active source

Tool Change Position - proximity sensor, Namur PNP, active source

Stopping Position - proximity sensor, Namur PNP, active source

Drawbar down sensor - Hall Sensor, active low

Tool Down - reed sensor, NPN, normally open

Tool Up - reed sensor, NPN, normally open

(All sensor inputs except for drawbar can be configured for different sensors than those shown.)

All sensor inputs have LEDs indicating their status. These inputs cannot be checked with a volt meter because the sensors are current devices.

+5V, +12V, GND - J5

120 VAC (J6 pin 1)

RET (J6 pin 2)

E-Stop (120 VAC) - J6 pin 3 (from 1100-1 TB1 pin 10) Disables all 120V and 230V outputs from the 1330 when VMC is in E-Stop.

Drawbar and Arm Interlock - J6 pins 5 and 6 (from 1100-2 TB1 23 & 24) Disables arm and drawbar when spindle is on. Drawbar SSR on 1100-2 must be jumpered or arm and drawbar will not work.)

Door Interlock (120 VAC) - J6 pin 7 (from 2000-1A J2 pin 3 or 1310-1C J1 pin 9)

Disables arm when doors are open. (If there is no 1310 or 2000 board, J6 pin 7 must be jumpered to J6 pin 8.)

Head Position Sensor - J11 (Hall sensor or magnetic reed switch) Disables arm movement (K9) if the Z-axis is not at tool change position. If no tool change position sensor is installed, then J11 pins 2 and 3 must be jumpered.

## Outputs

### 2 Motors

Motor for turret - 3-phase, bi-directional (5 triacs) (Interlocked with E-Stop)

Motor for arm - 3-phase, bi-directional (5 triacs) (Interlocked with E-Stop, doors, spindle, and head position)

### 3 Valves

Drawbar (interlocked with E-Stop, spindle, and head position)

Tool Down (interlocked with Tool Up and E-Stop)

Tool Up (interlocked with Tool Down and E-Stop)

Contactor supplying 230V 3-phase to 1330 (interlocked with E-Stop and overcurrent)

## LED Indicators

### Sensor Inputs (Green):

Tool Count - On at each tool position, off between tool positions.

Arm at Home - On when arm is in home (or idle) position.

Arm at Spindle - On when the arm is at the spindle.

Stopping - On when arm is at home or at the spindle.

Drawbar - On when drawbar is down.

Tool Down - On when tool bucket is down.

Tool Up - On when tool bucket is up.

ATC Fault (Red) - On when there is a tool change fault.

Heartbeat (Green) - Blinks indicating CPU is functioning.

Overload (Yellow) - Indicates a motor overload is occurring (flashes at 50/60 Hz).

(Turret overload  $\geq 4$  A, Arm overload  $\geq 7.5$  A)

Overcurrent (Red) - On after there has been an overcurrent.

(Turret overcurrent  $\geq 13$  A, Arm overcurrent  $\geq 30$  A)

### Output Indicators (Yellow):

Turret FWD On when turret moving forward. (Turret CCW)

Turret REV On when turret moving reverse. (Turret CW)

Arm FWD On when arm moving.

Arm REV On when arm commanded in reverse by Dual Arm menu.

Drawbar On while drawbar solenoid is commanded on. (K1)

Tool Down On while tool down solenoid is commanded on. (K2)

Tool Up On while tool up solenoid is commanded on. (K3)

Contactor On while 3-phase contactor is commanded on. (K4)

**Currents**     **Peak current** of the turret motor measures 4-6 A. Continuous current of the turret motor measures 0.8-1.2 A.

**Peak current** of the arm motor measures at 8-13 A. Continuous current of the arm motor measures at 2-3 A. (Since the arm movement is limited, this continuous current is less than 1 second.)

#### Current Sensing

There are two different values of current sensed for each motor: "overload" (current larger than allowable continuous value) and "overcurrent" (current well beyond allowable peak value). Overload will occur when the motor stalls. Overcurrent would occur when there is a short circuit or motor windings short.

The overload signal is returned to the microcontroller which checks its duration and shuts down the motor if it lasts beyond normal startup current. The overcurrent signal shuts down the triacs through hardware and is returned to the microcontroller with the overload signal. Overloads will occur whenever the motor is started because starting current is greater than locked rotor current. Therefore it is normal to see the Overload LED flash when the motor starts.

#### Functional Explanations

For board to have 120V for the SSR's:

- VMC must not be in E-Stop (E-Stop relay (K5) passes 120V thru CB1 to SSR's).
- CB1 must not be tripped.

For board to have 3-phase power:

- Board must have 120V power (see above).
- There must not be an overcurrent (D17 lit).
- Contactor SSR (K4) must be energized.

For board to have 3 phase power to Arm triacs:

- Board must have 120V power (see above).
- Board must have 3-phase power (see above).
- Spindle must not be on (and Drawbar relay on 1100-2 must be jumpered); this energizes the Drawbar Interlock relay (K7).
- If CE machine, 120V output from 2000 (J2 pin 3) or 1310 (J1 pin 9) board must go to J6 pin 7 (doors must be closed); if not CE, J6 pin 7 must be jumpered to J6 pin 3.
- CNC should not allow arm movement with doors open.

If all the above is true the Arm Power relay will be energized.

For drawbar to be energized:

- Board must have 120V power.

- Spindle must be off (Drawbar Interlock relay energized; this passes 120V power to Drawbar SSR and floats Drawbar enable to AND gate).
- Drawbar SSR must be energized.

For Tool Up or Tool Down solenoid to be energized:

- Board must have 120V power (see above).
- SSR for Tool Up or Tool Down must be energized.
- Logic on the 1330 will disable Arm Up if Arm down is on and vice versa.

For Turret Fwd or Turret Rev to be active (turret in motion):

- Board must have 120V power (see above).
- Board must have 3-phase power (see above).

(Spindle may be one. Turret motion with the spindle on is allowable but not arm motion.)

- Overcurrent latch must be reset by microcontroller.
- Turret Fwd or Turret Rev (not both) must be active (low).

For Arm Fwd or Arm Rev to be active (arm in motion):

- Board must have 120V power (see above).
- Board must have 3-phase power (see above).
- Spindle must be off (Drawbar Interlock relay energized; this pulls arm enable to OR gates low).
- Z-axis must be at tool change position (LED D20). If head is not at tool change position, K9 will not be energized which will disable K8. (If there is no head position sensor (J11) then J11 pins 2 and 3 must be jumpered. Shunt ELE-0088 is recommended for this.)
- If CE machine, 120V output from 2000 or 1310 board must go to J6 pin 7 (doors must be closed);
- If not CE, J6 pin 7 must be jumpered to J6 pin 3. (CNC should not allow arm movement with doors open).

If all the above is true the Arm Power relay will be energized.

Overcurrent latch must be reset by microcontroller.

Arm Fwd or Arm Rev (not both) must be active (low).

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**Sequence of Dual  
Arm-ATC Operation  
When Used With The  
Fadal Control**

**Feedback**      Tool Up sensor (Magnetic reed switch mounted at Bottom of Air Cylinder- normally open – “Tool Up” LED)

Tool Down sensor (Magnetic reed switch mounted at Top of Air Cylinder- normally open -“Tool Down” LED)

Above sensors have a LED mounted into the sensor and 1330-0 card that is lit when switch is closed.

Arm Stop (Proximity current sensor #1 mounted at Top on Arm – “Stopping Sensor” LED)

Arm Tool(Proximity current sensor #2 mounted at Center on Arm – “Arm at Spindle” LED)

Arm Home(Proximity current sensor #3 mounted at Bottom on Arm – “Arm at Home” LED)

Tool Count sensor (Proximity current sensor mounted under Turret Motor – “Tool Count” LED)

Drawbar sensor (Hall Effect sensor mounted under Drawbar Cylinder – “Drawbar” LED)

Above sensors have a LED mounted on the 1330-0 card that is lit when switch is closed.

**Part Numbers**      Magnetic Reed Switches ELE-1186  
Proximity Current Sensors ELE-1185  
Hall Effect Sensors ELE-0145

#	Error Message	Description
1	CAROUSEL SOLENOID FAILURE (OR SENSOR)	Tool Count Sensor was not seen.
2	DRAWBAR SOLENOID FAILURE (OR NO AIR)	The Drawbar Cylinder could not be moved down to extract tool. Check Air Supply. Check Tool.
3	DRAWBAR SENSOR FAILURE	The Drawbar Cylinder piston could not return home.
4	ATC ARM IS NOT IN HOME POSITION	The ATC Arm did not arrive at ATC Home.
5	ATC BUCKET UP SOLENOID/SENSOR FAILURE	The ATC Bucket Cylinder did not arrive at BOTTOM (Bucket move UP).
6	ATC BUCKET DOWN SOLENOID/SENSOR FAILURE	The ATC Bucket Cylinder did not arrive at TOP (Bucket move DOWN).
7	ATC ARM SOLENOID SENSOR/HOME SENSOR FAILURE	The ATC Arm could not move away from HOME.
8	ATC TOOL ARM OBSTRUCTED	The ATC Arm did not arrive at Spindle.
9	ATC TOOL SENSOR FAILURE	The ATC Arm TOOL Sensor was not seen.
10	ATC TOOL CLAMPING FAILURE	The ATC Arm could not move down from Spindle.
11	ATC TOOL UNCLAMPING FAILURE	The ATC Arm could not leave Tool Holders.
12	ATC INTERLOCK IS ON	
13	ATC COMMUNICATION ERROR WITH 1330-CARD	1400-5 cannot communicate with the 1330.
14	ATC AMBIGUOUS BUCKET POSITION	ATC Bucket is neither UP nor DOWN. Neither reed switch is seen.
15	ATC AMBIGUOUS TURRET POSITION	ATC Turret is in-between Buckets. Turret (Tool Count) Sensor is not seen.

### DA-ATC Tool Change Cycle—Fadal Control

- 1) Initiate Turret Rotate cycle Tx, where x is the Tool number to be moved to Arm Ready position.
- 2) Begin a new one second timer to initiate “Bucket UP” cycle, and verify that the Bucket is UP.
  - a. Enable 1330/K3 to power Air Valve to move Bucket UP.
  - b. If Air Cylinder bottom reed switch is CLOSED and the top reed switch is OPEN, then stop the timer. LED’s green “Tool Up” and yellow “Tool Up” are lit. Proceed to step 3.
  - c. If timer times out, the Bucket did not move up, and if bottom reed switch is OPEN and top reed switch is CLOSED, then get message #5—ATC BUCKET UP SOLENOID/SENSOR FAILURE. Halt system.
  - d. Or, if timer times out, the Bucket did not move up, and if top reed switch is OPEN and bottom reed switch is OPEN, then get message #14—AMBIGUOUS BUCKET POSITION. Halt system.

- 3) Begin a new one second timer to rotate Turret.
  - a. Enable 1330/K4 to CLOSE 3-Phase Contactor.
  - b. Turret motor rotates and TOOL COUNT sensor mounted below Turret Motor reports that Turret is away from home position, and TOOL COUNT LED goes out. LED's yellow "Contactor", green "Stopping Sensor" and "Arm at Home" are lit, TOOL COUNT is unlit.
  - c. If TOOL COUNT sensor is CLOSED again, then Turret has arrived at new tool, stop the timer. Proceed to step 4.
  - d. If timer times out, Turret Motor could not rotate, then get message #15—AMBIGUOUS TURRET POSITION. Halt system.
- 4) Repeat step 3, as Turret Motor rotates, 1330 counts impulses from TOOL COUNT sensor, until correct Tool is in position.
- 5) When correct Tool is in position, and TOOL COUNT sensor is CLOSED, disable 1330/K4 to open Contactor and stop Turret Motor.
- 6) Initiate Tool Change -- M6
- 7) Spindle OFF (M5). Orient Spindle (M19). Check for Orient Switch feedback.
  - a. If feedback received from Spindle Orientation Hall Effect switch, then Spindle is Oriented, STOP Spindle. K7 and K9, K3 and K4 OFF.
- 8) Control sends signal to 1330 card to begin Tool Change Cycle. 1330 card sends "Busy" signal to control.
- 9) Begin a new one second timer to initiate "Bucket DOWN" cycle.
  - a. Enable 1330/K2 to power Air Valve to move Bucket DOWN.
  - b. If Air Cylinder bottom reed switch is OPEN and the top reed switch is CLOSED, then stop the timer. LED's green "Tool Down" and yellow "Tool Down" are lit. Proceed to 10.
  - c. If timer times out, the Bucket did not move down, and if bottom reed switch is CLOSED and top reed switch is OPEN, then get message #6—ATC BUCKET DOWN SOLENOID/SENSOR FAILURE. Halt system.
  - d. Or, if timer times out, the Bucket did not move down, and if top reed switch is OPEN and bottom reed switch is OPEN, then get message #14—AMBIGUOUS BUCKET POSITION. Halt system.
- 10) Begin a new one second timer for "Arm to Spindle" cycle, and activate Triacs for Arm Motor to move.
  - a. Enable 1330/K4 relay to CLOSE 3-phase contactor.

- b. Stop the timer as soon as the Arm moves away from its home position, and the ARM STOP and ARM HOME sensors report that Arm is away. This verifies that the ARM STOP and ARM HOME signals are working properly. LED's yellow "Contactor" is lit; green "Stopping Sensor" and "Arm at Home" are NOT lit. Then proceed to step 11.
  - c. If the timer times out, and therefore the arm has not moved from the ARM HOME position, then get message #7, ATC ARM SOLENOID SENSOR/HOME SENSOR FAILURE. Halt system. Check Overload LED on 1330, Arm Motor Drive Belt, Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, 1330/CB1 Circuit Breaker and fuses ahead of Contactor.
- 11) Begin a new one-second timer to initiate "Arm Approaching Spindle/Bucket" cycle.
  - a. As soon as the ARM STOP and ARM TOOL signals are seen, stop the timer, disable 1330/K4 relay to disconnect Contactor to power OFF Arm Motor. LED's yellow "Contactor", green "Stopping Sensor" and "Arm at Spindle" are lit. Proceed to step 12.
  - b. If the timer times out, the arm has not arrived at Spindle and Turret Bucket. Get message # 8—ATC TOOL ARM OBSTRUCTED or if ARM STOP sensor was seen and ARM TOOL was not, get # 9--ATC TOOL SENSOR FAILURE. Halt system. Check Overload LED on 1330, Arm Motor Drive Belt, Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, 1330/CB1 Circuit Breaker and fuses ahead of Contactor.
- 12) Begin a new one-second timer to initiate "Drawbar Down" cycle.
  - a. Enable the 1330/K1 relay to power Air Solenoid to Drawbar Cylinder.
  - b. As soon as Drawbar Cylinder Hall Effects switch is seen, stop the timer. LED's yellow "Drawbar", green "Stopping Sensor", "Drawbar" and "Arm at Spindle" are lit; yellow "Contactor" is NOT lit. Proceed to step 13.
  - c. If timer times out, then Tool could not be extracted from Spindle. Get message #2—DRAWBAR SOLENOID FAILURE (OR NO AIR). Halt system. Check Drawbar Cylinder Hall Effects switch and its adjustment, air supply, check for broken Drawbar Cylinder piston, Drawbar Cylinder leaks, Drawbar/Belleville spring problems, and Tool Holder/Pull Stud problems.
- 13) Begin a new one second timer to initiate "Arm DOWN" cycle.
  - a. Enable 1330/K4 relay to CLOSE 3-phase contactor.



- b. Stop the timer as soon as the Arm moves away from its Spindle position, and the ARM STOP and ARM TOOL sensors report that Arm is away. This verifies that the ARM STOP and ARM TOOL signals are working properly. Then rotate Arm 180 degrees. LED's yellow "Contactor" is lit, green "Stopping Sensor" and "Arm at Spindle" are NOT lit. Proceed to step 14.
  - c. If the timer times out, and therefore the arm has not moved from the ARM TOOL position, then get message #10, ATC TOOL CLAMPING FAILURE. Halt system. Check Overload LED on 1330, Arm Motor Drive Belt, Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, 1330/CB1Circuit Breaker and fuses ahead of Contactor.
- 14) Begin a new one-second timer to re-initiate "Arm Approaching Spindle/Bucket" cycle.
- a. As soon as the ARM STOP and ARM TOOL signals are seen, stop the timer, disable 1330/K4 relay to disconnect Contactor to power OFF Arm Motor. LED's yellow "Contactor", green "Stopping Sensor" and "Arm at Spindle" are lit. Proceed to step 15.
  - b. If the timer times out, the arm has not arrived at Spindle and Turret Bucket. Get message # 8—ATC TOOL ARM OBSTRUCTED or if ARM STOP sensor was seen and ARM TOOL was not, get # 9--ATC TOOL SENSOR FAILURE. Halt system. Check Overload LED on 1330, Arm Motor Drive Belt, Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, and fuses ahead of Contactor.
- 15) Begin a new one second timer for "Clamp Tool" cycle.
- a. Disable 1330/K1 relay to stop Air Valve to Drawbar Cylinder.
  - b. If Drawbar Hall Effect Switch signal is OFF, then Tool is clamped. Stop the timer. LED's "Stopping Sensor", and "Arm at Spindle" are lit; yellow "Contactor" and "Drawbar", green "Drawbar" are NOT lit. Proceed to step 16.
  - c. If the timer times out, tool is NOT clamped. Get message #3—DRAWBAR SENSOR FAILURE. Halt system. This error message is incorrect. Check for fluid buildup in Drawbar Cylinder, broken return spring, mis-adjusted Hall Effect Switch.
- 16) Begin a new one second timer for the "Arm Return to Home" cycle.
- a. Enable 1330/K4 relay to CLOSE 3-phase contactor.
  - b. Stop the timer as soon as the Arm moves away from its Spindle position, and the ARM STOP and ARM TOOL sensors report that Arm is away. This verifies that the ARM STOP and ARM TOOL signals are work-

ing properly. Then rotate arm to ATC HOME position. LED's yellow "Contactor" is lit, green "Stopping Sensor" and "Arm at Spindle" are NOT lit. Proceed to step 17.

- c. If the timer times out, and therefore the arm has not moved from the ARM TOOL position, then get message #11—ATC TOOL UNCLAMPING FAILURE. Halt system. Check Overload LED on 1330, Arm Motor Drive Belt, Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, 1330/CB1 Circuit Breaker and fuses ahead of Contactor.

17) Begin a new one-second timer to initiate "Arm Approaching ATC Home" cycle.

- a. As soon as the ARM STOP and ARM HOME signals are seen, stop the timer, disable 1330/K4 relay to disconnect Contactor to power OFF Arm Motor. Disable Triacs to Arm Motor. LED's yellow "Contactor" is NOT lit; green "Stopping Sensor" and "Arm at Home" are lit. Proceed to 18.
- b. If the timer times out, the arm has not arrived at Spindle and Turret Bucket. Get message # 8—ATC TOOL ARM OBSTRUCTED. Halt system. Check Overload LED on 1330, Arm Motor Drive Belt, Contactor, move Arm manually by turning top of Arm Motor shaft—checking for resistance, check for dragging brake in Arm Motor, and fuses ahead of Contactor. This page intentionally left blank.

18) Begin a new one second timer to initiate "Bucket UP" cycle.

- a. Enable 1330/K3 to power Air Valve to move Bucket UP.
- b. If Air Cylinder bottom reed switch is CLOSED and the top reed switch is OPEN, then stop the timer. LED's green "Tool Up" and yellow "Tool Up" are lit. Proceed to step 19.
- c. If timer times out, the Bucket did not move up, and if bottom reed switch is OPEN and top reed switch is CLOSED, then get message #5—ATC BUCKET UP SOLENOID/SENSOR FAILURE. Halt system.
- d. Or, if timer times out, the Bucket did not move up, and if top reed switch is OPEN and bottom reed switch is OPEN, then get message #14—AMBIGUOUS BUCKET POSITION. Halt system.

19) Tool change cycle is completed. Stop "Busy" signal to control. Resume main program.

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**Changing tools on a TRM**

The TRM has no automatic tool changer. Switching tools on the TRM must be done manually.

**Warning**

Please take all the precautions necessary to ensure your safety and the safety of others while switching a tool.

**Releasing a tool**

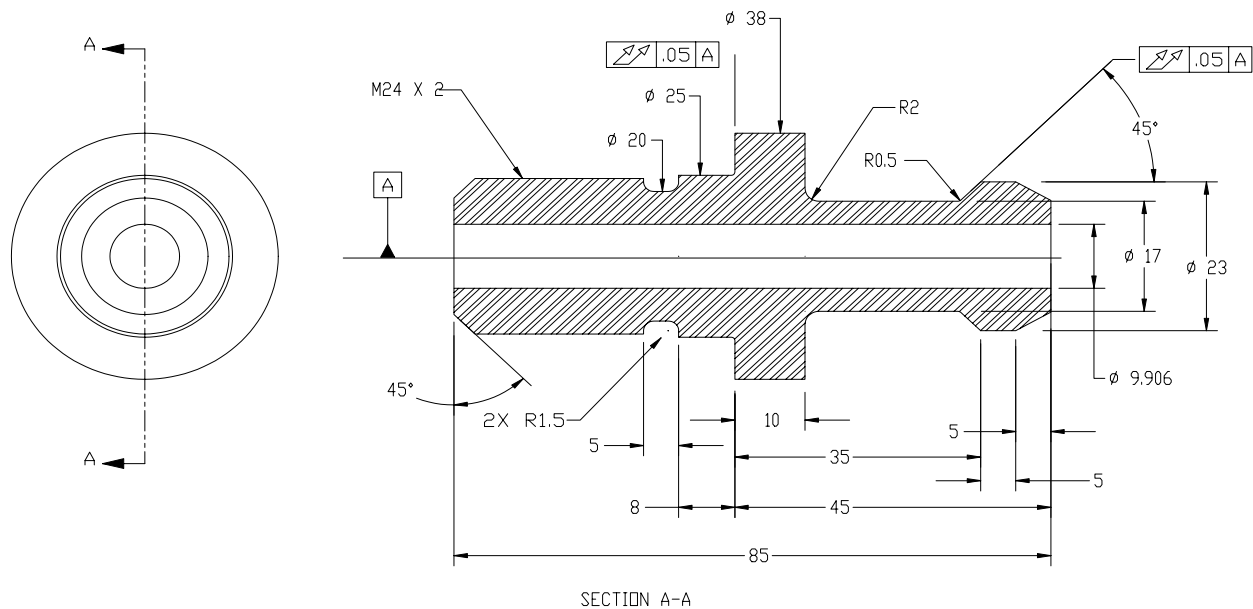
- 1) Make sure the spindle is at a complete stop and ready for a tool change.
- 2) Firmly hold the tool in the spindle.
- 3) Press the tool in/out button on the side of the head

**Inserting a tool**

- 1) Make sure the spindle is at a complete stop and ready for a tool change.
- 2) Firmly insert the tool in the spindle.
- 3) Press the tool in/out button on the side of the head.
- 4) Release the tool in/out button.
- 5) Make sure the tool is completely and correctly inserted before releasing the tool.

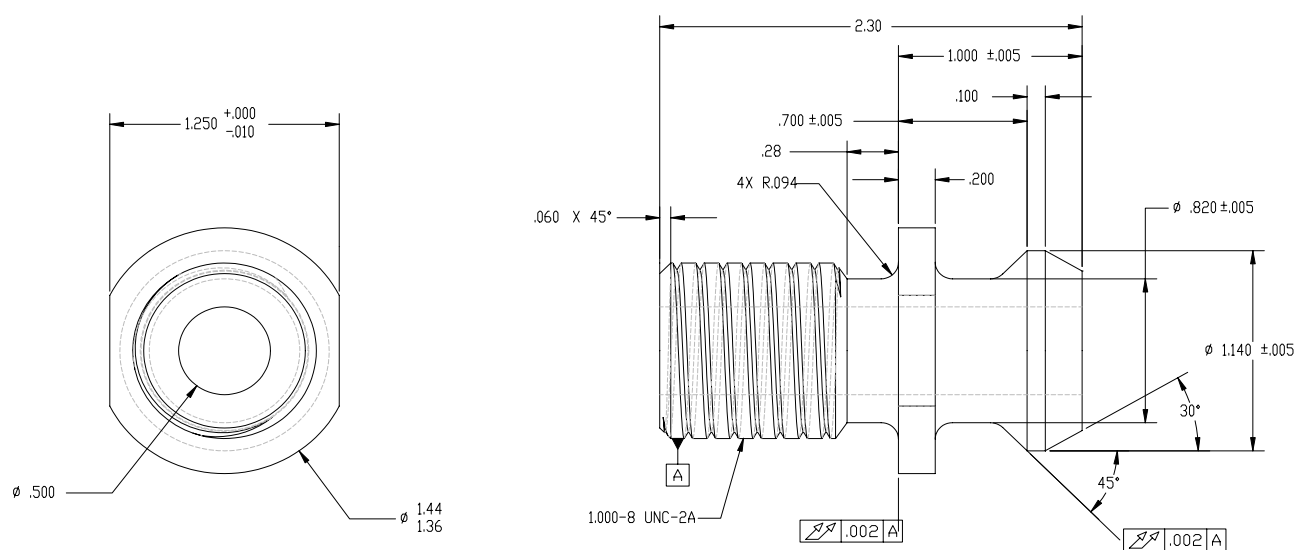


### 50 Taper Pull Stud Specs (CAT/BT)



TOL-0590

KNOB, TOOL RETENTION,  
50 TAPER BT, 45°



TOL-0591

PULL STUD, 50 TAPER, CAT

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## Section 06: Axis Drive Systems

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### Axis Drive Systems



**DANGER!** Hazardous voltages in this enclosure can kill.  
Use extreme caution when working in this area!

#### **Amplifier Chassis Operation**

All of the amplifier chassis that Fadal uses have the same basic operation.

The inputs to the chassis consist of Power input, which is either 86 VAC 3 phase or 120 VAC single phase, for DC machine and 230 VAC 3 phase, for AC machines, 120 VAC Fan (1100-1 TB2-1 & TB2-2) and a Control Signal 120 VAC (1100-1 TB1-8 & TB1-9). The Fan input is a 120 VAC to run the fans on the chassis and will be on whenever the machine is powered up. This input is fused on the 1100-1 Power Distribution Board with F23. The Control Signal is 120 VAC that activates the chassis' solid-state relays to allow the Power input to flow to the Bridge Rectifiers to convert the AC input to DC voltage for Amplifier power. This control signal comes from the 1100-1 TB1-8 and TB1-9 (this is the E-stop circuit amplifier controller enable signal from K2). From the rectifiers, the voltage is filtered by the large blue capacitor or bank of capacitors with a bleeder resistor.

On the AC Brushless amplifier chassis, the Regen Regulator or Voltage Comparator and a regen resistor provide the motor braking. The AC amplifier and chassis operate similar to the spindle drive. This circuit is connected to the DC busbus for the amplifier power and if the busbus power exceeds 400 or 420 Volts DC, the regen circuit turns on and dumps the excess power into the regen resistor.

The amplifier chassis bus voltage is measured across the blue capacitor or bank of capacitors and should about 120 VDC for 3 phase input DC amps, 160 VDC for single phase input and 320 VDC for AC amps.

**Troubleshooting the Amplifier Chassis**

If the amplifier chassis bus voltage is too low or zero, then check:

1. The power voltage input.
2. The control voltage input.
3. The fuses on the inputs to the chassis.
4. Disconnect the amplifiers (caution, do not allow the wires to touch any metal) and measure the bus voltage. If the voltage is good then one of the amplifiers is pulling the voltage down.
5. The solid state relays (see instructions).
6. The bridge rectifier (see instructions).
7. The capacitor(s).

If the AC Brushless chassis is not braking (stopping) the axis motors:

1. Check the regen resistor
2. Check the wire connections.
3. Replace the Regen regulator or voltage comparator.

Testing Instructions:

All the measurements performed in this instruction will be using the black lead (negative lead) in the common input. The red lead (positive lead) is the Volt, Ohm, Diode input.

**Note:** All readings are approximate.

**Solid State Relay**

With the relay disconnected from the circuit and the multimeter set to the Diode position, the contact side will read 6 to 8 Megohms and the control side will read an open, or OL on the meter, with the leads measuring one way. Swap the leads and about 1.5 Megohms will be read.

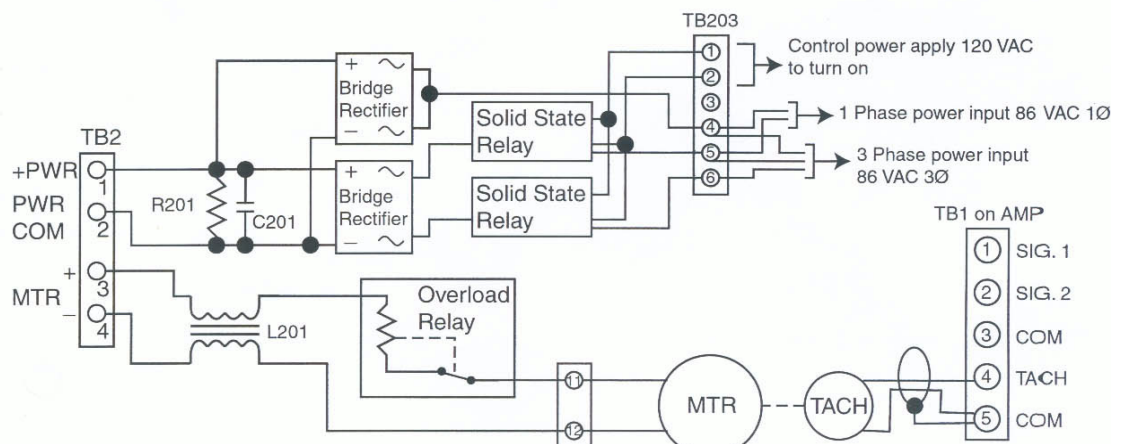
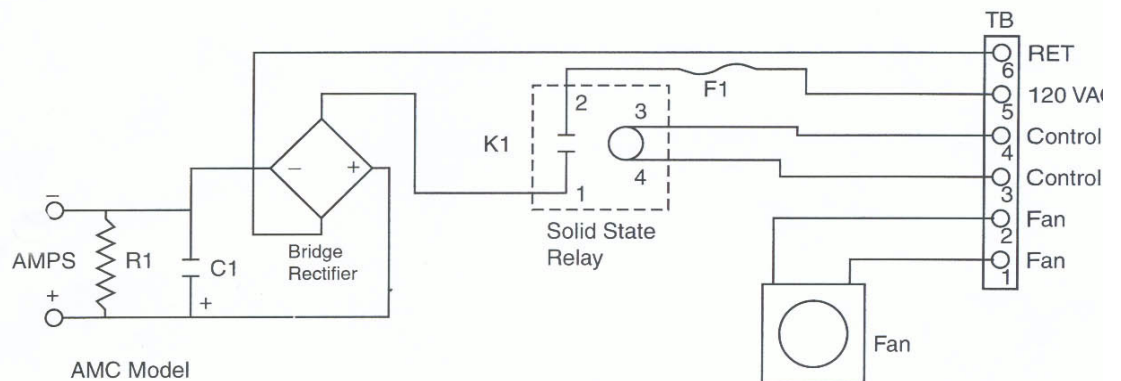
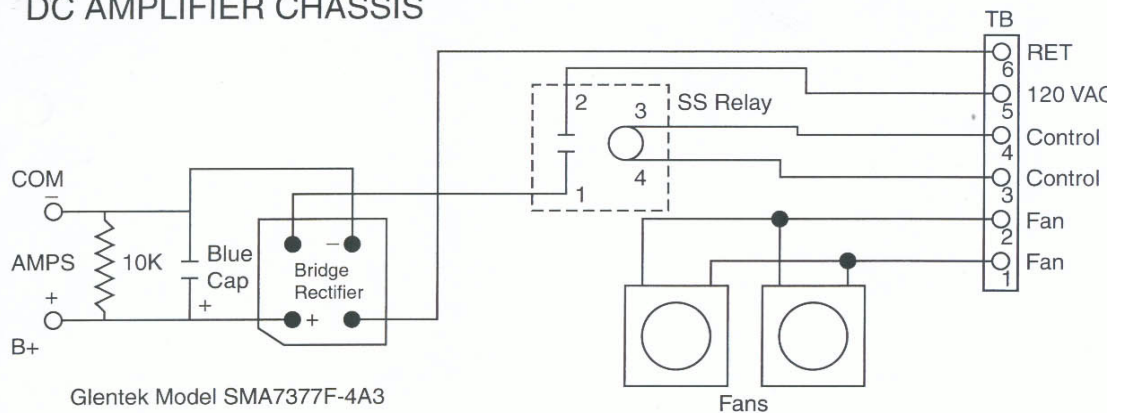
Check the circuit and verify that the control input is about 120 VAC and then check the output side, which connects to the bridge rectifier for the 3 phase power voltage. Both readings will be approximately the same.

**Bridge Rectifier**

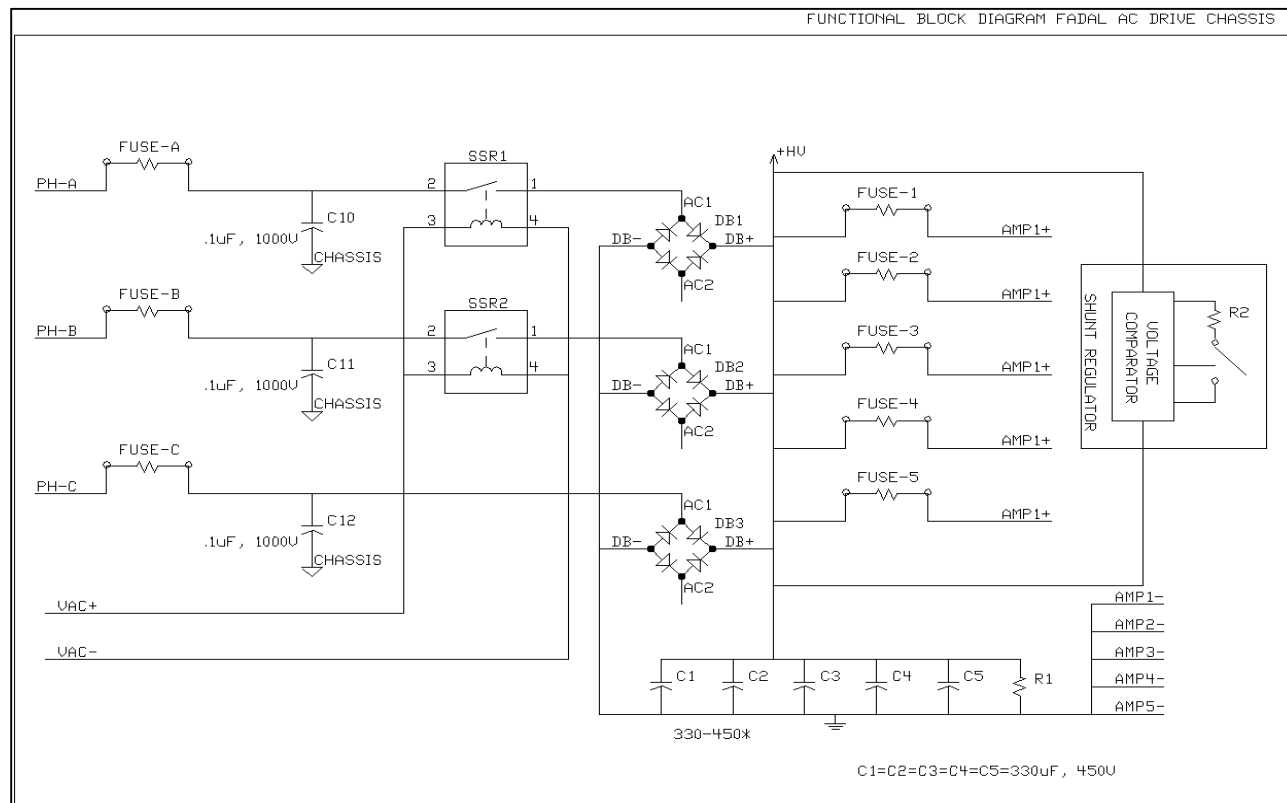
The rectifiers have two AC inputs, and two DC outputs (+DC and -DC). They are marked by the terminals or they have a cutoff corner by the +DC output. With the rectifier removed from the circuit and the multimeter set to read Ohms, place the black lead on the +DC and the red lead on the AC input or the black lead on the AC input and the red lead on the -DC. The meter will read 1 to 2 Megohms. With the Red lead on the +DC and the black lead on the AC input or the black lead on the -DC and the red lead on the AC input, an open will be read.

The next three pages have the wiring diagrams for the chassis that are installed in the Fadal VMCs.

## DC AMPLIFIER CHASSIS



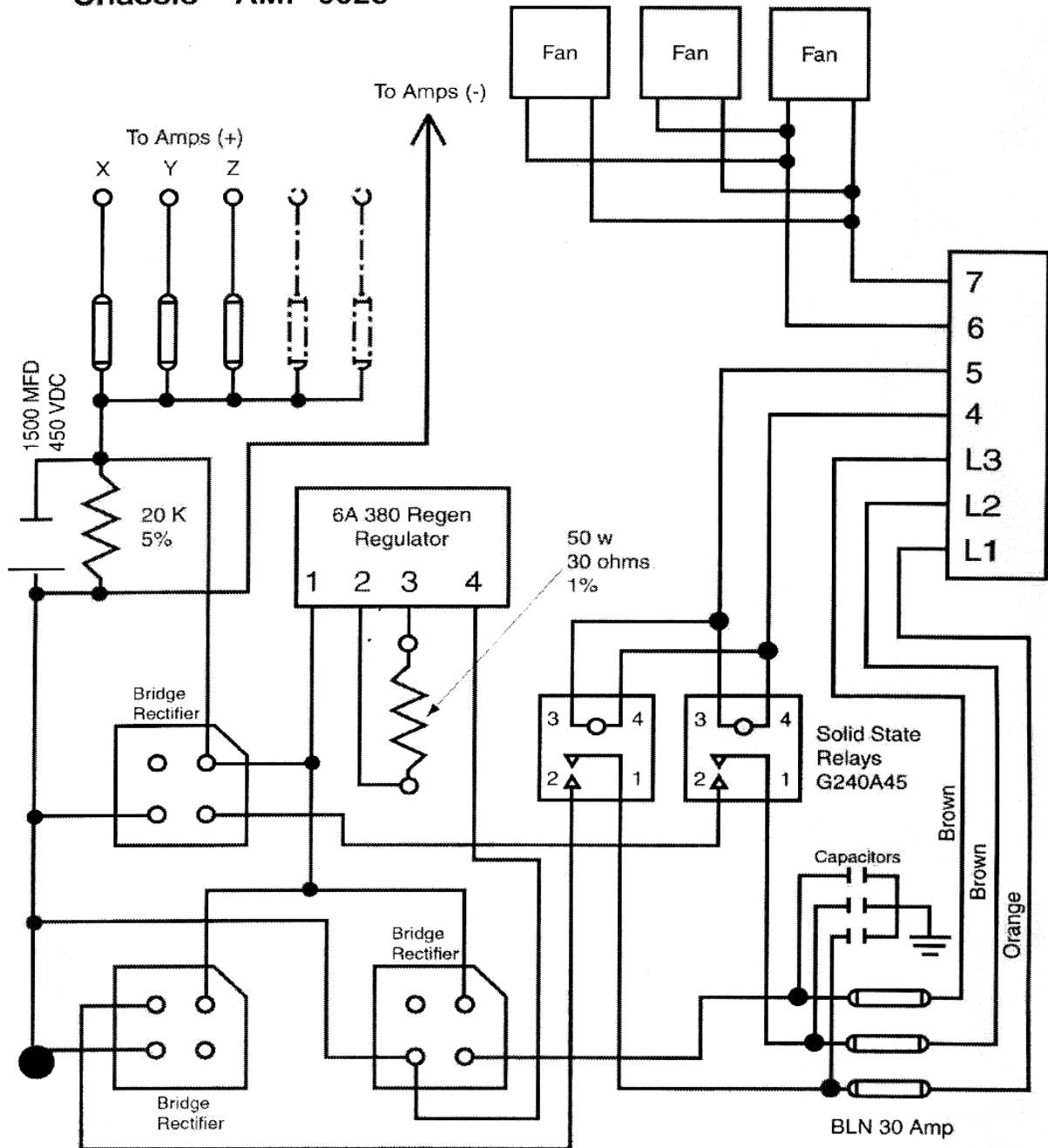
## AC Brushless Chassis Diagram



Location	Description	Manufacturer	Mfg. Part #
Fuse A,B,C	Fast acting, 30 A, 600 VAC Dimension (13/32" x 1 1/2")	Littlefuse	KLK30
Fuse 1,2,3,4,5	Fast acting, 20 A, 600 VAC Dimension (13/32"x1 1/2")	Littlefuse	KLK20
C10,11,12	.1 $\mu$ F, 1000 V 20% ceramic capacitor	Cera-mite	10GAP10
C1,2,3,4,5	.330 $\mu$ F, 450 V electrolytic capacitor	Illinois Capacitor	337LBA450M2EF
SSR1, SSR2	solid state relay	Gordos	G240A45
DB1,DB2,DB3	35A, 400V bridge rectifier	General Instruments	BBPC35-04
R1	20 K $\Omega$ 10W bleeder resistor	Various	20K,5%
R2	30 $\Omega$ 50W dumping resistor	Dale	RH5030



**Brushless Amplifier  
Chassis AMP-0028**



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**Amplifiers**

Both DC and AC axis drive amplifiers are Pulse Width Modulation (PWM) type. PWM is a method to output high current efficiently.

For the DC drives this is achieved by turning the power transistor on to full voltage output and then turning them off for no voltage output. The width of the pulse will determine the output average current that drives the motor. The process is done very fast to eliminate audible noise but the speed creates more electrical noise. When the amount of time the pulse is turned on is increased the average current is increased. If the time that the pulse is turned on is decreased the average current is decreased. The width of each pulse is the same so that a DC output is obtained. The output current is filtered to remove the electrical noise. Then the signal is outputted to the motor, through choke coils on some chassis. A DC tachometer is used to monitor the motor velocity. The tach outputs a DC voltage to represent a speed in RPMs that is 7 VDC per 1000 RPM. A resolver is used to feedback the position. The resolver has two input signals generated by the Clock Board, they are called SIN and COS and are 10 VAC peak to peak (about 3.54 VAC on a meter). The resolver uses these two to generate a third signal. Resolver signal is 5 VAC peak to peak (about 1.77 VAC on a meter). Each Axis Controller board receives the resolver signal at J2 bullet connector. This voltage can be checked at this point. The voltage must very close or there may be a problem with it. The controller compares the SIN and resolver signals to determine the position.

For the AC drives, this is achieved by turning the power transistors on to full voltage output and then turning them off for no voltage output. The width of the pulse will determine the output average current that drives the motor.

By varying the pulse slightly from pulse to pulse and using both positive and negative voltage an AC signal can be obtained. The process is done on three lines, each 120 degrees out of phase with each other. The axis motors are three phase motors. The frequency of the three phase input signal determines the RPM of the motor, the current determines the torque and the phasing determines the direction of rotation. An incremental encoder provides position information from the motor. It operates with light source through a focus lens through rotating glass disk with precision etched lines through a light mask to two photoelectric cells offset 90 degrees from each other. This creates 5 volt square waves A,/A,B,/B. A and /A are 180 degrees out of phase as well as B and /B are 180 degrees out of phase. A and B are 90 degrees out of phase, by counting the pulses the position can be determined and the direction is determined by is A or B the first signal. This information is sent to the controller board. The 3 phase input from the hall effect (U,V,W) returns the rotor position feedback for the amplifier to compensate the magnetic fields to optimize the

motor operation. The motor has a temperature sensor to detect over temperature in the motor, and information is returned in the hall effect cable. The amplifier sends a Absolute Current signal to J3 on the controller board. This signal is 1 volt for every 4 amperes output by the amplifier. The amplifier provides test points, they are: Signal – is a 1:2 output of the differential signal = & - input, Tach – a scaling output of 4 volts per 1000 RPM created by the amp from the encoder information, ABS – the current output to all 3 phases. Scaling is 1 volt per 4 amperes.

Both amps have a output of 10 VDC used for the fault signal in the E-stop circuit. They all also have inputs from the controller commanding speed and direction.

---

## DC Axis Drive Systems

**Note:** Set the master feedrate clock before beginning this procedure. The Position Loop Gain and Master Feedrate Clock are interrelated.

### DC Amplifier Adjustment

- 1) Enter the following program:
  - a. X-4. Y-4. Z-4. G1 F150. M49,M91.
  - b. X4.Y4.Z4.
  - c. M99P1
- 2) Press Auto, to start the program running.
- 3) At the amplifier to be adjusted, use a small screwdriver and turn the SIG2 potentiometer until the monitor's display of the appropriate axis reads the following error: 595 - inch ballscrew / 302 - metric ballscrew.
- 4) Press the SLIDE HOLD button on the keypad and adjust the balance of the amplifier to read between 0 - 1.
- 5) Press the START button on the keypad and the program will start again. Verify that the following error is still 595 or 302.
- 6) Press the SLIDE HOLD key to stop the machine. Press the MANUAL key and then type SETCS and HO, to send the machine home. Adjustment of the amplifier is complete. Repeat the procedure for all axes.

**Axis Software  
Version AC0017-5  
for AC Drive VMCs**

To improve the floor finish using G8 command, the default Contouring Gain has been changed. The Position Loop Gain #5911 program now requires different amplifier settings than previous axis software. VMC 6535 and 8535 also are set at different values from the other machines.

The Rapid Gain for the VMC6535 and 8535 is different from other 900 IPM machines. The Following Error will be around 3200 for X and Y axes in G0.

**Procedure for  
Setting Loop Gain**

This procedure has been changed from earlier versions and is applicable when AC0017-5 is installed on the Controller Cards. While amplifier adjustments may not require any changes when removing earlier software and installing AC0017, the adjustments should be verified.

The Balance program #5811 is not changed, and should be as follows:

N1	L100
N2	X-6. Y-6. Z-6. F150. G1 G91
N3	X6. Y6. Z6.
N4	M17
N5	M30
N6	M49 M91 (M91 sets the Normal Gain, and is important with AC0017-5)
N7	L101.1
N8	M2

Following the procedure for POSITION LOOP GAIN, please note the changes below. The Following Error displayed will not be the same as earlier versions of AC axis software when the AXIS DISPLAY Parameter in SETP is set to ERR.

	When M91 is active then Following Error:
AC Drive Machines with INCH Ballscrews: VMC 2016L, 3016L, 6030, 8030	600
AC Drive Machines with METRIC Ballscrews: VMC EMC, 2016L, 3016L, 4020, 4020A, 5020, 3020, 4525, 6535, 8535	600
AC Drive Machines with METRIC Ballscrews: VMC TRM	1200
AC Drive Rotary Tables-A-Axis	680
AC Drive Rotary Tables-A-Axis	680

M91 can be used to restore DEFAULT gain. This is identical to M90P50.

M92 can be used to increase gain for crisper performance. This is identical to M90P150.

M90Pxxx can be used to MODIFY gain where xxx represents the GAIN MODIFICATION FACTOR. The value used may range from 50 to 200, and is modal until POWER OFF, or until changed with another M90Pxxx, M91, or M92 command. This allows the user to freely select any appropriate gain value, and restore to the DEFAULT gain with M91, assuring flexibility over the performance of the machine.

**Setting Cold Start  
Position**

Cold start the VMC. The axis motors are now at their index marks. The VMC cold start indicators may be misaligned. The following procedure will measure the offset value.

**X-Axis**

- 1) Use a tape measure to measure the length of the table. Mark the center point with a marker or pen. Measure the table again, except, this time start measuring from the other end of the table. Mark that point.
- 2) Remove the cover from the X axis motor. Loosen the three screws that are securing the resolver.
- 3) Put a small drill into the spindle and jog the head down until the drill is approximately .100"[2.54mm] above the table. Move the X axis in either direction, by turning the resolver, until the drill is centered between the two marks that were made in step #1.
- 4) Tighten the three screws on the resolver and replace the motor cover.

**Y-Axis**

- 1) Press the MANUAL button until ENTER NEXT COMMAND is displayed. Type Ho, press the ENTER button, and then press the START button. This will send the machine back to the original cold start position.
- 2) Put a .0005"[.001mm] indicator into a tool holder and insert the tool holder into the spindle. Jog the Z axis and the Y axis until the indicator is centered inside the center T-SLOT, while rotating the tool holder.
- 3) Remove the cover from the Y axis motor and loosen the three screws that are securing the resolver.
- 4) Turn the resolver on the Y axis as needed, to position the indicator so that it reads the same value on both sides of the T-SLOT, while rotating the tool holder.
- 5) Tighten the three screws on the resolver and replace the motor cover.

**Z-Axis**

Refer to the Automatic Tool Changers Section for procedures on setting the Z axis cold start.

**Replacing A Servo  
Amplifier**

- 1) Power off the VMC.
- 2) Lock out/tag out the machine.

- 3) Remove the orange connector or disconnect signal wires on the front of the faulty card.
- 4) Disconnect the power and motor wires.
- 5) Using a long phillips screw driver, loosen the two screws securing the amplifier to the chassis. Slide the amp to the other side and remove.
- 6) Replace the amplifier.
- 7) Reconnect the orange connector or signal wires on the front of the new card making sure that they are installed on the correct terminals.
- 8) Connect the Power and Motor wires, insuring their correct position.
- 9) Turn the Loop Gain and Current Limit potentiometers fully clockwise.

A axis amplifier slot #1 (far left when installed)

X axis amplifier slot #2

Y axis amplifier slot #3

Z axis amplifier slot #4

After replacing one or more of the servo amplifiers or if an axis motor has been replaced, you must adjust the position loop gain.

#### **Setting Gain For The 1010-5**

Using software to set the gain enables the user to change gain setting on the fly in their part program.

We recommend that the gain be set to normal at all times in the SV and if high gain is desired use the M codes described below in the part program.

M90 = Default to gain set in the SV

M90 P# = Programmable gain

M91 = Normal gain

M92 = Intermediate gain

M93 = Maximum gain

#### **Verify The Gain Setting In The SV**

- 1) Return the machine to its COLD START position.
- 2) At the prompt "ENTER NEXT COMMAND", type SV, which will start the survey program.
- 3) Next select the X axis, and when the menu appears select #2 from the menu. This will read the current settings on the axis controller.
- 4) After reading the axis controller settings, the CNC will display the current gain setting. Menu selection #6 should read "CURRENTLY = NORMAL."

- 5) If the gain setting is not set to NORMAL select #6 from the menu and then press 0 to select normal gain. After selecting the gain, press selection #3 to write the setting back to the axis controller.



**IMPORTANT**

Changes to the setting must be written back to the axis controller or they will not be permanent.

- 6) Once the X axis has been verified do the same for all the other axes.
- 7) Verify that all axes have the same gain settings.

**Troubleshooting DC Amplifiers**

If errors occur or an axis is inoperative, go to the Troubleshooting Section. Flow chart number 4 is for axis control problems.

**AC Drive Systems**

**Information and Connections**

**Motor**

Cont. Torque @ 20 deg C	75 in.-lbs. (.864 newtons)
Peak Torque	240 in.-lbs. (2.77 newtons)
Resistance	1.9 ohms
Inductance	10.0 mH
Back EMF	78 V/k RPM
Weight	39 lbs. (17.69 kg)
Motor leads.	ØR red, ØS blue, ØT black
Encoder	Heidenhain ROD426 encoder
	8192 lines (32,768 counts)
	14 pin connector
Hall Signals and Temp Switch	10 pin connector

**Amplifier Chassis**

Wago connector on bottom	(L1,L2,L3, 4,5 (120VAC for SSR), 6,7 (120VAC fans)
Amplifier sequence	X, Y, Z, A, B (from top)
Fuse sequence on power supply	X, Y, Z, A, B (from front to back)



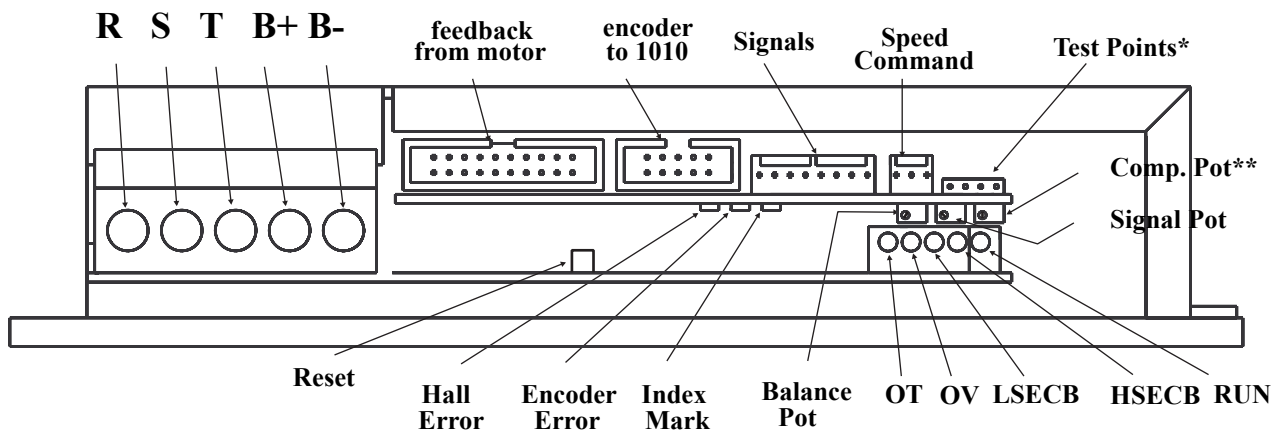
## Amplifier

Supply voltage	230 VAC 3phase
Bus voltage	325 VDC
Current	30A peak (3 sec.) 19A continuous
	LSECB trips for anything above 9A for longer than 3 sec.
Bus Capacitor	1500 uF 450 V
Regen (if equipped):	
	On 400 VDC
	Off 350 VDC
	Fault 450 VDC

## Load Percentage to Amperage Conversion

100%	=	19. Amps
50%	=	9.5 Amps
10%	=	1.9 Amps
5%	=	.95 Amps
1%	=	.19 Amps

## Physical Layout



**Figure 6-1** Glentek Amplifier

\*For the TRM, test points are replaced with RJ45 connector for communication.

\*\* There is no Comp Pot on the TRM amp.

## 3 or 4 pots: Not all amplifiers have Loop Gain Pot

Loop Gain	single turn pot	CW to increase gain
Balance	12 turn pot	
Signal Gain	12 turn pot	CW to increase gain
Compensation	12 turn pot	CCW to increase

## Three Surface Mount LEDs:

Hall Error	Red (invalid Hall state or illegal encoder transition)
------------	--

Encoder Error      Red (Heidenhain encoder error signal)  
Index Mark      Green

## Five Standard LEDs:

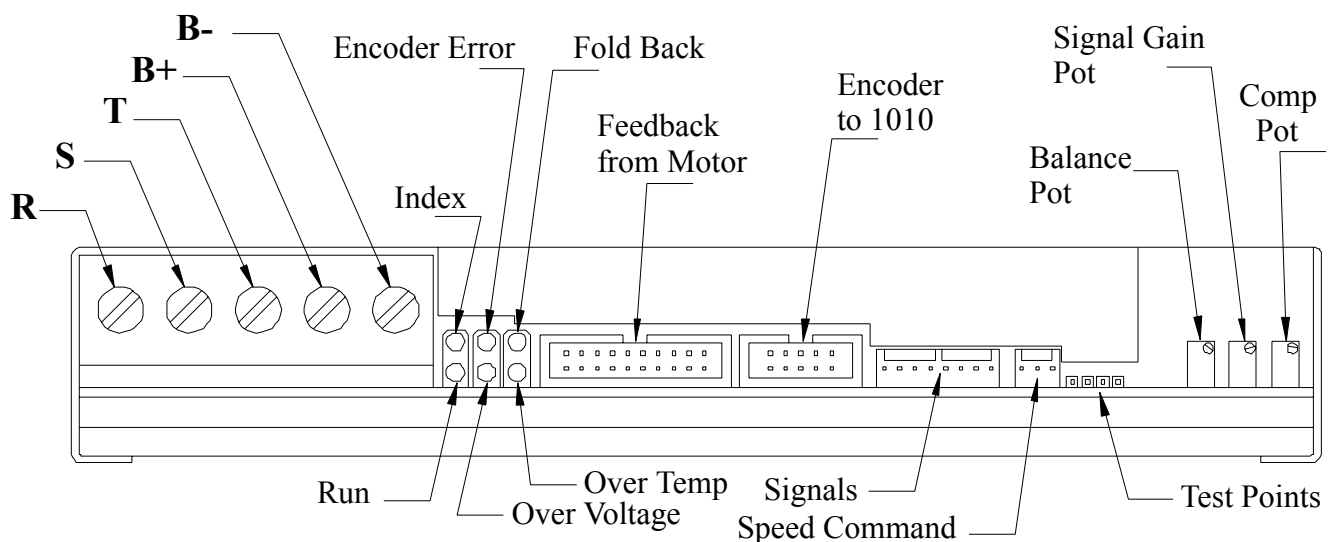
Over Temp      Red (motor or amplifier)  
Over Voltage      Red  
L.S.E.C.B.      Red (low speed overcurrent)  
H.S.E.C.B.      Red (high speed overcurrent)  
Run (or ON)      Green

## Signals Connector (from left) See pinout descriptions for 8-pin Molex Connectors

COM  
COM  
Absolute Current Output  
Fault I/O  
Total Inhibit  
- Limit Switch  
+ Limit Switch  
+12V output

## Test Points (from left)

COM  
Absolute Current      1V/4A  
Tach      4V/1000 RPM  
Signal



**Figure 6-2** AMC Amplifier

## 3 Pots:

Balance      10 turn pot

Signal Gain 10 turn potCW to increase sig gain  
 Compensation 10 turn potCCW to increase amp gain

**6 LEDs:*****Top Row:***

Foldback Red(OC folds back to continuous after 2 secs.)  
 Enc. Error Red(solid red for encoder error;  
 blinking if amp returns to trap mode)  
 Index Mark Green

***Bottom Row:***

Over Temp Red(motor or amplifier)  
 Over Voltage Red(high speed overcurrent or bus over-  
 voltage)  
 Run (or ON) Green

***Signals Connector (from left) See pinout descriptions for 8-pin Molex Connectors***

COM  
 COM  
 Absolute Current Output  
 Fault I/O  
 Total Inhibit  
 - Limit Switch  
 + Limit Switch  
 +12V output

***Test Points (from left)***

COM  
 Absolute Current 1V/4A  
 Tach 4V/1000 RPM  
 Signal

**Amplifier Power Connectors**

S.....white wire  
 T.....black wire  
 B+.....red wire  
 B-.....black wire

***20-pin IDC on amp to***

1.....A+.....green  
 2.....A-.....red  
 3.....+5V.....light blue  
 4.....+5V.....light blue  
 5.....M+.....white  
 6.....M-.....orange

7	.....	COM	.....	black
8	.....	COM	.....	black
9	.....	B+	.....	brown
10	.....	B-	.....	yellow
11	.....	ENC.ERR.	.....	purple
12	.....	nc		
13	.....	nc		
14	.....	U	.....	gray
15	.....	V	.....	tan
16	.....	W	.....	brown
17	.....	TEMP	.....	dark blue
18	.....	+5V	.....	pink
19	.....	COM	.....	black
20	.....	SHIELD		

#### 10-pin IDC on amp to

1	.....	A+	.....	green
2	.....	A-	.....	red
3	.....	+5V	.....	blue
4	.....	+5V	.....	blue
5	.....	M+	.....	white
6	.....	M-	.....	orange
7	.....	COM	.....	black
8	.....	COM	.....	black
9	.....	B+	.....	brown
10	.....	B-	.....	yellow

#### 8-pin Molex on amp

1	.....	+12V	.....	for Limit switches (unused at this time)
2	.....	+Limit	.....	to +Limit switch for axis (unused)
3	.....	-Limit	.....	to -Limit switch for axis (unused)
4	.....	Inhibit	.....	unused at this time
5	.....	Fault	.....	to axis fault line (1100-1 TB1 2-5) active low
6	.....	Abs Current	.....	Absolute current (1V/4A) to J3 on 1010
7	.....	Common	.....	for axis fault line
8	.....	Common	.....	for Limit switches (unused)

#### 3-pin Molex on amp to

1	....	Command Signal +	....	red	....	1010	....	J11-1 X&Y J11-2 Z
2	....	Command Signal -	....	black	....	1010	....	J11-2 X&Y J11-1 Z
3	....	Shield	....	shield	....	1010	....	J11-3

#### Test Points:

- SIGNAL is a 1:2 output of the differential Signal+&- input.
- TACH scaling is 4V/1000 RPM.
- ABS is the current output to all 3 phases. Scaling is 1V/4A. It is the peak value (but not showing all the spikes). It is an absolute value; it does not show direction.
- COM is common (logic ground for the above signals).

**Features     Axis Controller Card 1010-5B/C**

Encoder feedback (J5)  
Able to work with scales  
J1 and J2 no longer used  
J3 current sensor (input)  
J11 differential output  
Brushless software labeled AC-\_\_\_\_\_  
Position Loop Gain adjusted by LED, 25ipm

**AC Axis Adjustments**     Before adjusting any amplifiers, verify that scale cables (if applicable) are disconnected. If they are not disconnected, power down the machine, disconnect the cables, and then power up the machine.

**Potentiometer Adjustments (Axis Amplifier)**

- 1) Turn the Loop Gain, or Current, Potentiometer all the way clockwise (a clicking sound will be heard when the pot has reached the limit).
- 2) Slowly turn the Compensation Potentiometer counter clockwise until the axis motor produces a high frequency vibration, then turn the potentiometer clockwise 1-1/2 turns.
- 3) To adjust the Gain and Balance, the following program will be used:  
  
N1 M91 M49 G91 F150.  
N2 X-3.Y-3.Z-3.  
N3 X3.Y3.Z3.  
N4 MPP P2

The Signal gain and Balance can be set for either metric or inch pitch ballscrews.

**Metric**

- 1) Use a Multimeter set for VDC. Attach the black lead to the signal - (COM) and the red lead to the signal +.
- 2) Start the program and adjust the Signal Gain potentiometer until the multimeter reads 1.470VDC.

- 3) Adjust the balance potentiometer until the multimeter reads 1.470VDC in both directions.
- 4) When the above steps have been completed, the monitor will read 302 for the following error.
- 5) Repeat steps 1-4 for the remaining axis amplifiers.

**Inch**

- 1) Use a Multimeter set for VDC. Attach the black lead to the signal - (COM) and the red lead to the signal +.
- 2) Start the program and adjust the Signal Gain potentiometer until the multimeter reads 2.880VDC.
- 3) Adjust the balance potentiometer until the multimeter reads 2.880VDC in both directions.
- 4) When the above steps have been completed, the monitor will read 595 for the following error.
- 5) Repeat steps 1-4 for the remaining axis amplifiers.

**Note:** The following amplifier adjustments are made with the VMC set to INCH. Use the parameters page (SETP) to verify or change modes.

**Axis Card  
Adjustments**

Adjusting the amplifiers with the axis cards is done by using the red Light Emitting Diodes (LEDs) while adjusting the potentiometers. In order to use this method, the axis cards must have software version AC0003-5 or higher.

**Balance**

- 1) Press the MANUAL button until the ENTER NEXT COMMAND screen is displayed.
- 2) Type DI and press the ENTER button. Type DL, and press the ENTER button. This will display the percentage of load, instead of the axis following error, in 1% increments. This command prepares the axis card for balancing the amplifiers.
- 3) Press the MANUAL button to return to the ENTER NEXT COMMAND mode. Observe the red LED on the axis card. If the light is on or is blinking, the amplifier is not properly balanced.
- 4) Turn the Balance potentiometer, on the amplifier, until the LED goes out. The slower the light blinks, the closer the amp is to the balance point. If the LED starts blinking faster, the potentiometer is being turned the wrong way.

**Signal Gain**

- 1) After the balance has been adjusted, the Signal Gain must be adjusted. Change the program that was entered on the previous page to read as follows:

N2 M91 M49 G91 F25.  
N3 X-2.Y-2.Z-2. G1  
N4 X2.Y2.Z2.

- 2) Start the program. With the program running, observe the red LED on the axis card. The red LED should not be on. When the axis changes direction the LED will come on for a brief interval and go out until the next change of direction. Adjust the Signal Gain on the axis amplifier, until the light goes out. If the light goes out in one direction, but not the other, the balance will have to be adjusted again.
- 3) Perform the Balance and Signal Gain adjustments on the remaining axes. If the desired feed rate for adjustment purposes is 25 ipm (F25), mm pitch ballscrews will have a following error of 50 and Inch pitch ballscrews will have a following error of 100. Rotary tables will always have a 2000ipm feed rate for 90:1 ratios and 1000ipm for 180:1 ratio and a 680 following error. If the VMC is being adjusted for rotary dies, using a feed rate of 150 ipm, the following error for the X,Y, and Z axes is 465. The following error for 25 ipm is 78. The A and B axis still use a 2000 ipm feed rate. The following error is 540.

**Troubleshooting AC Amplifiers**

If errors occur or an axis is inoperative, refer to the Troubleshooting Section. Flow chart number 4 is for axis control problems.

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**SV Command**

The survey command (SV) is a utility that manages the axis compensation data. Each axis controller card stores the screw compensation, the zero offset, and the servo gain settings. To view or edit data, you must use the SV command.

**Using SV**

The previously used SV utility program was replaced in System 98 with a more advanced and easier to use editing utility screen. When entering the survey menu (type SV at the ENTER NEXT COMMAND prompt), the survey menu now automatically loads the survey into memory, starting with the default X Axis survey. If no survey exists, a new empty survey will be created. The survey is then automatically displayed on the screen in groups of 40 values at a time. If more than 40 values in any given survey exists, there will be an additional option located at the bottom of the first column called SURVEY VALUES. This option will allow the user to toggle between Page 1 (the first 40 values) and Page 2 (the remaining values), of the survey. The zero offset and gain options are also displayed on the bottom of the first column.

**Review or Change  
Survey**

To edit any values, the user must move a cursor, defined by an asterisk (\*) symbol, around the screen. This cursor may be moved up, down, left, or right by pressing the U, ENTER, D, BACKSPACE or the L and R keys respectively. To change the axis that is currently being displayed, the user must move the selector cursor to the currently selected axis located at the top of the first column. At this point, the user will be prompted with an ENTER AXIS ID prompt. The user may now type in the desired axis (X, Y, Z, A, or B).

The actual survey values may be altered by moving the selector cursor to the desired index location and then typing in the corresponding value. The editor will then place the value in the correct location and will check for errors. Errors will occur if the difference in the values of two adjacent indexes is greater than 9. If errors are found, the brackets around the index value will change from square brackets, [ ], to round brackets, ( ). All of the numerical errors must be corrected before the user is enabled to exit the menu. The menu may be exited by pressing the MANUAL key, or by selecting another axis in the survey menu.

Two new editing features have been added to help speed up the process of entering similar index values. The first feature, called the ALL command, is invoked by pressing the A button while the selector cursor is located on any index value. This command will give all of the indexes following the currently selected index the same value as that index. If, for example, the last 10 survey values all had the value of 1, the user may type the first 1, move the selector cursor back up to that value, and press the A button. The last 9 indexes will now have the same value as the selected index.

The second feature is used if a currently selected index has the same value as the previous index, then the user may press the space bar to copy the previous survey value into the current index. This feature may be used when adjacent index values have the same value.

**Determining the Zero  
Offset**

Cold start the VMC. With the Zero Offset set to 0, the axis motors are now at their index marks. The VMC cold start indicators may be misaligned. The following procedure will measure the offset value.

**X-Axis**

- 1) Use a tape measure to measure the length of the table, with the end covers removed. Mark the center point with a marker or pen. Measure the table again, except, this time start measuring from the other end of the table. Mark that point.
- 2) Put a small drill into the spindle and jog the head down until the drill is approximately .100" (2.54 mm.) above the table. Move the X axis in either



direction, by turning the resolver, until the drill is centered between the two marks that were made in step #1.

- 3) The number on the monitor, in the X axis display, is the offset amount. Record the value on a sheet of paper.

#### **Y-Axis**

- 1) Press the MANUAL button until ENTER NEXT COMMAND is displayed. Type HO, press the ENTER button, and then press the START button. This will send the machine back to the cold start position.
- 2) Put a .0005" indicator into a tool holder and insert the tool holder into the spindle. Jog the Z axis and the Y axis until the indicator is located in the center of the T-SLOT of the table.
- 3) Jog the Y axis as needed to position the indicator so that it reads the same value on both sides of the T-SLOT, while rotating the tool holder.
- 4) Record the value on a sheet of paper.

#### **Z-Axis**

Refer to Section One of this maintenance manual for procedures on Z axis cold start.

#### **Changing the Zero Offset**

The zero offset is used for scales and AC drives. The zero offset will move the axis in 0.0001 of an inch (0.00254mm) increments from the cold start position. To reset the zero offset, follow these steps:

- 1) In the SV program, move the selector cursor to the Zero Offset Index position, and enter the value of 0 (zero).
- 2) Press Manual to save the survey and exit.
- 3) Determine the proper offset value:

#### **AC-Drive Systems:**

Cold Start all 3 axes, and then Jog from the Cold Start position to the measured position (section 2.2.3). After moving to the measured point, insert the value, displayed on the monitor, into the SV program at the Zero Offset Index selection. When entering offsets, use the following examples as a guideline:

If the position recorded was .0105, enter 105.

If the position recorded was -.1350, enter -1350.

#### **Scale Systems:**

Use the SVT-0081 Encoder Tester (1000 line). Disconnect the scale feedback cable from the Axis Controller card and connect it to the Encoder Tester.

Connect the Encoder Tester to the spindle controller card for 5-volt power. Cold Start the axes, and Jog the axis until the closest green index light is seen. Insert the position value, displayed on the screen, into the SV program at the Zero Offset Index selection, and change the sign from + to - or from - to +.

**Changing Gain**

The default gain option may be changed by moving the selecting cursor to the change gain index. Select either normal, intermediate, or maximum gain.

**Saving a Survey to the Axis Control Card**

A survey may be saved by either exiting out of the survey menu by pressing the Manual key, or by selecting another survey to edit. On exiting, the CNC will automatically cold start to enable the changes. If a survey has not been altered before exiting, the CNC will not require a cold start. This new feature allows the user to go into the survey menu just to look at the current settings, without having to wait for a cold start when exiting.

If a mistake has been made and a user wants to reload an axis without saving the changes, move the selector cursor to display the Enter Axis ID prompt. At this prompt, re-enter the axis that is currently being edited. The message "Do You Want To Save Survey Before Re-Loading (Y/N)" will appear. Press "N" to reload the survey without saving the changes.

**Copying a Survey To A New Axis Control Card**

If an axis card needs to be replaced, copying the survey to a new axis card can be accomplished by using two new features called the SVREAD and SVWRITE commands. To replace an axis card, follow these steps:

- 1) Type SVREAD at the Enter Next Command prompt. All of the surveys will automatically be loaded into memory.
- 2) Shut off the machine and exchange the axis card to be replaced.
- 3) Turn the machine back on and type SVWRITE at the ENTER NEXT COMMAND prompt.
- 4) When prompted, type in which axis is to be replaced.
- 5) The survey will be automatically saved and a "survey successfully saved" message will be displayed.

Another method of copying axis surveys is to save them to disk using the PU,5 command. This option may also be used to prevent any accidental losses of surveys. To load a saved survey from a disk, the user must enter the diagnostics option (option 7) in the Functions menu. A submenu will appear with the option, 5-LOAD CONFIGURATION. If this option is invoked, the user will be asked for the filename of the survey. The survey will now be automatically loaded and saved. Note that any previously stored survey will be destroyed. To

prevent a user from accidentally loading in a survey, the survey may not be loaded in through the disk command in the functions menu.

## Axis Motors (XYZ)

### Motor Wiring

When installing an axis motor, it is important to wire the motor the same way that the one before it was wired. If the motor is from a different manufacturer, use the table below correctly wire that particular model or brand. Each motor has four wires, two wires for the power and two wires for the tachometer feedback. Connecting these wires the wrong way will result in axis motor runaways.

**AXIS MOTOR WIRING DATA FOR THE X, Y, AND Z AXIS**

MOTOR TYPE	VMC	MOTOR WIRE			TACH WIRE			TESTING WIRE CONNECTIONS			
		AXIS	CNC	MOTOR	AXIS	CNC	MOTOR	DIRECTION OF TABLE AND HEAD		DIRECTION OF MOTOR SHAFT WHEN MOTOR IS DETACHED FROM BALL SCREW	
RELIANCE E728	5	X	RED	BLK	X	RED	WHT	X	+	+	-
	10	Y	RED	BLK	Y	RED	WHT	Y	-	+	-
	15	Z	RED	BLK	Z	RED	BLU	Z	+	+	-
GLENTEK GM4050	5, 10	X	BLK	RED	X	RED	BLK	X	+	+	-
	15	Y	BLK	RED	Y	RED	BLK	Y	-	+	-
	2216	Z	BLK	RED	Z	RED	WHT	Z	+	+	-
GLENTEK GM5065	3016	X	RED	BLK	X	RED	WHT	X	+	+	-
	4020	Y	RED	BLK	Y	RED	WHT	Y	-	+	-
		Z	RED	BLK	Z	RED	WHT	Z	+	+	-
GLENTEK GM5065	6030	X	RED	BLK	X	RED	WHT	X	+	+	-
	8030	Y	RED	BLK	Y	RED	WHT	Y	-	+	-
		Z	RED	BLK	Z	RED	WHT	Z	+	+	-
GLENTEK GM6000	*VASAK (RED)	X	RED	WHT	X	BLK	WHT*	X	+	+	-
	6030	Y	RED	WHT	Y	BLK	WHT*	Y	-	+	-
	8030	Z	RED	WHT	Z	BLK	WHT*	Z	+	+	-

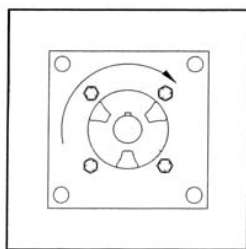


FIG. 1

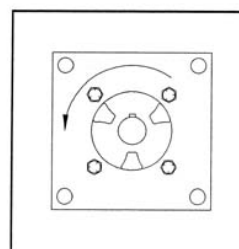


FIG. 2

FADAL 4/95

**Removal**

- 1) With the machine at the cold start position, depress the Emergency Stop button and power off the VMC.
- 2) Remove the four 3/8 hex head bolts holding the axis motor in place.
- 3) Remove the axis motor.
- 4) For DC motors, remove the end cap of the motor. For AC motors, remove the Rose Box cover or disconnect the cannon plugs. If the motor has cannon plugs, go to section 5.3 for installation instructions.
- 5) For DC motors, disconnect the two power wires and the two tachometer wires. For AC motors, disconnect the three wires of the power cable and the signal cable.
- 6) Loosen the 45 degree connector and pull all of the wires out of the motor.

**Installation**

- 1) Verify that the Emergency Stop button is pressed in.
- 2) For DC motors, remove the end cap of the motor. For AC motors, Remove the Rose Box cover.
- 3) Run the machine wires into the new motor. Tighten the 45 degree connector. For the motors with the cannon plugs, connect the power and signal cables to the new motor and proceed to step number 5.
- 4) For DC motors, connect the two power wires and the two tachometer wires using the DC chart in table 1. For AC motors, connect the three power wires together (red-red, blue-blue, and black-black or black-white, then connect the signal cable.
- 5) Reinstall the axis motor using the four 3/8" hex head screws. Center the motor during installation.
- 6) Power on the machine. Release the Emergency Stop button and observe the motor. If there is any malfunction or axis runaway, depress the Emergency Stop button.
- 7) Type CS, to cold start the machine.
- 8) Adjust the axis amplifier (section 1.1 for DC motors and 2.5 for AC motors)
- 9) Reset the cold start position (DC motors only, see section 1.2).

**Resolvers**

Before proceeding with the following instruction, verify that the VMC is at the cold start position and the Emergency Stop button is depressed.

**Removal**

- 1) With the machine at the cold start position, press the Emergency Stop button and power off the VMC.
- 2) Remove the four 3/8 hex head bolts holding the axis motor in place.
- 3) Remove the axis motor.
- 4) Remove the end cap of the motor.
- 5) Loosen the three screws that are holding the resolver in place.
- 6) Remove the two screws that are holding the resolver circuit board to the motor.
- 7) Rotate the motor shaft so that a 3/32" hex wrench can be inserted into the top screw on the resolver coupler
- 8) Loosen the screw and remove the resolver.

**Installation**

- 1) Insert the resolver into the coupler and hold the resolver flush to the mounting surface as the coupler screw is tightened.
- 2) Tighten the three screws that hold the resolver in place.
- 3) Install and tighten the two screws that hold the resolver circuit board to the motor.
- 4) Release the Emergency Stop button and cold start the machine. If the applicable axis is not aligned with the cold start mark after the machine has been cold started, then refer to section 1.2.

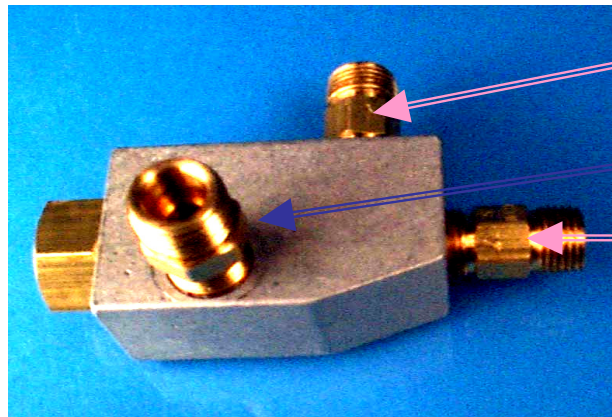
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**EMC and TRM Way  
Lubrication**

**The EMC and TRM model VMC's must be manually lubed by the owner every 3-6 months depending on use:**

- a. Remove X, Y, and Z way covers.
- b. Wipe off old grease and accumulated foreign objects.
- c. Use MOBILTEMP SHC 32 grease.
- d. Grease every lubrication port at the saddle, table, and head. Supply grease until it comes out from the ball slide or ball nut area.
- e. Move saddle, table, and head a few times through full travel to spread the grease throughout the system.
- f. Wipe off excess grease that accumulates at the end of the rails and ball screw shafts.
- g. Re-install X, Y, and Z way covers.

---

**Axis & Way Systems****Waylube System**

New Relief port  
(Arrow points away from  
valve)

Outlet to filter  
(No arrow)

Choke inlet from pump  
(Arrow points toward  
valve)

USE RECOMENDED WAYLUBE TYPE Castrol Magna BD68, Shell Tonna 68V or Mobil Vactra Oil #

**Operation** **Note:** Frequently clogging components indicate that the wrong waylube is being used. The recommended waylubes are Castrol Magna BD68, Shell Tonna 68V or Mobil Vactra Oil #2.

Two waylube systems have been used, the motor-driven piston pump and the Positive Displacement Injection (PDI). The early linear way VMC 15 models used hand pumped grease. For these machines use Mobil SHC32 grease and Bi-weekly grease with 3 to 4 strokes to the ballscrews and 2 strokes to the ways. **Caution:** Pump slowly to avoid damaging the lines.

The **System Software** determines the waylube cycles so both systems will operate correctly. The operation is as follows:

- One cycle is defined as: ON for 3 minutes 50 seconds and OFF for 10 seconds for a total cycle time of 4 minutes.
- After power on: two 4 minute cycles
- In Auto and not waiting mode: continuously run 4 minute cycles
- Just after exiting Auto: one 4 minute cycle.
- Enter Jog mode: one 4 minute cycle.

The CPU board issues the command to activate waylube. This command goes to the Computer Interface (1030) and then to the Mill Interface board (1040). The Mill Interface activates relay K19 on the 1100-2 board which outputs 110 VAC (TB1-11 & RET TB1-12) to the waylube pump.

The **Motor-Driven Piston Pump** type operates with the 110 VAC input running a 3 RPM motor. The motor drives some gears which move an arm up and down to pump the pump. This pump can be pumped manually by pulling up on the handle and released. The pump then pumps oil through a filter and then on to the line. The line goes to two junction blocks that output the oil through meters that restrict the amount of oil to each line to the ways and ballscrews.

The **Positive Displacement Injection (PDI)** lube system is a solenoid controlled pneumatic system. When the solenoid is activated by the 110 VAC input, it turns the air supply off and when the solenoid is deactivated the air supply is on to activate the pump. This is done so that both systems can use the same control program.

The pump is activated for 10 seconds, within the 4 minute cycle, during which oil is distributed to all of the valves on the junction block assemblies. The pump sends oil to the filter and then to the junction block assemblies, which may contain several different size valves, at a pressure ratio of 5:1. The valves inject a measured amount of oil to their respected lines. When the solenoid is deactivated the pressure is released through a relief valve. When the pressure drops below 50 psi, a spring inside the valve returns the valve to its at rest position. This position allows the injector cavity to refill with oil.

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#### **PDI Waylube Troubleshooting Observations and Tests**

Observe the operation of the PDI Waylube pump throughout a 4-minute cycle **with axes moving**. Proper operation would include 120VAC power ON to the VLV-0028 Air Valve on top of the Lubrication Pump for 3 minutes and 50 seconds. This is then followed by a 10 second power OFF to the Air Valve, during which time the gauge pressure increases to 200-350 PSI (14-24 bar). Again, the 3 minute 50 second power ON cycle repeats, and the gauge pressure reduces to 0.

---

#### **Air Valve Operation**

If the air valve does not operate, inspect F13 fuse and K19 relay on the 1100-2 board. Use SVT-0104 Test Relay as substitution for K19. If Test Relay shows no 5VDC, then trace 5VDC circuit back to motherboard through 1100-2 / J1-7, 1100-1 / J2-7, 1100-1 / J1-23, and 1060-0 / J7-23 to the 1040-2 card. Remember that 5VDC relative to ground is present on BOTH legs of the K19 relay until it is energized by the 1040 card pulling one leg to ground. Test for 120VAC at valve coil when energized. If power is OK, then test mechanically by pressing white button on end of air valve when not energized. Air line output from valve can be disconnected to check for air flow.



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**Pump Operation**

Disconnect output oil lines from gauge, and using a short piece of 5/32 air line, close output Y fitting by inserting the tubing, one end into each side of the Y. Cycle pump until pressure builds.

Does pressure now rise and fall from 200-350 PSI and return to 0 as described above over a 4-minute cycle? If so, then pump operates OK.

If not, is pressure at maximum constantly? Then replace LUB-0051 Choke Valve inside reservoir of pump, as it may not be releasing pressure from output when Air Valve stops air flow.

Is pressure at or near zero constantly? Then the pump piston may not be returning to top of the stroke. Disconnect the air supply, and then remove the threaded stop rod with the plastic cap on it from the top of the pump assembly. Insert a screwdriver to measure how far down the piston is. It should be at the top of the stroke).

If stuck in lowest position, then replace LUB-0038 assembly.

If piston was not stuck or does not stick at lowest position, then LUB-0051 Choke Valve may have a ruptured diaphragm. Replace LUB-0051.

The newer version of the LUB-0051 Choke Valve releases pressure when the machine is powered off. This device restricts the strong impulse from the high pressure of the pump to protect the individual injectors, but also is the relief valve when the pump is turned off, so that the pressure drops to zero to reset the injectors.

The problem is that the pressure rises to the maximum when the machine is powered off, and the constant pressure damages the valve diaphragm when the machine is not being used. If the valve is damaged, the result then is that the pressure never climbs to the maximum because the diaphragm leaks, and no lube flows, or, the pressure never declines below the 50 PSI minimum because the relief valve is blocked, and the injectors cannot reset.

The newer version has an extra port on it, as shown below, and allows the pressure to bleed off when the machine is powered off. Installation of the new Choke Valve is simple. Note that two of the ports are similar, except that a marked arrow points into the valve on one, or away from the valve on the other. Thread the port that has the arrow pointing INTO the new Choke Valve onto the pump's piston housing. Install the port tube that feeds the lube into the filter unit onto the 1/4 inch compression fitting, (it is different from the other two). The

third port has the arrow pointing AWAY from the Choke Valve and is not connected to anything at all.

If Waylube Pump is operating OK, and system cannot develop greater than 200 PSI (14 bar), then inspect system for a leak. Inspect under table for ruptured hose and replace with LUB-0071 or LUB-0073 Waylube Carrier Update kit.

If OK, then one of the PDI Injectors may be leaking. Determine which manifold is leaking by isolating each section separately. Inspect Injectors for one that is not seating. Replace LUB-0083, LUB-0084, or LUB-0085 Injector or complete Manifold assembly.

### **Checking Ways for Oil (Both)**

- 1) Look under the head on the Z-axis ways for a thin film of oil flowing down the column ways.
- 2) Look behind the rear y-axis chip tray for oil on the base ways.
- 3) Remove either the left or right way cover on the table to check for oil on the X axis ways.

### **Replacing Way Wipers (Both)**

- 1) If the way wipers are damaged, they will need to be replaced.
- 2) Replace damaged way wipers with identical parts only.

### **Replacing Valve Manifold Assemblies (Both)**

- 1) To ensure a valve assembly is replaced with the correct part, use the valve assembly listed in the Fadal Parts Manual, only.
- 2) Loosen each line attached to the manifold. Remove the two attaching bolts of the manifold. Remove the old manifold and install the new manifold using the existing attaching bolts. Insert each line and tighten.

## **Waylube Pump**

### **Pump Assembly Replacement**

- 1) Verify that the machine is in the cold start position. (Both)
- 2) Power off the machine and lock out the main disconnect. (Both)
- 3) Disconnect the air supply line from the machine. (PDI)
- 4) Remove the air fitting from the solenoid. (PDI)
- 5) Remove the oil lines and "Y" fitting from the filter element. (Both)
- 6) Disconnect the wiring to the solenoid and the float switch. (PDI)

- 7) Disconnect the wiring to the motor and the float switch. (Motor)
- 8) Remove the four screws that attach the tank. (Both)

**Caution!**

Tank will come off.

- 9) Remove the waylube pump assembly. (Both)
- 10) Install a new waylube pump assembly and reattach the fitting, “Y” fitting, and oil lines.
- 11) Install tank and fill the oil reservoir with Fadal recommended way lube.
- 12) Connect the wiring to the float switch and solenoid or motor using insulated crimps.
- 13) Reconnect the air supply line. (PDI)
- 14) Manually activate the solenoid to fill the oil lines and filter element assembly. (PDI)
- 15) Manually pump the pump to fill oil lines. (Motor)
- 16) Check for oil and air leaks. (Both)

**Pump Electrical Components**

The electrical components consist of relays, fuses, float switch wiring, and solenoid wiring.

- 1) The relay and fuse are located on the 1100-2 power distribution board. (Both)
- 2) The float and solenoid wiring are located on the top of pump. (PDI)
- 3) The float and motor wiring are located on top of the pump.

**Filter Replacement****LUB-0049 Filter Element, PDI B6 889**

- 1) Disconnect the air supply line from the VMC. (PDI)
- 2) Unscrew the filter element bowl (LUB-0049) and remove the filter. (Both)
- 3) Unscrew the filter. (Motor)
- 4) Install a new filter in the bowl. Fill filter with Fadal recommended way lube oil and reattach the filter element assembly.

- 5) Reconnect the air supply line to the VMC. (PDI)
- 6) Manually activate the system. (Both)
- 7) Check for oil and air leaks. (Both)

#### **Procedure For Flushing Way Lube System**

Flushing the way lube system is necessary when the incorrect waylube is installed in the machine. Non-approved waylubes may contain paraffin wax or silicone that cause clogging.

**Note:** Place plastic bags over the drains of the coolant tank to keep kerosene out of tank.

- 1) Replace the external filter on the Bijur way lube pump. (Both)
- 2) Remove the oil line between the way lube pump and the three port junction T located near the pump mount.
- 3) Verify the flush pump air regulator is fully counterclockwise.
- 4) Flush each line individually. Do not try to flush through PDI injection valve. This will destroy them and the motor meter can be flushed through.
- 5) Attach an air line to the flush pump.

#### **WARNING**

Verify that the air regulator is closed.



- 6) Insert the 3/8" hose from the flush pump into a container of grade A kerosene.
- 7) Slowly open the air regulator clockwise to start the flush pump.
- 8) Increase the air pressure; use caution and verify that the output pressure does not exceed 180 psi at the gauge. The pump ratio is 4:1. An input air pressure of 45 psi will produce an output air pressure of 180 psi.
- 9) Enter a program that will exercise all axes to their limits. Start the program running.
- 10) Maintain a constant flow of kerosene through the way lube system.
- 11) If kerosene is found dripping down the column from underneath the Z axis head, the manifold filters are probably clogged. Replace the 8 port junction block located on the Z axis head. Start over at step 4.

- 12) Remove the 3/8" hose from the kerosene and place the hose in a can of clean fresh waylube.
- 13) Slowly open the regulator clockwise on the flush pump. Pump oil through the lines, until the system is well lubricated.
- 14) Stop the machine and return it to the COLD START position.
- 15) Turn the flush pump air regulator fully counterclockwise and remove the air line.
- 16) Remove the flush pump and reattach the oil line from the Bijur pump to the 3 port junction.

### Cool Power – Ball screw / Spindle Cooling System

The purpose of the Cool Power system is to control thermal expansion. This is accomplished by pumping coolant continuously through the ballscrews and spindle. Different models have different cooling configurations.

**Note:** All temperatures are in Fahrenheit unless stated otherwise.

### Electrical Operation

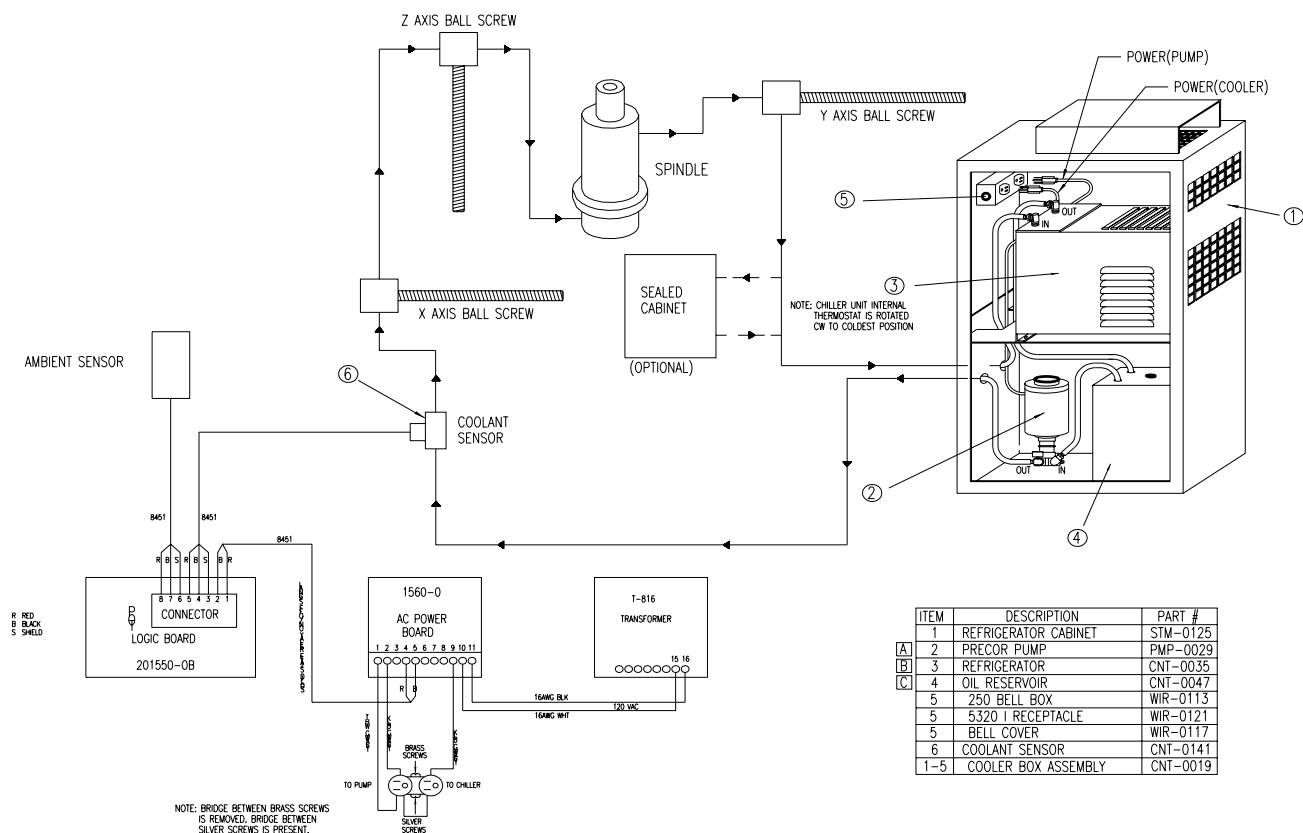
The electrical portion consists of:

Chiller Controller board (1550-2, PCB-0209)

Chiller Overload / Relay board (1560, PCB-0046)

Two or three Temperature Sensors (CNT-0022)

120 VAC input from the transformer



A double 120 VAC outlet (must have the bridge between outlets removed see note)

Chiller Unit

Coolant Pump Motor

**Note:** 120 VAC output must have the bridge between the brass screws removed. Bridge between silver screws is present.

When the machine is powered on, the coolant pump remains on all the time and the coolant temperature is monitored by a coolant sensor and compared to an ambient sensor. When a difference of one or two degrees is detected the chiller is activated to cool the coolant.

The sensors have three wires, a ground, a reference (REF) voltage and a signal output (ambient or coolant). The sensor circuits on the controller consist of +12 VDC through a resistor to the REF line and signal (ambient or coolant) input line to a resistor and a OP AMP. These circuits compare the ambient to the coolant to determine when the temperatures are different.

If a difference is detected, the chiller controller then activates a solid state relay on the chiller overload / relay board to turn on the chiller. This is accomplished by the controller outputting the +5VDC on pin 1 to the 1560 board pin 4 and connecting to the Solid State Relay (SSR) + control. On pin 2 the controller will pull the line to about zero volts to activate the chiller relay. On the 1560 board the wire is connected to pin 5 of 1560 which is connected to the control on the SSR.

The 120VAC input to the 1560 is on pin 11 and the RET is on pin 10. Both are connected to the transformer. The 120 VAC is routed through a fuse (F1) to two circuit breakers, one (CB1) outputs 120 VAC to the pump motor on pin 1 and the other (CB2) outputs 120 VAC to the contacts of the SSR and when activated outputs to pin 9 which connects to the chiller. The chiller consumes about 2,000 watts for start up and about 500 watts during normal operation.

The current chiller controller is a dual controller; it can operate one or two chillers. On this board J2 is a 8 pin connector and the pins are connected as follows: 1 - +5VDC, 2 – SSR, 3 – Gnd, 4 – Coolant, 5 – REF, 6 – Gnd, 7 – Ambient & 8 – REF.

With the dual chiller configuration, J1 on the controller board is connected to a second 1560 board. The connections are 1550-J1-1 to 1560(2) pin (5 VDC), 1550-J1-2 to 1560(2) pin 5 (SSR), 1550-J1-3 to sensor ground, 1550-J1-4 to sensor signal (coolant) and 1550-J1-5 to sensor REF. **Note:** J2 on the 1550 is CH-1; connect here for a single coolant system and J1 is CH-2; connect here for the second.

The chiller controller board is normally in slot three in the control card cage. It receives the + 5 VDC and + 12 VDC from the backplane but does not communicate to the other boards.

The controller has a heart beat LED to indicate that the board is operational. It also has a test button for each chiller. When the test button is pressed the chiller will run for one minute. There is an LED for each chiller to indicate that it is turned on. There is also an LED for the timer to indicate that the timer is running, a 2.5 minute delay between power up and when the chiller can be activated. This allows the pressure in the chiller unit to decrease to the point where the compressor is able to restart after turned off and immediately power on. A timer button deactivates the timers. If the coolant temperature exceeds 100 degrees, the chiller unit is activated regardless of the ambient temperature. If the coolant temperature falls below 60 degrees the chiller is inhibited.

#### **Older Controller Boards**

For older controller boards with adjustable temperature control, the spindle / head must be the same temperature as the base of machine before adjusting. The chiller must be off. Adjust R17 CCW until TEMP LED is off. Turn CW until it comes ON. Find midpoint between on and off.

#### **Coolant flow paths**

Different models of the VMC have different coolant configurations.

The configuration, the coolant and the amount of coolant will affect the cooling process. If the tank is full the temperature swings are larger then if the tank is low because more fluid is required to cool and larger temperatures range from top to bottom of the tank.

#### **VMC 15 7,500 RPM Spindle Configuration**

No cooling system.

#### **VMC 15 10,000 RPM Spindle or VMC 4020A / 5020A 7,500 RPM Spindle Configuration**

Spindle is cooled by flood coolant pumped through the spindle and returned on the base under the saddle.

#### **VMC 2216 / 3016 / 4020 Metric ballscrews, 10,000 RPM Spindle Configuration**

The coolant flow path is coolant tank to pump to coolant sensor to X axis ballscrew to Z axis ballscrew to spindle to Y axis ballscrew to chiller and back to coolant tank.

#### **VMC 2216 / 3016 / 4020 Metric ballscrews, 10,000 RPM Spindle, Sealed Cabinet Configuration**

The coolant flow path is coolant tank to pump to coolant sensor to X axis ballscrew to Z axis ballscrew to spindle to Y axis ballscrew to cabinet cooler to chiller and back to coolant tank.

**VMC 6030 / 8030 10,000 RPM Spindle Configuration**

The coolant flow path is coolant tank to pump to spindle to Y axis ballscrew to coolant sensor to chiller and back to coolant tank.

**VMC 6030 / 8030 10,000 RPM Spindle, Sealed Cabinet Configuration**

The coolant flow path is coolant tank to pump to spindle to Y axis ballscrew to coolant sensor to cabinet cooler to chiller and back to coolant tank.



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**Motor Couplers**

The motor couplers are the connection between the motor and the ballscrew. When replacing the motor or the ballscrew measure the distance from the end of the coupler and the motor or ballscrew. Install the coupler on the new motor or ballscrew and place the coupler back to the same dimension as before. The first couplers were three pronged with a insert disk between them.

A problem when milling a circle was found, the center was off specification as much as .0005 inch (.0127mm) in both X and Y axis. Larger machines may be off more than smaller machines. This has to do with the MTR-0071 Coupler Insert Disk, manufactured of Delrin, deflecting on axis direction change and yielding a small amount of backlash as the castings are reversed in direction.

Couplers, MTR-0154 and MTR-0155, were put in to production to reduce error in backlash. This is a precision coupler with an Aluminum Bronze insert manufactured to within .0001 inch (.0025mm) of tolerance. The Aluminum Bronze material will not deflect nor collapse under these loads, and it provides a bearing to the coupler yokes. These will be shipped as a set of three parts: the ballscrew coupler, the motor coupler, and the Aluminum Bronze insert.

MTR-0154COUPLER SET, ALM BRZ; 5/8

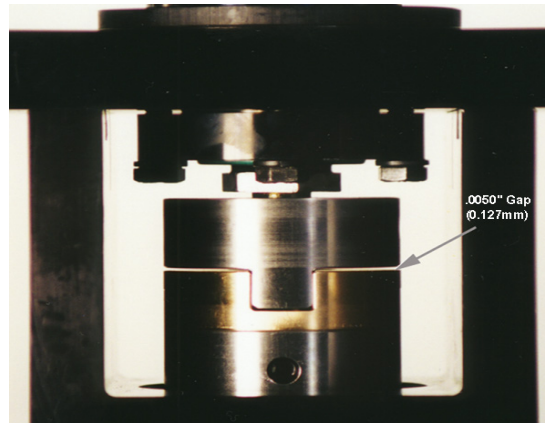
MTR-0155COUPLER SET, ALM BRZ; 7/8

MTR-0154 is intended to fit all machines that use GTK GM4050 or Reliance motors, and MTR-0155 is intended to fit all machines with the larger GTK GM6000, and AC drive motors.

No lubrication is necessary on these couplers, but the installation procedure is important. Use caution to prevent any nicks or bumps to the Aluminum Bronze Disk.

- 1) Remove old coupler components.
- 2) Install new coupler onto ballscrew, measuring from face of Ballscrew Bearing mount to coupler pocket.
- 3) Install coupler onto motor, measuring from face of motor flange to coupler pocket.
- 4) Insert Aluminum Bronze Disk onto Ballscrew Coupler, making certain not to gouge or burr the edges, and aligning the two lobes horizontally to retain the disk.
- 5) Install the motor, using SVT-0122 Motor Alignment Guides, and bolt in place.
- 6) Check to be certain that the maximum gap between the Coupler lobe and the Disk pocket is .070 inch (1.8mm), and the minimum is .050 inch (1.27mm).

- 7) Operate the machine and check for Motor axis to Ballscrew axis alignment. Re-center motor under the 4 bolts to reduce Coupler Insert Disk runout, to prevent premature wear.



**Figure 6-3** These couplers will provide an audible “click” if the axis is jogged back and forth. This is normal.

Report clanking noise in axis, vibrations and slamming in G0 moves, ballbar analysis discrepancies, backlash problems, misposition problems, and premature wear of couplers.

Aluminum Bronze disk style couplers wear down, and clearances between components result in one or more of the symptoms described above.

A new type of Bellows Coupler, made with a stainless steel bellows and bonded between two aluminum mounts is currently being installed. The Bellows enables the Motor shaft centerline to drive the Ballscrew and flex slightly if any mismatch in alignment exists, thus eliminating moving components.

Installation may be required:

- 1) For VMCs 6535, 4525 and 3020 on X-Axis, remove the 3 screws mounting the first way cover section to the table, and slide it back to view the motor and coupler. Remove Motor Cover.
- 2) For VMCs 6535, 4525 and 3020 Y-Axis, remove the rear hood from the Y-Axis cover, and slide forward when Y is at positive limit.
- 3) Remove motor and old coupler.
- 4) Install the new Bellows Coupler tight against the Ballscrew jam nut.
- 5) Using a 5 mm Allen wrench, tighten the Coupler bolt to 20 Foot-Pounds (15 N-M).

- 6) Using SVT-0122 Motor Alignment Guide Rods, slide the Motor into the Mount and Coupler.
- 7) Tighten the Coupler Bolt as above.



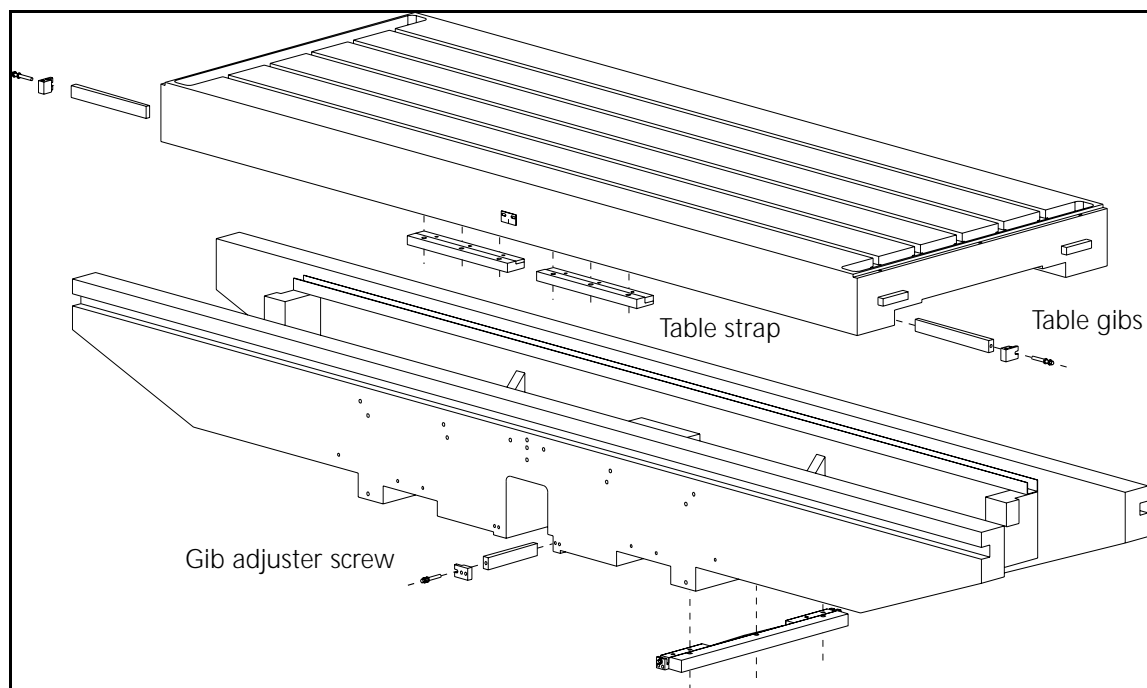
*Figure 6-4* MTR-0189 Coupler, Bellows; 7/8 Shaft. MTR-0190 Coupler, Bellows; Siemens.

## Gib Adjustment



### IMPORTANT

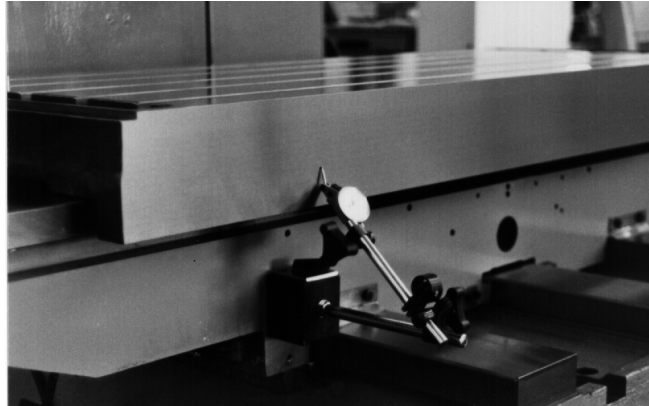
DO NOT rush gib adjustments—they are critical! Do not adjust any gibs unless the machine is leveled properly.



*Figure 6-5* Gib Adjustments

There are two gibs at the front of the table and from 4 to 6 Gib/Strap assemblies on the underside of the table (depending on the VMC model, see Figure 6-1). The following procedure covers adjustment of the front table gibs. There are two front gibs, one on the left and one on the right. This adjustment procedure is applicable for all VMC models.

- 1) Center the table at the X-axis cold start position. Attach a magnetic base and an indicator just below the gib, as shown in Figure 6-7. Adjust and set at a zero reading.



*Figure 6-6* Attach Magnetic Base and Indicator

- 2) Place a pry bar between the front table gib/strap assembly and the saddle.
- 3) With the pry bar, move the table forward so the solid rear way of the table is against the saddle.
- 4) Zero the indicator.
- 5) Place the pry bar between the rear table gib/strap assembly and the saddle.
- 6) Gently pry the table the opposite way.
- 7) The indicator reading is the adjustment that needs to be made. A properly adjusted set of gibs will have a front to back motion of .0003".
- 8) If the gib needs adjusting, there is a gib adjuster screw located at the end of the gib. Turning this screw clockwise will loosen the gib and turning it counter clockwise will tighten the gib.
- 9) Repeat the above steps until a .0003" indicator motion is achieved. Then, perform the procedure over again for the gib at the opposite end.

After both gibs have been completely adjusted, run the table to its extremes at the plus and minus ends and then return the table back to center. Then, repeat the above gib adjustment procedure for verification.

**Table Gib/Strap  
Assembly**

When adjusting gibs with shim stock, use extreme care to prevent ripping the shim and leaving pieces of it between the gib and way surfaces.

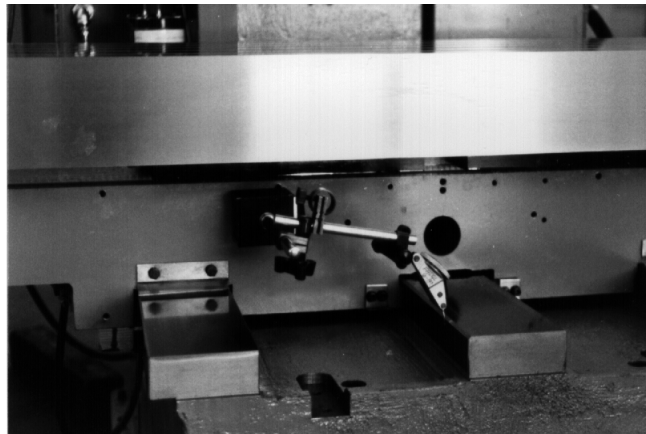
There are gib/strap assemblies on the underside of the table at the front and rear. Depending on the model of VMC there will be from one to three gib/strap assemblies at the front and at the rear.

Adjust the gib/strap assembly as follows:

- 1) Jog the table in the X-axis to clear the cold start indicator.
- 2) Loosen the three hex head bolts. The slot for the bolt is tapered. When the gib is moved, the head of the bolt may bind. Verify that the bolt is loosened enough to allow the gib to slide from left to right.
- 3) Slide the gib to the right to loosen the gib. The gib must be loosened first before it can be tightened. To move the gib, use an open end wrench or a hex head and tap with a mallet.
- 4) To adjust, slide the gib to the left (operator orientation is facing the strap) until it contacts the underside of the saddle. Use finger pressure to push the gib.
- 5) Verify that each of the three hex head bolts are not caught in the tapered slot. If the bolts are binding on the slot, loosen and re-adjust the bolts.
- 6) Tighten the three hex head bolts.
- 7) Repeat the above steps for the opposite table gib/strap assembly.

**Saddle Gibs** There are two gibs to the right of the center base rail and two gib/strap assemblies on the underside of the saddle. The following procedure covers adjustment of the center saddle gibs only. The following adjustments apply to all VMC models. It may be necessary to remove the rear Y-axis tray to adjust the saddle gibs.

- 1) Center the saddle to the Y-axis cold start position. Attach the magnetic base and indicator to the saddle. Position the indicator as shown in Figure 6-8. Set the indicator to zero.



*Figure 6-7* Position Indicator

- 2) Standard machines: Place a pry bar between the right saddle gib/strap assembly and the base.
- 2) Performance Models: Place a pry bar between the X axis ballscrew mount and the table.
- 3) With the pry bar, move the saddle so the solid way of the saddle makes contact with the center base rail.
- 4) Zero the indicator.
- 5) Standard machines: Place the pry bar between the left saddle gib/strap assembly and base.
- 5) Performance models: Place the pry bar between the other side of the X axis ballscrew mount of the table.
- 6) Gently pry the saddle the opposite way.
- 7) The indicator reading specifies the amount that the gib should be adjusted. A properly adjusted set of gibs will have a side to side motion of .0003".

- 8) If the gibs need adjusting, there is a gib adjuster screw located at the end of each gib. Turning this screw clockwise will loosen the gib and counter clockwise will tighten the gib.
- 9) Repeat the above steps, until .0003" indicator motion is achieved, then adjust the gib at the opposite side.

After the gib adjustments are complete, run the saddle to its extremes at the plus and minus end and then back to center again. Then, repeat the above gib adjustment procedure for verification.

### **Saddle Gib/Strap Assembly**

When adjusting gibs with shim stock, use extreme care to prevent ripping the shim and leaving pieces of it between the gib and way surfaces.

There is one gib/strap assembly on the left side of the saddle and one on the right. Each gib/strap assembly has two gibs that require adjustment. Adjust the saddle gib/strap assembly as follows:

- 1) Loosen both the front and back gibs on the strap by turning the gib adjuster screw clockwise.
- 2) Insert a .001" shim about three to four inches between the gib and the way. Place shims in both the front and rear at the same time.
- 3) Tighten the gib to pinch the shim between the gib and way by turning the gib adjuster screw counter clockwise. Tighten the screw enough to prevent the shim from moving.
- 4) Slowly turn the gib adjuster screw clockwise while pulling on the shim.



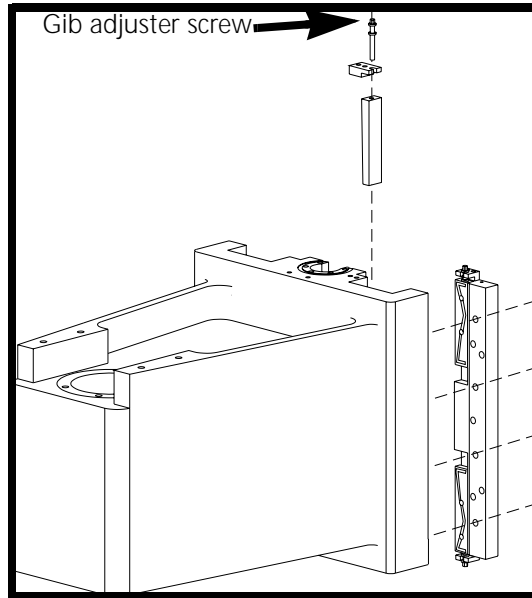
#### **WARNING**

Shim stock is very sharp!

- 5) When the shim starts pulling out, stop turning the gib adjuster screw and remove the shim completely.
- 6) Turn the gib adjuster screw 3/4 turn counter-clockwise.
- 7) Repeat the above steps for the front, rear, left, and right gibs.

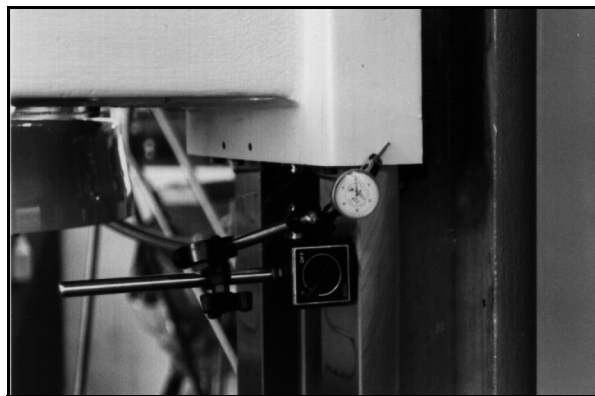


**Head Gibs** There are two gibs that ride between the column ways, one at the top and one at the bottom. See Figure 6-9. There is also one gib/strap assembly on the back of each column rail (the 3020 and 4525 have two gib/strap assemblies on each way).



**Figure 6-8** Gib Strap Assemblies on Spindle Head

- 1) Remove the Z axis head cover.
- 2) Center the Z axis head within its travel limits so it will be easy to work on.
- 3) Attach a magnetic base and indicator to the column, as shown in Figure 6-10.



**Figure 6-9** Magnetic Base and Indicator Mounting on Spindle Head

- 4) Using a pry bar between the left side of the head and Z-axis way, move the head so the inside of the left way contacts the left column way.

- 5) Zero the indicator.
- 6) Place the pry bar between the right side of the head and Z-axis way.
- 7) Gently pry the head the opposite way.
- 8) Make adjustments according to the indicator reading. A properly adjusted Z-axis head gib is .0002' to .0003" motion side to side.
- 9) If the gibs need adjusting, there is a gib adjuster screw located at the end of each gib. Turning this screw clockwise loosens the gib and counter clockwise tightens the gib.
- 10) Repeat the above steps, until indicator motion is .0002" to .0003", then adjust the gib at the opposite side.

After both gib adjustments are complete, run the head to its extremes at the plus and minus end and then back to center again. Then, repeat the above gib adjustment procedure for verification.

#### **Head Gib/Strap Assembly**

When adjusting gibs with shim stock, use extreme care to prevent ripping the shim and leaving pieces of it between the gib and way surfaces.

There is one gib/strap assembly at the left and right side of the head. Each gib/strap assembly has a top and bottom gib that requires adjusting. Adjust the head gib/strap assembly as follows:

#### **Top Gibs**

- 1) Loosen all four gibs by turning the gib adjuster screws clockwise.
- 2) Insert a .001" shim, approximately 3" to 4" long, between the column and the Z-axis head. Do both the left and right sides.
- 3) Tighten the gib, to pinch the shim between the head and way, by turning the gib adjuster screw counter clockwise. Tighten the gib enough to prevent the shim from moving.
- 4) Slowly turn the gib adjuster screw clockwise while pulling on the shim.



#### **WARNING**

Shim stock is very sharp!

- 5) When the shim starts to pull out, stop turning the gib adjuster screw and remove the shim, completely.
- 6) Do the same for the other side.

- 7) Turn both gib adjuster screws one turn counter-clockwise after the shims have been removed from the left and right sides.

**Bottom Gibs**

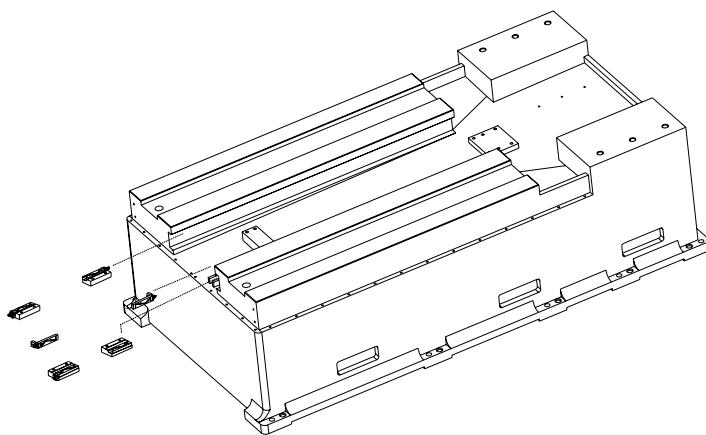
- 8) Insert a .001" shim about 3" to 4" long between the rear of the column way and the bottom gib. Do the same for left and right sides.
- 9) Tighten the gib to pinch the shim between the gib and way by turning to the gib adjuster screw counter clockwise. Tighten the gib enough to prevent the shim from moving.
- 10) Slowly turn the gib adjuster screw clockwise while pulling on the shim.

**WARNING**

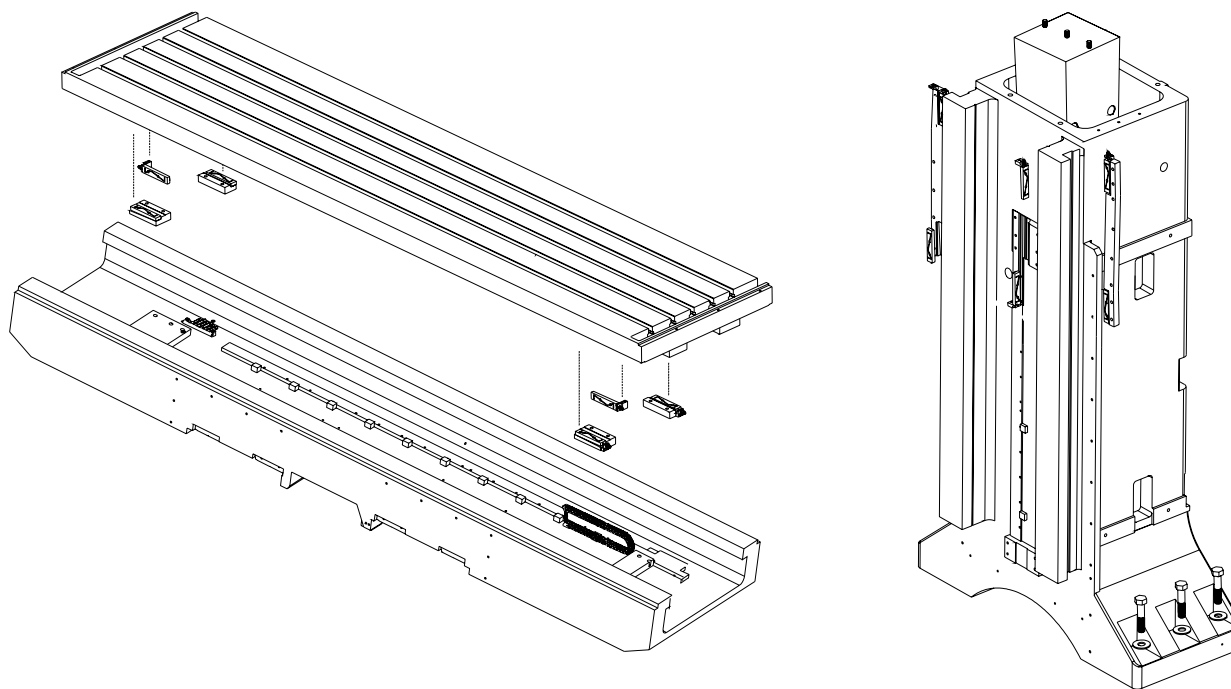
Shim stock is very sharp!

- 11) When the shim starts pulling out, stop turning the gib adjuster screw and remove the shim completely.
- 12) Do the same for the other side.
- 13) Turn both gib adjuster screws one turn counter clockwise after the shims have been removed from the left and right sides.

## 6535/4525/3020 Gib & Strap Adjustments



*Figure 6-10* Base: gib & strap location.



*Figure 6-11* Saddle & column: strap & gib location.

### Table Gibs

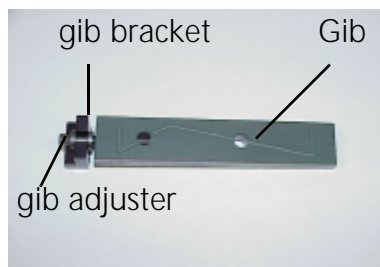
There are two (2) gibs at the front of the table and four (4) GIB/STRAP assemblies on the underside of the table. The following steps describe how to adjust the front table gibs. There is one at the left and one at the right.

- 1) With the table centered at the X axis cold start position:
  - a. Attach a magnetic base and indicator just below the gib to be adjusted, and set a zero reading.



*Figure 6-12* Set Zero Reading

- b. Place a pry bar between the X axis ballscrew mount and the table.
    - c. With the pry bar, move the table forward so the solid rear way of the table is up against the table.
    - d. Zero the indicator.
    - e. Now place the pry bar between the other side of the X axis ballscrew mount and the table.
    - f. Gently pry the table the opposite way.
    - g. The indicator reading is the adjustment that needs to be made. A properly adjusted set of gibs will have front to back motion of .0003 (+/- .0001).
    - h. If the gibs need adjusting, there is a gib adjuster screw located at the end of each gib. Turning this screw clockwise will loosen the gib and counter clockwise tighten the gib.



*Figure 6-13* Gib Adjustment

- i. Repeat the above steps until you get .0003 indicator motion, and then go to the other gib at the opposite end. **Note:** If the gibs are more than a .0010" out of adjustment, then adjust one side to about .0009" and

repeat on the opposite end. Repeat the steps to .0003". This is to avoid maladjustment due to binding.

After both gibs have been completely adjusted run the table to its extremes at the plus and minus end and then back to center again. Then repeat the above gib adjustment procedure for verification.

#### Table Gib/Strap Assembly



##### **WARNING**

Shim Stock is very sharp. Handle with care.

When adjusting gibs with shim shock be very careful not to cause the shim to rip and leave a piece between the gib and way surface. There are GIB/STRAP assemblies on the underside of the table at the front and rear. There will be two (2) GIB/STRAP assemblies at the front and rear. The front straps are wider than the rear straps. Adjust the table GIB/STRAP assembly as follows:

- 1) Loosen both the front and back gibs on the strap by turning the gib adjuster screw clockwise.
- 2) Insert a .001" shim about 3-4" between the gib and the way. Place shims in both the front and rear at the same.
- 3) Tighten the gib to pinch the shim between the gib and the way by turning the gib adjuster screw counter clockwise. Tighten the gib enough to prevent the shim from moving.
- 4) Slowly turn the gib adjuster screw clockwise while pulling on the shim.
- 5) When the shim begins to pull out, stop turning the gib adjustment screw and remove the shim completely.
- 6) Turn the gib adjuster screw 3/4 turn counterclockwise.
- 7) Repeat the above steps for the front, rear, left and right gibs.

#### Saddle Gibs



##### **WARNING**

Shim Stock is very sharp. Handle with care.

There are two (2) gibs on the inside of the right rail on the base and two (2) GIB/STRAP assemblies on the underside of the saddle on each side to the inside of the rails. The GIB/STRAP assemblies are wider on the right side to

allow space for the gibs. It will be necessary to remove the way covers to adjust the gibs.

- 1) With the saddle centered at the Y axis cold start position, attach a magnetic base and indicator to the saddle and place the indicator near the gib to be adjusted.
- 2) Place a pry bar between the saddle and the outside of the base rail.
- 3) With the pry bar, move the saddle so the solid way of the saddle contacts the inside of the left base rail.
- 4) Zero the indicator.
- 5) Now place the pry bar between the saddle and the outside of the base rail.
- 6) Gently pry the saddle the opposite way.
- 7) The indicator reading is the adjustment that needs to be made. A properly adjusted set of gibs will have a side to side motion of .0003".
- 8) If the gibs need adjusting, there is a adjuster screw located at the end of each gib. Turning this screw clockwise will loosen the gib and counter clockwise will tighten the gib.
- 9) Repeat the above steps until you get .0003" indicator motion, then adjust the other gib on the opposite side.

After both gibs have been completely adjusted run the saddle to its extremes at the plus and minus end and then back to center again. Then repeat the above gib adjustment procedure for verification.

When adjusting gibs with shim stock be very careful not to cause the shim to rip and leave a piece between the gib and way surface. There are GIB/STRAP assemblies on the underside of the saddle at the front and back of both sides. The right side straps are wider than the left side straps.

Adjust the saddle GIB/STRAP assembly as follows:

- 1) Loosen both the front and back gibs on the straps by turning the gib adjustment screw clockwise.
- 2) Insert a .001" shim about 3-4" between the gib and the way. Place shims in both the front and back at the same time.
- 3) Tighten the gib to pinch the shim between the gib and the way by turning the gib adjuster screw counter clockwise. Tighten the gib enough to prevent the shim from moving.

- 4) Slowly turn the gib adjuster screw clockwise while pulling on the shim.
- 5) When the shim begins to pull out, stop turning the gib adjuster screw and remove the shim completely.
- 6) Turn the gib adjuster screw  $\frac{3}{4}$  turn counterclockwise.
- 7) Repeat the above steps for the front, rear, left and right gibs.



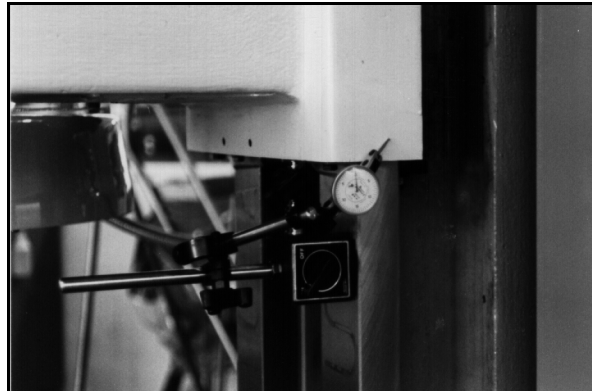
## Head Gibs

**WARNING**

Shim Stock is very sharp. Handle with care.

There are two (2) gibs that ride between column ways on the right side, one at the top and one at the bottom. There is also two (2) GIB/STRAP assemblies on the back of each column rail. The center gibs are adjusted in this section. Either gib can be adjusted first.

- 1) Remove the Z axis head cover.
- 2) Center the Z axis head within its travel limits so it will be easy to work on.
- 3) Attach a magnetic base and indicator to the column, as shown in Figure 6-13.



*Figure 6-14* Attach Magnetic Base and Indicator to Column

- 4) Using a pry bar between the left side of the head and Z-axis way, move the head so the inside of the left way contacts the left column way.
- 5) Zero the indicator.
- 6) Place the pry bar between the right side of the head and Z-axis way.
- 7) Gently pry the head the opposite way.
- 8) Make adjustments according to the indicator reading. A properly adjusted Z-axis head gib is .0002' to .0003" motion side to side.
- 9) If the gibs need adjusting, there is a gib adjuster screw located at the end of each gib. Turning this screw clockwise loosens the gib and counter clockwise tightens the gib.

- 10) Repeat the above steps, until indicator motion is .0002" to .0003", then adjust the gib at the opposite side.

After both gib adjustments are complete, run the head to its extremes at the plus and minus end and then back to center again. Then, repeat the above gib adjustment procedure for verification.

### Head Gib/Strap



#### **WARNING**

Shim Stock is very sharp. Handle with care.

When adjusting gibs with shim stock be very careful not to cause the shim to rip and leave a piece between the gib and way surface. There are two (2) GIB/STRAP assemblies top and bottom on both sides, left and right. The two (2) top and the two (2) bottom must be adjusted together.

### Top Gib/Strap

- 1) Loosen all four (4) gibs by turning the gib adjuster screws clockwise .
- 2) Insert a .001" shim about 3-4" long between the column and the Z axis head, be sure the shim is in the center of the way. Do the same for the left and right side.
- 3) Tighten the gib to pinch the shim between the head and way by turning the gib adjuster screw counterclockwise. Tighten enough to prevent the shim from moving.
- 4) Slowly turn the gib adjuster screw clockwise while pulling on the shim.
- 5) When the shim begins to pull out, stop turning the gib adjuster screw and remove the shim completely.
- 6) Do the same for the other side.
- 7) Turn both gib adjuster screws one (1) turn counterclockwise after the shims have been removed from the left and the right.

### Bottom Gib/Strap

- 8) Insert a .001" shim about 3-4" long between the rear of the column way and the bottom gib. Do the same for the left and right side.
- 9) Tighten the gib to pinch the shim between the gib and the way by turning the gib adjuster screw counterclockwise. Tighten enough to prevent the shim from moving.
- 10) Slowly turn the gib adjuster screw clockwise while pulling on the shim.

- 11) When the shim begins to pull out, stop turning the gib adjuster screw and remove the shim completely.
- 12) Do the same for the other side.
- 13) Turn both gib adjuster screws one (1) turn counterclockwise after the shims have been removed from the left and the right side.

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**SQUARENESS TEST:**  
(Measures  
Squareness from X  
to Y)

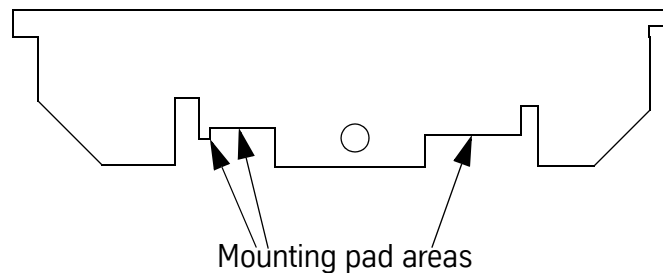
- 1) Level Machine.
- 2) Adjust TABLE, SADDLE and HEAD GIBS. Set for Turcite gibs: .0003" Non-Turcite gibs: .0005".
- 3) Adjust TABLE, SADDLE and HEAD STRAP GIBS.
- 4) The above items must be properly set or the SQUARENESS TEST may be invalid.
- 5) Using a granite plate, zero indicator at point A (front left position on plate) and make a 10.000 inch move in X axis from point A to point B (front right position on plate). Using MDI mode enter "X10.0 F50. G1."
- 6) Take a reading at point B. If not zero, adjust the granite plate for a zero reading.
- 7) Repeat steps 5 and 6 until both A and B positions read zero.
- 8) Zero indicator at point C (front of right side position on plate) and make a 10.000 inch move in Y axis from point C to point D (back of the right side of the plate). Using MDI enter "Y10.0 F50. G1."
- 9) Record reading at D. This is the squareness value, and it should be within .0006 inch.



*Figure 6-15* Granite Plate (top view)

**Installing VMC  
Linear Way Saddle**

- 1) Level machine ways.
- 2) Clean way mounting pads.
- 3) Position mounting pads for saddle.
- 4) Position grease line couplers upward.
- 5) Install safety stop to rail.
- 6) Stone saddle at mounting pad areas and clean.

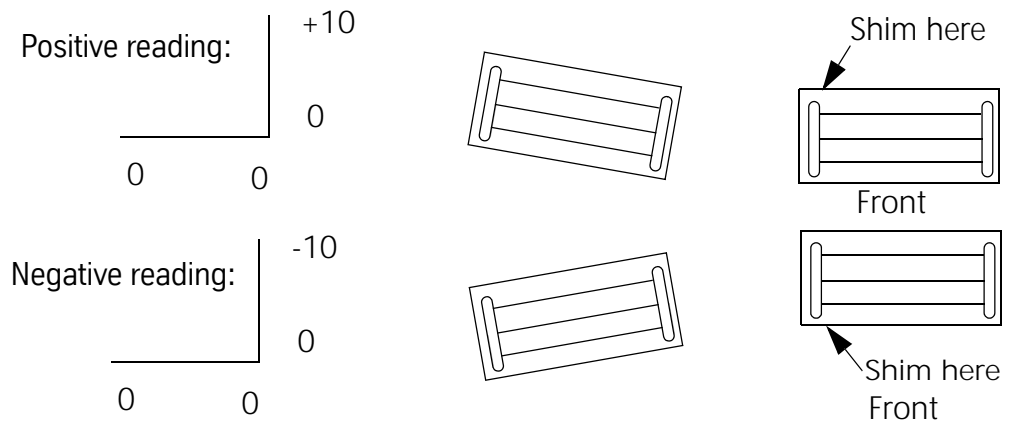


- 7) Install saddle assembly to mounting pads, slowly lower and check pad position and grease line couplers as installing.

**Note:** Check several times when lowering the saddle.

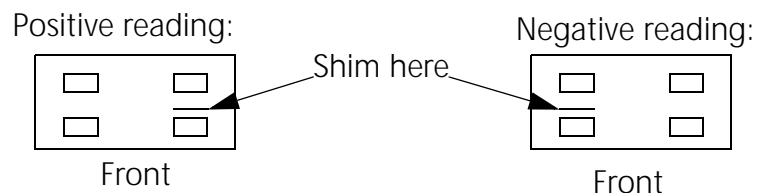
- 8) Install mounting pad bolts (5/16-18 X 1" long so-cap) and leave loose.
- 9) Tighten set screws, double check for tightness.
- 10) Tighten mounting pads.
- 11) Install Y axis ball screw assembly.
- 12) Install Y axis limit stop assembly.
- 13) Remove table teleflex covers.
- 14) Jog table to the left and Install Y axis grease lines.
- 15) Jog table to the right and Install Y axis grease lines.
- 16) Install table teleflex covers.

## Procedure for Correcting the Saddle Squareness



- 1) Shim size is error size. Example  $.0007 - .0012 = .001$  shim  
 $.0013 - .0017 = .0015$  shim
- 2) Loosen mounting bolts.
- 3) Loosen set screws.
- 4) Loosen Y axis ball screw at column.
- 5) Pry saddle away from mounting pad area (hard stop).
- 6) Install shim (between pad and hard stop) and pry saddle to mounting pad.
- 7) Tighten set screws, double check tightness.
- 8) Tighten mounting pad bolts.
- 9) Align Y axis ball screw and tighten.
- 10) Check plate reading.

## Procedure for Correcting the Table Squareness



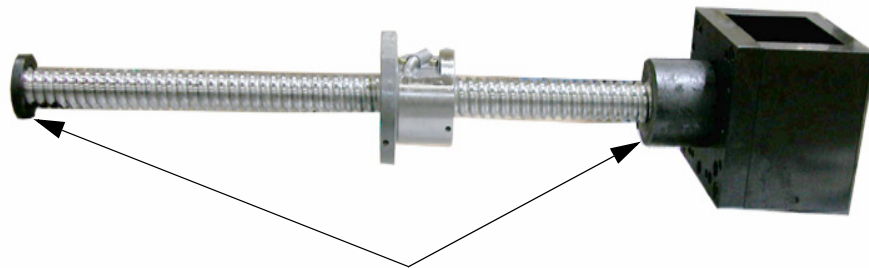
- 1) Shim size is error divided by 1.7.
- 2) Remove front and rear table covers.
- 3) Loosen mounting pad bolts to table.

- 4) Loosen set screws.
- 5) Loosen X axis ball screw nut at table block.
- 6) Pry table away from mounting pad area (hard stop).
- 7) Install shim (between pad and hard stop) and pry table to mounting pad.
- 8) Tighten set screws, double check tightness.
- 9) Tighten mounting pad bolts.
- 10) Align X axis ball screw nut and tighten.
- 11) Install front and rear table covers.
- 12) Check T-slot reading.

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## Axis Limit Stops

### TRM & EMC X, Y, Z Axis



EMC ballscrew limit stops

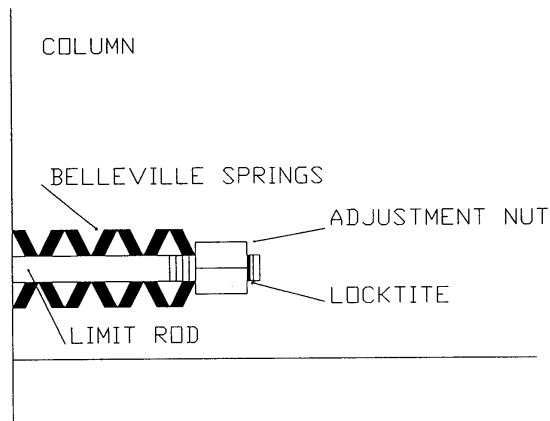
*Figure 6-16* EMC ballscrew with limit stops.

No adjustment is needed for the EMC or TRM ballscrew limit stops. Each is created to the exact dimension needed to prevent an axis from traveling beyond it's intended range.

### Mechanical Y Axis

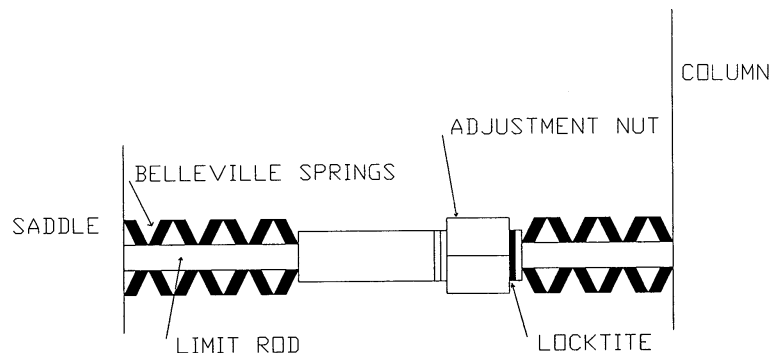
- 1) Position the saddle to its positive limit.

- 2) Go to the rear of the column and locate the limit bar.



**Figure 6-17** Locate Limit Bar at Rear of Column

- 3) Tighten the adjustment nut until there is no play between the Belleville springs, but loose enough so the springs will rotate.
- 4) After adjusting, use blue Locktite on the nut.
- 5) Position the saddle to its negative extreme.
- 6) Go to the front of the column and locate the limit bar.



**Figure 6-18** Locate Limit Bar at Front of Column

- 7) Tighten the adjustment nut until there is .25 gap between the Belleville springs and the column.
- 8) After adjusting, use blue Locktite on the nut.

## Backlash

For VMCs equipped with the PDI waylube pump, turn the power to the pump off and on. JOG the axis that is being inspected a few inches back and forth to ensure the ways of the machine are riding on a film of oil.

**Backlash Parameter Description**

Backlash parameter values allow the control to compensate for the physical limitations of the ball screw when changing tool direction. Values are entered in tenths (ten-thousandths of an inch). The control stores three values for the X-axis and the Y-axis (at center, at negative limit, at positive limit) and one value for each of the Z, A, and B axes (at center).

**Note:** Values are NOT stored for axes not installed on a given machine.

**Entering Backlash Values**

Backlash values are entered into the control using the BL command. The format of the command is:

BL, a, b, c, d

where a = axis number (X=1, Y=2, Z=3, A=4, B=5)

b = compensation (in tenths) at center

c = compensation (in tenths) at negative limit (X and Y axes only)

d = compensation (in tenths) at positive limit (X and Y axes only)

Typing BL <ENTER> (that is, without values) will display currently stored values.

**Determining Proper Backlash Values**

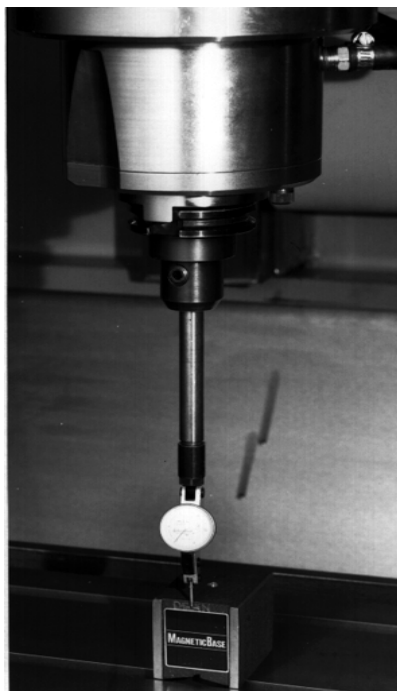
There are several methods for determining the correct value(s) of each axis. The programmatic method described here is the most reliable.

The following is an example of a programmatic method for determining the three backlash values for the X-axis. The same applies to Y-axis, just substitute Y for X. For Z-axis replace Z values with X and X values with Z. The value determined (i.e., center, negative limit, or positive limit) depends on the tool location on the axis (see STEP 3).

- 1) Enter the cold start command CS <ENTER>. After the cold start, DO NOT return to the last home position.



- 2) From the command mode, clear the current backlash values for the X axis by typing BL,1,0,0,0 and pressing the ENTER button.



*Figure 6-19* Establish a Zero Reading

- 3) Place a surface indicator in a tool holder and JOG the needle to Z-.1 and X.1 from the X-positive side of a block in the center of the table. The face of the indicator should be toward the right side (X-positive) side of the machine. From the command mode, type SETH and press the ENTER button.
- 4) Insert the following program into memory:

```
N1 G91 G1 X-.1 F (See note below)
N2 G4 P66000
N3 Z.25 G5
N4 X-.1
N5 X.1
N6 Z-.25
N7 G4 P66000
N8 X.1
N9 M2
```

**Note:** For part programs requiring close tolerances, setting the feed rate in line N1 to match the feed rate of the part program to be run will maximize the accuracy of the backlash values.

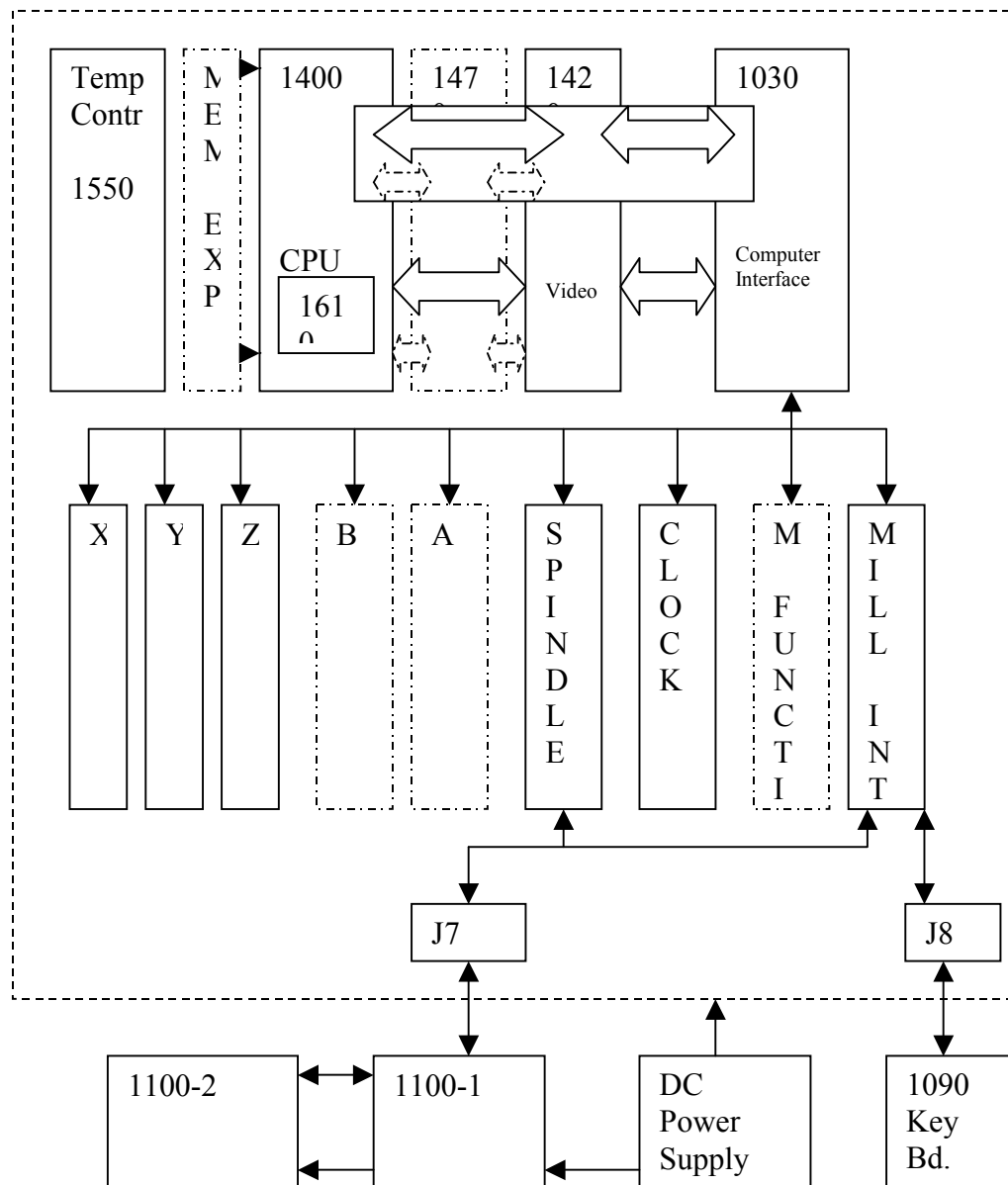
- 5) Run the program in the following manner:
  - a. At line N2 the control will be in the waiting state. Adjust the dial of the surface indicator to zero on the needle, then press the START button to continue.
  - b. At line N7 the control will be in the waiting state. Read the indicator dial to see how many tenths the needle is away from zero.
  - c. Press the START button followed by the MANUAL button.
  - d. Enter the number determined in step b as the backlash value (see ENTERING BACKLASH VALUES above).
  - e. Repeat steps a through c and verify that the indicator now reads zero after step c. If not, adjust the backlash value entered in step d. Continue this process until the indicator consistently reads zero after step c.
- 6) Repeat step 4, placing the block at the negative limit of the X axis. Repeat step 5 to determine the negative limit value.
- 7) Repeat step 4, placing the block at the positive limit of the X axis. Repeat step 5 to determine the negative limit value.

**Note:** When entering the value for the negative limit, you MUST enter at least a comma for the at-center value; when entering the value for the positive limit, you MUST enter at least a comma for both the at-center and the negative-limit values. For example, to set a value of 5 tenths (.0005) for the negative limit of the Y axis without affecting the current value for the center, type BL,2,,5, ENTER ; to set a value of 3 tenths (.0003) for the center and 2 tenths (.0002) for the positive limit on the X axis without affecting the current value for the negative limit, type BL,1,3,,2, ENTER.

- 8) The home position was set with the indicator tip close to an edge. Before continuing with other operations, the home position must be reset.
  - a. From the command mode, type SETCS and press the ENTER button.
  - b. Type HO and press the ENTER button, followed by the START button.
  - c. After the axes return to the cold start position, type SETH and press the ENTER button.

## Section 07: CNC Controls

### Fadal's Block Diagram



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**Electrostatic Discharge (ESD)**

An electrostatic field is an electrical field surrounding objects with an electrical charge. This is a static electrical field and will vary for many reasons such as material or Relative Humidity. Everyone has experienced static electricity when you receive a shock by touching something. This shock is the static electricity discharging through a current path. ESD can and will damage electrical components. The damage may not be immediately noticeable and it could be hours, days or weeks before the circuit fails. To avoid the damage to the components follow the precautions listed:

- Do not touch leads or pins.
- Store boards or components in electrical conductive containers.
- Never install or de-install PBCA or electrical components with the power applied.
- Discharge yourself by touching the cabinet prior to handling components.
- Observing these precautions helps to reduce the failure rate.

---

**Functional Description****Boards in Motherboard or Backplane**

The backplane or motherboard provides power and the interconnecting circuitry between the PCBs. The original backplane (1060-0) had 17 slots for PCBs and the current backplane (1060-1A) has 14 board slots. The reduction in slots was done for cost savings since with the newer PCBs the slots were no longer used. Also the new motherboard does not have TB1 and TB2 so if M-Functions are used a M-Function Interface board (1340-0) and cable (WIR-1679) are required. This difference is noted because the description will be done by slot location. The CPU PCB (1400) is the processing board and for this discussion will be referred to as 1400 with a dash number referring to different models of the board. The block diagram on the preceding page is for the 1400-5 model. However, it should be a good reference for all models.

**Slot 1 to 4**

The first two CPU PCBs (1400-1 & 1400-2) could be placed in any of the first five slots but is normally in slot 5. These first slots were used for memory expansion with a Optional Battery Backed Memory Board (1460-0 for 1400-1 & 1460-1 for 1400-2) which contained 128K of RAM. With the 1400-2 up to three of these Memory Boards could be installed. Each memory board needed to be configured with jumpers for the proper segment of memory. See the Board Jumper Configuration section for details. When Fadal started using a chiller on the coolant for the spindle and ballscrews a **Chiller Controller Board** (now in **Slot 3**) was added. The Chiller Controller Board (1550) uses the connection to the motherboard for DC voltage inputs but has no signals to the

other boards. The Chiller Controller monitors a ambient temperature and one or two coolant temperatures and activates the chiller(s) when temperature difference exceeds a couple of degrees.

**Slot 5** This is the **Central Processing Unit (CPU) Board** (1400) slot. All CPU boards come with 38K of battery backed memory. This memory is used to store the following:

- CNC Part Program
- Tool Data – both Length and Diameter
- Fixture Offset Data
- SETP parameters
- Backlash

The CPU board executes the part program by issuing commands to the other boards and monitors the inputs from the other boards and proceeds as required by program and external information.

The Fadal CPUs are as follows:

- **1400-1** – This was the first CPU, it is very rare, if you have problems with one please call Fadal for assistance.
- **1400-2** – Served many years as the CPU. Can be in any of the first 5 slots however try to keep them in slot 5. Has a **Program Module** (1610-0) plugged into it, this module provides the operating program for the CPU. For optional memory expansion, memory expansion boards (1460-1) were added in slots 1 to 4. Each board contained 128K. Up to three memory boards could be added for a total of 422K.
- **1400-3** – This CPU board was an interim CPU between the 1400-2 and the 1400-4. It has to be in slot 5 because of the bus board which connects the Computer Interface Board and the CPU. This CPU uses the Computer Interface for the video signal. This CPU uses the **Program Module** (1610-1) and the Expanded Memory Boards that plug into the CPU Board. (J4-J5) Up to 422K Expanded Memory total.
- **1400-4** – This CPU board was used for years. It has to be in slot 5 because of the processor bus board which connects the Computer Interface Board (1030), the Video Graphics Board (1420-4) and the CPU. This CPU uses the Video Graphics for the video signal and the graphics. This CPU uses the **Program Module** (1610-1) and the Expanded Memory Boards that plug into the CPU Board. (J4-J5) Up to 422K Expanded Memory total.
- **1400-5** - This CPU board is the current CPU. It has to be in slot 5 because of the processor bus board which connects the Computer Interface Board (1030), the Video Graphics Board (1420) and the CPU. This CPU uses the Video Graphics for the video signal and the graphics. This CPU uses the **Program Module** (1610-1) and the **Expanded Memory Boards** that plug into the CPU Board. (J4-J5) Up to 16MB Expanded Memory total.

**Expanded Memory Boards** that plug into the CPU Boards at J4 and J5 are as follows:

- 128K Expanded Memory Board (1460-21) PCB-0040
- 384K Expanded Memory Board (1460-22) PCB-0041
- 4MB Expanded Memory Board (1460-34) PCB-0042
- 8MB Expanded Memory Board (1460-38) PCB-0043
- 16MB Expanded Memory Board (1460-316) PCB-0044

**Slot 6** If either the Dual Arm Tool Changer (DATC) or the Advanced Feed Forward (AFF) option is installed in the machine then a **Option Sec. PCB (1470)** PCB-0191 will occupy this slot. This board requires a processor bus board connection.

**Slot 7** This spot has the **Video / Graphics Board (1420-6)** installed. It provides Video display storage, Video monitor control, Graphics Display and Video output (J2). This board is connected to the processor bus board. This slot had a **Video Board (1420)** for the 1400-1 and 1400-2 CPU boards.

**Slot 8** The **Computer Interface PCB (1030)** provides communication between the CPU and the controller and interface boards. The RS232 communications is also handled by this board. The functions performed by the 1030 are S100 Bus interface, Priority Interrupt and Device Selection. This board is connected to the processor bus board. During the 1400-3 CPU usage the Computer Interface board provided the Video Signal to the monitor.

**Note:** HS Processor Interface Board (1730-5 current) connects the 1400, 1470, 1420 and the 1030.

**Slot 9** The **X-Axis Controller Board (1010)** belongs in this slot. Please see Axis Controller Board information section below.

**Slot 10** The **Y-Axis Controller Board (1010)** belongs in this slot. Please see Axis Controller Board information section below.

**Slot 11** The **Z-Axis Controller Board (1010)** belongs in this slot. Please see Axis Controller Board information section below.

**Slot 12** The **B-Axis Controller Board (1010)** belongs in this slot. Please see Axis Controller Board information section below.

**Slot 13** The **A-Axis Controller Board (1010)** belongs in this slot. Please see Axis Controller Board information section below.

**Axis Controller Boards**

The axis controller boards receive input position, direction and speed commands from the CPU via Computer Interface then outputs commands to the axis amplifier. The amplifier moves the axis motor and the resolver / tach or encoder provides position and speed information back to the controller board. The axis controller then uses this information to adjust the outputs to the amplifier to maintain the commanded speed and position. It also reports back to the CPU with the results. The Axis Controller boards are the same for each axis except for the jumper configuration at J4 position on the board and the EPROMs change from linear travel (X, Y, & Z) to rotary travel (A & B). The J4 jumpers determine the axis travel for that board. **It is very important that the jumpers are set correctly.** Refer to the Board Jumper Configuration section for proper configuration.

The Axis Controller boards store and use the ballscrew compensation, amplifier gain and position offset information. The position offset information is used for cold start position, for DC machine this would be zero unless glass scale option and for AC machine either the encode or glass scale.

There have been several versions of the Axis Controller board:

- 1010-1 has one program EPROM and one Tab EPROM (ballscrew compensation)
- 1010-4 has two program EPROMs U7 & U10 and comp., gain & offset are stored in EEPROM
- 1010-5 has two program EPROMs U15 & U18 and comp., gain & offset are stored in EEPROM
- 1010-6 has two program EPROMs U15 & U18 and comp., gain & offset are stored in EEPROM

Each version of the Axis Controller board requires its own software. The -5 & -6 versions use the same software. For the current proper software version for any board refer to the **“Fadal Machining Centers Current Software”** listing. This listing is published periodically and can be obtained by request.

The connections for the axis controller boards are: J1 – Signal 2 output, J2 – Resolver signal input, J3 – not used, J5 – Encoder input and J6 – Optional scale input. Not all of these connections are used on each machine.

Special configurations:

**Servo Coolant** option – uses an axis controller board with special program EPROMs. If no rotary table is installed, this board can be installed in either slot 12 or 13. With an A-axis installed the servo coolant must be in slot 12. If an A & B axis are installed, a Servo Coolant option CANNOT be added.

**Tri-Tech Head** option – both Axis Controllers in slot 12 & 13 are

configured as A-axis and SETP parameter is set.

**Two pallets each with an A-axis** option - both Axis Controllers in slot 12 & 13 are configured as A-axis and special software is installed.

The feedback to the Axis Controller boards for a DC machine is as follows:  
The tach outputs a DC voltage to represent a speed in RPMs that is 7 VDC per 1000 RPM. A resolver is used to feedback the position. The resolver has two input signals generated by the Clock Board, they are called SIN and COS and are 10 VAC peak to peak (about 3.54 VAC on a meter). The resolver uses these two to generate a third signal, Resolver signal is 5 VAC peak to peak (about 1.77 VAC on a meter). Each Axis Controller board receives the resolver signal at J2 bullet connector. This voltage can be checked at this point the voltage must very close or there may be a problem with it. The controller compares the SIN and resolver signals to determine the position.

- J14** The **Resolver Test Board** (1060-0-1) PCB-0010 isolates the SIN and COS signals from the clock Board and distributes them to each axis. The result is that the machine can determine the axis at fault. If the motherboard has J14 and there is a DC axis then either a Resolver Test board or a Resolver Jumper board (1060-0-0) is required.

The feedback to the Axis Controller boards for a AC machine is as follows:  
An incremental encoder provides position information from the motor. It operates with light source through a focus lens through rotating glass disk with precision etched lines through a light mask to two photoelectric cells offset 90 degrees from each other. This creates 5 volt square waves A,/A,B,/B. A and /A are 180 degrees out of phase as well as B and /B are 180 degrees out of phase. A and B are 90 degrees out of phase, by counting the pulses the position can be determined and the direction is determined by is A or B the first signal. This information is sent to the controller board. The 3 phase input from the hall effect (U,V,W) returns the rotor position feedback for the amplifier to compensate the magnetic fields to optimize the motor operation. The motor has a temperature sensor to detect over temperature in the motor, information is returned in the hall effect cable. The amplifier sends a Absolute Current signal to J3 on the controller board. This signal is 1 volt for every 4 amperes output by the amplifier. The amplifier provides test points, they are: Signal – is a 1:2 output of the differential signal + & - input, Tach – a scaling output of 4 volts per 1000 RPM created by the amp from the encoder information, ABS – the current output to all 3 phases. Scaling is 1 volt per 4 amperes.

- Slot 14** The **Spindle Controller Board (1010)** is a 1010 controller board but is NOT interchangeable with the axis controller because different components are installed on the board. An exception is the 1010-6 which has jumpers for both axis and spindle controller configurations. The Spindle Controller board must



have spindle jumper configuration and the proper spindle software. The Spindle Controller sends the spindle forward and reverses signals to the 1100-2 board and the speed command directly to the spindle drive. Encoder information is fed back to the controller for rigid tapping, this provides spindle position to coordinate Z axis with spindle. A 1010-1 can not be used as a rigid tapping spindle controller.

**Slot 15** The **Clock Board (1020)** generates the system clock signals used for feedrate control and Sine / Cosine signals to the resolver to be used for position feedback. The feedrate override control pot signal is input at J1.

**Slot 16** The **M-Function Board (1050)** is used when more than the five standard M-Functions is required or when a return signal is required. Please refer to detailed section (Section 09 Attached Optional Devices – M-Function Board use and setup).

**Slot 17** The **Mill Interface Board (1040)** interfaces the control to the relays, switches, sensors and keyboard. It takes the CPU commands and activates the relays to perform the commanded task. Reads the sensors, switches and keyboard and sends the information to the CPU via Computer Interface Board.

#### **Boards Outside the Motherboard**

The **Power Distribution and Relay PCB 1100-1** has inputs of 120VAC, 5VDC and the control signals. The control signals used by the 1100-2 board are routed to another connector and go to the 1100-2 board. The control signals from the Mill Interface (1040) activate relays when required by pulling the control line low or about zero volts. This board has the Emergency Stop relays K1 & K2, high & low range, coolant pumps, Amplifier control, M-functions and power to the pendant.

The **Power Distribution and Relay PCB 1100-2** has inputs of 120VAC, 5VDC and the control signals. The control signals from the Mill Interface (1040) and Spindle Controller (1010) activate relays when required by pulling the control line low or about zero volts. This board has the spindle forward & reverse signals, ATC controls, Drawbar, Orientation and waylube.

The **Keyboard Interface Board 1090** receives inputs from the Keyboard, Manual Pulse Generator (MPG), Remote MPG (optional), optional stop, block skip, rapid travel, Resolution, axis selection, emergency stop, keylock, slide hold and start switches codes and sends the information to the Mill Interface (1040) board. Also takes the feedrate pot input and sends it to the clock board and the spindle pot input and sends it to the Spindle Controller board.

---

**DC Power Supply**

The Fadal VMCs require a DC Power Supply. The power supply requires an input voltage of 115VAC (105-125VAC @ 47-63Hz). This input is provided from the transformer and the Start / Brown-out circuit has a Solid State Relay (K1) on the power supply with the button mounted on the side of the cabinet by the main power quick disconnect box. The brown out will occur at around 70VAC for the Condor and around 50VAC for the Tri-Mag power supply. The Outputs are +5VDC (+5.05-5.5VDC), +12VDC (+11.9-12.6VDC) and -12VDC (-11.9-12.6VDC). Maximum ripple on all outputs is 1% Peak to Peak Volts.

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**Door Interlock  
Monitor Board 2000-  
1B (PCB-0196)**

<b>Terminals</b>	<p>The terminal connections for the 2000-1B are identical to the 2000-1A.</p> <p>The 2000-1B has two additional connectors (J3 and J4) that are for future use. These connections do not change the functioning of the board.</p>
<b>Inputs</b>	<p>There are three door interlock switches monitoring the left access panel, right access panel and front door respectively. Each switch has a normally open and a normally closed contact. Each switch and each contact are monitored separately. These inputs are J1 pins 1-12.</p> <p>The 120 VAC Emergency Stop circuit from 1100-1 TB1-10 goes to J2 pin 5.</p>
<b>Outputs</b>	<p>The logic level outputs are external slide hold (J1 pin 16), and additional external slide hold and "OK" signals (J3 and J4).</p> <p>A 120 VAC output to control the spindle contactor is at J2 pins 3 and 2.</p>
<b>Power</b>	<p>The board requires +5V and COM (J1 pins 15 and 17). If these inputs are reversed, diode D12 will short out the board, preventing damage. The 120 VAC is also required for operation (J2 pins 1 and 6).</p>
<b>Operation</b>	<p>The 2000-1B monitors the interlocks for the three doors. If any door is open, an External Slide Hold is sent to the CNC control. If one circuit of the switch indicates door closed but the other indicates door open, a door open condition will be assumed by the board. The External Slide Hold is sent immediately when a door is opened. In addition, after a 5-10 second delay which allows time for a controlled stop, the spindle contactor will be de-energized, LEDs which removes power to the spindle drive; the delay is adjustable within the range of 5 seconds minimum to 10 seconds maximum by the Delay Adjust</p>

potentiometer (R48). An Emergency stop will also de-energize the spindle contactor after the delay.

J3 and J4 are for future use. J3 pin 1 is identical to J1 pin 16 (active low output to generate External Slidehold). J3 pin 2 is an active high External Slidehold. J4 are Doors Closed signals which will change with the Doors Closed LED (D10). J4 pin 1 is active high (sourcing) and J4 pin 2 is active low (sinking).

### Indicators (LEDs)

The LEDs on the 2000-1B are slightly different than the 2000-1A:

- There is only one green LED (D10) for the doors. It will be on only if all doors are closed and all circuitry is indicating doors closed.
- There is a separate red LED for each door circuit (one for the normally open of each door and one for the normally closed of each door). The red LED will be on if that circuit is indicating a door open condition.
- There is a yellow LED for each door. This indicates a fault condition in a door circuit (i.e. one circuit indicating door open but the other indicating door closed). This LED will flash whenever the door is opened or closed because the two circuits do not change state at the exact same instant. The flash is normal.
- There are two red LEDs for the External Slidehold outputs. D16 indicates the status of J1 pin 16 and J3 pin 1. D17 indicates the status of J3 pin 2. The LEDs light when the output is active. J1 pin 16 and J3 pin 1 are active low. J3 pin 2 is active high. J3 is for future use.
- A green LED has been added for the status of the spindle solid state relay. It will light when the output for the spindle contactor is on. In other words, it will light when all the doors are open and will go out 5-10 seconds after a door is opened.

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### Emergency Stop Circuit Overview

#### Basic Hardware Operation Description: Normal Operation (No Fault)

The Emergency Stop (E-stop) circuit is designed to stop the moving functions of the machine when a fault is detected.

When the CPU (1400) issues an enable E-stop command to the Mill Interface (1040), the Mill Interface pulls Panic line (pin 15) down (to ground or about zero volts) which activates K20 on the Power Distribution (1100-1). With K20 contacts closed, 120 VAC is allowed to flow through fuse F14 out 1100-1 TB2-26 to the overload relay switch contacts (number of relay(s) vary for different models and configurations) and the E-stop switch (normally closed) then returns to 1100-1 TB1-10. From this point a wire is contacted to 1100-2 TB1-25 and on the 1100-1 to the coils of K1 and K2, activating K1 and K2.

K1 and K2 normally closed contacts open. One side of these contacts is connected to ground. The other side to the fault lines (1100-1 TB1-2, TB1-3, TB1-4, TB1-5, TB1-6, TB1-7), by opening the contacts the 10VDC (8 to 12 VDC) fault lines will allow the Axis Amplifiers or Spindle Drive and Controller PCBA to operate. K2 normally open contacts are connected to 120 VAC through fuse F17 and outputs (1100-1 TB1-8) to the control input on the Amplifier Chassis. This control input activates the solid-state relays on the Amp. Chassis closing the contacts and allowing power to the bridge rectifiers to power up the Amplifiers.

The connection to the 1100-2 (TB1-25) has three paths on the board. The first connects to the coil of K33 and activates the relay closing the contacts and allowing the 120 VAC input power to the Turret Motor. The second supplies 120 VAC to Spindle Forward, Spindle Reverse and Orientation circuits. The third connects through the normally closed contacts of K3 and provides power to the Drawbar and Slide Motor Reverse circuits. This third path also provides a safety function by removing power for the Drawbar and Slide Motor Reverse circuits when the Spindle Forward (K3) is activated.

This is the normal operation of the E-stop circuit providing power to all the circuits involved and allowing the fault lines to stay up (10VDC).

**Fault Condition** When there is a fault, the E-stop circuit shuts down the machine. It accomplishes this by removing the power to each device. First, the power to K1 and K2 is removed connecting all the fault lines to ground. This informs the Amplifiers and the Controller Boards that they are in E-stop. It also removes the control voltage to the Amplifier Chassis, which removes the power to the Amplifiers. The 120 VAC to the 1100-2 is removed and this causes K33 to open its contacts and stop the Turret Motor. Power is removed from Spindle Forward, Spindle Reverse, Orientation, Drawbar and Slide motor Reverse circuits.

Functional Block and Wiring Diagrams are at the end of this section.

**Basic Software Operational Description** There are many possible combinations of software functions. The computer board CPU(1400) communicates with the Computer Interface (1030), which communicates with the other boards, Axis Controllers (1010), Spindle controller (1010) and the Mill Interface (1040), or vice versa.

If the CPU initiates an E-stop condition then it disengages the panic line.

The Axis Controllers declares an E-stop to the CPU upon detecting the Fault line down (if cold started) or if the controller detects a problem in operation of the axis, such as the following error being too large.

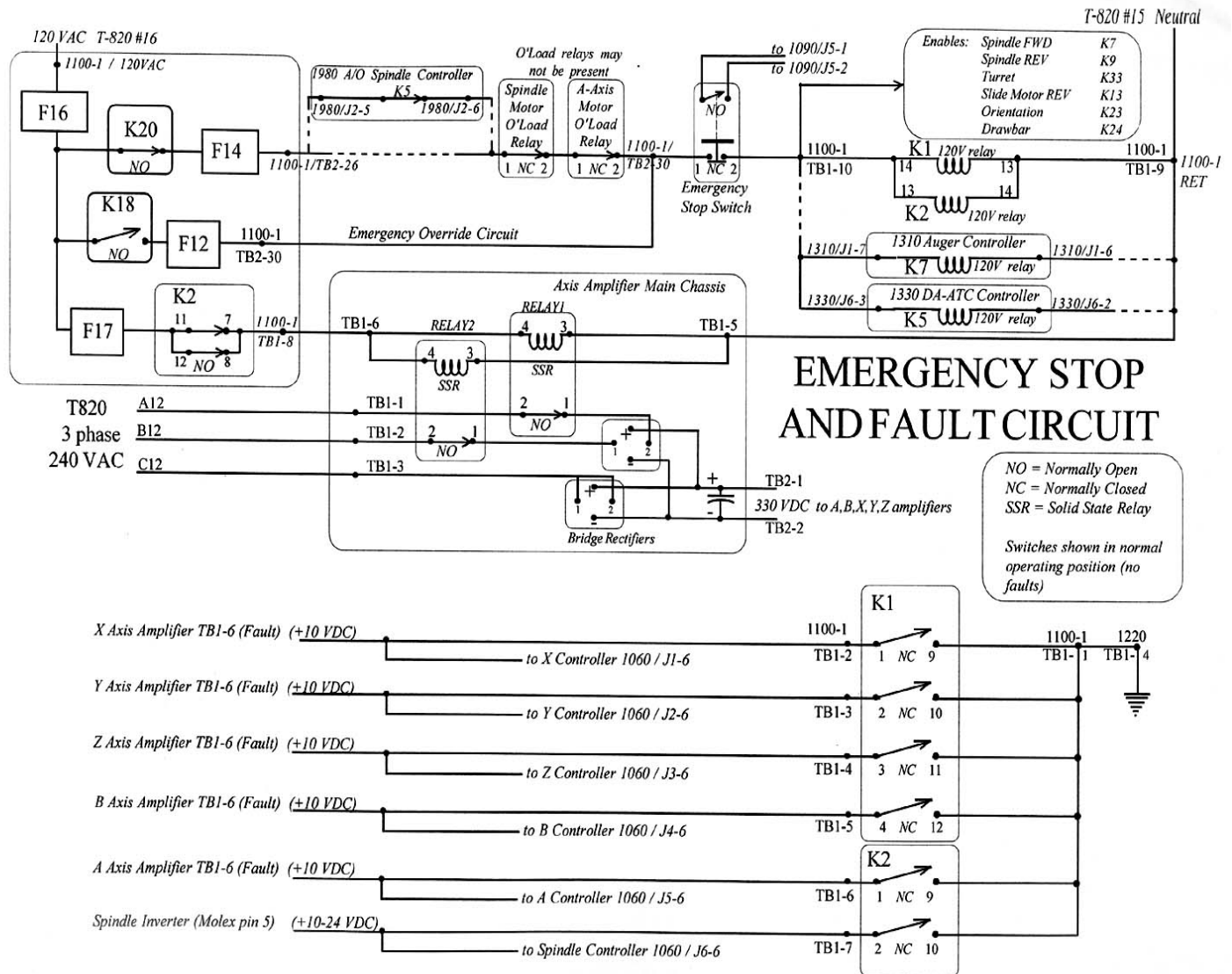
If the operator hits the E-stop switch then the switch opens the 120VAC line to the 1100-1 TB1-10 to initial the hardware E-stop and reports to the CPU though the Keyboard Interface (1090) to the Mill Interface to the Computer Interface to the CPU.

**Troubleshooting Tips**

Some possibilities for error and troubleshooting tips:

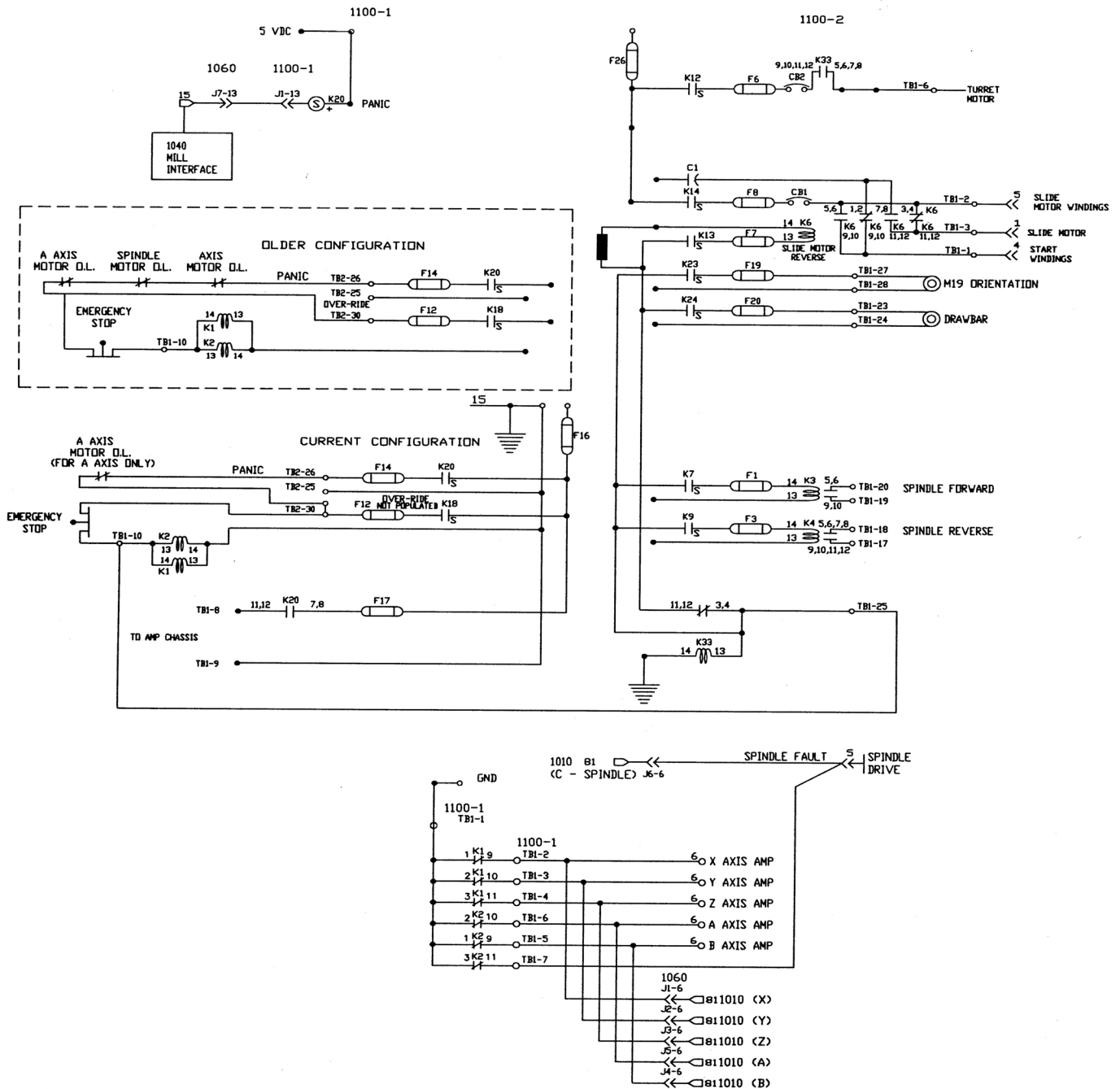
- The machine does not use K18.
- Some of the new machines do not have Overload Relays.
- For troubleshooting purposes, place a jumper between F16 and F12 this bypasses the automatic part of the circuit. Use caution when the machine is jumpered because it cannot stop itself. An AC machine must be powered up with the E-stop button pushed in, because the axis will run away if control is not up first.

# Emergency Stop and Fault Circuit



## Emergency Stop Circuitry

### EMERGENCY STOP CIRCUITRY

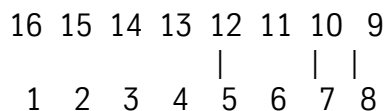


### Fadal Axis Board Jumper

Axis Board 1010-6 at the J4 is an access connection jumper. Jumper the required axis as shown on the silk screen.

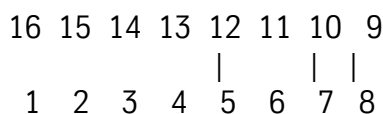
Axis Boards 1010-1, 1010-4 and 1010-5 at the J4 Jumper Block are as follows:

Slot 9- X Axis Controller (5 to 12, 7 to 10, 8 to 9)

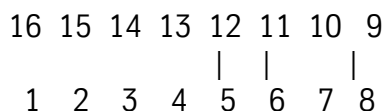


Slot 9- X Axis Controller 4020 w/ Pallet, 3020, 4525 (7 to 10, 8 to 9)

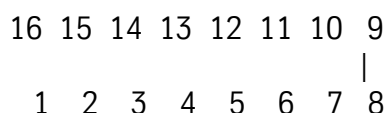
Slot 9- X Axis Controller



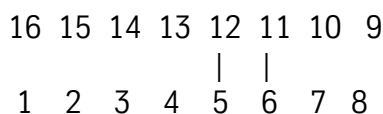
Slot 10- Y Axis Controller (5 to 12, 6 to 11, 8 to 9)



Slot 11- Z Axis Controller (8 to 9)



Slot 14- Spindle - C Axis Controller (5 to 12, 6 to 11)



**Note:** Jumper 5 to 12 is for direction. This jumper may or may not be installed due to other wire connections. The following are marked as the standard



but may be incorrect for the wiring connections in a given machine or rotary table.

Slot 13 –A Axis Controller – VH65, TR65, SMW 175, SMW 275 (5 to 12, 7 to 10)

Tri Tech Head both controller boards

16 15 14 13 12 11 10 9

1 2 3 4 5 6 7 8

Slot 13 – A Axis Controller – VH5C, VH65 Left Hand, Tsudakoma A, Technara, V 300, V 400, SMW 225 (7 to 10)

**Note:** AC motor tables also need the red and black wires reversed from normal for this configuration.

16 15 14 13 12 11 10 9

1 2 3 4 5 6 7 8

Slot 13 – A Axis Controller – Tsudakoma A & B (6 to 11, 7 to 10)

16 15 14 13 12 11 10 9

1 2 3 4 5 6 7 8

Slot 12 – B Axis Controller – TR65 (5 to 12, 6 to 11, 7 to 10)

16 15 14 13 12 11 10 9

1 2 3 4 5 6 7 8

Slot 12 – B Axis Controller – Tsudakoma (5 to 12, 7 to 10)

16 15 14 13 12 11 10 9

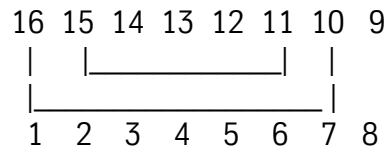
1 2 3 4 5 6 7 8

#### Axis Controller 1010-6

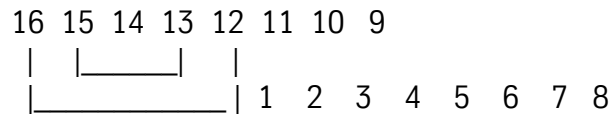
For axes X, Y, Z, A & B place jumper on proper position on J4 and jumpers at J16 & J19. For Spindle place jumper on proper position on J4 and install jumpers at J17 & J18. Install J4 REV-Dir, as required.

## 1460-1 Memory Expansion Boards

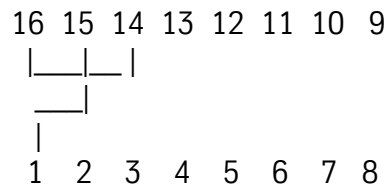
Expanded Memory Board – Slot 1-4 First 128K (10 to 16, 11 to 15)



Expanded Memory Board – Slot 1-4 Second 128K (12 to 16, 13 to 15)



Expanded Memory Board – Slot 1-4 Third 128K (1 to 15, 14 to 16)



## Master Feedrate

The master feedrate clock is adjusted by potentiometer R6 on the clock Rate Clockcard (1020), slot #15. This is the second potentiometer from the bottom as the card is in the machine (it can also be found just above the feed rate potentiometer connector). The adjustment procedure is as follows:

- 1) Enter the command PR <ENTER>
- 2) Press #3 (START NEW PROGRAM) <ENTER>
- 3) Enter NEW PROGRAM NUMBER <ENTER>
- 4) Press #6 (EXIT)
- 5) From the prompt ENTER NEXT COMMAND type in IN <ENTER>

Enter the following program:

```

N1 G91
N2 X-20. F100. G1 G8 M49
N3 X20.          (continued)
  
```

N4 X-20.  
N5 X20.  
N6 X-20.  
N7 X20.  
N8 M2\_ \_

- 6) From the prompt ENTER NEXT COMMAND: Type in SETCS then home the machine with the H0 command.
- 7) Position the X axis at +10 inches if travel is less than 40 inches on X. Enter the SETX command.
- 8) Push the AUTO key to begin program execution.
- 9) When the program is complete, the time will be shown in the top right-hand corner of the video display. The move should take 72 seconds +1.5/-0.
- 10) If not, adjust potentiometer R6 until the move takes 72 seconds +1.5/ -0 to complete.

---

#### **Feedrate Potentiometer (Pot) Adjustment**

- 1) After cold starting the machine go to Manual Data (MD) mode.
- 2) Enter "X-10. G0" <ENTER> <START>
- 3) Enter "X20. G1 F100. M49" <ENTER>
- 4) Observe the following error number while axis is moving.
- 5) Enter "X-20." <ENTER>
- 6) Observe the following error number while axis is moving. This number should be the same as in the positive direction. If not, the Amplifier Loop Gain adjustment needs to be performed first.
- 7) Set the feedrate pot on 100%.
- 8) Enter "X20. G1 F100. M48" <ENTER>
- 9) Observe the following error number while axis is moving. If the following error is the same as before then it is set correctly. If it is not, turn pot until the following error is the same and loose and adjust the knob to 100%.
- 10) Enter "G28" <ENTER>
- 11) Turn feedrate pot to 0%.

- 12) Enter "X-2.0 G1 F100. M48" <ENTER>
- 13) If the X axis does not move then it is set correctly. If the X axis moves, adjust R19, the third pot up from the bottom on the Clock board for no movement.
- 14) <SLIDE HOLD>
- 15) <MANUAL>

---

### Zero Out Memory Procedure

A Zero Out Memory chart follows this procedure.

- 1) Send machine to COLD START.
  - Type SETCS < ENTER >
  - Type HO <ENTER>
  - Press START.
- 2) Display and record the BACKLASH settings.
- 3) Type BL <ENTER>. Record the displayed values.
- 4) Display and record the PARAMETER settings. **NOTE:** Some parameters appear ONLY in Format 1 or in Format 2, but NOT IN BOTH FORMATS.
  - Type SETP <ENTER>. Record the displayed values.
  - Type P <ENTER> to display the second page of settings. Record the displayed values.
  - Type P <ENTER> to display the third page of settings. Record the displayed values.
- 5) After all BACKLASH and PARAMETER settings have been recorded, zero memory:
  - Press <MANUAL> to get to ENTER NEXT COMMAND.
  - Type DI < ENTER >.
  - Type G0 3000 <ENTER> to display the Diagnostics Menu.
  - Press spacebar to get to Page 2 of the Diagnostic Menu, and select option 5 -- ZERO MEMORY.
  - Answer "Y" (type Y) to both questions the control asks. Memory is reset.

**NOTE:** If you are replacing a module(s), now is the time to power down the machine, replace the modules, and power up. Then proceed directly to STEP 6 below.

- Select option 2-START CNC. This will take the control back to ENTER NEXT COMMAND.

6) Restore PARAMETER values as needed:

**NOTE:** The control will ask for BACKLASH values, but the PARAMETER values must be checked first.

- Type SETP <ENTER> to check and, if needed, reenter PARAMETER settings -page 1.
- Type P <ENTER> to check and, if needed, re-enter PARAMETER settings -page 2.
- Type P <ENTER> to check and, if needed, re-enter PARAMETER settings -page 3.

7) Restore BACKLASH values:

- Power off the machine, wait 15 seconds, power on the machine, then COLD START.
- Enter the BACKLASH values previously recorded as follows:

for X axis	BL,1,value1, value2, value3 <ENTER>
for Y axis	BL,2,value 1, value2, value3 <ENTER>
for Z axis	BL,3,value <ENTER>
for A axis	BL,4,value <ENTER>
for B axis	BL,5,vafue <ENTER>

8) Load the programs and offsets back into the machine. The procedure is now complete.

## Zero-out Memory

LAST HOME POSITION X \_\_\_\_\_ Y \_\_\_\_\_ Z \_\_\_\_\_

X-AXIS BACKLASH \_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_

Y-AXIS BACKLASH \_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_

Z-AXIS BACKLASH \_\_\_\_\_

A-AXIS BACKLASH \_\_\_\_\_

B-AXIS BACKLASH \_\_\_\_\_

**BACKLASH settings****PARAMETER settings – Page 1**

FORMAT: \_\_\_\_\_

BAUD RATE: \_\_\_\_\_

SPINDLE AFTER M6: \_\_\_\_\_

AXES: \_\_\_\_\_

TRAVEL: \_\_\_\_\_

PENDANT: \_\_\_\_\_

DEFAULT: \_\_\_\_\_

A-AXIS RATIO: \_\_\_\_\_

M60/A-AXIS BRAKE: \_\_\_\_\_

DEFAULT: \_\_\_\_\_

B-AXIS RATIO: \_\_\_\_\_

M60/B-AXIS BRAKE: \_\_\_\_\_

DEFAULT: \_\_\_\_\_

TOOL CHANGER CAP: \_\_\_\_\_

IMM FIXED CYCLE: \_\_\_\_\_

RPM FACTOR: \_\_\_\_\_

SPINDLE TYPE: \_\_\_\_\_

ORIENTATION FACTOR: \_\_\_\_\_

**PARAMETER settings – Page 2**

DEFAULT: \_\_\_\_\_

M8: \_\_\_\_\_ M7: \_\_\_\_\_

3 PHASE &gt; 5% LOW: \_\_\_\_\_

PU FORMAT: \_\_\_\_\_

N-WORDS ORDERED: \_\_\_\_\_

TOOL TABLE: \_\_\_\_\_

CRC MODE: \_\_\_\_\_

BINARY BUFFERS: \_\_\_\_\_

HIGH TORQUE: \_\_\_\_\_

SPINDLE OFF: \_\_\_\_\_

TURRET FACTOR: \_\_\_\_\_

CMD MENU: \_\_\_\_\_

PALLET: \_\_\_\_\_

GAIN: \_\_\_\_\_

RAMP: \_\_\_\_\_

ASPECT: \_\_\_\_\_

TIMERS: \_\_\_\_\_

OVERLOAD: \_\_\_\_\_

**PARAMETER settings – Page 3**

SCREW: \_\_\_\_\_

IPM: \_\_\_\_\_

XYZ RAMP: \_\_\_\_\_

Z TAP GAIN: \_\_\_\_\_

VECTOR: \_\_\_\_\_

AXIS DISPLAY: \_\_\_\_\_

AUTO BRAKE: \_\_\_\_\_

A-PALLET: \_\_\_\_\_

B-PALLET: \_\_\_\_\_

5-AXIS HEAD: \_\_\_\_\_

G0 DETAIL: \_\_\_\_\_

FEEDBACK: \_\_\_\_\_

PCBA Compatibility  
Chart

PCBA Number	Description	1	2	3	4	5	Notes
1400-1	CPU	X					
1400-2	CPU		X				
1400-3	CPU			X			
1400-4	CPU				X		
1400-5	CPU					X	
1460-1	128K RAM Expansion	X	X				
1460-21	128K RAM Expansion			X	X	X	
1460-22	384K RAM Expansion			X	X	X	
1460-34	4MB RAM Expansion					X	
1460-38	8MB RAM Expansion					X	
1460-316	16MB RAM Expansion					X	
1420	Video	X	X				
1420-4	Video Graphics				X	X	
1420-5	Video Graphics 32 MP				X	X	
1420-6	Video Graphics VGA					X	
1030	S100/ Interface	X	X				
1030-1B	S100/ Video			X			
1030-1C	Computer Interface				X	X	
1010-1	Axis Controller	X	X				
1010-4	Axis Controller		X	X	X	X	
1010-5	Axis Controller				X	X	
1010-6	Axis/Spindle Controller				X	X	
1010-1S	Spindle Controller	X	X	X	X	X	No Rigid Tap
1010-4S	Spindle Controller		X	X	X	X	No Rigid Tap
1010-5S	Spindle Controller			X	X	X	
1020-0D	Clock				X	X	
1020-0F	Clock	X	X	X	X	X	
1050-0	M-Function (up to 20)	X	X	X	X	X	
1050-3A	M-Function (2 function)	X	X	X	X	X	
1040	Mill interface	X	X	X	X	X	
1040-2	Mill Interface	X	X	X	X	X	Pallet Changer
1090	Keyboard Interface	X	X	X	X		
1090-3A	Keyboard Interface		X	X	X	X	CNC HS88
1090-4B	Keyboard Interface			X	X	X	32 MP Only
1100-1	Power Distribution	X	X	X	X	X	
1100-2	Power Distribution	X	X	X	X	X	

1100-3	Power Distribution			X	X	X	Pallet Changer
1170	Power Surge	X	X	X	X	X	240 VAC input
1170-1	Power Surge	X	X	X	X	X	480 VAC input
1550-0B	Temp. Controller		X	X	X	X	
1550-2	Dual Temp Controller		X	X	X	X	
1610-0	Program Module		X				
1610-1	Program Module			X	X	X	
1750-0	Modem		X	X	X	X	
1730-0	Buss Board			X			
1730-4	Buss Board			X	X	X	
1730-5	Buss Board			X	X	X	Required 1470
1470	Option Sec.					X	
1310-0	Auger Board					X	
1330	DATC Controller Board					X	



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## Section 08: Spindle Drive Systems

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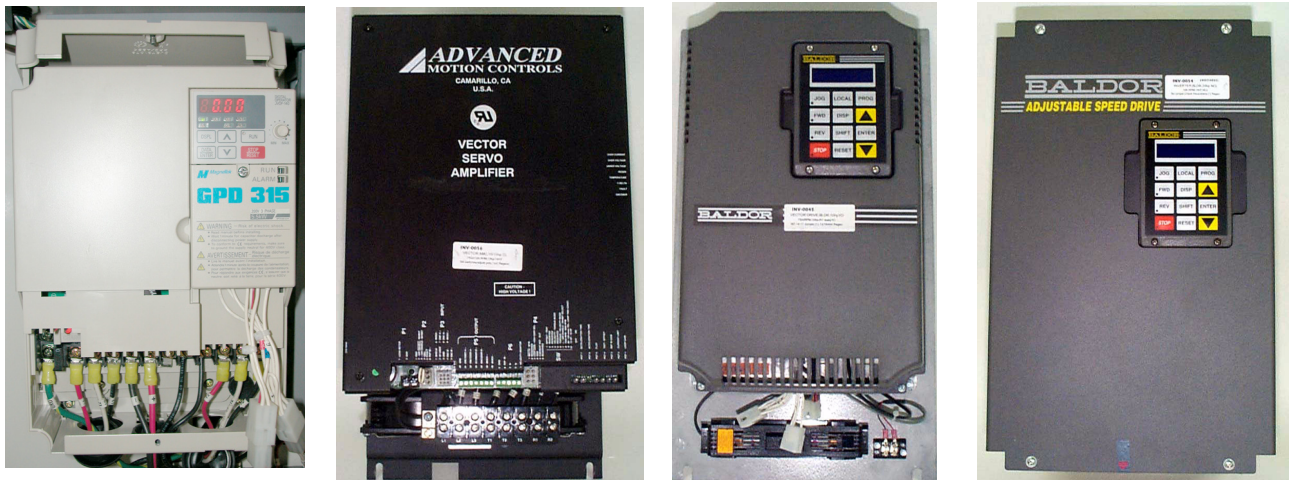
### Spindle Drives

Fadal has used many spindle drives when manufacturing VMCs. The drives in the beginning were inverters and are currently Vector Drives. The difference between inverters and vector drives is the monitoring of the output and the adjustments made due to that information. Inverters (Lovejoy, Toshiba, Sweo) take the input commands for speed and direction then product an output to the motor. The inverter assumes that the motor is running correctly. The vector drive (Baldor, AMS) monitors the motor speed and direction as well as the output current. It takes this information and makes corrections to the output to keep the motor operation proper. Rigid tapping requires the vector drive. The Mitsubishi drive that was used is in the middle. It monitored the motor and made corrections but was not completely a vector drive and would not rigid tap.

---

### Inverter/Vector Drives

EMC model VMCs use the Yaskawa drives. The TRM does not use Inverter/Vector drives, all other Fadal VMCs use one of two drive designs from Baldor or AMC. The basic operation of each drive is the same.



*Figure 8-1* Yaskawa, AMC, Baldor Small, Baldor Large (From Left to Right)

**Inverter/Vector Drive  
Inputs & Outputs****Drive Ground**

The drive is required to have a ground connection. A green and yellow 16 AWG (10 AWG for 50 taper) wire grounds the drive to the machine chassis.

**Input Three Phase Power**

The three phase 230 VAC (460 VAC for 50 taper) input connects to terminals L1, L2 and L3 (R, S and T). This voltage should be between 220 and 240 volts (460 and 480 for 50 taper). When the voltage is too high, braking problems or damage to the drive may occur. When the voltage is too low, faults may occur while accelerating or cutting under load. The voltage leg to leg, in all three combinations, must be checked when installing new machines or changing the power source for the machine. If the voltage to the machine must be adjusted, it is better to be close to the lower end of the voltage range.

**Output Three Phase Power**

The drive outputs a three phase signal for the spindle motor. This signal varies in frequency and voltage depending on the motor's speed. The output voltage is checked leg to leg. The output voltage should be about 80 VAC (60 VAC for 50 taper) at 300 RPM 20 Hz and all three legs should be about equal (No more than a 2 volt variation). The output voltage should be about 200 VAC at 900 RPM 60 Hz and should remain the same through 2500 RPM in the low range.

If a problem is detected (Output fault), check the spindle motor leads with an Ohm meter by disconnecting the output leads at T1, T2 and T3. Check the leads going to the motor side leg to leg. Resistance readings between the three combinations of legs should each read between .05 to .8 ohms, and should read close to the same for each combination. The leg to ground resistance should be open when measured with an ohm meter and 80 meg ohms minimum when using a meg ohm meter for all three legs.

**Drive Control 6 Pin Molex Connector**

The drive control 6 pin molex connector has the inputs from the spindle controller card and the fault line from the inverter. Pin 1 is the common line for the spindle direction, pin 2 is the spindle reverse signal, pin 3 is the spindle forward signal, pin 4 is the common for speed control, pin 5 is the fault line and pin 6 is spindle speed command signal.

For standard spindle operation the voltage output (20 volts DC) for the drive spindle direction (pin 2 reverse and pin 3 forward) is determined by the pulling of the appropriate signal to ground by activating K3 or K4 on the 1100-2 board. When this voltage is pulled to about ground level the drive knows which direction to run in and is enabled.

The drive also requires a speed command signal (0 - 10 volts DC through pin 6). This signal, along with the direction signal, allows the spindle to be

operated. On a standard machine a 1.3 volt DC signal will result in a speed of about 300 RPM in low range.

On machines with rigid tapping both the K3 and K4 relays are active, enabling drive, and a speed command of either positive or negative voltage (-10 to +10 VDC) is used to determine spindle speed and direction.

The fault line receives a voltage from the drive (10 VDC). An E-stop fault in another device will drop this voltage to zero by deactivating K2 on 1100-1 board.

#### **Inverter Wye Delta 6 Pin Molex Connector**

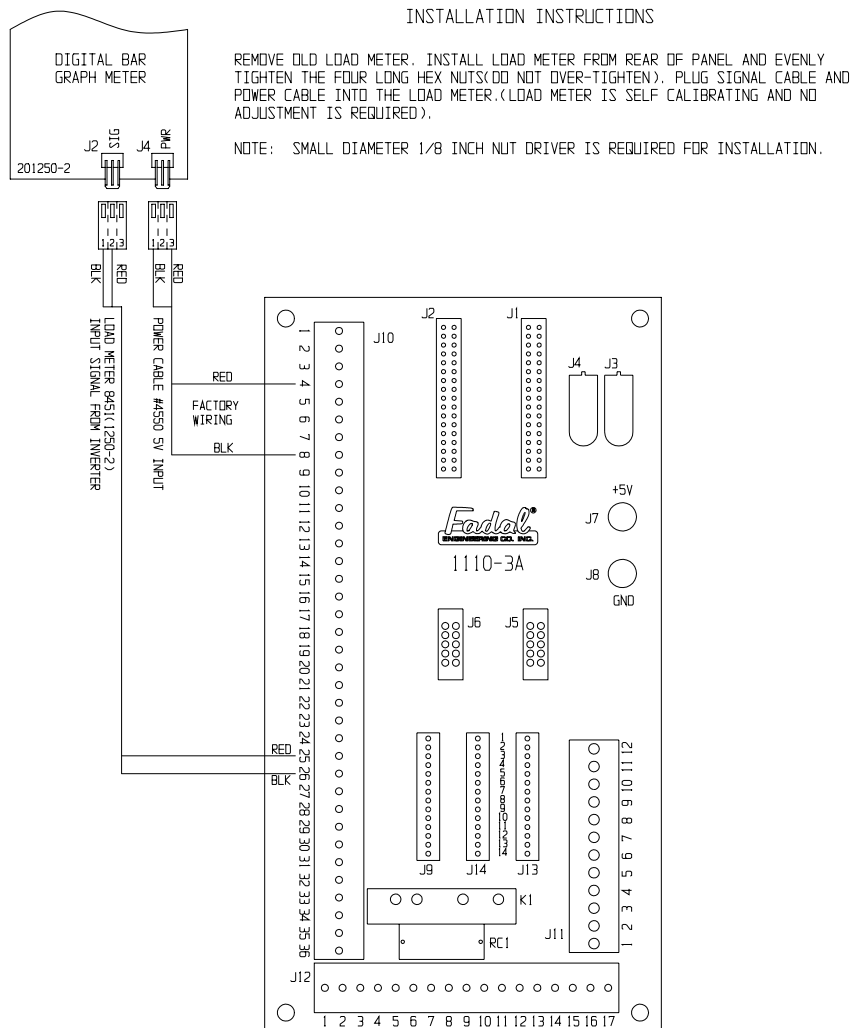
Machines that use the Wye Delta motor configuration send input to the drive through pin 1 and pin 4 when in the delta mode.

The High gain option sends signals through pin 3.

#### **Load Meter Output**

The drive produces an output voltage for load meter indication. This voltage output is proportional to the total current that the drive is using, and is displayed by the load meter as a percentage of the total current that the drive can develop or use.

63,1'/(2\$'0(7(5:,5,1\*',\$\*5\$0

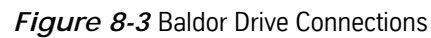


**Figure 8-2** 1250-2 Spindle Load Meter Wiring Diagram

### Vector Drive Encoder 9 pin Molex Connector

The encoder output signals A, /A, B & /B are input through this connector. There is a +5V ground line through this connector also.

Output the encoder signals to the spindle controller PCBA through the Rigid Tapping Cable.



---

## Adjustments

### Adjusting the Baldor Vector Drives

Whenever a Baldor Drive's DC Power Supply or a spindle controller card is replaced, it will need to be ZERO BALANCED to the machine. On Rigid Tapping machines in particular, the control sets the RPM and direction by supplying a precise -10 to +10 VDC control voltage through pins 4 and 6 at the control molex plug hanging on the right side of the inverter. To reverse the direction, a negative 0 to 10 VDC control voltage is sent. In rigid-tapping this allows the spindle motor to be rapidly reversed and ramped up and down. If the control voltage at idle is not exactly 0 VDC, then it is possible for the inverter to interpret it as a command to move in one direction or another at a slow speed.

### Auto Tuning/ Zero Balance

Verify that the inverter is installed properly, the spindle is off, and the keypad is installed. Use the keypad to complete the following procedure:

- 1) Install the display unit in inverter (if not already installed).
- 2) The display should read OFF MOTOR SPEED REMOTE 0 RPM.
- 3) Press PROG.
- 4) Press the DOWN ARROW twice. The display will read LEVEL 2 BLOCKS.
- 5) Press ENTER.
- 6) Press the DOWN ARROW three times. The display will read AUTO TUNING.
- 7) Press ENTER.
- 8) Press the UP ARROW once. The display will read CMD OFFSET TRM.
- 9) Press LOCAL.
- 10) Press ENTER two times. The display will read TEST PASSED.
- 11) Press RESET three times. The display will read PRESS ENTER FOR PRESET SPEED.
- 12) Press the DOWN ARROW once. The display will read ENTER FOR PROGRAMMING EXIT.
- 13) Press ENTER.



*Figure 8-4* Keypad

14) Press LOCAL. The display will read OFF MOTOR SPEED REMOTE 0 RPM.

**Baldor Spindle Drive  
Parameter Usage for  
Fadal VMC**

The inverter replacements are **INV-052** and **INV-054**. These two units are replacements for inverters (Toshiba, Sweo and Mitsubishi). They cannot be used in machines with Rigid Tapping. They do not have encoder feedback and **do not require Zero Balancing or Auto Tuning**. If the drive is Zero Balanced in error, recovery procedure is to set the ANA CMD Offset parameter to -1.

**NOTE:** When in the inverter replacement unit, it is necessary to change to Input / Operating Mode parameter to Keypad in order to make changes and return it to Fan Pump 2 Wire for operation.

**Baldor Vector Drives** require Zero Balancing whether rigid tapping is installed or not. The other tests and procedures are normally not necessary to perform. With INV-0070 the Motor Mag Amps parameter should be checked to insure that the current software is installed. To determine whether or not the parameters are changeable in the unit, change a parameter and power off machine, power on and check the parameter to determine if the new value was retained.

**Terms and  
Procedures:**

The **Zero Balancing or Auto Tuning** function matches the drive's zero or speed reference point to the input speed command on pins 4 and 6 of the 6 pin Molex connector coming from the spindle controller board. The purpose is to match the zero point so that the speed command voltage input will obtain the same RPM of the motor for the same voltage for both positive and negative. If this is not set correctly problems such as hard reversals in Rigid Tapping, damaged threads, out-of-balance Spindle Motor, or Spindle turning slowly at idle in Rigid Tap standby may occur. Whenever the Input power to the machine, Baldor Drive, DC power supply, or a Spindle Controller card is replaced, it will need to be "Zero-Balanced" to the machine.

<i>TYPE:</i>	<i>DISPLAY:</i>
---	"OFF MOTOR SPEED REMOTE 0 RPM"
LOCAL	"STOP MOTOR SPEED LOCAL 0 RPM"
PROG	"PRESS ENTER FOR PRESET SPEEDS"
↓ ↓	"PRESS ENTER FOR LEVEL 2 BLOCKS"
ENTER	"PRESS ENTER FOR OUTPUT LIMITS"
↓ ↓ ↓	"PRESS ENTER FOR AUTOM TUNING"
ENTER	"CALC PRESETS P: NO"
↑	"CMD OFFSET TRM P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
RESET	"CMD OFFSET TRM P: PRESS ENTER"
RESET	"PRESS ENTER FOR AUTO TUNING"
RESET	"PRESS ENTER FOR PRESET SPEEDS"
↑ ↑ ↑ ↑	"PRESS ENTER FOR INPUT"
ENTER	"OPERATING MODE P: FADAL SPECIAL"
↑ ↑ ↑	"ANA CMD OFFSET P: XX.X%" (Note: XX.X is the Offset value)
RESET	"PRESS ENTER FOR INPUT"
RESET	"PRESS ENTER FOR PRESET SPEEDS"
DISPLAY	"STOP MOTOR SPEED LOCAL 0 RPM"
LOCAL	"OFF MOTOR SPEED REMOTE 0 RPM"

If the "ANA CMD OFFSET" value reads any value other than 0.0%, then the "Zero Balance Offset Trim" has been set.

The **Factory Parameters** procedure is to load or re-load the factory parameters.

Replacement Baldor Vector Drive unit will not run properly, but display is lit. The Factory Parameters may not have been loaded from the Eproms or PLC. Load Factory Parameters using INV-0017 Display Unit, and following procedure:



<i>Keystrokes:</i>	<i>Display shows:</i>
	Off 0 0 RPM
	REM 0.0A 0.0 HZ
PROG ↓ ↓	PRESS ENTER FOR LEVEL 2 BLOCKS
ENTER	PRESS ENTER FOR OUTPUT LIMITS
↑ ↑ ↑	PRESS ENTER FOR MISCELLANEOUS
ENTER	RESTART AUTO/MAN P: CONTINUOUS
↑ ↑ ↑	FACTORY SETTINGS P: NO
ENTER ↑	FACTORY SETTING P: YES
ENTER	FACTORY SETTINGS <i>(Loading parameters)</i> LOADING PRESETS
	FACTORY SETTING P: NO
RESET RESET	PRESS ENTER FOR PRESET SPEEDS
↓ ↓	PRESS ENTER FOR LEVEL 2 BLOCKS
ENTER	PRESS ENTER FOR OUTPUT LIMITS
↓ ↓ ↓	PRESS ENTER FOR AUTO TUNING
ENTER	CALC PRESET P: NO
LOCAL	CALC PRESETS P: NO

↑↑	CMD OFFSET TRIM P:      PRESS ENTER
↑↑ ↑↑	TEST PASSED PRESS ENTER
RESET RESET RESET ↓	PRESS ENTER FOR PROGRAMMING EXIT
ENTER	STOP 0 V    0 RPM LOC  0.0 A  0.0 HZ
LOCAL	OFF  0 V    0 RPM REM  0.0 A  0.0 HZ

The **Motor Tuning** procedure tunes the drive to the motor. This is not necessary to perform because the factory parameters are set up for our motors. This procedure can be used for troubleshooting on units that will or will not retain parameter changes. These tests must be performed with motor unloaded (Belts must not be engaged): CUR LOOP COMP, FLUX CUR SETTING, FEEDBACK TESTS, and SLIP FREQ TEST.

<b><i>TYPE:</i></b>	<b><i>DISPLAY:</i></b>
---	"OFF MOTOR SPEED REMOTE 0 RPM"
LOCAL	"STOP MOTOR SPEED LOCAL 0 RPM"
PROG	"PRESS ENTER FOR PRESET SPEEDS"
↓ ↓	"PRESS ENTER FOR LEVEL 2 BLOCKS"
ENTER	"PRESS ENTER FOR OUTPUT LIMITS"
↓ ↓ ↓	"PRESS ENTER FOR AUTO TUNING"
ENTER	"CALC PRESETS P: NO"
↑	"CMD OFFSET TRM P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"CUR LOOP COMP P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"FLUX CUR SETTING P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"FEED BACK TESTS P: PRESS ENTER"
	<i>NOTE: this test will test the encoder and encoder feedback to the Vector drive.</i>
ENTER	"PRESS ENTER TO START THE TEST"
	<i>(If test fails continue on with the rest of the tests. Then come back and use this test for troubleshooting the encoder circuit.)</i>
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"SLIP FREQ TEST P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"SPD CNTRLR CALC P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"PRESS ENTER FOR MENU EXIT"
RESET	"PRESS ENTER FOR AUTO TUNING"
RESET	"PRESS ENTER FOR PRESET SPEEDS"
DISP	"STOP MOTOR SPEED LOCAL 0 RPM"
LOCAL	"OFF MOTOR SPEED REMOTE 0 RPM"

### Motor Mag Amps for INV-0070

On VHT machines equipped with INV-0070, during an acceleration cycle the spindle motor will slow down and then speed up several times, appearing similar in symptoms to that given by a failing encoder. Acceleration to full speed may take longer than the 2.2 seconds programmed into the drive.

The Motor Mag Amps parameter in the INV-0070 Spindle Drive Unit is set too high by the Auto-Tuning procedure, and needs to be manually set to 22.

In Auto Tuning, the parameter Flux Current is used to calculate the spindle Motor Mag Amps. **Note:** when running this self-tuning parameter the belts must first be disengaged to obtain an accurate measurement.

After following the Auto-Tuning procedure, and with the machine powered on:

KeystrokesBaldor Display

	STOP MOTOR SPEED LOCAL 0 RPM
Press PROG key	PRESS ENTER FOR PRESET SPEEDS
Press ↓↓	PRESS ENTER FOR LEVEL 2 BLOCKS
Press ENTER Key	PRESS ENTER FOR OUTPUT LIMITS
Press ↑↑↑↑↑	PRESS ENTER FOR MOTOR DATA
Press ENTER key	MOTOR VOLTAGE P: 230V
Press ↑↑↑↑↑ key	MOTOR MAG AMPS (This value will vary P: XX.X A between drives)
Press ENTER key (Using the ↑ ↓ and shift keys change the value to 22) Press ENTER	
Press RESET	PRESS ENTER FOR MOTOR DATA
Press RESET	PRESS ENTER FOR PRESET SPEED
Press DISP	OFF MOTOR SPEED REMOTE 0 RPM

**NOTE:** Do not re-run the Auto-Tuning procedure without restoring value 22 in the Motor Mag Amps parameter.

### Yaskawa Drive 515 (INV-0072)

#### Set up Instruction, Initializing and balancing the drives

- 1) Use this procedure for new drive installation, or replacement
- 2) Power off Machine
- 3) Install Yaskawa Drive with display unit.
- 4) Power on Machine
- 5) Press "MENU" to display \*\*Main Menu Operation\*\*
- 6) Press "UP ARROW" 1 time to display \*\* Main Menu Initialize\*\*
- 7) Press "ENTER" to display \*\*Select Language English\*\*
- 8) Press "UP ARROW" 3 times to display \*\*Init Parameters /No Initialize\*\*
- 9) Press "ENTER" to display \*\*A1-03= 0 /No Initialize\*\*
- 10) Press "UP ARROW" 1 time to display \*\*A1-03= 2220 2- Wire Initial\*\*
- 11) Press "ENTER" to display \*\*Entry Accepted\*\*  
(loading parameters)  
  
Init Parameters  
No Initialize
- 12) Press "MENU" to display \*\* Main Menu \*\*  
Operation
- 13) Press "ENTER" to display Frequency Ref  
U1-01= 1 RPM (RPM may be fluctuating)
- 14) Press "JOG" and hold for 2 sec. Zero bias signal Frequency Ref (Balancing)  
U1-01= 1 RPM

Any time press and hold the "JOG" for few second until balance 0 to 1 count, thus zero bias the command signal.

**Yaskawa V7 (INV-0071) on Fadal EMC Spindle setup Instructions**

**Before beginning, please note:**

All references to the V7 Manual are to TM 4315, dated 04/02/2001. The latest V7 manual can be downloaded from [www.drives.com](http://www.drives.com)

This instruction set assumes that the Yaskawa V7 hardware has been flashed with Fadal default software. Please check the Monitor Display U-10 and verify that it has value XXXX. The value in U-10 is the software version that is installed on this V7.

The Monitor displays can be accessed from the keypad by pressing DSPL until the LED moves to MNTR. Then press DATA/Enter and use the L button to move to Monitor U-10. (See page 4-3 in the V7 Manual)

Refer to page 4-2 in the V7 manual for more details on how to use the V7 keypad.

**Setting Access level for parameters**

Using the DSPL key on the V7 keypad, move the LED to PRGM. Select parameter n001 and press DATA/ENTER. Select value 5 and confirm data by pressing DATA/ENTER. This opens all n-constants for programming access. When you complete the task, reset n001 to 0 or 1.

**Displaying Fault Sequence**

Using the DSPL key on the V7 keypad, move the LED to MNTR. Use the L button to move to MonitorU-09 and press DATA/ENTER. Use the L button to scroll through the last four faults. (See page 6-8 in the V7 Manual).

**Adjusting zero point on Analog velocity input**

When performing this adjustment, be sure that the CNC analog velocity output to the V7 is asking for zero speed. This procedure will show how to zero out any noise on the analog line between the CNC and the V7.

**Caution: If this procedure is performed when the CNC analog velocity signal is not zero, the spindle will not operate correctly.**

Using the DSPL key on the V7 keypad, move the LED to PRGM. Select parameter n069-Analog Frequency Reference Bias. This parameter has an adjustment range of -100 to 100. You will probably need a value of between -005 and 005.

In order to verify that the value you select is correct, you will have to use the DSPL button to return the LED to FREF and verify that the value is zero. If it is not, repeat the procedure.

**Regenerative Resistors**

If on command of a rotating spindle to stop (M5), the Spindle Vector Drive causes the motor to brake and coast, brake again and then coast alternately until it finally stops.

If Spindle Vector Drive units are faulting on deceleration, resetting, and then faulting again, and resetting, this could be due to inoperative Regen Resistors, or Vector Drive parameters not matched to the resistors.

Regenerative energy is the power generated when the power supplied to the motor is less than the motor requires to maintain the running RPM. The motor will begin to act like a generator as it slows to the new power level. When the motor is decelerated and begins to regenerate energy to the motor control, the control must dispose of this energy or burn up. Regenerative braking capability is the control's ability to either absorb the energy or pass the energy somewhere else.

Fadal uses the regenerative braking principles for stopping the spindle and for stopping the axis motors on AC brushless machines. Regenerative resistors are used to dispose of the excess energy created in the regenerative braking process. The regen resistors used for the spindle braking process are:

- ELE-0148 Regen Resistor 25 ohm
- ELE-0149 Regen Resistor 13 ohm 1100 Watt
- ELE-0150 Regen Resistor 24 ohm 1200 Watt
- ELE-0929 Regen Resistor 19.5 ohm 3205 Watt

The 25 ohm regen resistor was used with the Toshiba 5 HP inverters, the 24 ohm resistors were used with the Mitsubishi Brake unit, the 13 ohm have been used for years by most of the other drives, such as Baldor and AMC, including the Glentek brake unit, and the 19.5 ohm has been available for the last year or so. The smaller Mitsubishi drives had internal regen resistors. These regen resistors convert the excessive energy into heat and are connected to the spindle drive to absorb more energy either as a single resistor, or two in parallel, or even three in parallel. **Do not make a combination of resistors with a total resistance of less than 6 ohms; this would cause excessive current in the circuit.**

To perform a basic test on the regen resistors, disconnect one or both wires for the regen resistors from the Spindle Vector Drive unit. With an ohmmeter, measure the resistance between the two wires of the Regen Resistor. The results should be the value of the regen resistor if one resistor, or the value of the resistor divided by the number of resistors connected in parallel. When two or more resistors are connected in parallel the wattage ratings of the individual resistors are added together, and define the amount of power that can be dissipated without burning up.



The braking circuit is the circuit, internal to the drive or on an external brake unit, that outputs the excessive power to the regen resistors. This circuit monitors the DC buss voltage of the drive and when it exceeds approximately 385 volts DC (765 volts DC for 50 taper), the circuit will activate and dissipate the excess voltage. If the buss voltage reaches approximately 400 volts DC (800 volts DC for 50 taper), the drive will produce a “DC buss high” or “Buss Overvoltage” fault and base block the drivers causing the spindle to coast. Fadal’s current drives will automatically reset and try to regen again. If the drive faults after regen, then it resets, and the spindle will coast and brake alternately until it stops.

If this symptom occurs on a Baldor Vector Drive and the Resistors test OK, then check the parameters for correct setting. To check the Baldor parameters with the keypad unit, depress the <Local> key for local mode, <Prog> key for program mode, then the <Down Arrow> key until “Level 2 Block” is displayed. Press the <Enter> key, <Down Arrow> key until “Brake Adjust” is displayed. Press the <Enter> key, and then the <Down Arrow> key until “Resistor Ohms” is displayed. Set this value to be the net resistance value of the Regen Resistors as installed in the machine. Press the <Down Arrow> key until “Resistor Watts” is displayed. Set this value to that of the total Regen Resistors’ wattage rating. Reset the drive to “Remote” and check performance.

If the stopping load is heavy, as it is on the 15K RPM machines, then an additional Regen Resistor can be added in parallel to absorb more power and may correct the problem. Don’t forget to reset the parameters.

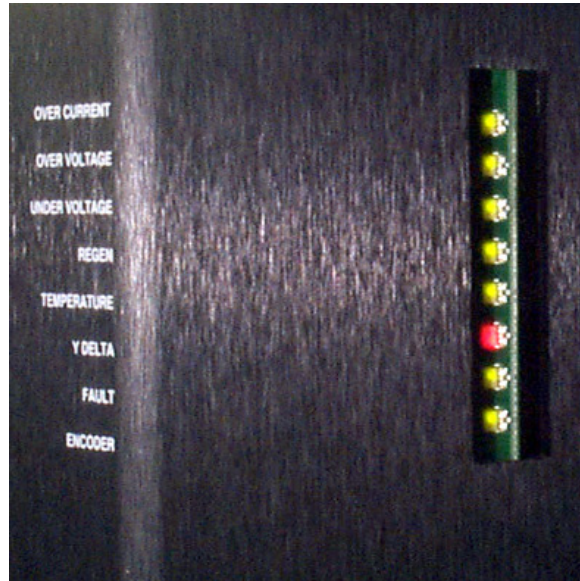
If the deceleration causes the spindle to coast without an attempt to regen, then check the regen resistors, the regen circuit fuse, and then the regen circuit. In the current Baldor 15HP drives the regen circuit PCB can be replaced (INV-0068). In many cases the regen circuit can be disconnected and a Glentek brake unit (INV-0030) can be substituted for the regen circuit. (Please consult with Fadal before performing).

To connect the Regen Resistors to the drives, use the following guide:

Toshiba	PA & PB
Mitsubishi or Glentek Brake	PR & P
AMC, Baldor Sweo, Sweo	R1 & R2
Baldor 10HP	B+/R1 & R2 with external fuse in series
Baldor 15HT and VHT	B+/R1 & R2 (some drives may have external fuse)

**Adjusting the AMC  
Vector Drive**

The AMC VE150AD Vector drive works with all spindle controller cards. The AMC Drive HP rating must match the motor HP rating. If they are mismatched, the motor may not run to full speed.



*Figure 8-5* Match AMC Drive HP Rating with Motor HP Rating

**LEDs**

- Over Current - Red for over current; otherwise green
- Over Voltage - Red for bus over voltage; otherwise green
- Under Voltage - Red for bus under voltage; otherwise green
- Regen - Red when active; otherwise green
- Temp - Red for drive overtemp; otherwise green
- Wye/Delta - Red for Wye, green for Delta
- Fault - Red for fault; otherwise green
- Encoder pulses - flashes when encoder pulses received

**Velocity Monitor Output**

Velocity Output P6-1 gnd P6-5 (0.1167V/100 RPM)

## Switch Positions

Table 1: Switch Positions

#	Switch	Position
1	Test/Offset	Off (Offset)
2	Magnetizing Current Only	Off
3	NC	Off
4	Torque/Velocity Mode	Off (Velocity Mode)
5	Reserved	Off
6	Velocity/Torque Mode	On (Velocity Mode)
7	+/- Direction Inhibit/Enable Select	Off (Enable)
8	5000/7500 Motor RPM	On/Off (5000/7500 RPM)
9	150/50 m/sec vel Loop Time Constant	On
10	10hp/15hp Motor	On/Off (10/15hp)

**Note:** Switches are located under cover; cover must be removed for access.

Switches should be preset; only switch 8 and 10 are changed. See Figure 7-6.

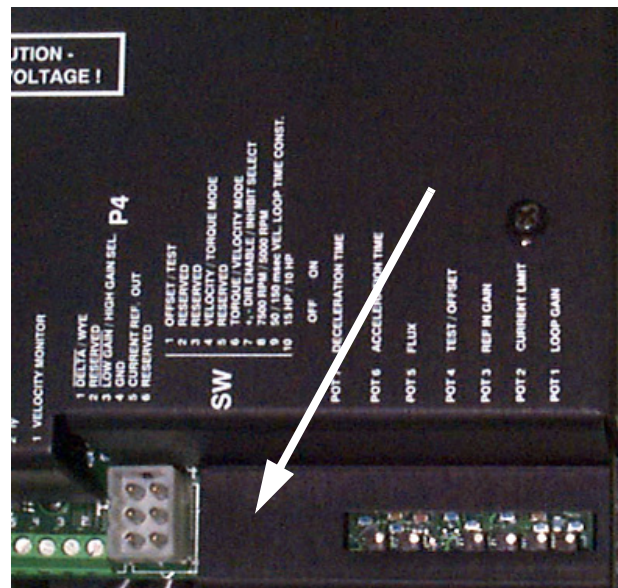


Figure 8-6 Switches are Preset

### Pots: (16 turn pots)

- Deceleration Time\* (CW to increase time)
- Acceleration Time\* (CW to increase time)
- Flux (This pot has been removed)
- Test/Offset
- Ref. In Gain (signal gain)

- Current Limit
- Loop Gain

\* Accel & decel pots have no effect in rigid tap mode.

### Adjustments

Switches and pots will be preset to initial settings by AMC.

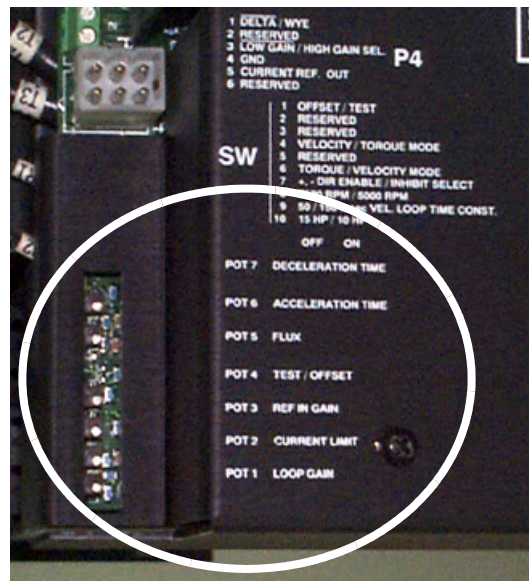
### Switch Settings

8 On-5000 RPM Off-7500 RPM

10 On-10hp motor Off-15hp motor

### Pot Adjustments

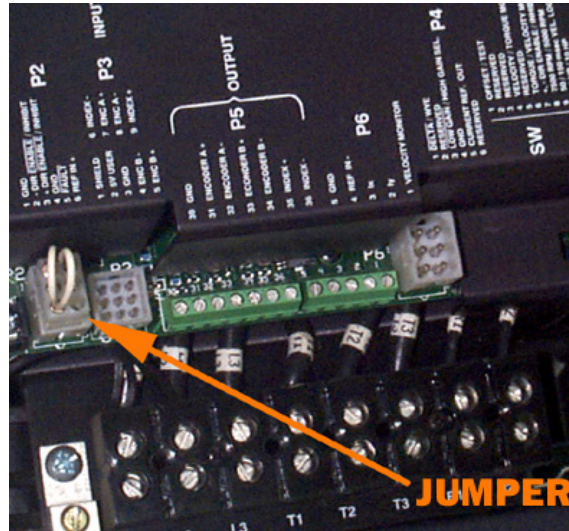
Adjust Accel, Decel, Loop gain, Offset, and Reference gain in the following order:



*Figure 8-7* Pot Adjustments

- 1) ACCEL/DECEL: These pots have no effect in rigid tap mode. Machine must be off. Measure from P6-5 to test point below pot. 20k ohms for 2.2 sec Acc/Dec (11.8k for 3.5 sec). Turn CW to increase time.

- 2) LOOP GAIN: Remove P2 connector and install jumper plug (FOR & REV to COM). Turn the Loop Gain CW until it hums, then turn two turns CCW. Remove jumper plug and install P2 connectors.



*Figure 8-8* Remove Jumper Plug

- 3) TEST/OFFSET:

**Rigid Tap Machines:**

In MDI enter "G84.2".

Adjust Offset for 0 VDC at P2 pins 4 and 6 (Ref In+ and Gnd).

**Non Rigid Tap Machines:**

Remove P2 connector and install jumper plug (FOR and REV to COM).

Adjust Offset until spindle stops.

Remove jumper plug and install P2 connector.

- 4) REF. GAIN:

In MDI, enter "S1000 M49 M3".

Adjust Ref. Gain for -1.22 VDC at Velocity Monitors (P6-1, gnd P6-5).

**Note:** If pots were not preset, or if problems are encountered, preset pots as follows:

- 5) LOOP GAIN: Turn fully CCW (minimum loop gain).
- 6) CURRENT LIMIT: Turn fully CW (maximum current).
- 7) REF. GAIN: Turn fully CW (maximum gain).

- 8) TEST/OFFSET: Turn fully CCW, then \* turns CW (middle).
- 9) FLUX: Not Adjustable.
- 10) ACCEL/DECEL: 20k ohms for 2.2 sec Acc/Dec (11.8k for 3.5 sec) (Measure from P6-5 to Test points below pots. Machine must be off when setting pot with ohmmeter).

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**Rigid Tapping  
(Optional Feature)****Fadal Rigid Tapping  
Procedure**

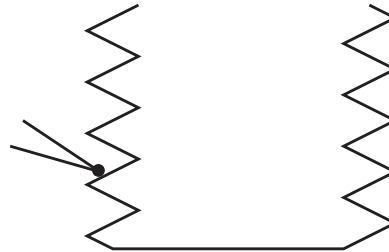
This method of rigid tapping program is for Format 1.

- 1) Place the rigid tapping test screw (SVT-0077) in the spindle.

If using the test programs in the machine, use program # 6000. If not, enter the following program:

```
G84.2  
G84.1 R0+0 Z-1. Q0.0714 F1000.  
X0.0001  
X-0.0001  
M99 P4
```

- 2) Once the program is loaded, jog the Z axis down. Insert the indicator tip into the second thread from the bottom of the rigid tapping test screw. The tip must be touching the lower thread side at the half way point.



*Figure 8-9* Insert Indicator Tip Into Second Thread

- 3) Type SETZ and press the ENTER key.
- 4) Move the indicator back away from the test screw and start the test program. Observe that the program appears to be running correctly.
- 5) Press the SINGLE STEP key. Verify that the rigid tapping test screw is back to the original position. Move the indicator back into position.
- 6) Run the test. The indicator reading should not exceed .001" on either side of the indicator zero. If the indicator exceeds .001, adjust the ramp and gain in SETP. the ramp effects the center point (it should be at the zero) and the gain affects the total fluctuation (it should be within +/- .001).

The following are starting points for each machine type:

Software Version AC-  
0017 and Later

-

**Table 2: Metric Screws**

	7,500 RPM	7,500 RPM	7,500 RPM	7,500 RPM	7,500 RPM	10,000 RPM	15,000 RPM
	A Models	L Models	EMC	6535 40T	6535 50T	ALL	1:2 ratio
RPM Factor	0	0	0	0	0	0	0
Orientation Factor	10	15	20	10	10	10	10
Gain	60±15	45±15	45±15	70±15	50±15	90±15	90±15
Ramp	100 or less	100 or less	100 or less	100 or less	100 or less	100 or less	100 or less
Z Tap Gain	Medium	Normal	Normal	Medium	Medium	Medium	Medium
XYZ Ramp	160	160	160	250	250	160	160

**Table 3: Inch Screws**

	7,500 RPM	10,000 RPM	15,000 RPM
	L Models	ALL	ALL
RPM Factor	0	0	0
Orientation Factor	15	10	10
Gain	56±15	80±15	65±15
Ramp	100 or less	100 or less	100 or less
Z Tap Gain	High	High	High
XYZ Ramp	100	100	100



**Before AC-0017  
Software Version**

-

**Table 4: Metric Screws**

	7,500 RPM	7,500 RPM	7,500 RPM	7,500 RPM	7,500 RPM	10,000 RPM	15,000 RPM
	A Models	L Models	EMC	6535 40T	6535 50T	ALL	1:2 ratio
RPM Factor	0	0	0	0	0	0	0
Orientation Factor	15	15	15	10	15	10	10
Gain	38±15	38±15	38±15	70±15	50±15	58±15	45±15
Ramp	100 or less	100 or less	100 or less	100 or less	100 or less	100 or less	100 or less
Z Tap Gain	Normal	Normal	Normal	Medium	Medium	Normal	Normal
XYZ Ramp	160	160	160	250	250	160	160

**Table 5: Inch Screws**

	7,500 RPM	10,000 RPM	15,000 RPM
	L Models	ALL	ALL
RPM Factor	0	0	0
Orientation Factor	15	10	10
Gain	58±15	82±15	65±15
Ramp	100 or less	100 or less	100 or less
Z Tap Gain	High	High	High
XYZ Ramp	100	100	100

Procedure for Setting GAIN Parameter:

For Rigid Tapping with VMCs that have METRIC Ballscrews, the GAIN in SETP must be set to 80.

Procedure for Setting Z TAP GAIN Parameter:

For Rigid Tapping with VMCs that have METRIC Ballscrews, the Z TAP GAIN in SETP must be set to MEDIUM.

Procedure for Setting XYZ RAMP Parameter:

XYZ RAMP in SETP for all other AC Drive machines EXCEPT 6535 and 8535 are set at 160.

The XYZ RAMP setting for the VMC6535 and 8535 is 250, instead of 160. The VMC6535 and 8535 also require SYS101.3 or later software.

Procedure for Adjusting Amplifiers:

The procedure for adjusting Loop Gain on AC Amplifiers is not changed when using the 25 IPM and the flashing LED on the controller card.

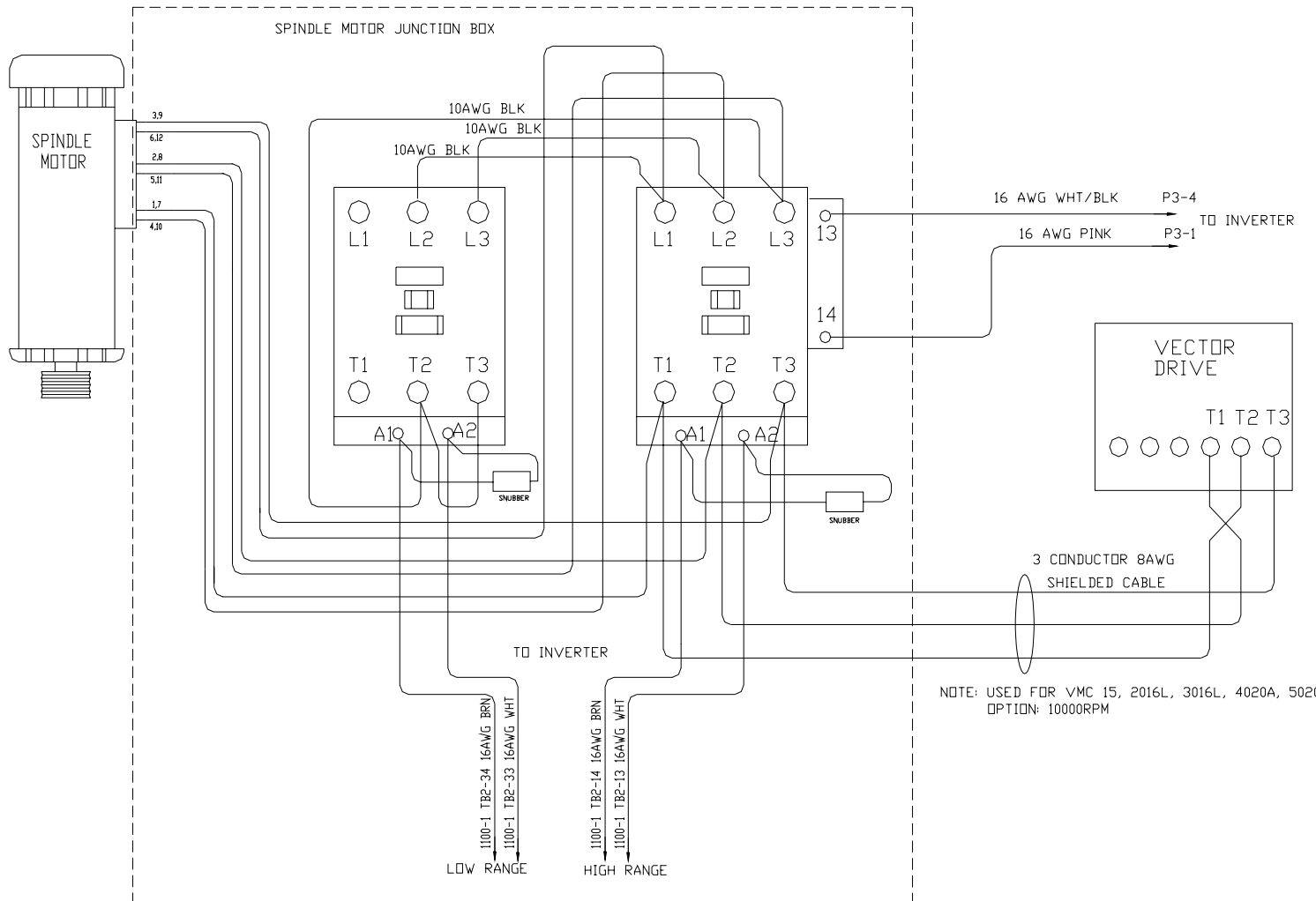
In general, when updating from an earlier software version to AC0017, the amplifiers will not need adjusting, but, the displayed following errors in Program 5811 will be similar to those shown in the table above.

---

## Motors

<b>7.5 HP Motor</b>	The 7.5 HP motor is standard on EMC model VMC's.
<b>10 HP Motor</b>	The 10 HP motor is standard on all VMC models except the EMC, 4020A, 5020A, 6030 and 8030. It is continuously rated at 10 HP with a peak rating of 15 HP.
<b>15 HP Motor</b>	The 15 HP motor is the standard motor on the following VMCs: 4020A, 5020A, 6030 and 8030. It is an optional motor on all other VMC models. It is continuously rated at 15 HP with a peak rating of 22.5 HP.
<b>20 HP Motor</b>	The 20 HP Very Hi-Torque Motor is an optional motor available on the following model VMCs: 3020, 4020, 6030 and 8030. It is continuously rated at 20 HP with a peak rating of 30 HP.
<b>35 HP Motor (50 HP Drive)</b>	The 35 HP motor is a standard motor on the VMC 6535 50 taper. It is continuously rated at 35 HP with a peak rating of 50 HP.

**WYE / DELTA Motors** Standard motors are run in the wye mode only. Wye / Delta motors offer a flatter torque curve over the entire speed range of the motor/spindle system.



**Figure 8-10** WYE Delta Relay Wiring Diagram

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**Belt Drive Systems****Posi-Drive Belt System**

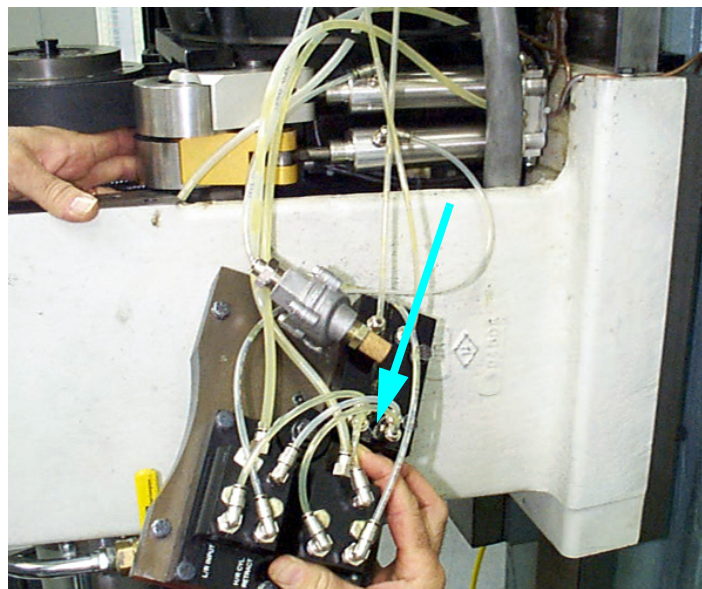
The Posi-Drive Belt System features two belts that run on a 1-2 and 2-1 reduction pulley arrangement.

**Spindle Belts Replacement on Auto Hi/low System**

The spindle drive belts are Gates 315K10. Gates manufactures the belts to Fadal specification. When replacing the spindle belts, use only the belts supplied by Fadal Machining Centers. The belts supplied by Fadal are sized.

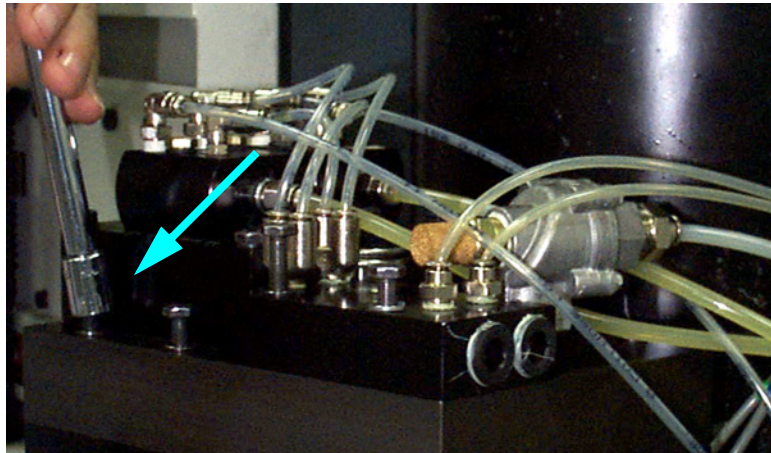
The following steps are for replacing the belts on the auto HI/LOW spindle:

- 1) Verify that the VMC is aligned with the cold start indicators.
- 2) Power off the VMC and lock out the main disconnect.
- 3) Disconnect the air supply from the VMC.
- 4) Remove four each of the 1/4" cap bolts on the Head Cover and remove the Head Cover. Cut all the wire ties holding the air lines and wires in place.
- 5) The Auto Hi/Low pistons need to be released. Determine which piston is applying force on the belts, the upper piston is the low speed belt piston the lower piston is the high speed belt piston. To release the actuator, push the check valve into the actuator. With the check valve released, pull the idler away from the belts.



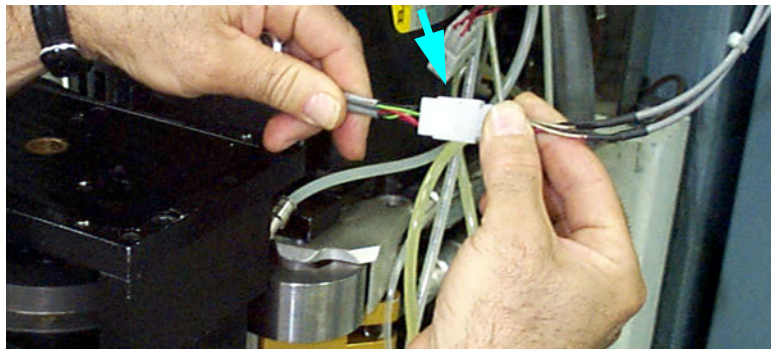
*Figure 8-11* Release Check Valve and Pull Idler Away from the Belts

- 6) Remove six each of the 1/4" hex bolts holding the Drawbar Cylinder assembly.

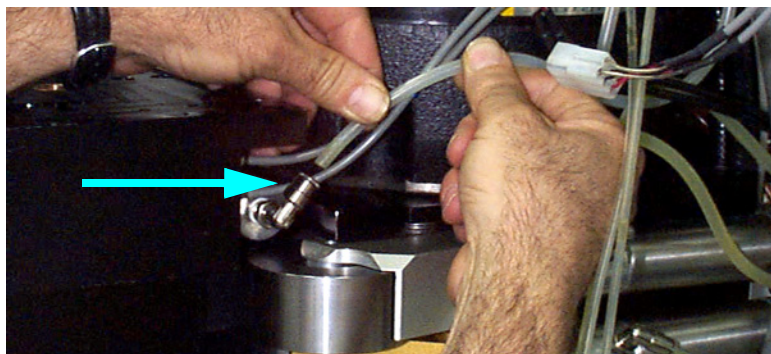


*Figure 8-12* Remove Hex Bolts Holding Drawbar Cylinder Assembly

- 7) Remove the Drawbar Cylinder assembly.
- 8) Disconnect the Orientation Bridge/Drawbar hall effect sensor 6 pin molex connector. Disconnect air line to the Orientation piston.

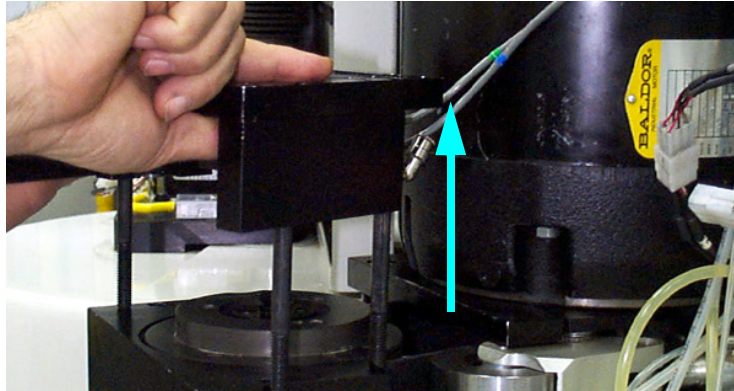


*Figure 8-13* Disconnect Orientation Bridge/Drawbar



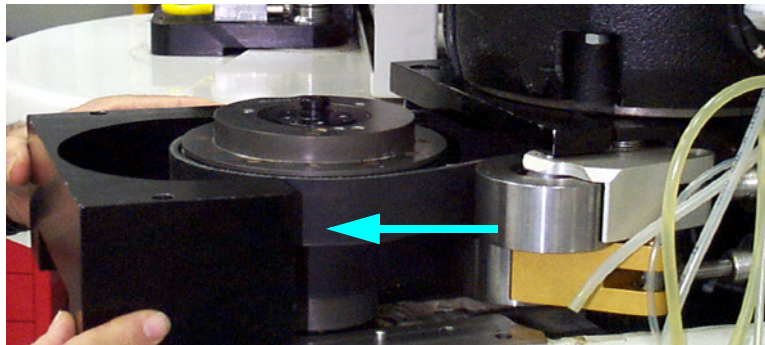
*Figure 8-14* Disconnect Air Line to Orientation Piston

- 9) Remove three each of the 3/8" socket head cap screws holding the Orientation Bridge assembly.



**Figure 8-15** Remove Socket Head Cap Screws

- 10) Remove the Orientation Bridge assembly and front belt guide.

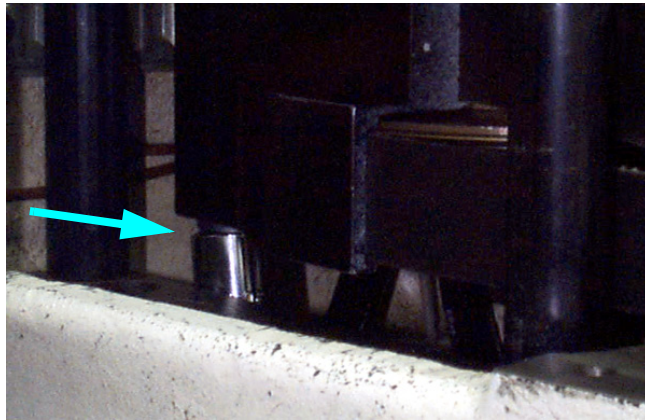


**Figure 8-16** Remove Orientation Bridge Assembly & Front Belt Guide

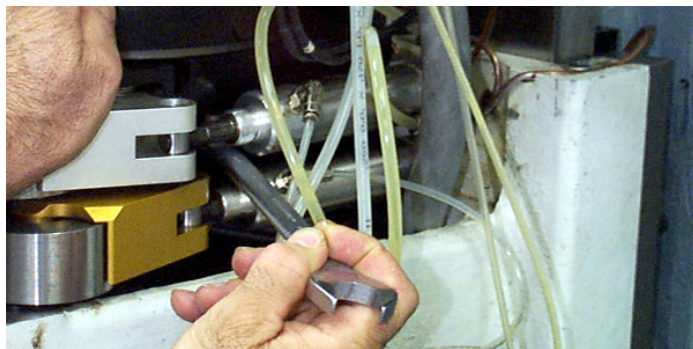
- 11) Remove the Core Cover located on the bottom of the head.



- 12) Remove both of the 1/2" bolts to the rear belt guide, as well as the left 1/2" Spindle motor bolt.

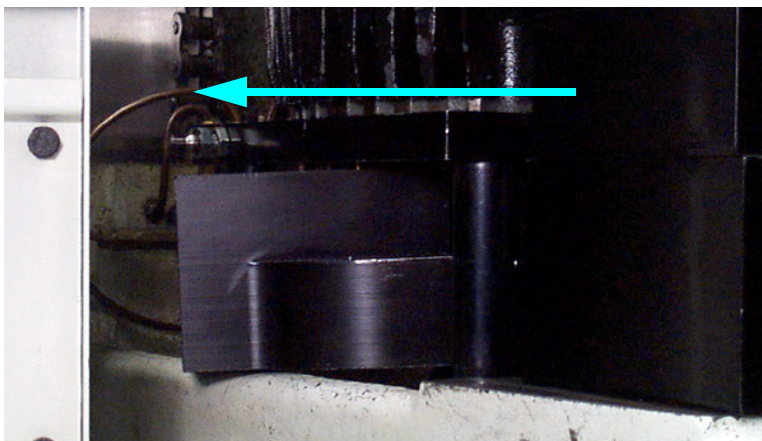


*Figure 8-17* Remove Bolts to Rear Belt Guide



*Figure 8-18* Remove Spindle Motor Bolt

- 13) Swing the spindle motor forward and remove the rear belt guide from the left side.



*Figure 8-19* Remove Rear Belt Guide

14) Remove the 2 spindle drive belts.

15) Replace the 2 spindle drive belts. Reassemble using the previous steps in reverse order.

**Motor Plate  
Tensioner Cable**

Machines equipped with a motor plate tensioner cable system, as shown in the figure below, will need adjusting when belts are replaced.

Adjustment procedure:

- 1) Disconnect the air supply from the machine. Remove the tension from the belts. Place an indicator as shown. Use either a dial indicator or a travel indicator.

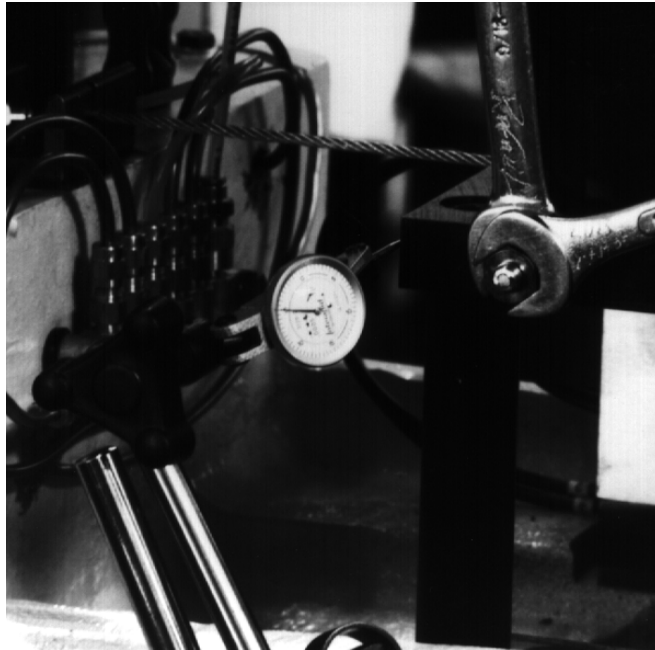


*Figure 8-20* Place Indicator

- 2) Once the indicator is in place, you will need two 9/16" open end wrenches to tighten and lock the cable tensioner screw.



- 3) Zero the indicator and slowly turn the 3/8" hex head bolt.



*Figure 8-21* Zero Indicator

- 4) Adjust the screw until the plate moves .002 to .005 on the indicator.
- 5) After adjusting, lock down the 3/8" jam nut with the other wrench while holding the adjuster screw. Watch the indicator to verify that there is no movement.

---

### Hydraulic Hi/low System

The hydraulic hi/low system requires very little maintenance. It is an air over oil system with check valves. Periodically check that you can see fluid in the 1/4 inch lines that go to the rear of the cylinder. If the lines have an excessive amount of bubbles then it is an indication that the oil level is low.

#### Filling

- 1) Remove the head cover.
- 2) Disconnect the air supply from the machine.
- 3) With the air source disconnected one actuator will still be engaged. To release the actuator, push the check valve into the actuator.
- 4) With the check valve released, pull the idler away from the belts.
- 5) Remove the 1/4" line that goes to the rear of the cylinder and fill with Mobil DTE heavy medium oil.

- 6) The reservoir is full when oil enters the 5/32 line on the actuator.

**WARNING**

DO NOT allow an excessive amount of oil to flow into the separator.

- 7) Reattach the 1/4" line to the fitting on the cylinder.
- 8) Repeat the above steps for the other range.
- 9) Reconnect the air supply to the machine.

**WARNING**

Verify that the oil lines are secure.

- 10) In MDI, cycle between the high and low ranges about 10 times. This will fill the cylinders.

**MDI Example**

Type:  
MD, ENTER  
S.1, ENTER  
S.2, ENTER

Repeat the S.1 and S.2 to continue switching ranges.

**7,500 RPM Poly  
Chain Belt**

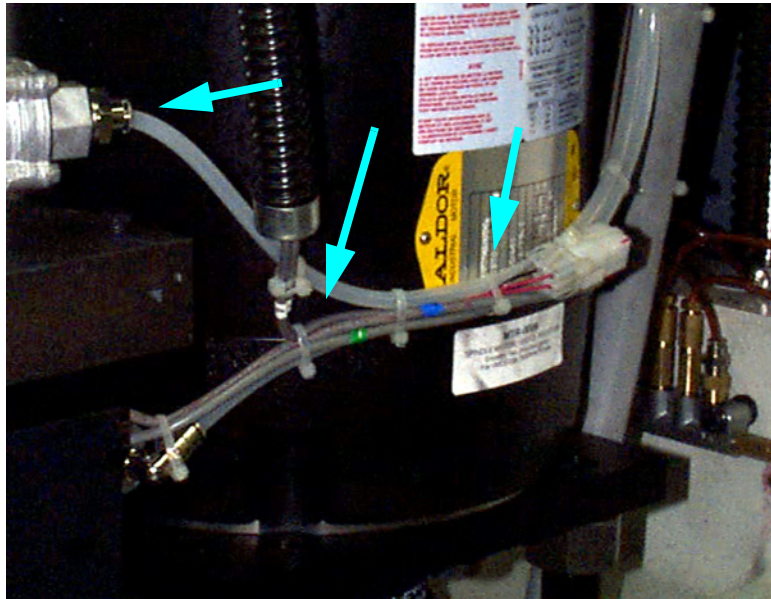
This system features a single belt that runs on a 1-1 pulley arrangement.

**Spindle Belt Replacement**

The spindle drive belt is a Gates Poly-chain. Gates manufactures the belt to Fadal specification. When replacing the spindle belt, use only the belts supplied by Fadal Machining Centers.

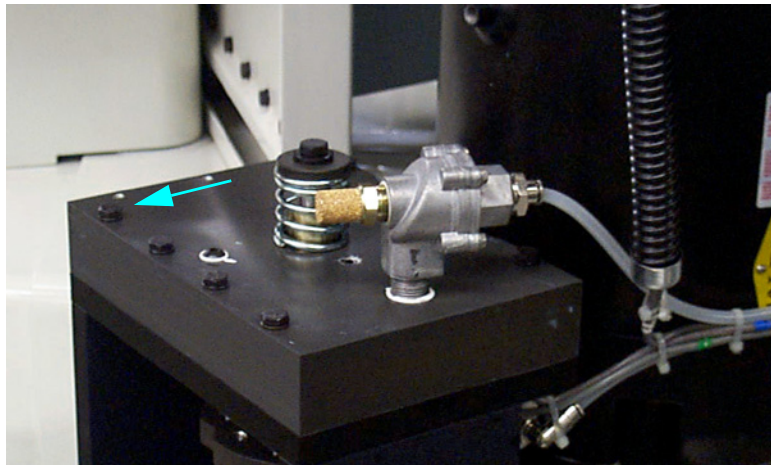
- 1) Verify that the VMC is aligned with the cold start indicators.
- 2) Power off the VMC and lock out the main disconnect.
- 3) Disconnect the air supply from the VMC.
- 4) Remove four each of the 1/4" cap bolts on the Head Cover and remove the Head cover.

- 5) Cut all the wire ties holding the air lines and wires in place. Disconnect the 1/4" assembly.



*Figure 8-22* Cut Wire Ties Holding Air Lines and Wires

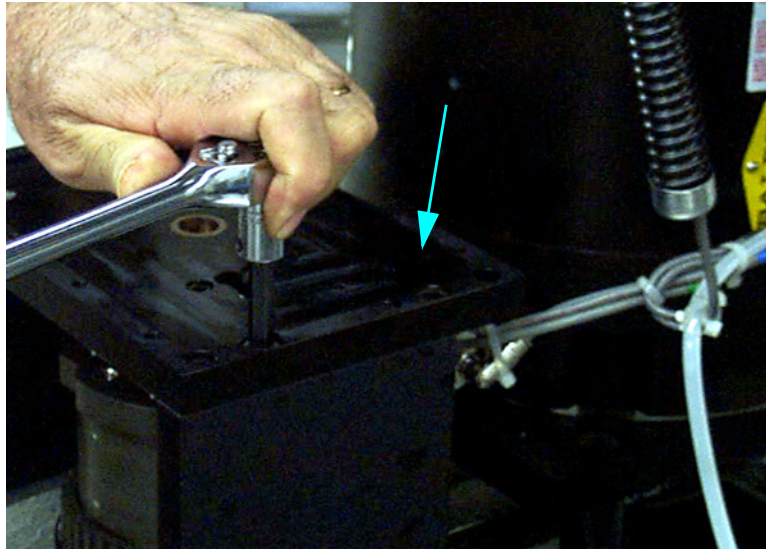
- 6) Remove each of the six 1/4" hex bolts to the Drawbar assembly.



*Figure 8-23* Remove Hex Bolts to Drawbar Assembly

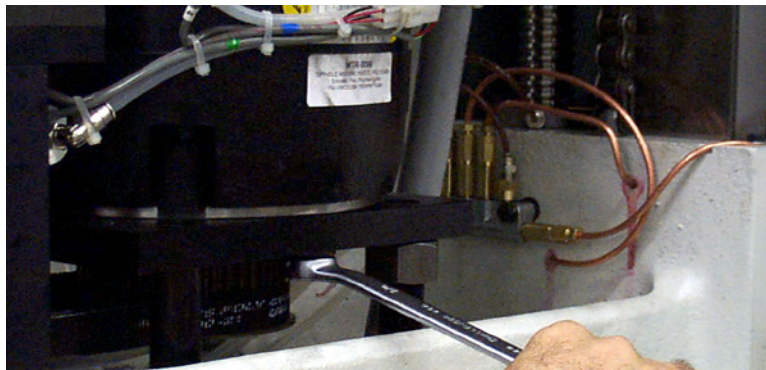
- 7) Remove the Drawbar assembly.

- 8) Remove each of the four 3/8" cap bolts to the Orientation Bridge assembly.



*Figure 8-24* Remove Cap Bolts to Orientation Bridge Assembly

- 9) Remove the Orientation Bridge.
- 10) Loosen each of the two 1/2" hex bolts to the Spindle motor.



*Figure 8-25* Loosen Hex Bolts to Spindle Motor

- 11) Swing the Spindle motor forward.
- 12) Remove the Spindle drive belt.
- 13) Install the new Spindle drive belt.
- 14) Mount a Mag base with an indicator on the head and touch off the top-front edge of the spindle pulley.
- 15) Set a zero reading while there is NO belt tension, then push back on the Spindle motor until about .0005" of deflection is seen on the indicator.

16) Tighten two each of the 1/2" hex bolts to the Spindle motor.

17) Verify that the reading has not changed.

**Note:** If the belt tension is too tight, then vibration will appear at the tool tip, and a poor finish may result.

18) Reassemble using the previous steps in reverse order.

**Table 6: Application List for Spindle Drives and Regen Resistors**

Part No.	Spindle Type	CE	Size	Regens	Ohms	Used
<b>Baldor (production):</b>						
INV 0020	15HP 10000RPM HT	No	C	2	13 OR 19.5	19.5
INV 0041	10HP 10000RPM	No	B	1	13 OR 19.5	19.5
INV 0042	10HP 10000RPM	No	C	2	13 OR 19.5	19.5
INV 0043	15HP 7500RPM HT	No	C	2	13 OR 19.5	19.5
INV 0045	10HP 7500RPM	No	B	1	13 OR 19.5	19.5
INV 0058	20HP 10000RPM VHT	No	C	2	13 OR 19.5	19.5
INV 0070	25HP 10000RPM VHT	Yes	C	3	19.5	19.5
INV 0073	35HP 7500RPM	YES		3	19.5	19.5
<b>AMC (production):</b>						
INV 0056	All types except VHT	Yes		2*	13 OR 19.5	19.5
<b>Baldor (service):</b>						
INV 0039	15HP 10000RPM HT	Yes <sup>1</sup>	C	2	13 OR 19.5	19.5
INV 0044	10HP 7500RPM	Yes <sup>1</sup>	C	1	13 OR 19.5	19.5
INV 0046	15HP 7500RPM HT	Yes <sup>1</sup>	C	2	13 OR 19.5	19.5
INV 0052	10HP 10000RPM NCL	No		1	13	
INV 0054	20HP 10000RPM NCL	No		2	13	
<b>Yaskawa (production):</b>						
INV 0071	10HP 7500 RPM	YES		2	13	
<b>Others:</b>						
INV 4551	TOSHIBA	No		1	13	
INV 4556	SWEO	No		1	13	
INV 4558	MIT.	No		INTERNAL	NONE	
INV 4552	TOSHIBA	No		2	13	
INV 4557	SWEO	No		2	13	
INV 4558-320	MIT. (BRAKE+)	No		2	13	
INV 4551-15	TOSHIBA	No		1	13	
INV 4558-15	MIT.	No		INTERNAL	NONE	
INV 4554	SWEO	No		1	13	

Table 6: Application List for Spindle Drives and Regen Resistors

Part No.	Spindle Type	CE	Size	Regens	Ohms	Used
INV 4558-320	MIT. (BRAKE+)	No		2	13	
INV 4551-15	TOSHIBA	No		1	13	
INV 4558-15	MIT.	No		INTERNAL	NONE	
INV 4554	SWEO	No		1	13	
INV 4554-175	BALDOR-SWEO	No		1	13	
INV 4554Y-175	BALDOR-SWEO	No		1	13	
INV 4554Y-180	BALDOR-SWEO	No		1	13	
INV 4558Y	MIT. CL	No		INTERNAL	NONE	
INV 4555	SWEO	No		2	13	
INV 4555-175	BALDOR-SWEO	No		2	13	
INV 4555Y-175	BALDOR-SWEO	No		2	13	
INV 4555Y-180	BALDOR-SWEO	No		2	13	
INV 4558-315	MIT. (BRAKE+)	No		2	13	
INV 4554-175-V15	BALDOR-SWEO	No		1	13	
INV 4554-180-V15	BALDOR-SWEO	No		1	13	
INV 4558-205	MIT.	No		INTERNAL	NONE	
INV 4558-15CL	MIT.	No		INTERNAL	NONE	
INV 4558-305-6.5K	MIT.	No		INTERNAL	NONE	
INV 4558-305-V15	MIT. (BRAKE+)	No		2	13	
INV 4558-180-A	BALDOR-SWEO	No		2	13	
INV 4554-SP	BALDOR-SWEO (single phase)	No		1	13	
AMP-0064	Glentek, spindle drive, TRM	No		1	19	

\* FD2 uses 1 for 10HP, 2 for 15HP

<sup>1</sup> Cannot be used for current CE production



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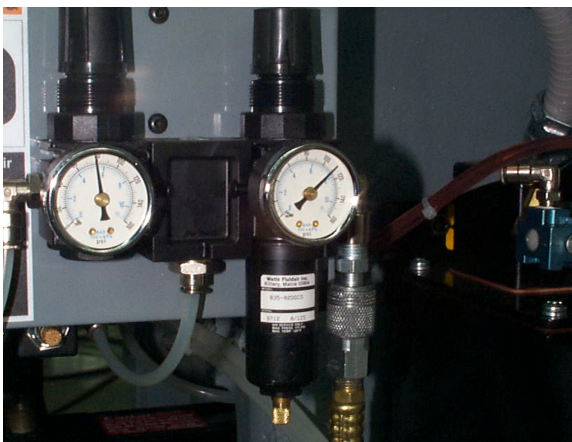
**Tools Sticking in the Spindle During a Change Cycle**

There are many different solutions to problems leading to sticking tools, and although most machines experiencing a sticking tool problem will exhibit only one or two of these symptoms, it is better to check out all of them in each case. Inspection and elimination of the items on this list ensures a complete resolution to the problem.

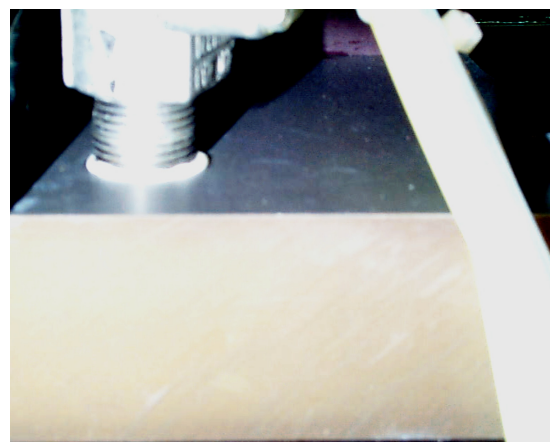
Please refer to testing procedure in item 18.

**1. Air Supply Pressure**

Minimum air pressure from the building to the machine must be greater than 80 PSI, or 5.5 Bar. The supply volume must be adequate enough to not drop more than 5 PSI during a tool change cycle. Check for restrictions in the building plumbing, air filtration system, regulator bowl, lack of a closed loop in air supply plumbing around the shop, or excessive water in the air supply. A good test for inadequate volume is the observation of large pressure drops during a tool change cycle, or when other machinery in the shop uses air. Those machines with dual regulators should have the main regulator on the right side set no greater than 120 PSI (8 bar), and the secondary regulator at 70-80 PSI (5-5.5 bar). The main regulator feeds the Drawbar Cylinder, and its output force is computed at 100 PSI, for example, 38 square inches x 100 pounds per square inch or 3800 pounds pushing force. An increase of pressure to the Drawbar Cylinder proportionately increases Drawbar force at a factor of 38:1.



Dual Air Regulator set at 80 PSI and 120 PSI



Exhaust Valve pipe nipple

**2. Drawbar Cylinder Hall Effects Switch**

Tool "Popping" can be reduced on machines equipped with Drawbar Cylinder Hall Effects switches, by checking the adjustment on the switch. If the switch is up too high, then the Z-axis may start up prematurely in the Tool Extraction cycle, wrenching the tool out of the spindle. Note that there is a new parameter in SETP labelled "Do you have Air Valve feedback?" This does not mean that electric signals are returning to the control from the air valve. It means that there could be Hall Effects switches on the Idlers and Drawbar Cylinder, and if so, the answer would be "YES". To answer "NO" might mean that the control will ignore any such feedback and Z-axis may lift off the tool prematurely.

**3. Insufficient Air Volume: MAC In-Line Valve**

In some cases, the rear MAC In-Line valve that delivers air to the Drawbar Cylinder may have reduced output by volume. There have been cases of 40% reduction in airflow when this valve experiences a failure. This condition will not allow the Drawbar Cylinder to fill fast enough to provide enough impact to operate properly. A simple test is to swap the valve with another in the manifold and retest.

**4. Air Leaks; Exhaust Valve**

Inside the Exhaust Valve on top of the Drawbar Cylinder is a diaphragm valve/seat. A tiny pinhole leak in the diaphragm will cause the valve to leak out the exhaust and not fill up the Drawbar Cylinder. Inspect the diaphragm visually for a rupture, and replace if necessary. Part numbers are VLV-0032 and VLV-0033 for repair kits, the large valve style or the small valve style, respectively.

**5. Air Leaks; Exhaust Valve Nipple**

The pipe nipple that attaches the Exhaust Valve to the Drawbar Cylinder Housing may be cracked from overtightening, and then leak. Inspect and replace, if necessary.

**6. Air Leaks; Drawbar Cylinder Bushing**

Test for an air leak with soapy water sprayed around the air lines. The bronze bushing that guides the Drawbar Cylinder Shaft may be worn, or damaged, or too rough internally to prevent premature wear to the O-ring around the shaft. Disassemble the Drawbar Cylinder and inspect/replace the O-ring and bushing. A new bushing design will be available soon to not only house a second O-ring, but provide a smoother surface to reduce O-ring wear. It will be retrofittable to all earlier Drawbar Cylinders. It has been included in the Sticking Tool Retrofit kit listed on the last page.

**7. Air Leaks; Drawbar Cylinder Plate**

Another source of air leaks can be from the large O-ring around the Drawbar Cylinder Plate, and to discover this will require disassembly and inspection. The Drawbar Cylinder Plate itself can be cracked or distorted. When reassembling, please note the correct location of the magnet for the Hall Effects switch, and avoid cutting the large O-ring accidentally.



**8. Air Leaks;  
Hydraulic Actuator  
Assembly Bolts**

Two of the 1/4-20 bolts used to mount the Hydraulic Actuator assembly penetrate the Drawbar Cylinder housing, and may not have been sealed with teflon tape adequately. Test with soapy water for air leaks, sealing the bolt threads with teflon tape.

**9. Air Leaks;  
Coolant-Thru  
Drawbar Cylinder**

On Coolant-Thru Drawbar Cylinders equipped with a brass "shuttle valve" there is a port fitted to the top of the housing that was designed to feed air first to the shuttle valve, and then down the Drawbar Shaft to clear off the tool holder. The existence of this port is a leak to the Drawbar Cylinder, bleeding off air from the chamber. Earlier versions had a large port, and later versions have an orifice restricting airflow.

A mechanical air valve can be installed to draw air for the shuttle valve back at the main regulator, instead of from the Drawbar Cylinder. Contact the Fadal Parts Department for details.

**10. Orientation  
Bridge "Lifting"**

When the Drawbar Cylinder pushes downward with 3000 to 4000 pounds force, and meets resistance in extracting the tool, an upward force is created that wants to "lift" the Orientation bridge up from the head casting. The 3 bolts that hold the Bridge down to the Belt Guide resist this upward movement. During a tool change, inspect the movement upward of the Orientation Bridge. A closer inspection might reveal stripped bolt threads, distortion of the Bridge plate, damaged pockets in the Bridge plate containing the 3 bolt heads. A new design Orientation Bridge and Belt Guide will have 4 bolts holding it down, and is included in the Sticking Tools Retrofit kit listed below.

**11. Black Oxide Tool  
Holders**

We recommend "Side Ground" tool holders. Those manufactured with "Crush Ground" or those with Black Oxide coated finish are more vulnerable to tool sticking problems.

**12. Dirty Tool  
Holders**

Foreign matter on the tool holder taper, and sometimes coolant gel from evaporated coolant on the taper, will contribute some to the problem. As a test, clean the tapers thoroughly, and spray an anti-rust lubricant such as LPS-3 or Ironclad (not WD40) on the taper and retest.

**13. Spring Pilot;  
Oversized Diameter**

The outer diameter of the Spring Pilot, either non-locking or locking, may be too large and fit too tightly into the spindle bore. Check for score marks on the pilot, which would indicate galling of the surface. Recently the Knock-Out Cap was redesigned to provide a capturing ridge to contain the upper points of the crown of the spring pilot. With the increased tool retention forces, we have seen some distortion of the pilot. Check the inner bore of the Spindle Rotor where the Spring Pilot is located and carefully stone any developed burrs.

- 14. Spring Pilot; Ball Pockets Incorrect** With the Spring Pilot removed from the spindle, carefully inspect the 4 ball pockets and insert (4) BRG-0004 1/4 steel balls into them. Remount the Spider on top of them. The balls should easily retract full travel when pressed, and return under gravity force. Any binding indicates a misformed pocket. The pockets themselves should show no sign of distortion that might restrict ball travel when heavily loaded.
- 15. Drawbar Scored** Inspect the shaft of the Drawbar itself, particularly where the Belleville springs may contact it. Should the Belleville springs twist around the Drawbar, they may shift off of their rims, and dig into the Drawbar, and resist up and down movement. The introduction of hardened flat washers every 10th Belleville spring helps prevent the stack shift. A newly designed Drawbar and Spring Pilot will be available soon that has a larger diameter shaft which should restrict the stack shift from occurring. See the Sticking Tools Retrofit kit below.
- 16. Damaged Drawbar** At the bottom of the Drawbar is a pocket for the Pull Stud of the tool holder, and around its perimeter are 8 holes for the 3/16 inch balls to grasp the Pull Stud. Earlier Drawbars had a deeper pocket, and CAT tools were pushed out of the spindle by the lowest rim of this pocket contacting the pull stud. Eventually the rim of the Drawbar was distorted and the balls might not retract as smoothly as expected. Later Drawbars have a shorter pocket so that the Drawbar shaft pushes on the top of the pull stud, rather than on its base. A damaged Drawbar rim might prevent the pull stud from extraction smoothly.
- 17. Damaged Floater** The Floater is located by two 3/16 balls in a circular track in the spindle throat. These hold the Floater steady when the Drawbar is pressed through it, and the step at the bottom of the Floater allows the 8 3/16 balls to retract out of the way to release the tool. Should the Floater be damaged in a way that allows it to move with the Drawbar, the Pull Stud cannot be extracted from the Drawbar. Replace the damaged Floater, if necessary.
- 18. Testing Procedure** Use the following page to measure Drawbar performance, both before inspection, and after completion of the procedures outlined in this bulletin, for comparison.

**MEASURING  
DRAWBAR  
PERFORMANCE**

In order to measure the amount of push force that the Drawbar Cylinder has upon the tool, place a tool holder into the spindle (without a tool in it) and Jog the machine **slowly** downward in Z-axis onto the SVT-0066 Pressure Gauge-3000PSI. Once the gauge begins to register after contact, press the Tool In/Out button to release the tool. Measure how much **net force** is pressed upon the tool by the Drawbar.

Use the following chart to figure the amount of force that is lost.

Drawbar Cylinder force		_____	(38 x #PSI)
Less Drawbar return spring	-	100	
Less Belleville Springs-		800	
Net Force	=	_____	
Less Pressure Gauge reading	-	_____	
Lost Pressure Force	=	_____	

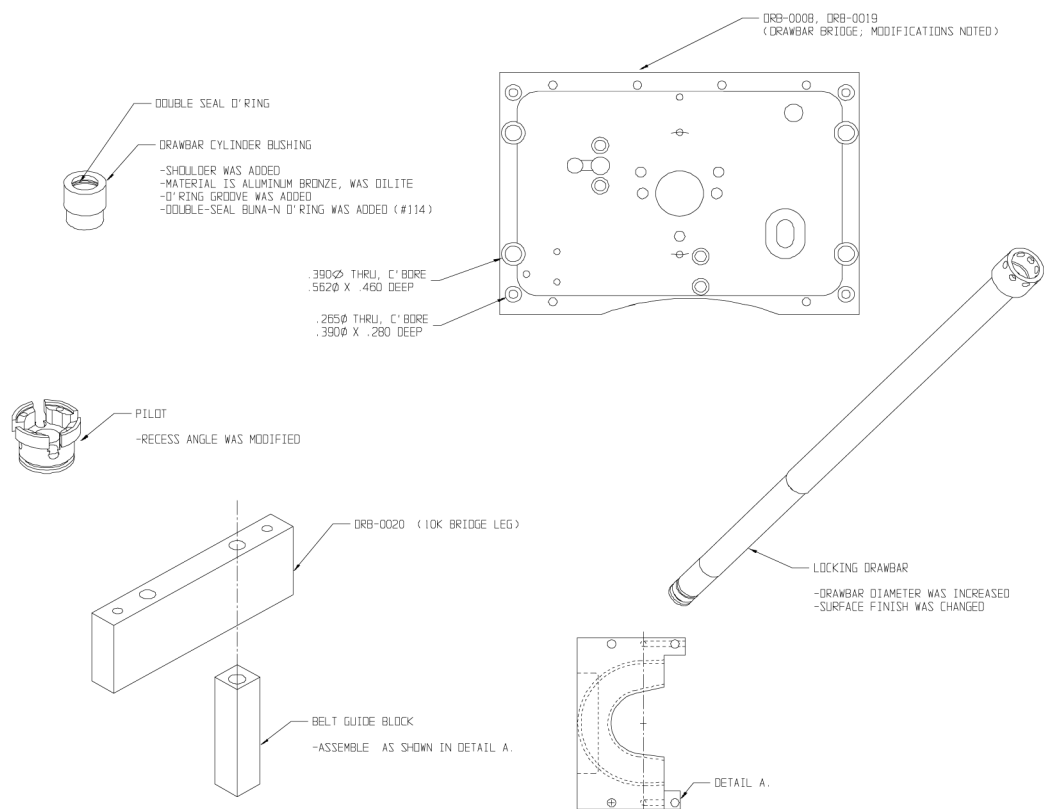
Drawbar Cylinder force is the air pressure in PSI multiplied by 38. Figuring the Drawbar return spring to be about 100 pounds, and the resistance from the Belleville Springs to be 800 pounds, we deduct 900 from the Drawbar Cylinder force. This gives us the expected Net Force.

However, it is necessary to measure with the Pressure Gauge what the Net Force **actually** is. The difference is lost forces, such as binding, friction losses, etc. A higher number Lost Pressure Force will result in Sticking Tools.

The technician should check items 1 through 17 in this section and the corrections should restore any missing forces and allow more of the Drawbar Cylinder pressure to reach the tool holder.

**DRB-0024 Sticking  
Tools Kit, 10K LDB****DRB-0025 Sticking  
Tools Kit, 10K LDB-  
CT=**

## DRAWBAR KIT (FOR SERVICE)



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**Tap-Tap Cycle**

The purpose of the Tap-Tap Cycle is to release tools that are stuck in the spindle. When the Drawbar Cylinder is activated, the Drawbar Hall Effect switch is activated to indicate that the tool was successfully released. If the switch is not activated a repeating Tap-Tap cycle is initiated, where it applies the Drawbar Cylinder pressure, releases, and then applies the Orientation cam-roller to the spindle pulley, and over again. This process aimed at knocking the tool loose will repeat until a timeout and fault mode is reached.

To adjust the Tap-Tap cycle drawbar Hall Effect switch (ELE-0145), temporarily reverse the air lines to the Drawbar Cylinder and the Orientation Bridge, so that when a M19 is called in MDI, the Drawbar Cylinder will be activated constantly. May need to use a 5/32" to 1/4" adapter fitting. The Hall Effect switch reads the drawbar cylinder magnet (left side of orientation bridge).

Using "DI" and "DS" from the command line, display switches. Locate DRAWBAR and watch the "01". While adjusting the switch position lower (away from the drawbar cylinder), when it changes to "00", rotate the switch upward until it changes back to "01", and then further upward 1/2 turn, and tighten locknut. Don't forget to restore air lines properly.

This process enables the control to know the difference between a tool that is stuck in the spindle, and one that was removed. If it was stuck the Tap-Tap cycle is initiated.

In some situations, most likely in VMC15 or 15000 RPM machines, where there is not a Hi/Low idler assembly installed, you may experience trouble extracting tools. A quick and simple test of the Tap-Tap cycle can be achieved by disconnecting the 1/4" air line to the drawbar cylinder (at either end). Without any tools in the spindle or in the turret pocket, make a tool change. The slide will advance to the spindle, the drawbar cylinder solenoid will activate, blowing air out into the room, and begin the Tap-Tap cycle. Over and over the machine should blow air out the disconnected line, and then stop and activate the orientation cylinder and tap on the pulley, and then repeat until it faults. If the drawbar cylinder Hall Effect switch is not properly adjusted, it may continue making a tool change without using the drawbar.

Also, if the machine does not have Hi/Low idlers, then jumpers must be installed at 1060/J9/10-11 and 1060/J11/4-5. These jumpers fool the control into thinking that there is an idler assembly installed so that it will know to monitor the drawbar cylinder switch and not ignore it. If no jumpers are present, then add them using about 4 inches of # 16 wire and Molex pins.

A further solution for those customers who have the Tap-Tap cycle and yet still have a problem is the Drawbar Cylinder Adapter assembly. This device uses

the air output to the drawbar cylinder from the air valve assembly to trigger a valve that supplies up to 120 PSI air to the Drawbar Cylinder to extract the stuck tool. It is simple to install and setup and should be used in conjunction with the Tap-Tap cycle.

Sanding the upper one-third of the taper of the spindle with a fine grade (600 grit) of sand paper also helps (100RPM for 10 seconds).

Troubleshooting the Tap-Tap cycle:

- 1) Check the Drawbar Hall Effect switch and its adjustment.
- 2) The wires connect to J9 pins 1,2 & 3 for the Drawbar Hall Effect switch.
- 3) The 1040 Mill Interface board reads the switch and activates the relays for the air valves.
- 4) The 1030 Computer Interface board communicates the instructions between the 1040 and the CPU 1400 board and the 1610 Program Module.

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### Spindle Drawbar and Belleville Spring Replacement

#### Drawbar Removal

- 1) Remove the Drawbar Cylinder Assembly.
- 2) Remove the Orientation Bridge Assembly.
- 3) Place a long 3/8 inch drive extension or similar item in the spindle and jog the head down until the extension is under slight tension between the drawbar and the table. **Caution:** Do not place high tension on the extension; it only needs to support the drawbar. Place a piece of wood between the extension and the table, if needed.
- 4) Remove the Knock out cap (on locking drawbars only).
- 5) Place pilot tool on spring pilot.
- 6) Use wheel puller to depress the spring pilot.
- 7) Remove spring retainers.
- 8) Remove wheel puller.
- 9) Jog head up and remove the extension and the drawbar. Be careful not to drop the ball bearing.

10) Now remove the belleville springs or the floater.

11) To reinstall, reverse the above steps.

**Replace Belleville  
Springs**

- 1) Remove drawbar (See Section A).
- 2) Using a spring hook or a magnet remove the belleville springs (Be sure to remove any broken pieces).
- 3) Install replacement springs starting with first one cupped downward and reverse every other one. The quantity will vary depending on the spindle pocket size (See the spring quantity chart).
- 4) Reinstall drawbar.

**Remove Floater  
(This will rarely be  
necessary.)**

- 1) Remove the drawbar (See Section A).
- 2) The floater has two ball bearings that hold it in place. Using a floater removal tool or a magnet pull the ball bearing toward the center and the floater should come out. If badly damaged the floater can be difficult to remove.

### Spindle Belleville Springs Quantity Chart

There have been many spindle and spring retainer combinations over the years. To determine the number of Belleville Springs in a spindle, three factors have to be considered: The depth of the spring pocket in the spindle, the depth of the spring retainer and the width of the Belleville springs. The following chart is a guide line for the number of springs and may vary slightly from spindle to spindle.

This chart covers the most common depths of spindles. In most cases the deeper spring retainers will use one less spring then number in the chart.

Spindle Type	Spindle Depth	Number of springs	Remarks
10K Non-Locking	2.00	19	
10K Non-Locking	3.00	30	
10K Non-Locking	4.25	43	
7.5K & 15K Non-Locking	4.326	44	
7.5K & 15K Non-Locking	4.627	47	
10K Locking	2.00	18	
10K Locking	3.00	29	
10K Locking	4.25	42	
10K Locking	4.326	40	
10K Locking	4.627	44	



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**Spindle Pre-Load****Measuring the Spindle Pre-Load**

- 1) Place a Pressure Gage (SVT-0066) on the table and align it with the Spindle nose.
- 2) Set an indicator on the Head and touch the indicator tip on the nose of the Spindle.
- 3) Jog the head (Z axis) down until the pressure gage reads 1000 pounds.
- 4) Zero the Indicator.
- 5) Jog the head (Z axis) up until it is no longer in contact with the pressure gage.
- 6) Depress the "Tool In Out" Button on the keyboard.
- 7) Release Button.
- 8) Read the value on the indicator.

If adjustment is necessary on a adjustable spindle then turn the spindle preload adjustment nut clockwise to tighten and counter clockwise to loosen.

Listed below are the "Fadal factory recommended specifications" for the various spindles.

<b>RPM Rating</b>	<b>Preload setting: (Deflection at 1,000 psi.</b>	<b>Lube Method</b>
15,000 / 10,000.	0014-.0017 (Can Not be adjusted)	Air/Oil
7,500	0013-.0015 (Adjustable preload)	Grease Pac
10,000	0013-.0015 (Adjustable preload)	Grease Pac
15,000	0017-.0019 (Adjustable preload)	Grease Pac

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**Spindle Duty Cycle**

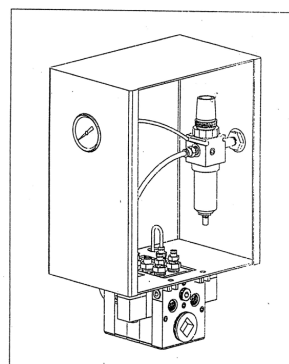
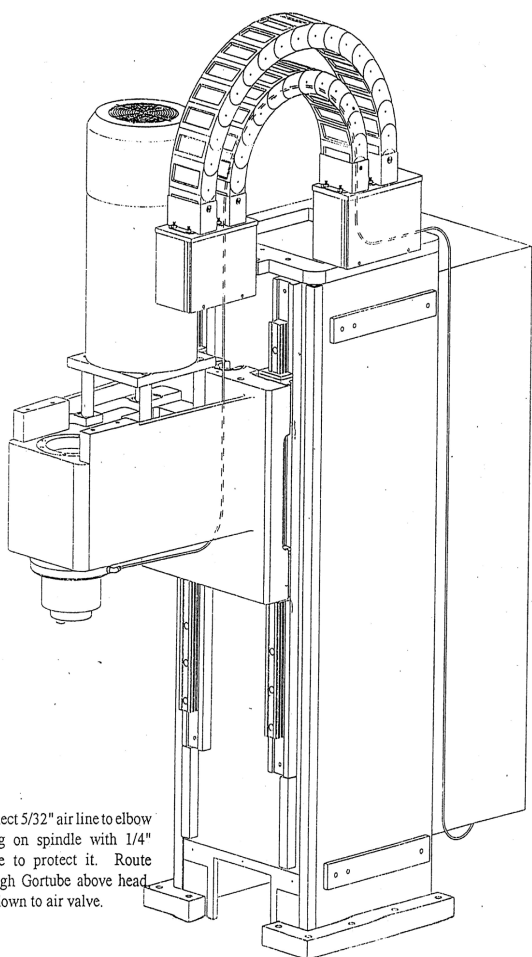
It is the recommendation of the Engineering Department in conjunction with the bearing manufacturers that the following procedures be followed to increase spindle life under extreme operating conditions.

Spindles operating under 8,000 RPMs need no cool down period regardless of on time or load to the tool.

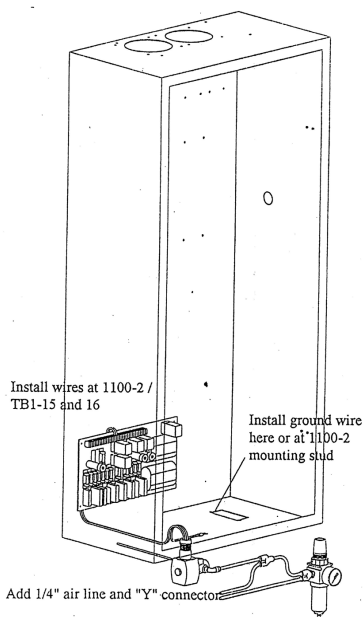
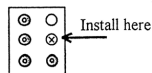
Fadal recommends that Spindles operating at over 8,000 RPMs for extended periods of time should be shut down for a period of at least 20 minutes after

every 5 hours of continuous operation. This will allow cooling of the races and re-lubrication of the grease lubricated bearings. The actual load to the spindle is not a factor at these higher RPMs. The time period should be monitored as closely as possible to increase spindle life.

## Air Positive Flow System



Remove plug, and install 1/4" x 1/8" MIPT bushing and 5/32QD x 1/8 MIPT fitting into MAC valve at "Orientation OFF" position.



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## Spindles

### 7.5K & 10K Grease Packed Spindles

#### Components

The 7.5K and 10K grease packed spindles are self contained units.

#### Functional Description

These spindles are belt driven and require no maintenance. There is air supplied to the spindle on the top and bottom for positive pressure.

These spindles are self-contained, therefore they should be replaced when bad. The 7.5K spindle has a non-locking drawbar and the 10K has a locking drawbar.

### 15K Air/Oil Spindle

#### Components

The 15K air/oil system consists of a spindle, a spindle lubricating oil supply pump, a vacuum pump, a positive displacement injector (PDI) block, a coalescent filter, four pressure switches (2-15psi, 1-80psi, 1-265psi) mounted on a pressure switch manifold, an electronic control board with wire harness, and various standard plumbing parts. This spindle is also belt driven.

#### Functional Description

The electronic control board controls the ON time of solenoids for oil and air while monitoring:

- Supply oil pressure
- Oil reservoir level
- Supply air pressure
- Air/oil pressure to the upper and lower bearings of the spindle

The pump pressurizes oil to the PDI block. Oil pressure is monitored by an oil pressure switch. Air is supplied to the PDI block through a coalescing filter from a solenoid valve. Air pressure to the machine is monitored by an air pressure switch. The PDI block mixes air and oil. The two lines carry the air/oil mixture to the upper and lower bearings. The pressure of each line is monitored by a pressure switch. A vacuum pump is used to remove any oil that blows by the upper or lower bearings, to reduce oil leakage.

**Spindle/Lube Pump/  
Control****Spindle**

Bearings	Ceramic Steel Hybrid
Lubrication	Air and oil pressure feed back control
Operating temp.	Ambient +20°F during steady state operation
Motor Power	15 HP
Max. Speed	15,000 RPM
Max. Cut	3/8"
Max. Depth of cut	3/8"
Max. Tool diameter	3/4"

**Spindle Lube Pump**

Lube Pump	Air and oil feed back pressure control
Oil	Mobil DTE 797 Steam Turbine Oil or equivalent
Oil Cycle	Nominal 0.025 cc/injection cycle
Oil Filtration	5 micron absolute
Air Flow	160 SCFH @ 80 psi
Air Filtration	10 micron
Venturi Vacuum Pump	9" Hg

**Control Circuit**

Supply voltage	120 VAC
Overload protection	2 amp (fused)

**Spindle Removal**

- 1) Verify that the VMC is aligned with the cold start indicators.
- 2) Power off the VMC and lockout/tagout the main disconnect.
- 3) Disconnect the air supply from the VMC.
- 4) Remove the head cover by removing the four 1/4 -20 socket head cap screws.
- 5) Disconnect the electrical connection to the orientation bridge assembly at the six pin connector plug.
- 6) Disconnect the two 1/4" air lines from the orientation bridge assembly.
- 7) Remove the draw bar cylinder plate by removing the six 1/4" hex head bolts and set them aside.
- 8) Remove the orientation bridge assembly and the front belt guide by removing the three 3/8" socket head cap screws.
- 9) To swing the spindle motor forward, loosen the 1/2" hex bolt on the left side of the spindle motor and loosen the two 1/2" hex bolts on the right side of the spindle motor.



10) Remove the spindle drive belt.

#### **WARNING**

Use heavy duty work gloves when handling the heated spindle and pulley.

11) Using a propane torch, direct the flame at the spindle pulley for approximately 6-10 minutes while slowly rotating the spindle. Maintain an even amount of heat throughout the pulley. The spindle pulley will drop down on the spindle when it is expanded enough to remove it from the spindle.

12) Label and disconnect the upper and lower spindle cooling lines from the spindle. Disconnect the 5/32" air seal line from the lower spindle flange. This will be reused later as the air supply to the vacuum pump.

13) Loosen the upper spindle retainer clamping screw.

14) Remove the six 1/2" hex bolts and lock washers from the upper spindle retainer and lift the retainer from the spindle. Ensure that the cooling line O-ring and the spindle O-ring are removed.

15) Remove the coolant supply manifold by removing the 1/4" socket head cap screw. Move it out of the work area and support it so that the lines are not crimped.



#### **WARNING**

Support the spindle with a wooden block while performing the next step.

16) Remove the six 3/8" socket head cap screws holding the spindle in the head, remove the old spindle and O-ring. Discard the used O-ring. Save the socket head cap screws.

### **Component Installation**

#### **Regulator/ Separation Block Mounting**

The regulator should be installed at the same location that it was at when the machine was originally installed.

#### **Installing Spindle Lubrication Pump**

Mount the spindle lubrication pump plate assembly to the side of the column above the way lube pump. On older model VMCs four 1/4-20 holes may need to be drilled and tapped; use the spindle lubrication pump plate assembly as a template.

#### **Vacuum Pump Installation**

Using the vacuum pump base as a template, drill through and tap two 1/4-20 holes into the left counter weight arm on top of the column. Mount the vacuum pump to the plate.

**Pressure Manifold Mounting**

Mount the pressure switch manifold block on the inside bottom of the cabinet, by removing the four knockouts and drilling the necessary mounting holes.

**Control Board Mounting**

Mount the control board on the inside upper right side of the cabinet, by drilling the necessary holes to attach.

**Solenoid Modification**

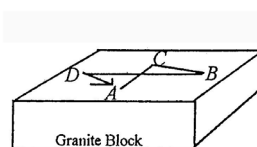
- 1) Remove the solenoid fitting on the solenoid closest to the rear of the cabinet.
- 2) Install the T-fitting and 1/4" to 5/32" reducer on solenoid.

## Spindle Tram

- 1) Level Machine.
- 2) Adjust TABLE GIBS, SADDLE GIBS, and HEAD GIBS.

Watch for Turcite gibs: .0003"  
Non-Turcite gibs: .0005"

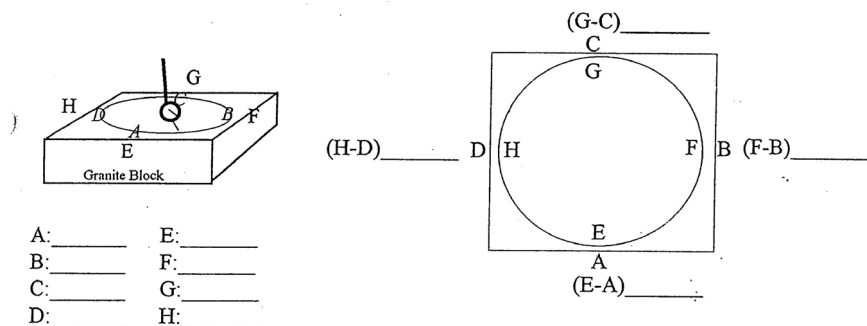
- 3) Adjust TABLE STRAPS.
- 4) Adjust SADDLE STRAPS and HEAD STRAPS.
- 5) Above items must be checked properly or Spindle Tram test may be invalid.



- 6) Establish X,Y plane by mounting an indicator in spindle. Touch off granite block at points A,B,C, and D by moving in MDI as follows:

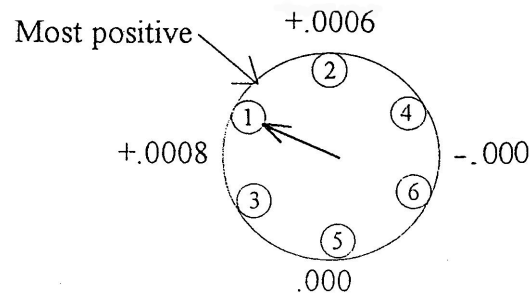
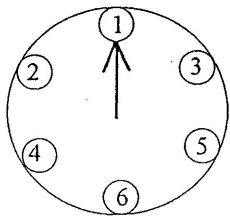
Zero indicator at A Y-10. F75. G1 (Move to C and record)  
Y5.X5. (Move to B and record)  
X-10. (Move to D and record)  
Y5.X5. (Verify zero at A)

- 7) Sweep indicator over the same four points by rotating spindle by hand. Check each point at E,F,G,H.



**Adjusting Spindle  
Tram**

If spindle is to be installed, follow this procedure. Clean all surfaces and replace O-rings. Mount spindle in head using 6 SoCap bolts. Check tram as described above. Determine which position shows the most POSITIVE error. Imagine a pointer using diagram below, and align arrow on diagram to point towards most POSITIVE direction. Loosen 6 bolts slightly, and tighten according to the diagram bolt pattern with a torque wrench. First, tighten to 25 Ft.Lb. and then to 55 Ft.Lb. Retest tram, and install upper O-Ring and clamp ring. Tighten these 6 bolts also using the following bolt pattern.

**15K Air/Oil Spindle  
Installation**

- 1) Verify that the lower spindle O-ring is in good condition (not cut, torn or pinched).
- 2) Position the 15K spindle in the head with O-ring seal.
- 3) Install six socket head cap screws and evenly tighten them until they are snug. Torque the socket head cap screws in increments of 25 ft/lbs then 40 ft/lbs.
- 4) Place a magnetic dial indicator base on the spindle. Check the run out on a true plate. The run out should be less than  $.0005"$  ( $.0127\text{mm}$ ).
- 5) Shim the spindle if necessary to achieve a proper run out specification.
- 6) Verify that the upper spindle retainer O-rings are in good condition (not cut, torn or pinched).
- 7) Align the upper spindle retaining ring with the cooling passage. Lightly cover the hex head bolts with gasket sealing compound and evenly tighten them until snug. Torque the hex head bolts to 30 ft/lbs.
- 8) Snugly tighten the retainer ring clamping screw.



- 9) Using a propane torch, direct the flame at the spindle pulley for approximately 5 minutes. Maintain an even amount of heat throughout the spindle pulley.

**WARNING**

Use heavy duty work gloves when handling the heated spindle and spindle pulley.

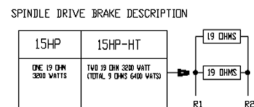
- 10) While the spindle pulley is heating, place the spindle pulley locating spacer (part # SVT-0096) on the ground surfaces of the head.
- 11) Find the orientation mark on the top of the spindle housing and position the spindle so that the orientation mark is toward the front of the VMC. Secure the spindle so that it will not rotate when installing the spindle pulley.
- 12) Place the spindle pulley on the spindle so that it rests on the locating spacer, at the same time align the orientation marks of the spindle and the spindle pulley.
- 13) Allow the spindle pulley to cool to the touch before continuing with the assembly.
- 14) Install the spindle drive belt.
- 15) Place a dial indicator against the top front edge of the pulley and set it at zero.
- 16) Swing the spindle motor towards the rear of the machine until the dial indicator reads .0003" (.0076mm).

**WARNING**

Do not adjust the belt tension more than the recommended deflection.

- 17) Tighten the 1/2" hex bolt on the left side of the spindle motor and the two 1/2" hex bolts on the right side of the spindle motor.
- 18) Install the orientation bridge assembly and front belt guide with the three 3/8" socket head cap screws, and tighten them snugly.
- 19) Install the draw bar cylinder plate with the six hex head bolts, and tighten the bolts.
- 20) Connect the six pin connector plug into the orientation bridge assembly.
- 21) Connect the two 1/4" air lines to the orientation bridge.
- 22) Connect the coolant lines removed from the old spindle to the upper and lower connections on the new spindle.

1) Using the figure below and the following clarifying instructions, install the wire harness assembly inside the control cabinet.



- 5) Inspect the machine for the version of mill interface board (1040) installed. The 15K spindle system requires a 1040-2B or newer mill interface board. Update the machine to the newer card if necessary.

**Plumbing Spindle**

- 1) Pull four 5/32" air lines from the back of the machine up through the cable ways to a point just above the head next to the motor mounts. Leave a portion of the lines coiled for extra.

**Note:** Check the machine for the High/Low option 5/32" lines. If these lines are present they can be used instead of pulling the new lines through the cable ways. Label these lines as 21, 22, 25 and 26 if used.

- 2) Pull the 5/32" air seal line previously removed from the old spindle up through the cable way. Connect it to the fitting (32) on the vacuum pump.
- 3) Insert three 5/32" lines in 3 foot lengths into the fittings located on the lower spindle flange. The three lines are the inlet line stamped "AIR/OIL IN" (23), the exhaust line stamped "AIR OUT" (29), and the vacuum line stamped "VACUUM" (27).
- 4) Cover the two lines (23, 27) with 1/4" nylon tubing from the fittings to the point where they enter the head.
- 5) Feed the line from the fitting on the lower flange stamped with "AIR/OIL IN" (23) up through the head to where the four lines are located next to the motor mount.
- 6) Insert three 5/32" lines in 3 foot lengths into the three fittings located on the upper bearing retainer just below the pulley. The three lines are the inlet line stamped "AIR/OIL IN" (24), the exhaust line stamped "AIR OUT" (30), and the vacuum line stamped "VAC/AIR" (28).
- 7) Feed the inlet line, stamped "AIR/OIL IN" (24) on the upper bearing retainer, into the head and up along side the other lines from the lower flange.
- 8) The four lines coming to the head from the back of the machine are two PDI lines (21, 22) and two Pressure switch lines (25, 26). Be sure to keep these lines labeled.
- 9) Connect one air/oil PDI line (21) and one pressure switch line (25) to the double end of the Y-fitting.
- 10) Connect the inlet line, stamped "AIR/OIL IN" (23) on the lower flange, to the single end of the Y-fitting.

- 11) Connect the other air/oil PDI line (22) and the other pressure switch line (26) to the double end of the second Y-fitting.
- 12) Connect the inlet line, stamped "AIR/OIL IN" (24) on the upper bearing retainer, to the single end of the Y-fitting.
- 13) Feed the two outlet lines, one from the lower flange Stamped "AIR OUT" (29) and one from the upper bearing retainer stamped "AIR OUT" (30), into the inside of the head and fasten them to any hose with a nylon wire tie. These two lines are the exhaust lines.
- 14) Verify that a 5-in-line valve system or air-seal valve is installed on the machine. If they currently do not exist on the machine, order and install part number VLV-0006.
- 15) Feed the lower vacuum line (27) up through the head to the vacuum pump and connect it to the Y-fitting (27) on the vacuum pump.
- 16) Feed the upper vacuum line (28) along the top of the head to the vacuum pump and connect it to the fitting (28) on the vacuum pump.
- 17) Verify that all plumbing lines are installed correctly. Secure loose lines as necessary with nylon wire ties.

#### **Install Component Plumbing**

- 1) Complete the installation of all lines for the air supplies, oil supply lines and pressure feed back lines.
- 2) Before filling the spindle lubrication pump with the recommended oil (Mobil DTE 797 Steam Turbine Oil), remove the reservoir and inspect the float on the level switch. The cutaway ridge on the float should be on top. Remove the float and reverse it if the ridge is on the bottom of the float.

#### **Start Up After Installation**

- 1) Fill the reservoir on the spindle lube tank with Mobil DTE 797 ISOVG32 oil or equivalent. Any other viscosity oil will cause damage to the spindle.
- 2) Check the wiring on the circuit control board.
- 3) Plug in the air supply line to the machine and set the regulators to 80 psi for the left regulator and 120 psi for the right regulator.
- 4) Remove the oil pressure line from the oil pressure switch fitting on the pressure switch manifold. Hold the line over a collecting container. Prime the spindle lubricating pump by depressing the solenoid button with a small screwdriver until all air bubbles are removed from the oil pressure line.

**Note:** Observe the color of the oil coming out of the oil pressure line. If the color is DARK BROWN, there is way lube oil in the pump. Prime the line until the way lube oil is flushed out. The spindle oil color is LIGHT YELLOW, prime the oil pressure line until the oil coming out is this color.

- 5) Replace the oil pressure line at the oil pressure switch fitting.
- 6) Press the reset button on the control board and observe the LED lights (if any lights are illuminated then take the action necessary to correct the condition).
- 7) Prime the PDI block with the spindle inlet lines at the Y-fitting on the head disconnected. Prime until oil is seen flowing through both of the 5/32" lines coming out of the PDI block. Prime by pressing the spindle lubrication pump solenoid button with a small screwdriver. Press it for 10 seconds and release it for 10 seconds and repeat until oil flow is satisfactory. Priming can only be done while the air is flowing to the spindle. If air is not flowing then press and release the reset button. This will provide 2 minutes of air flow.
- 8) After priming the PDI block, run the spindle at 10,000 RPM and monitor the temperature for 20 minutes. If the temperature is high, check the PDI block operation.
- 9) Run the spindle at 15,000 RPM and monitor the temperature. The spindle temperature should be below 100°F after one-half hour. This is the steady-state temperature of the spindle.
- 10) If the temperature exceeds this specification, verify the oil line connections and the oiling cycle.

### Normal Operation

The air/oil spindle lubrication system operates automatically using the 1980-0 control board. The pressure switches will cause an emergency stop condition if the system is not operating properly.

On start-up the 1980-0 Control Board LEDs operate as follows:

- 1) Power on without air and oil to the machine.

**HB** - blinking.

**OIL, AP, LEV, AIR** - illuminate.

**OE, UAP, LAP** - remain out for 13 seconds from power ON, then illuminate.

**OIL** - illuminates, turns OFF in 15 seconds from power ON.

- 2) Power on with air and oil to the machine (Green CNC button depressed).

**HB** - blinking.

**OIL, AIR** - illuminate.

**AP, LEV, OE, UAP, LAP** - remain OFF.

**OIL** - illuminates, turns OFF in 15 seconds from power ON.

**AIR** - illuminates, turns OFF in 2 minutes from power ON.

3) While the spindle is running.

**HB** - blinking.

**OIL** - illuminates only during oiling cycle for 15 seconds every 20 minutes.

**AIR** - illuminated continuously, turns OFF 2 minutes after the spindle stops.

**AP, LEV, OE, UAP, LAP** - remain OFF.

## Troubleshooting

### LED Indications

**HB LED** - Normally flashes indicating that the 1980-0 control board is functioning properly.

**AP LED** - This LED will illuminate when air pressure does not reach or drops below 80 psi. Air pressure less than 80 psi will cause an emergency stop of machine.

Adjust the regulator air output pressure to clear this condition. If the regulator fails to maintain pressure repair or replace the regulator.

If the air pressure is correct, check the setting of the air pressure switch. The slotted adjusting screw, on top of the switch, should be two turns from flush with the switch housing. Check for loose wires. The switch may be faulty if adjusting it has no effect.

**LEV LED** - This LED will illuminate when the oil level in the spindle lube pump tank is low. A low oil level signal will cause a feed hold on the machine until corrected.

Check the sight glass for an adequate level in the supply tank. If tank level is okay, then check for binding, an inverted float, the level float sticking or loose electrical wiring.

**OE LED** - This LED will illuminate when the oil pressure does not reach or drops below 265 psi. Low oil pressure will cause an emergency stop of the machine.

Correct the oil pressure output, by adjusting the air pressure to the pump/PDI block. Loose wires, broken hoses, a bad pressure switch or failure of the

solenoid can also cause this indication. If the oil pressure is still low, verify that the air and oil filters are clean replace elements if required.

**UAP LED/LAP LED** - These LEDs will illuminate if the oil pressure to the upper or the lower spindle bearings drops below 15 psi. Low bearing pressure will cause an emergency stop of the machine.

Loose wires, broken hoses, a faulty pressure switch or the pressure switch adjusted too low can also cause this indication. The adjusting screw, on top of the pressure switch, should be flush with the top of the housing.

### Reset Condition

If any of the above errors occur remedy the problem. Press the reset button located near the top of the 1980-0 control board to clear the error signal. The reset button can be pressed while the spindle is running. The 1980-0 control board will also reset if the power to the CNC is turned off then on.

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## Coolant Thru the Spindle

### Electrical

The coolant thru pump receives its three phase power from the transformer routed though three fuses to a overload starter relay that is controlled by mist coolant output from 1100-1 TB2-23 & 24. K22 (protected by F18) is turned on with a M8 or M7 (SETP setting).

### Mechanical

When the pump is activated, it draws coolant into the filter and then to the pump. The coolant is pumped up to the Drawbar Cylinder. The coolant flows down though the Drawbar Cylinder rod to the seals. The system is designed to ride together under the pressure of the three weak springs, and then hydraulically press together when coolant is present. It will need lubricant present at least 1 or 2 times a day to prevent premature abrading. This is accomplished by activating the coolant thru.

### Coolant-Thru Spindle Seal Kit Instructions

- 1) With a tool already installed in the spindle, remove Drawbar Cylinder and Hydraulic Actuator assembly, if equipped.
- 2) Using 1/4-20 x 2 bolts, thread into CNT-0041 Seal Retainer Ring to hold it into the Orientation Bridge upon disassembly.
- 3) Remove the Orientation Bridge and lay aside, being careful not to fold nylon air lines.

- 4) Remove existing Ceramic Seal retainer and Locking Drawbar Knock-out cap.
- 5) Using Gear Puller and SVT-0073 Drawbar Removal Tool, remove LDB Spring Pilot and replace inner and outer O-rings with HDW-0155 and HDW-0158 respectively.
- 6) Re-install Spring Pilot.
- 7) Now, replace HDW-0177 O-ring on Drawbar and mount new style knock out cap using original bolts.



**WARNING:** Do not handle the graphite seal with bare hands, wear latex gloves while installing. Finger oils contain acids which will shorten the service life of the seal.

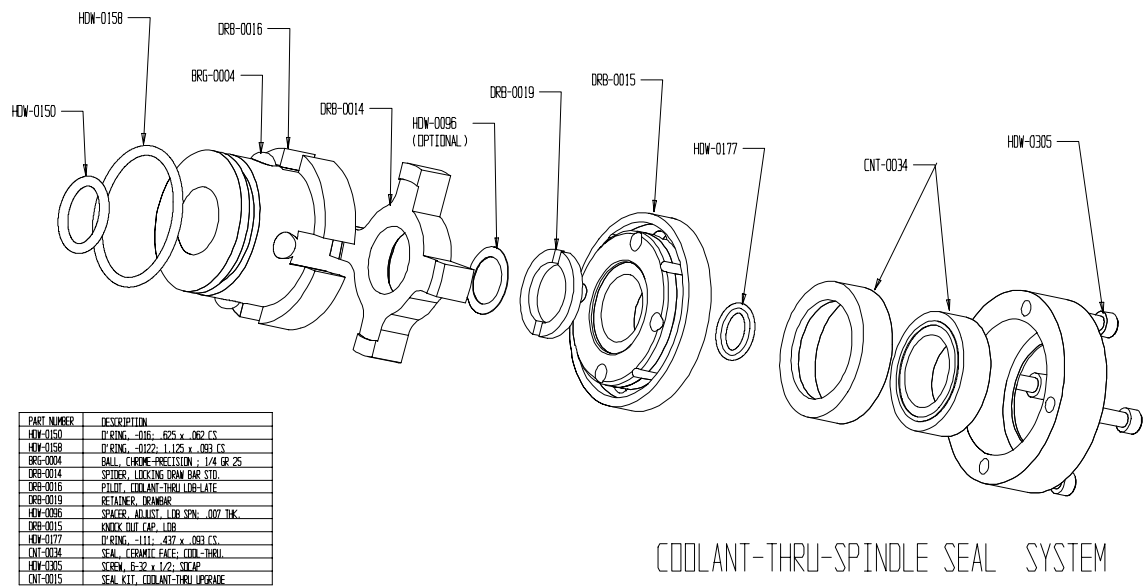
- 8) Assemble Ceramic seal face into its boot, and press into pocket on new retainer with smooth or unmarked side into pocket first. Install HDW-0177 O-ring onto DRB-0015 Knock-Out cap.
- 9) Mount new Retainer and Ceramic Seal assembly onto Knockout Cap, rotating slightly over the HDW-0177 O-ring. Do not level Ceramic Seal face as in previous versions; it is self-leveling.
- 10) Replace O-rings in the Orientation Bridge, and replace the CNT-0033 Graphite seal.
- 11) Note that the CNT-0041 Retainer has two similar sized O-rings but has the HDW-0156 on the outer piston portion, and the HDW-0150 inside at the top, and HDW-0155 inside at the bottom.
- 12) Place a small amount of Plain water, NOT oil or COOLANT, on the white Ceramic Seal face before mounting the Orientation bridge. Align the Orientation Bridge with the SVT-0071 Coolant-Thru Alignment tool, and reassemble it and the Drawbar Cylinder. Don't forget to remove the two bolts holding the seal retainer.
- 13) After reassembly, run the spindle at S150 RPM for 30 seconds to level out the Ceramic Seal, and lap the Graphite to the Ceramic Seal face.

#### **Determining the Leak Location**

- 1) Examine area under the Orientation Bridge and around the pulley. If the wires for the orientation and drawbar down hall effect switches has coolant on them then the O-rings (HDW-0150) at the top of the Piston Housing, coolant -thru (CNT-0042) are most likely the problem.
- 2) Remove the Drawbar Cylinder and the Orientation Bridge (don't forget your coolant-thru retainer screws).

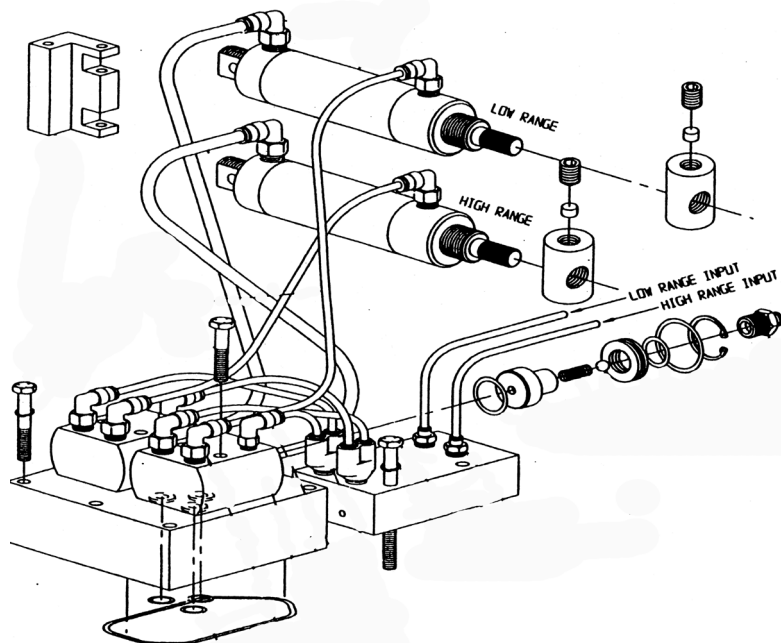


- 3) With an indicator, check the level of the Ceramic Seal, this seal needs to be level and is manufactured to a 2 Light-Bars flatness. Run out less than .0003" (.0076mm)
- 4) Verify that the Piston assembly moves freely up and down under the spring pressure on the orientation bridge.
- 5) Inspect the Graphite and Ceramic seals for pitting or chipping.
- 6) Check the O-rings in the Piston assembly.
- 7) Install a 10 micron filter.

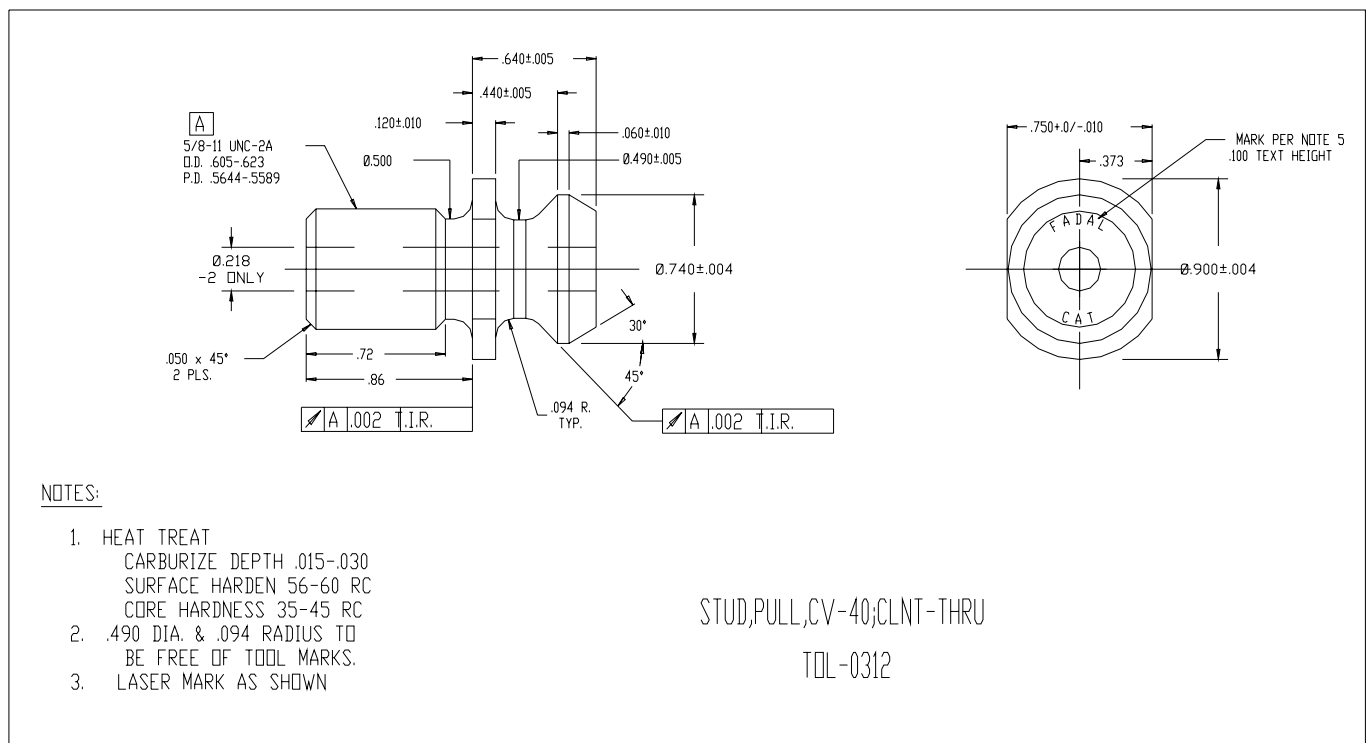
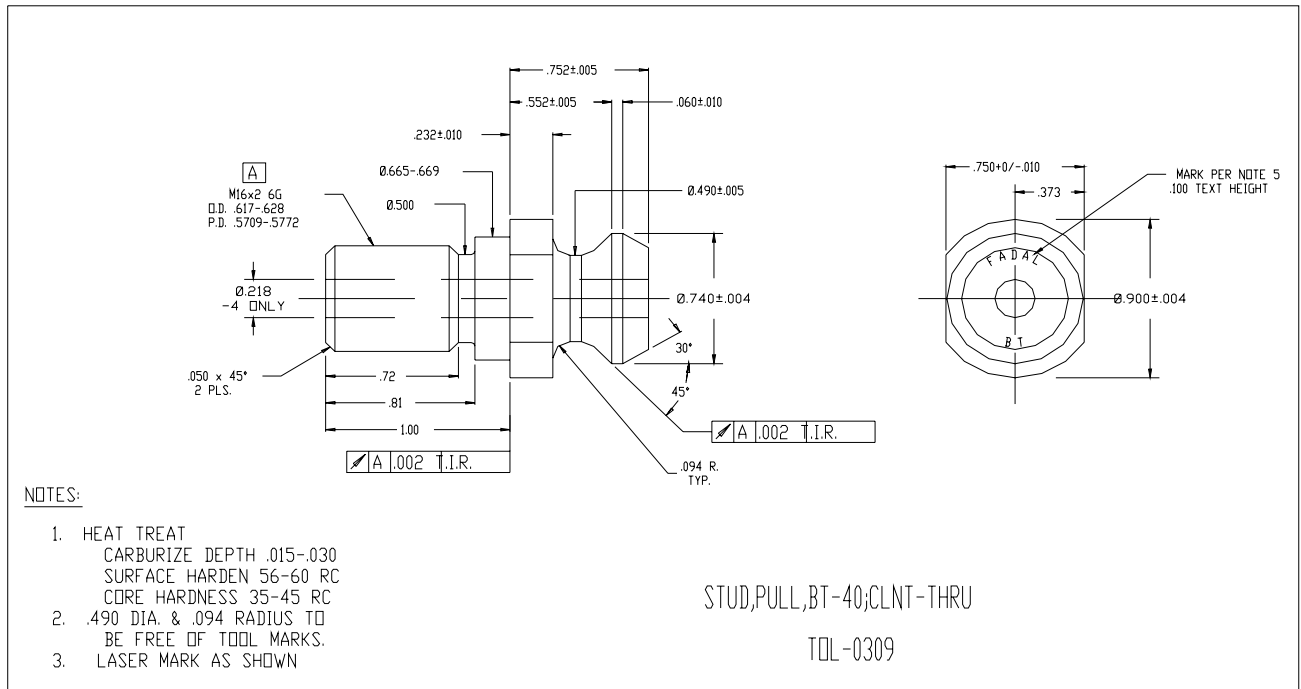


E:\3D MODELING\COOLANT THRU SPINDLE SEAL SYSTEM 07/16/97

Hydraulic Actuator  
Set-up



## 40 Taper BT & CAT Pull Studs





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## Section 09: Attached Optional Devices

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### M-Function Board Use and Setup

#### Miscellaneous Functions (M-Codes)

Miscellaneous functions, or M-codes, are used to control actions other than the normal machine movement. M-functions may control functions such as starting and stopping of motors, indexers, turning coolant on and off, changing tools, and clamping and unclamping parts. M functions are the letter M followed by a two-digit code. The following page has a list of the Fadal M-codes.

Fadal provides user available M-functions. Additional functions or functions requiring feedback require optional hardware.

**Note:** List of M function codes used by the Siemens Controlled Fadal VMC.

M0	NC STOP
M1	Optional Stop
M2 / M30	NC Program End
M3	CW Spindle On
M4	CCW Spindle On
M5	Spindle Off
M6	Tool Change
M7	Coolant 1
M8	Coolant 2
M11	Reset Tool Order
M19	Orient and Lock Spindle
M41	Low Gear
M42	High Gear
M83	Spindle Set Up (Gear Ratio Measurement)

## Fadal M Functions

M0	Program Stop	M48.3	Dual Rotary Pot Active Pallet B
M1	Optional Stop	M49	Feed Rate and RPM Pot Inactive
M2	End of Program	M49.1	Servo Coolant Pot Inactive
M3	Spindle on Clockwise	M49.2	Dual Rotary Pot Inactive Pallet A
M3.1	Sub-Spindle On Ignore Magnet CW	M49.3	Dual Rotary Pot Inactive Pallet B
M3.2	Acknowledge Spindle Magnet	M60-69	User Attached Devices
M4	Spindle On Counter Clockwise		M60 A Axis Brake On
M4.1	Sub-Spindle On Ignore Magnet CCW		M61 A Axis Brake Off
M4.2	Acknowledge Spindle Magnet		M62 B Axis Brake On
M5	Spindle Off		M63 B Axis Brake Off
M6	Change Tool		M64 MP Probe Active
M7	Coolant 1 On		M65 TS-20 Probe Active
M7.1	Servo Coolant 1 On		M66 MP-12 Probe Active
M8	Coolant 2 On		M67 Laser Probe Active
M8.1	Servo Coolant 2 On	M80	Automatic Doors Open
M9	Coolant Off	M81	Automatic Doors Close
M10	Cancel Reciprocation	M90	Default Gain (from SV command)
M11	X-Axis Reciprocation	M90.1	Advanced Feed Forward Gain Enable
M12	Y-Axis Reciprocation		P=Gain (50-250)
M13	Z-Axis Reciprocation	M91	Normal gain
M14	B-Axis Reciprocation	M92	Intermediate Gain
M15	A-Axis Reciprocation	M94	Feed Forward
M16	C-Axis Reciprocation		P=Angle Tolerance
M17	End of Subroutine		Q= Line Length (Moves less)
M18	Cycle Cushman Indexer		Ex: M94 P91 Q.002
M19	Spindle Stop / Orient	M94.1	Feed Forward by Feed Rate Modification
M20	Cycle General Purpose Indexer		State Feed Rate Before M94.1 Line
	Also: Automatic Doors Close		P=Angle
	Also: Toggle On/Off Hydrosweep		Q=Percentage change each modification
M30	End of All Subroutines		R0+=Min. Feed Rate Modification
	Also: End of Program (Format 2)		R1+=Length to Ignore M94.1
M31	Exchange Pallets		R2+=Modify feed every, this angle, from P
M32	Store / Load Pallet		Ex: M94.1 P170 Q10. R0+50. R1+1. R2+15.
M32.1	Load and Verify Pallet A	M94.2	Advanced Feed Forward On
M33	Store / Load Pallet B		P=Ramp, Q=Detail Window
M33.1	Load and Verify Pallet B	M95	Feed Forward Cancel
M41	Low Range RPM	M95.1	Feed Forward by Modify Cancel
M42	High Range RPM	M95.2	Advanced Feed Forward Cancel
M45	Execute Fixed Cycle	M96	Roll CRC
M46	Positive Approach On	M97	Intersectional CRC
M47	Cancel Positive Approach	M98	Execute Sub Program
M48	Feed Rate and RPM Pot Active		P=Program #
M48.1	Servo Coolant Pot Active		L=# of repetitions, Line repeat / Sub repeat
M48.2	Dual Rotary Pot Active Pallet A	M99	End of Sub Program
			Also: Line Jump, P=Line #, Ex: M99 P#

**WARNING:**

Any wires leaving the control box must be in a grounded conduit. Please obey the electrical code. In Applications where there is high current, use M-functions to activate relay.

**Fadal Normally Supplied M-Functions**

Fadal supplies M-Functions M60 thru M69 with all machines. They are output on the 1100-1 board. The even numbered M-code activates the relay and the odd number deactivates the relay. Each set of M-codes has a relay and a fuse. On the terminal block (TB), each M-function set has two connections with a 120 VAC connection on one side and a return (RET) on the other side.

To show proper connection of the M-Function, use the M60 / M61, which uses connections TB2, pins 39 and 40. Next to pin 40 is a 120 VAC connection. Jumper this 120 VAC connection to pin 39 and connect the two wires, from the device, to the RET next to pin 39 and to pin 40 (see the example on the next page).

Up to 3 amps at 120VAC may be taken from the 120 VAC output next to the terminals.

This group of M-Functions uses solid-state relays; therefore, 120 VAC must be used across the output connections.

**Fadal Optional M-Functions**

**Note:** If the machine that the M-Function option is being installed in has a 1060-1A Motherboard, then a PCB-0175 circuit board, an M-Function interface, 1340-0, and a WIR-1679 Cable Assembly with a 40pin, 1060-1A to 1340 are required. A WIR-0178 Cable, a 5C indexer, and an MTR to Control may also be needed.

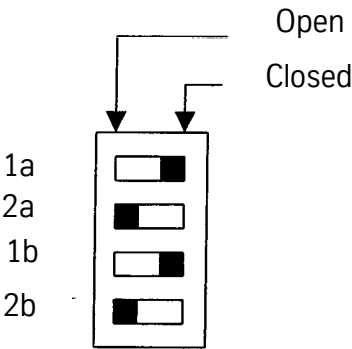
**1050-3A M-Function PCBA (PCB-0008) - Two M Functions.**

The 1050-3a, M-Function board, decodes two (2) M-Functions. The M-Functions are selected by installing jumpers at U6 on the circuit board. The following example illustrates how to select the M-functions using jumpers. The M20 and M80 M-functions are displayed.

U6 (Jumper)

M20	1	16	"A" M-Function
M30	2	15	"B" M-Function
M40	3	14	
M50	4	13	
M60	5	12	
M70	6	11	
M80	7	10	
M90	8	9	

**U7 (Dip Switch)** Each M-Function can be set for the desired reset condition using the set of switches located at U7. Switches 1 a & 2a correspond to the "A" M-Function, switches 1 b & 2b correspond to the "B" M-Function.



**Reset Options** The selected M-Function delays the part program until the condition for reset is satisfied (see chart below for the four (4) reset conditions).

Duration of relay Closure	CNC Proceeds	M-Function			
		«A» 1a	2a	«B» 1b	2b
(1) .1 sec. Pulse	Immediately after pulse	open	open	open	open
(2) .1 sec Pulse	At reset closure	closed	open	closed	open
(3) Held	At reset closure	open	closed	open	closed
(4) Held	After reset release	closed	closed	closed	closed

**Note:** Electro-Mechanical relays are required for any device not using DC.



## M-Function Contacts

Each M-Function has one set of normally open contacts. The contacts are available to the user at TB 1, TB2 and TB3 on the backplane.

"A" M-Function - TB 1 pins 7 & 13

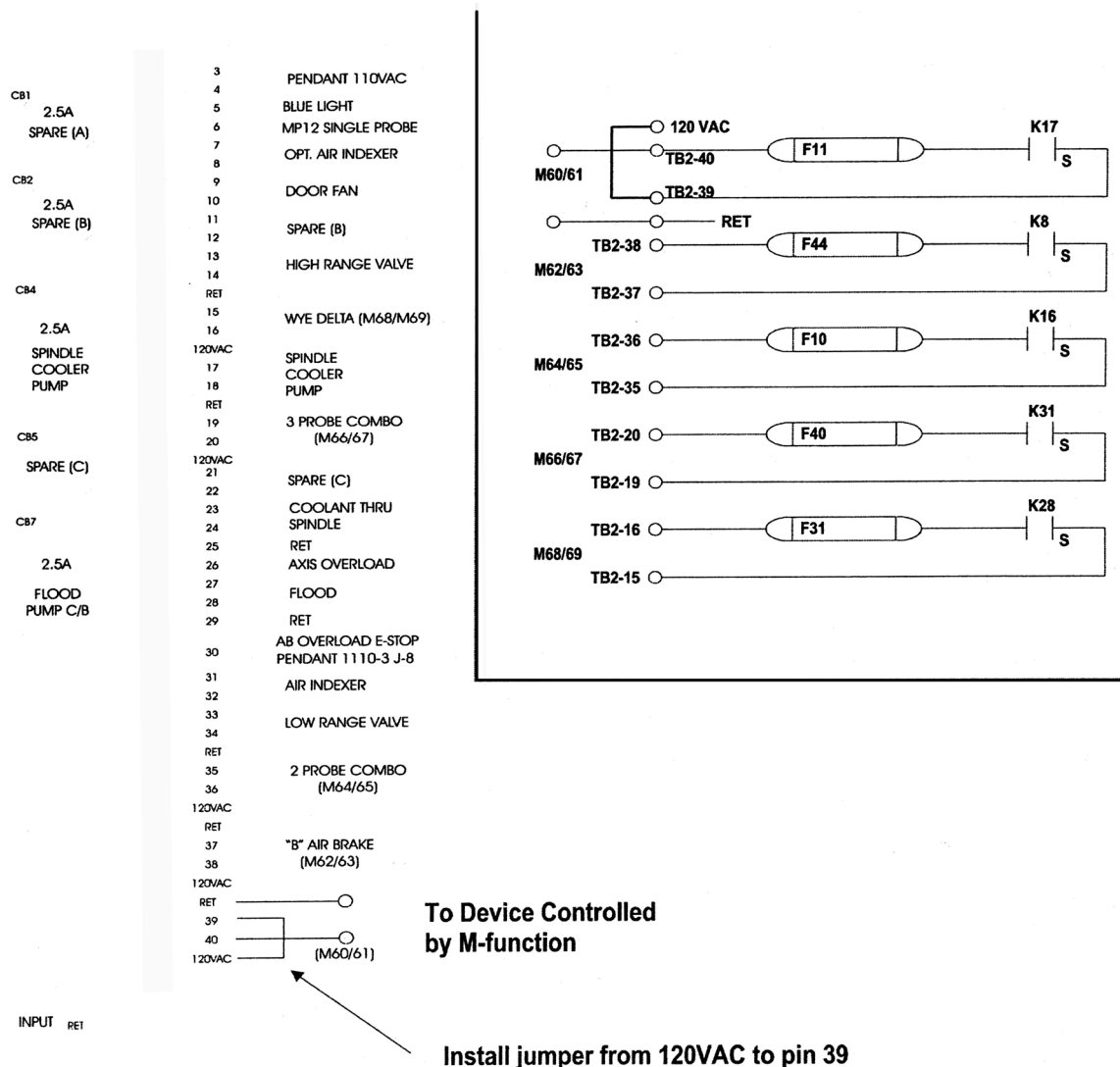
"B" M-Function- TB2 pins 11 & 10

A reset condition is accomplished by connecting between the terminals of TB3, pin 1 & 2. TB3 is located on the lower portion of the motherboard.

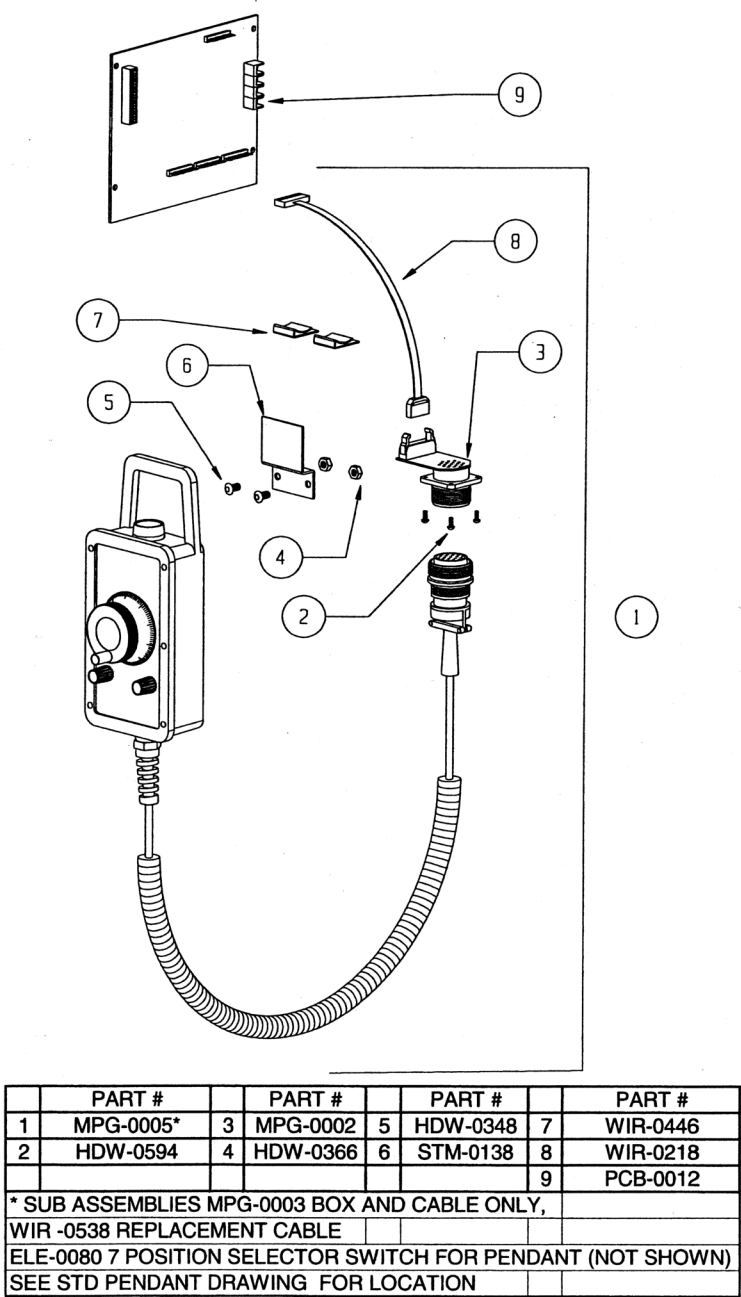
**Note:** WIR-0178 Cable, SC Indexer; MTR to CNTRL (indexer cable)

1050-0 M-Function PCBA (PCB-0007) - One to twenty M functions

## M-Function Hook-up



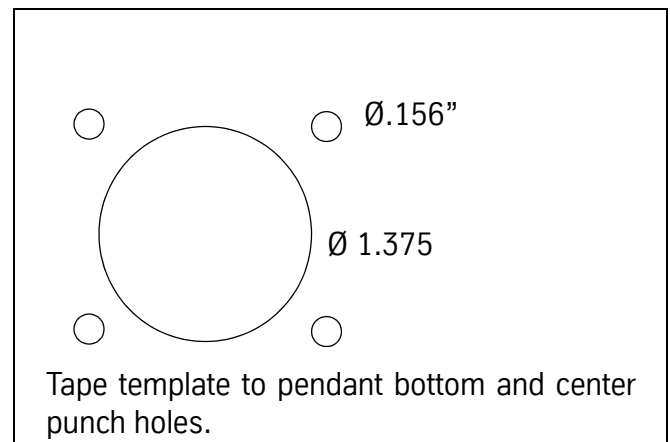
Remote Manual  
Pulse Generator



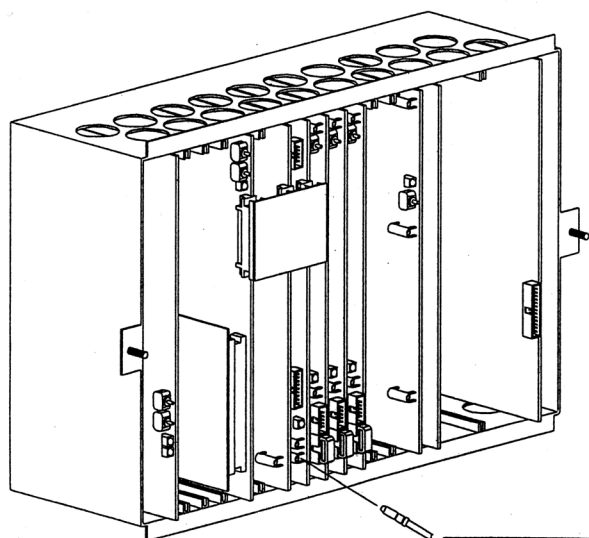
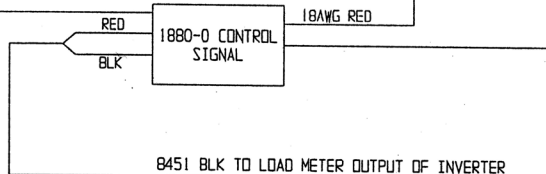
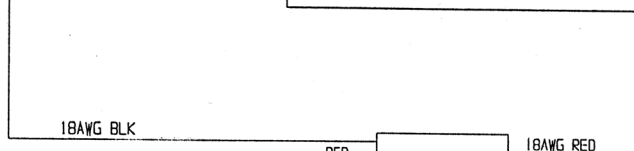
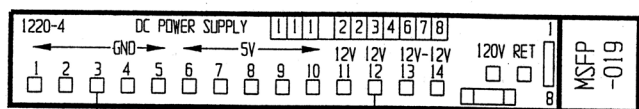
**Installation  
Procedure**

- 1) If Remote MPG is to be installed on a NEW style pendant (CNC88HS), remove tacked-on cover for adapter with hammer and punch or chisel.
- 2) If Remote MPG is to be installed on earlier pendant that does not have pre-drilled holes, then mount the adapter jack about 3" from the back side and 3" from the left side (as viewed from the front). Some pendants may have a 1110-1 board mounted here, so locate 3" from the right side in that case.
- 3) Using the template, mark and center punch the 5 hole locations. Punch the center hole using a hole punch or a large step drill. Diameter is 1.375 inches. Then drill the four mounting holes at .156 inches in diameter.
- 4) With a gasket between the jack and the floor of the pendant, install using (4) 6-32 screws and keps nuts.
- 5) Remove the 201090 board and replace with the enclosed 201090-3. A board reconnecting all cables and wires into the same locations as was on the original board. Connect included cable with 12-pin connector at J7, and install the two separate wires at connector J5 on the new 201090-3A at pins 5 and 8 (either wire at S or 8).
- 6) Plug the 14 pin connector from cable #5241 to connector on 201770-0. Note pin 1 orientation on connector (red stripe on ribbon) and board. Reversed plug will not only cause Remote MPG not to operate, but will damage unit.
- 7) Remove 6-position axis selector switch on pendant and replace with #1453-2 7-position switch. Wiring is identical to old switch.

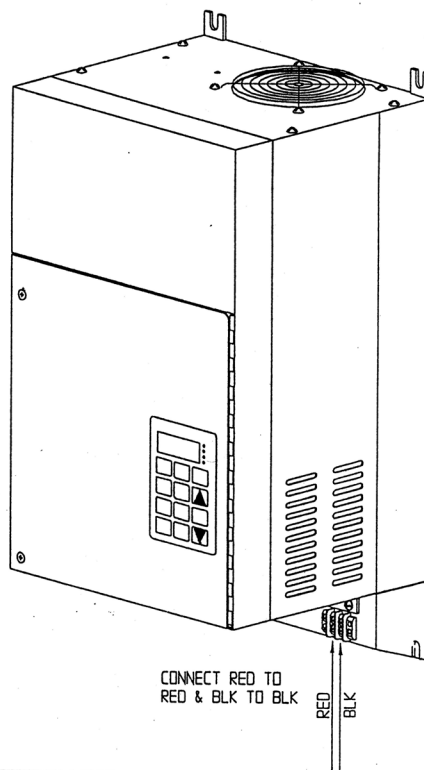
Red-1  
Wht-2  
Grn-4  
Blk-C



## Dynamic Tool Load Compensation

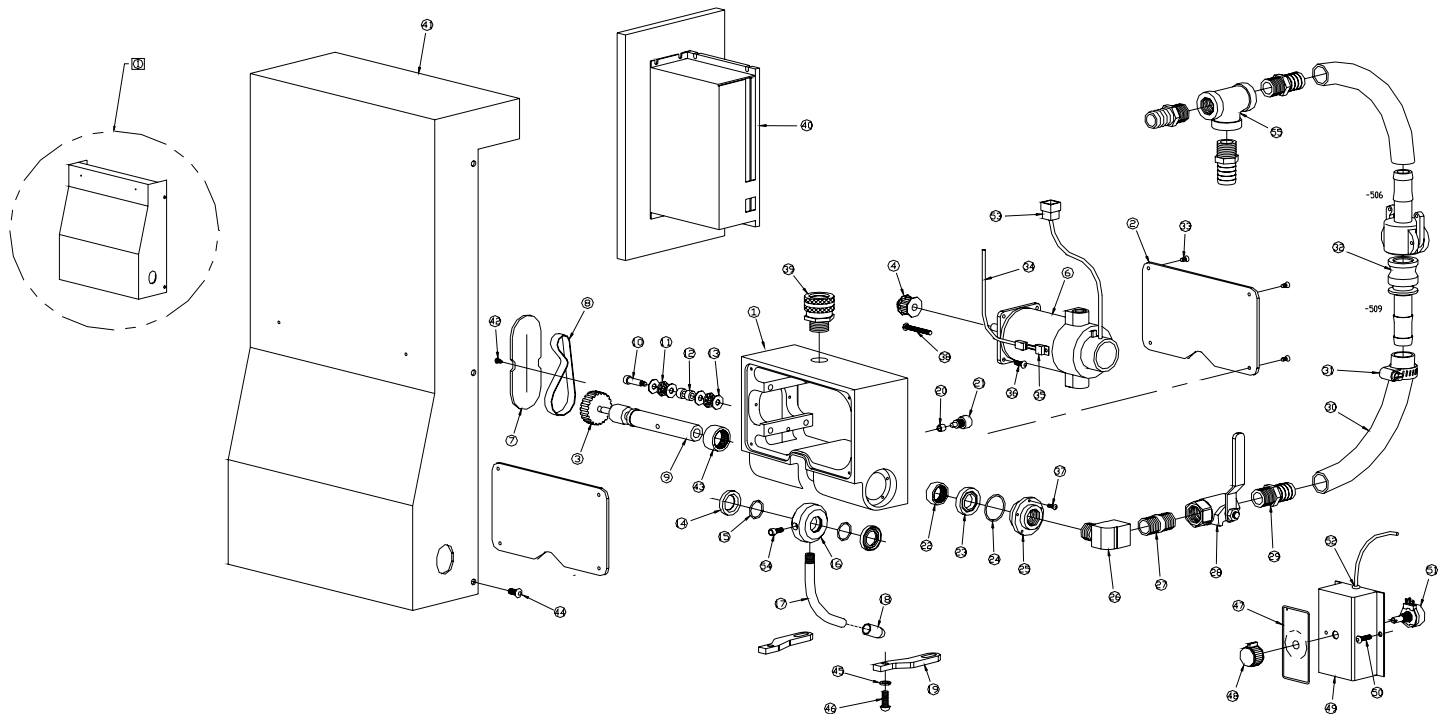


PLUG CONNECTOR INTO J5 (POTS) ON 1030-1 BOARD



N:\MAIN\PR2\QC\1880-0.PRT

## Servo Coolant Assembly



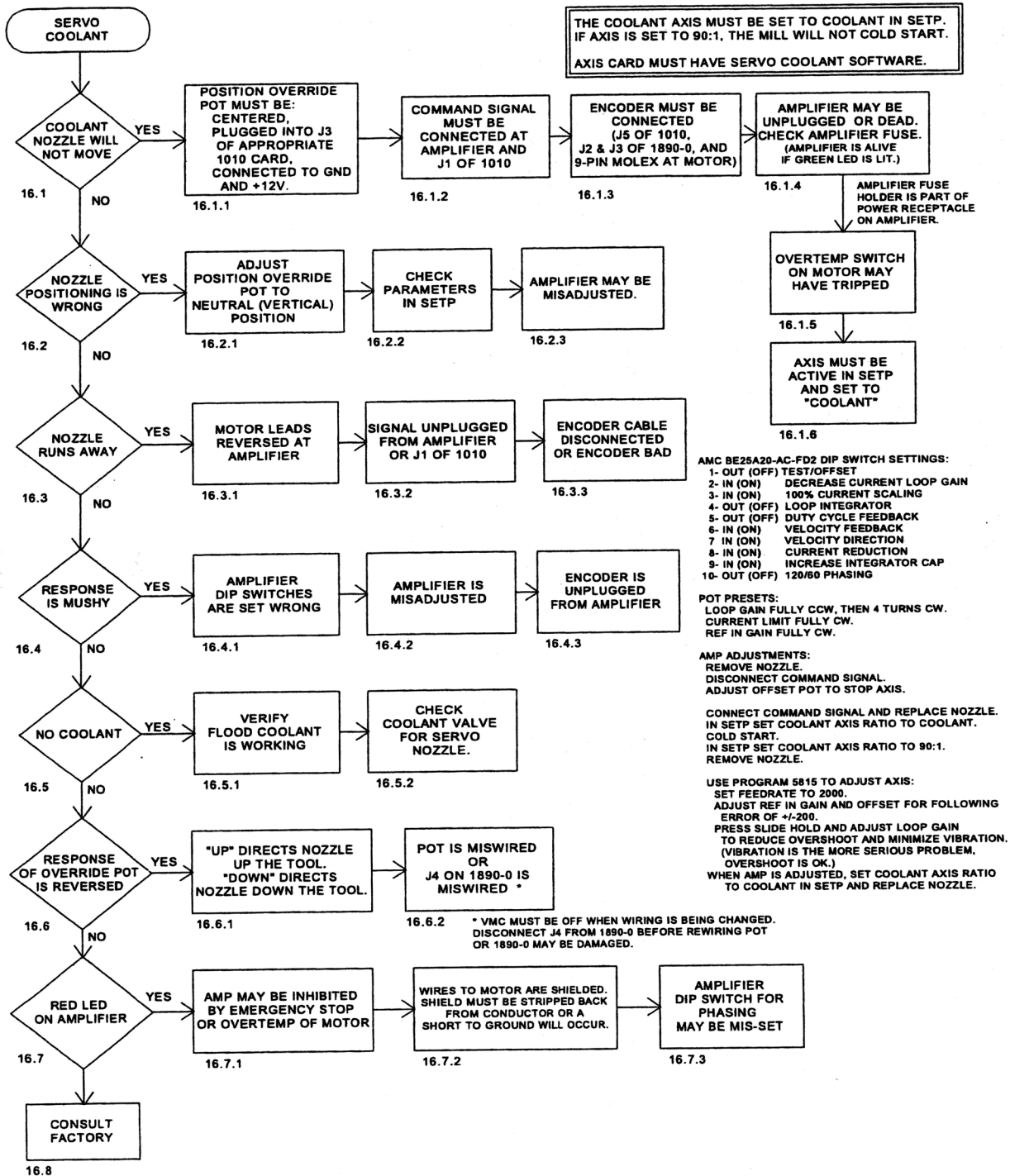
ITEM	QTY.	PART DESCRIPTION	PART #
1	1	SERVO COOLANT HOUSING	CNT-0188
2	2	COVER, SERVO COOLANT	CNT-0190
3	1	LARGE PULLEY (4607-103)	PUL-0049
4	1	SMALL PULLEY (4607-102)	PUL-0048
5		DELETED	
6	1	1/17 HP. BODINE MOTOR/ ENCODER	MTR-0055
7	1	COVER, SERVO COOLANT, SIDE	CNT-0189
8	1	PULLEY BELT	BEL-0028
9	1	COOLANT SHAFT	CNT-0153
10	1	250 X .75 X 10-32 SHOULDER BOLT	HDW-0800
11	2	THRUST ROLLER BEARING NYA-411	BRG-0120
12	2	NEEDLE ROLLER BEARING B-44	BRG-0116
13	4	THRUST WASHER TRA-411	BRG-0119
14	2	CR SEAL 7414	HDW-0758
15	2	O-RING	HDW-0696
16	1	COOLANT WHEEL	CNT-0155
17	1	SPRAY TUBE	CNT-0152
18	1	PIPE NOZZLE	CNT-0161
19	2	MOUNTING TAB	CNT-0160
20	1	PIPE GUIDE SPACER	CNT-0157
21	1	PIPE GUIDE SCREW	CNT-0156
22	1	NEEDLE ROLLER BEARING B-126	BRG-0118
23	1	CR SEAL 7434	HDW-0757
24	1	O-RING	HDW-0697
25	1	PIPE ADAPTER	CNT-0154
26	1	1/2 x 1/2 90° STREET ELBOW	PLM-0189
27	1	1/2 NPT SHORT NIPPLE	PLM-0092
28	1	COOLANT VALVE	VLV-0017

29	4	1/2 x 1/2 HOSE BARB	PLM-0104
30	1	1/2 PARKER HOSE	PLM-0014
31	6	HOSE CLAMP	HDW-0253
32	1	QUICK DISCONNECT	PLM-0020/PLM-0144
33	4	6-32 x .375 FLATHEAD	HDW-0325
34	1	SERVO COOLANT HARNESS ASSEMBLY	WIR-0533
35	1	TEMP SWITCH	ELE-0722
36	4	10-32 x .5 SDCAP.	HDW-0302
37	6	6-32 x .375 BUTTON HEAD	HDW-0594
38	4	SCREW, 10-32 X 1.75, ROUND HEAD	HDW-1114
39	1	1/2 APPLETON	WIR-0517
40	1	AMPLIFIER (BE25A20ACD-F01)	AMP-0013
41	1	SERVO COOLANT COVER	STM-0674
42	4	6-32 x .25 BUTTONHEAD	HDW-0593
43	1	BH-1312 ROLLER BEARING	BRG-0117
44	6	1/4-20 x .5 BUTTONHEAD	HDW-0346
45	2	1/4 SPLIT LOCKWASHER	HDW-0279
46	2	1/4-20 x .75 BUTTONHEAD	HDW-0589
47	1	SRV. CLNT. LABEL	LBL-0044/LBL-0180/LBL-0246
48	1	KNOB	HDW-0671
49	1	SERVO COOLANT BOX	STM-0759
50	2	10-32 x .5 BUTTONHEAD	HDW-0348
51	1	SPINDLE POTENTIOMETER	ELE-0066
52	1	1/4 RUBBER GROMMET	HDW-0687
53	1	CONNECTOR	WIR-0048
54	1	10-32 x .5 SDCAP.	HDW-0302
55	1	1/2 NPT TEE	PLM-0089

① USE STM-1132 INSTEAD OF STM-0674 (ITEM 41)  
FOR SLANT MACHINES WITH CHAIN HOIST OPTION

NOTES:

## Servo Coolant Control



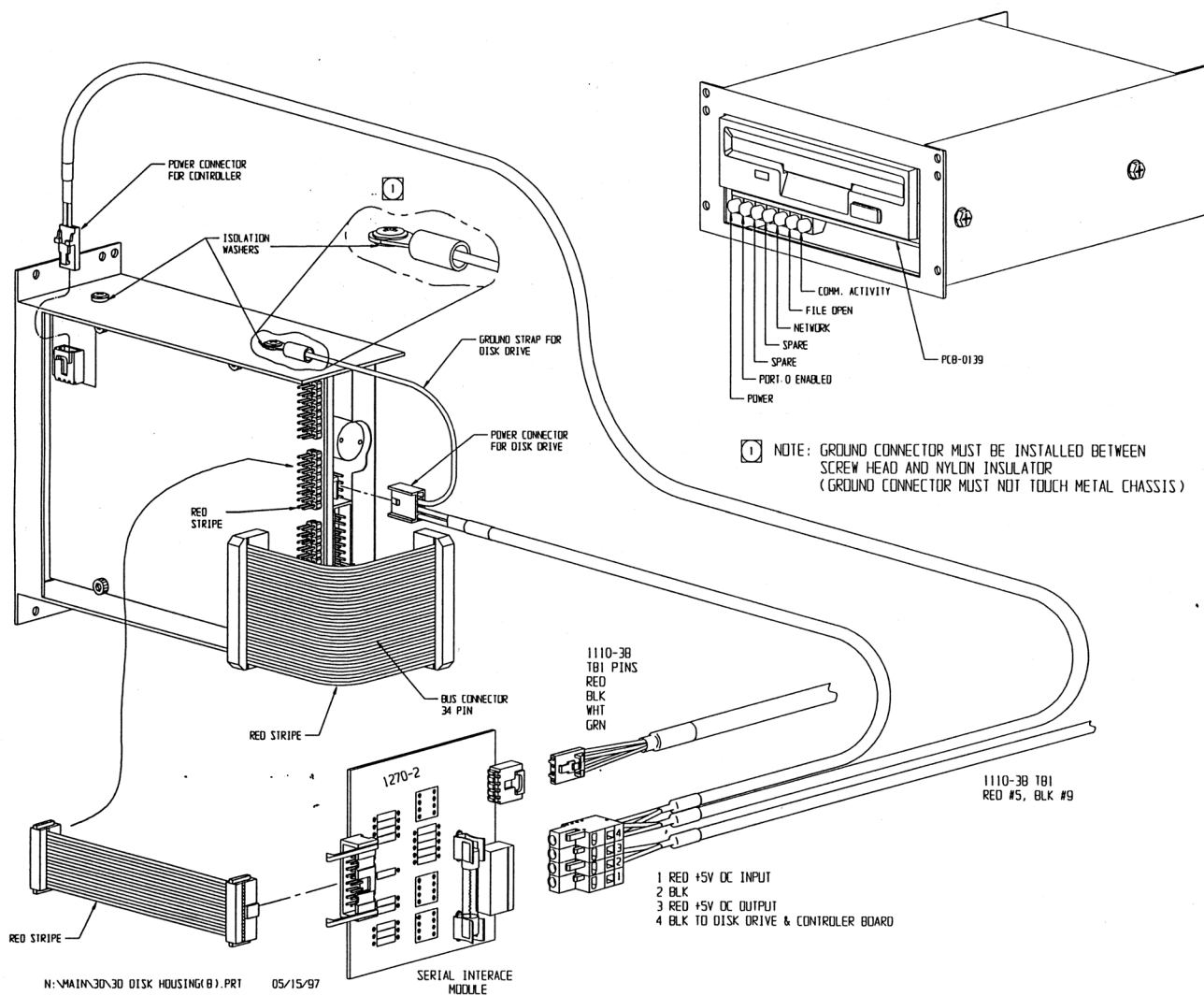
**Troubleshooting  
Checklist**

- 1) Make sure all connectors are plugged in properly.
- 2) Check dip switch settings. Switch 2=3=6=7=ON; Switch 1=4=5=8=9=10=OFF.
- 3) Check AC line fuse. AC LINE FUSE=16A, 250 VAC Slow blow (dimensions 5x20 mm) Wickman Part Number 19195-16. Check shunt regulator fuse (amplifier case must be removed to do this). SHUNT FUSE= Bussman Part #MDLL3, 3A, 250 VAC Motor delay fuse (dimensions, d=6.3mm, l=32 mm).
- 4) With the power removed, use a DVM to check between motor phases (Motor A, B and C), between motor phases and PGND and between motor phases and +HV. The cover must be removed to access +HV and PGND points. If any shorts are detected, the amplifier should be replaced.
- 5) Check AC bus voltage. Nominal voltage should be approximately 115 VAC. If the shunt regulator is on too long or if the AC line voltage is too high (over 130 VAC), the shunt fuse could blow causing an amp over voltage condition. The shunt regulator trip voltage is 185 VDC (130 VAC). The amplifier should over voltage at 195 VDC (137 VAC). Amplifier specified input voltage is 30-125 VAC.

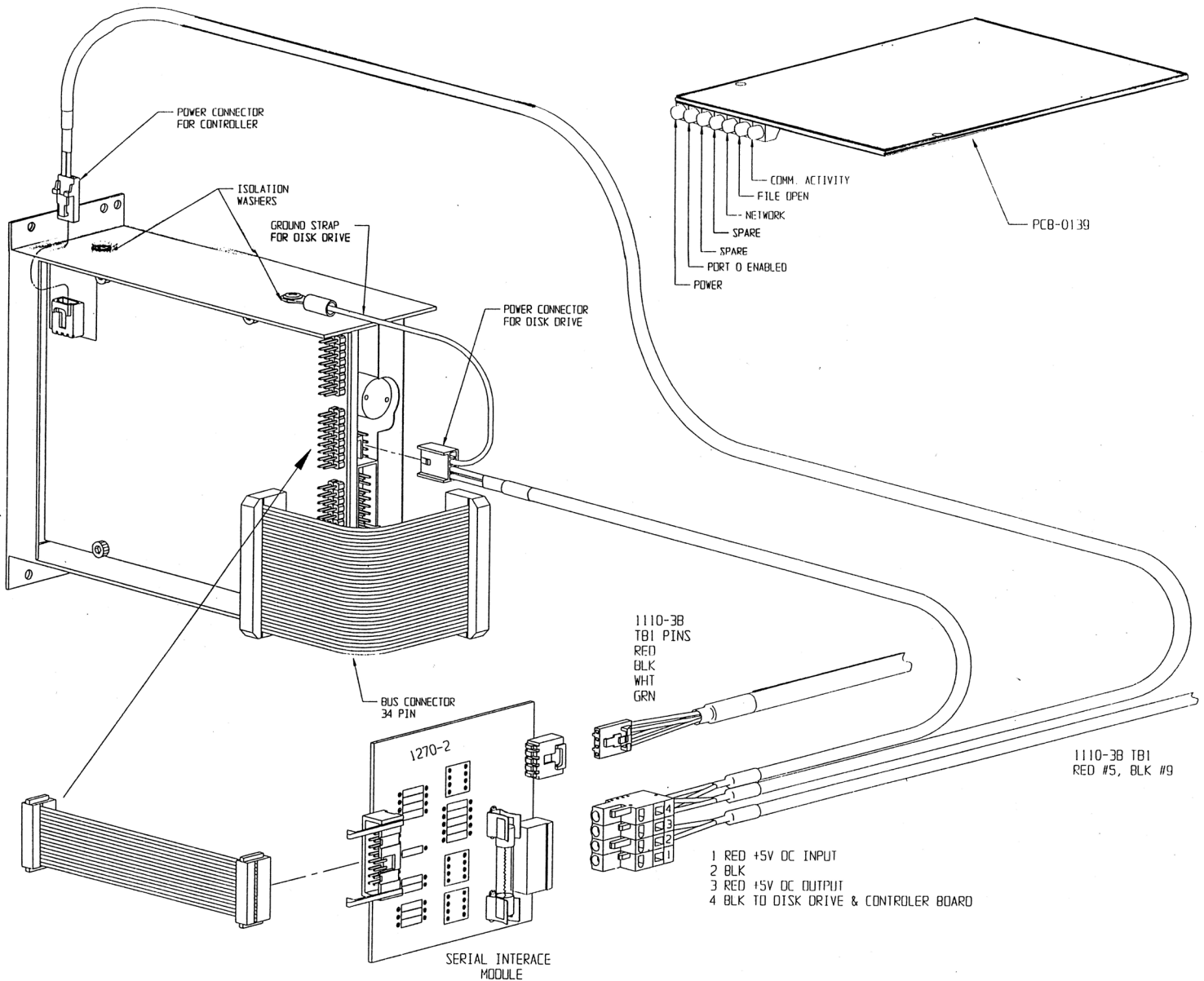
LED: RED LED indicates the following faults: output short circuit, over-voltage, over temperature, inhibit, and power-up reset.



## CNC 88 HS Optional Diskette Drive







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**CNC88HS Optional  
Diskette Drive-  
Miscellaneous**

**Specifications** 3.5" diskette medium. 1.44 Megabyte capacity; will read/write 720K diskettes. MS-DOS format.

**Requirements** Software version 96.1 A6-3 or later.

**Access from Control** The drive is accessed from the Functions menu on the CNC by selecting option 0-DISK. A submenu is displayed with the following options:

FUNCTIONS-----PRESS MANUAL TO ABORT--  
DISK FUNCTIONS;

1-DISK TO MEMORY	3-DIRECTORY	5-FORMAT	7-RUN PROGRAM
2-MEMORY TO DISK	4-DELETE	6-VIEW	

Disk to Memory- Loads a program from a diskette into CNC memory.

Memory to Disk- Saves a program from CNC memory onto a diskette.

Directory- Displays a list of the files and directories on a diskette.

Delete- Deletes a file from the diskette.

Format- Formats a diskette (all files on diskette are deleted).

View-Displays the contents of a file from a diskette (one page at a time) on the CNC monitor.

Run Program- Runs the VMC from a file on a diskette using DNC.

Options are:

- 1) Error checking
- 2) Dry run
- 3) Mid-program start by block #

**Note:** The % character is not needed for running DNC from a diskette, but can be included in the file on the diskette.

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**Access from  
Program Using  
Macro Statement  
#DISK**

Macro language statement #DISK invokes a program on disk from within a program in the CNC memory. After processing the file from disk, control is routed back to the line of the program in memory that follows the #DISK statement. Macro Statement Format #DISK,filename

**Macro Statement  
Format**

# DISK filename

Example:

N1 G90 GO S10000 M3 EI XO YO

N2 H 1 Z.1 M7

N3 #DISK CAVRUF- Calls the disk file named CAVRUF and runs it relative to Fixture 1.

N4 GO Z.1- Program execution continues with this line, positioning the head to Z.1 after CAVRUF finishes running the first time.

NS E2 XO YO- Positions to XO YO of Fixture 2

N6 #DISK CAVRUF- Calls the disk file named CAVRUF and runs it again, this time relative to Fixture 2.

**Restrictions on File  
Content and Format**

The file needs to be in text file format, without any formatting characters or codes, such as those a Word Processor might use. In addition, the following guidelines apply:

- 1) The file needs to consist of standard CNC program words, similar to what would be typed or transmitted into the memory of the machine.
- 2) The file must not contain an O word.
- 3) The file should not contain an M30, M99, or an M2. The CNC will return to the program in memory automatically at the end of the file.
- 4) The lines can be numbered, but do not need to be.
- 5) The file itself cannot contain any #DISK statements.

Note: The % character is not needed for running a program from disk, although it can be included in the file.

**Restrictions on User Defined Subroutines**

The file executes in the CNC memory just as if it were a part of the program that executes the #DISK statement, with the following restrictions on user-defined subroutines:

- 1) The program on the disk cannot define a user-defined subroutine.
- 2) The disk file cannot call a user-defined subroutine.

**Subprograms and Fixed Subroutines ARE Allowed**

Subprograms and fixed subroutines can be called from the disk file. Use the standard subprogram call format: M98 P# (where # is the subprogram to call). After the subprogram has executed, the program returns to the line after the subprogram call. For example, L100 might be used in memory to define subroutine one, but this cannot be accomplished in the disk file.

**Diskette Drive Error Codes**

CODE	DESCRIPTION	CAUSE
1001	Reserved	
1002	FILE ALREADY EXISTS	File selected for reading or deletion not in directory
1003	FILE DOES NOT EXIST	File selected for reading or deletion not in directory
1004	ILLEGAL COMMAND	Command not recognized
1005	DISKETTE FULL	Diskette has no room for transmitted data, or directory has no room for another entry
1006-1008	Reserved	
1009	COMMUNICATIONS ERROR	Mini-file detected check character error or other software or hardware communications problem
1010-1099	Not Used	
1100	DISK READ ERROR	Mini-file unable to read directory without error. Usually caused by an unformatted diskette
1101	BLOCK CHECK ERROR	Four attempts failed to read diskette block without error
1103	SEEK ERROR	Mini-file could not track while reading, or before writing, data block
1104	DISKETTE TIME-OUT	Mini-file could not access diskette. Usually due to lack of diskette in drive
1105	DISK WRITE PROTECTED	Minifile tried to write on write-protected diskette

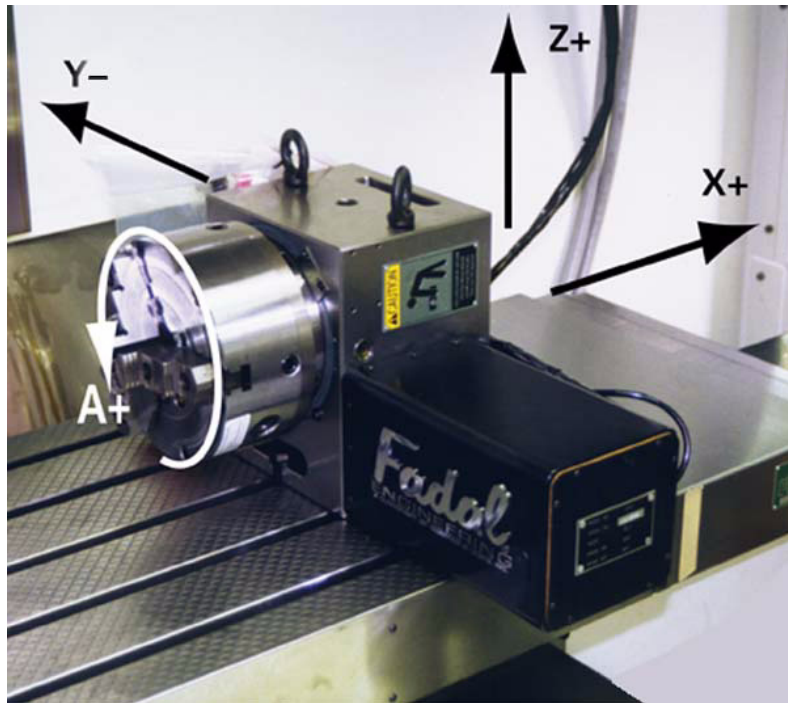
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## Section 10: Rotary Tables

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### Rotary Tables, 4th Axis



*Figure 10-1* Rotary Table

#### **Pre-installation**

Remove the top of the shipping crate:

- 1) With a large screwdriver gently pry the clips from the bottom of the crate.
- 2) Remove the crate top.

Install all items except the Rotary Table itself. These items are included specifically for your VMC configuration, and may include:

- Amplifier Servo Card
- Axis Controller Card
- Brake Solenoid
- Overload Relay
- Air Lines and Fittings
- Prewire Harness

### Remove the Rotary Table from the Shipping Crate:



#### IMPORTANT

Wear Safety goggles, steel toe shoes and gloves to reduce the risk of injury.

The VMC table, or any surface on which the rotary table rests, must be free of chips, or anything else that might damage it.

- 1) Loosen 3/8-16 bolts securing the rotary table and/or tail stock to the crate.
- 2) Using proper lifting procedures to reduce the risk of muscle strain. Remove the rotary table and/or tail stock.
- 3) Save the shipping crate. It will be needed if the rotary table needs to be returned to FADAL for any reason.

### Installation

- 1) Stone both the table and the bottom surface of the rotary table to remove any possible dings. Wipe clean with a light oil.
- 2) Jog the VMC's table to the X+ and Y+ limits to ease installation. The rotary table normally sits on the right side of the VMC table.
- 3) Using proper lifting procedures, position the rotary table above the VMC's center T slot, and attach the supplied table keys with two 1/4-20 x 1/2 socket head cap screws.
- 4) Secure the rotary table to the table using two 1/2-13 x 1 3/4 hex head bolts and hard washers with two 1/2-13 T-nuts. DO NOT TORQUE BOLTS UNTIL THE ROTARY TABLE IS SQUARE.

### Squaring the VH-65

- 1) Place a tool holder with indicator in the VMC spindle.
- 2) Square the rotary table at the face plate surface using a soft-face mallet, and tighten the 1/2-13 bolts when square.

### Connecting the VH-65 Motor Cable

With the POWER OFF and LOCKED OUT at the main power box:

- 1) Remove the 4th axis dummy plug located on the top right panel on the inside of the machine. If you have 4th and 5th axis prewire, the 4th axis plug is nearest the back of the machine. To remove the plug, unscrew the top ring of the connector while simultaneously pulling. Store the plug in a

clean container for future use, as the machine must have either the rotary table or the dummy plug installed in order to operate.

- 2) Uncoil the cable by clipping only the wire ties holding the cable in a loop. The other ties are for the 1/4 inch air line.
- 3) Plug the motor cable in the vacant 4th axis receptacle by lining the orientation pin with the slot, then push up while turning the top ring of the connector. Be sure the two connectors mate firmly or a faulty connection may result.
- 4) Insert the 1/4 inch brake line in the brass fitting located next to the 4th axis connector.

#### **Horizontal Installation Difference(s)**

The rotary table will rest on its back with the motor cable hanging over the edge of the table. To square the unit, indicate the bottom of the unit. Use toe clamps in the top and bottom clamp slots to secure the unit to the table.

#### **Installing the Servo Control**

With the POWER OFF and LOCKED OUT at the main power box, open the main control box located on the right side of the column.

- 1) Place the 4th axis servo amplifier into the left most open slot of the amplifier chassis.
- 2) Bolt in place with the screws provided on the chassis.
- 3) Connect the numbered wires to their corresponding positions on the terminal block.
- 4) Remove the card retainer bracket.
- 5) Remove the 4th axis servo controller from its electrostatic bag.
- 6) Verify jumper settings located at J4 on the card. The rotary table requires jumpers from 5-7 and 7-10. Jumpers may vary with different rotary head types.
- 7) Place the card in open slot #13 of the card cage with the components facing left and firmly press the card into position.
- 8) Replace the card retainer.
- 9) To avoid damage to the unit observe any special notes or tags that may be supplied with the rotary table, such as current limit settings.

**Setting the VMC  
Parameters**

With the power on, in the COMMAND MODE type SETP then press the enter key. There are three parameters associated with the rotary table.

- 1) Set AXES: to X,Y,Z,A
- 2) Set A-AXIS RATIO: to 90:1
- 3) Set M60/A-AXIS BRAKE: to YES
- 4) Press the manual key to exit from the SETP mode.
- 5) Power the machine off and then back on to activate the parameters.

**Note:** Failure to set M60/A-AXIS Brake to YES may cause damage to the VH-65.

**Balancing the  
Amplifier**

Before balancing the amplifier, verify correct timing of the clock card. Using the X axis, establish a constant feed rate for a set distance with the feed pot locked out, and time the move with a stopwatch. The following sample program executes a 20" move at 100 IPM, which should take 12 to 12.5 seconds.

- 1) Enter the X axis, program a 20" move at 100 IPM with feed pots out (M49).

```
N1 L100  
N2 M49  
N3 X20. F100.  
N4 X-20.  
N5 M17  
N6 M30  
N7 L101.1
```

- 2) Move the machine to X-10."
- 3) Type SETX <<ENTER>>.
- 4) Run the program in single block.
- 5) Time the move with a stopwatch, it should take 12 to 12.5 seconds.
- 6) Take several readings and average them.

If the readings are incorrect, adjust or replace the clock card as required. If the readings are correct, proceed with evaluating the following error.



**Evaluating the Following Error**

To evaluate the A-axis following error, enter the following program into the VMC. This program can also be loaded from the TA,2 programs, program number 5815. If you use 5815, you MUST modify the F word on line 4 to match the 90:1 ratio for the A axis (that is, change F1" on line 4 of program 5815 to F2000").

```
N1 L100
N2 M49
N3 A360.00 G1 F2000.
N4 A-360.00
N5 M17
N6 M30
N7 L101.1
```

The following error for each axis is displayed next to the axis position readout on the control.

- 1) Run the test program and observe the following error for the A-axis.
- 2) If the error is 670-690, no adjustment is necessary.
- 3) If not, adjust by slowly turning the SIG2 pot, on the amplifier, until the error reads 680.

**Setting the Voltage**

Once the amplifier is balanced, the voltage must be set. With the test program running, and using a meter set to DC voltage:

Place the black lead on COM and the red lead on SIG2. The voltage should read +1.660 VDC. If not, turn the SIG2" pot until +1.660 VDC is read on the meter.

**Setting Backlash at the Control**

Zero any existing backlash correction in the VMC for the A-axis by typing BL,4,0 <<ENTER>>.

Check backlash at the rotary:

- 1) Position an indicator on the end of a horizontal T slot.
- 2) Place the machine in jog with the selector on A-axis and .010 increments.
- 3) Zero the indicator.
- 4) Jog +.03 then -.03.
- 5) Verify that the indicator reads zero. Repeat steps 3 and 4 until a zero reading is obtained.

6) Jog -.03 then +.03.

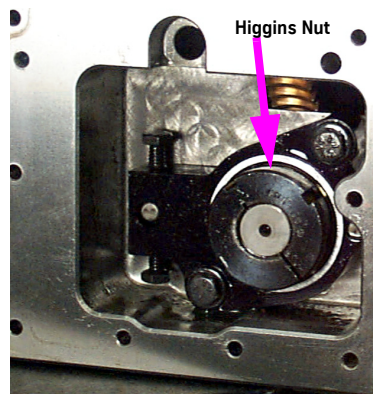
The difference on the indicator is the backlash. The backlash should be between .0004 and .0010. If it is more, mechanical adjustment is necessary. Backlash is entered in tenths. An error of .0007 would be entered: BL,4,7 <<ENTER>>.

### Setting the VH-65 Worm Gear Backlash

After disassembly or repairs, set the mechanical backlash for the VH-65 as follows:

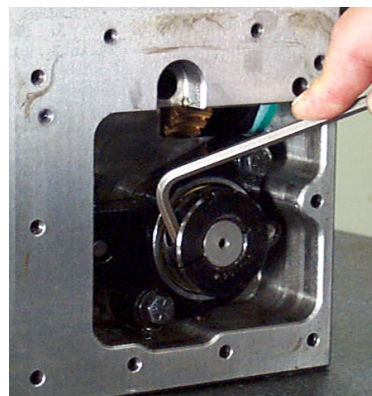
**Note:** Setting the backlash requires a granite plate or other precision surface.

1) The Higgins nut pre-load should be no more than hand tight.



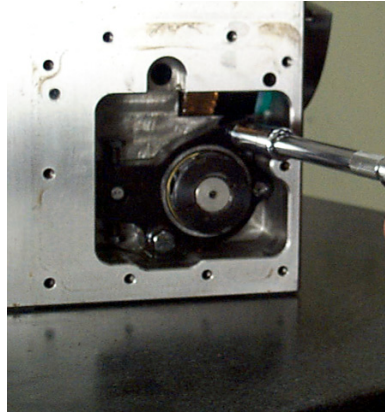
*Figure 10-2* Higgins Nut

2) Secure the Higgins nut to the worm shaft by tightening the set screw.



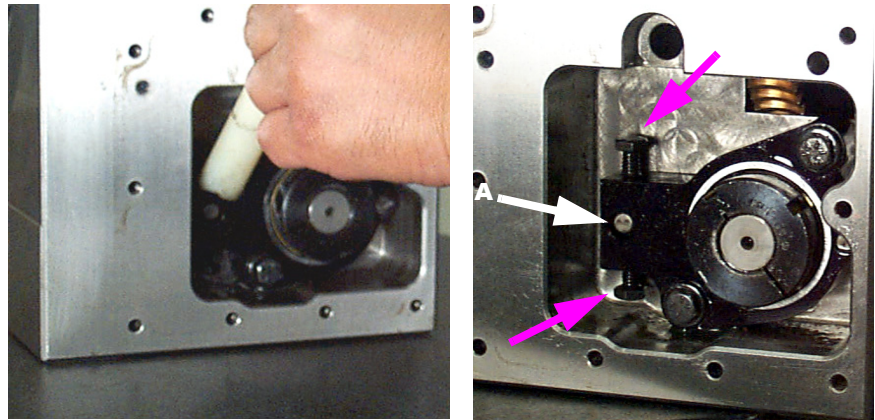
*Figure 10-3* Tighten Set Screw

- 3) The bolts holding the worm pivot plate must be loose to allow setup for the adjustments.



*Figure 10-4* Loosen Bolts Holding Worm Pivot Plate

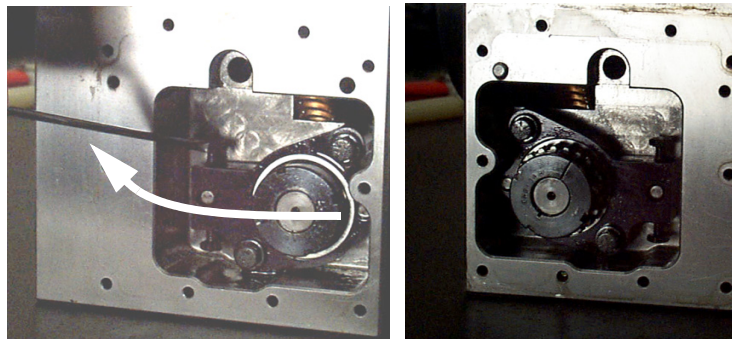
- 4) The pivot adjustment screws should be set to zero (pivot plate resting on pin A) before starting the adjustment procedure.



*Figure 10-5* Set Pivot Adjustment Screws to Zero

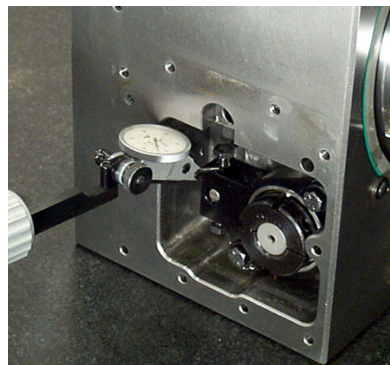
- 5) Turn the top pivot adjusting screw one turn on the side opposite of the motor. Turn the screw on the motor side two turns. (A turn for this

procedure is as far as the wrench will move from one side of the pocket to the opposite side).



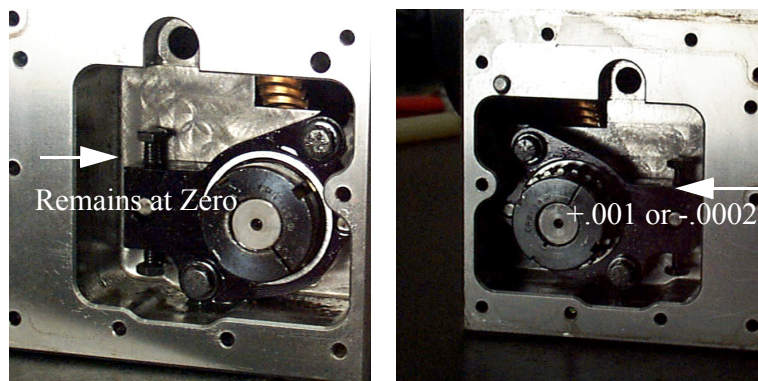
**Figure 10-6** Turn Top Pivot Adjusting Screw and Screw on Motor Side

- 6) Set an indicator on a stand. Zero the indicator on the worm pivot plate of the side opposite the motor.



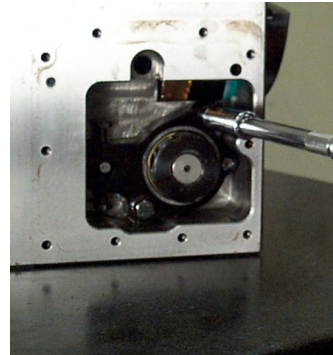
**Figure 10-7** Zero Indicator on Worm Pivot Plate

- 7) Move the indicator to the opposite side and take a reading off of the motor side pivot plate. Adjust the motor side pivot plate so that it is  $+.001$  or  $-.0002$  ( $+.0254\text{mm}$  or  $-.0508\text{mm}$ ).



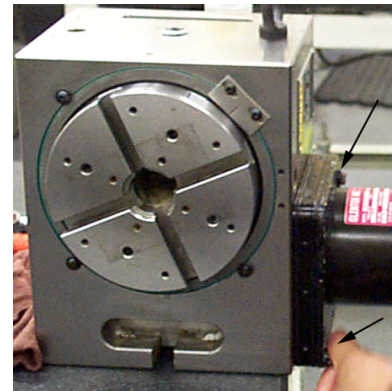
**Figure 10-8** Move Indicator and Take Reading

- 8) Keep checking that the pivot plate on the side opposite the motor stays at zero, adjust back to zero if required. Continue adjusting and checking pivot plate heights until the plates are adjusted.
- 9) Tighten pivot plate bolts until snug.



**Figure 10-9** Tighten Pivot Plate Bolts

- 10) Tighten adjustment bolts until they are touching the pin, do not tighten beyond just touching the pin.
- 11) Install motor plate o-ring and set motor on housing with two bolts at opposite corners.



**Figure 10-10** Install Motor Plate O-Ring and Set on Housing

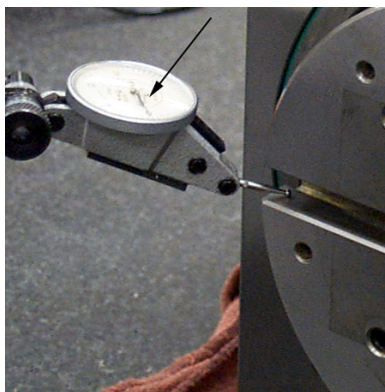
- 12) Connect power leads to the motor.
- 13) Enter the following program to run the motor:

```
N1 L100  
N2 G91  
N3 A360. G0  
N4 A20.  
N5 A-360.
```



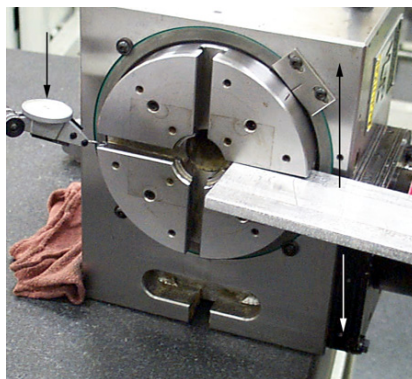
N6 M17  
N7 M30  
N8 L101.1  
N9 A-0.09

- 14) Listen to the operation of worm gear. Any knocking or banging indicates a bad gear adjustment on the worm or motor gear. Exit the program and enter the JOG mode.
- 15) Place an indicator on the face of the chuck, near the outer edge of the chuck as shown.



*Figure 10-11* Place Indicator on Face of Chuck

- 16) Zero the indicator and jog the axis in each direction returning to the initial position. The indicator should not be more than  $\pm .0002$  (0.0508mm) from zero. If the indication exceeds this, continue with the next step to determine the cause of backlash error.
- 17) Zero the indicator. Using a flat plate in the slots of the chuck, place force up and down on the plate. If there is movement indicated, the worm gear adjustment is off. If there is no movement the motor gear backlash is the cause.



*Figure 10-12* Place Force on Plate

- 18) To correct worm gear backlash, adjust the worm gear backlash on the exposed side of the housing with adjusting bolts until indicator moves less than .002 (0.508mm) when the plate is pressed.

#### **Verifying Air Brake Engagement**

Verify the brake is energized when the M60 command is executed.

- 1) In MDI mode type M60 <<ENTER>> and then press <<START>>.
- 2) There should be a sound of air from the solenoid.

If there is no sound of air:

- 3) Verify that there is air to the machine.
- 4) Verify that the air valve is functioning.
- 5) Type M61 <<ENTER>> to deactivate the brake.

#### **Adjusting the Cold Start**

The Cold Start position is used as a machine zero position. The relation of the A-axis cold start and the VH-65 T slots is set at the discretion of the person doing this procedure. The T slots may be at any angle. If it is desired that the T slots are timed to the cold start position, perform the following procedure:

- 1) Jog the A-axis to the Cold Start position, align the marks.
- 2) Type CS <<ENTER>>.
- 3) Run an indicator along either the horizontal or vertical T slot. If the reading is not zero, a resolver adjustment is necessary. The resolver is located on the end of the motor, inside the motor cover.
- 4) Remove the end plate and gasket from the motor cover.
- 5) Loosen the three retaining screws around the resolver. Do not remove them!
- 6) Slowly turn the resolver until the T slot is zero.
- 7) Tighten the retaining screws.
- 8) Type CS then <<ENTER>>.
- 9) Recheck the T slot.

Repeat the above steps until the adjustment remains at zero.

- 10) Double check the retaining screws.
- 11) Replace the cover and gasket.

---

**Maintenance****Gear Oil**

The gear oil is the primary concern in rotary table maintenance. The oil should be changed every six to twelve months, depending on usage.

- 1) Remove the 1/8-27 NPT plug from the cover plate opposite the motor.
- 2) To allow the oil to flow more freely, wipe off any chips and dirt from the top of the rotary table and remove the 1/2-14 NPT plug. (No lubrication maintenance is required for the VH-5C.)

As a replacement oil use:

MOBILGEAR 626  
LUBRICATION OIL  
ISO VG 68

- 3) Replace the 1/8-27 NPT plug using teflon tape.
- 4) Using a funnel, fill the rotary table with the recommended oil or an approved equivalent gear oil through the top of the unit. Fill to the line on the sight glass, approximately 48 fl. oz.
- 5) Replace the top plug using teflon tape.

**Coolant**

Some types of coolant have a tendency to swell the motor cover gasket and attack the sealing compound. If this occurs, we recommend switching coolants. Wynns 941 has shown to be a satisfactory coolant.

**Face plate**

The rotary table face plate and any tooling must be free from chips and dings. Stone both surfaces and wipe clean.

**Serialized Matched Sets**

Rotary tables heads and tailstocks are serialized. FADAL maintains a record of the center line height of all serialized heads and tailstocks. If a customer desires at a later date to purchase a matching component, this may be easily accomplished.

**Removal and Storage**

- 1) Wipe any coolant, chips or dirt from the rotary table, motor cable, connector and any fixtures.
- 2) Jog the table for best access to the rotary table.
- 3) Turn off the power and lock out the main power box.



- 4) Unscrew the motor cable connector from the 4th axis receptacle, place a plastic bag around the connector for protection, and replace the dummy plug in the receptacle.
- 5) Coil up the cable and wire tie it in a loop.
- 6) Make sure there are no chips between mating connections.
- 7) Remove any fixtures that are attached to the face plate. The fixtures will add extra weight and make the rotary table awkward to lift.
- 8) Loosen the 1/2-13 hex bolts that mount the unit to the table.
- 9) Carefully slide the unit to the edge of the table.
- 10) Screw in the 1/2-13 eyebolts.
- 11) Ease the rotary table off of the table using the proper lifting procedure.
- 12) Wipe off the bottom of the unit and place it on a clean flat surface.
- 13) Lightly coat with a protective oil to keep it from rusting. The unit may be stored in the original container for protection.
- 14) Power on the machine.
- 15) Type SETP <<ENTER>> to bring up the parameters.
- 16) Change the axes selection from X,Y,Z,A TO X,Y,Z (from 4 to 3).
- 17) Exit the parameter screen.
- 18) Power the machine off and then back on. This will reset the parameters.

### Rotary Set-Up

If the controller card is a PCB-0217 (1010-6) then use the following chart for placing the jumper on the rotary table.  
Install J4 (REV-DIR) as required.

**Table 1: Jumper Placement on Rotary Table**

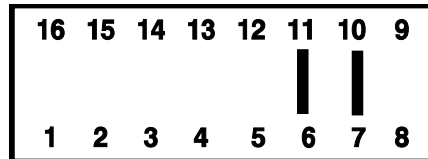
Mode	J16	J17	J18	J19	J4	JP8	JP10
X-AXIS	ON	NONE	NONE	ON	X-AXIS	NONE	NONE
Y-AXIS	ON	NONE	NONE	ON	Y-AXIS	NONE	NONE
Z-AXIS	ON	NONE	NONE	ON	Z-AXIS	NONE	NONE
A-AXIS	ON	NONE	NONE	ON	A-AXIS	NONE	NONE
B-AXIS	ON	NONE	NONE	ON	B-AXIS	NONE	NONE
SPINDLE	NONE	ON	ON	NONE	SPINDLE	NONE	NONE

For all other controller cards use the following:

**FADAL VH-65 &  
VH-5C**

- 1) Set the jumpers on the 1010-5 card as follows:

**201010-4  
JUMPER BLOCK  
AT J4**



**(U7) EPROM  
(U10) EPROM  
B-AXIS**

*Figure 10-13* VH65 & VH-5C Jumper Block

**Note:** The 5C does not use the 6-11 jumper line.

- 2) Set the axes configuration in the SETP to 4 which will select X,Y,Z,A. Once the number of axes has been set, the A axis' ratio and brake parameters will be displayed.
- 3) Set the A axis ratio to 90:1.
- 4) Set the M60/A axis brake to YES.
- 5) Exit the SETP by pressing <MANUAL> and do the CS command.
- 6) Using service program PR,5815, set the position loop gain for the rotary table. Change the fourth line in the subroutine to a feedrate of F2000. and make sure the 360 degree move is for an A axis, i.e. A360.
- 7) Adjust the SIG2 potentiometer on the amplifier until the voltage is 1.660VDC at SIG2 and COM terminals of the amplifier. (Refer to section 6 for a full description of amplifier adjustment procedures.)
- 8) Check and make sure the rotary table rotation is in the correct direction.
- 9) Verify axis brake operation using the procedure in Section 6.
- 10) Set backlash using the procedure in section 6.
- 11) Square up the rotary table so that it is perpendicular with the X axis.

### FADAL V-300 (V-400) Rotary Table

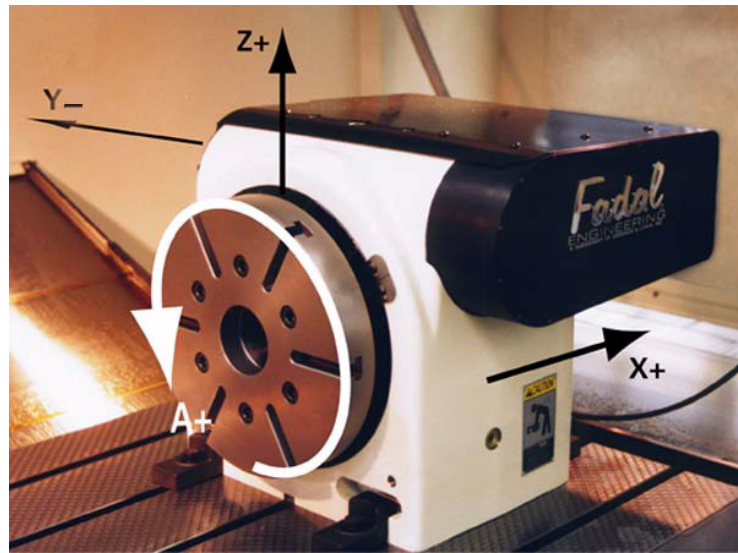


Figure 10-14 FADAL V-300 (V-400) Rotary Table

- 1) Set the jumpers on the 1010-5 card as follows:

**201010-4  
JUMPER BLOCK  
AT J4**

16	15	14	13	12	11	10	9
				1		1	
1	2	3	4	5	6	7	8

**(U7) EPROM  
(U10) EPROM  
A-AXIS**

Figure 10-15 V-300 (V-400) Jumper Block

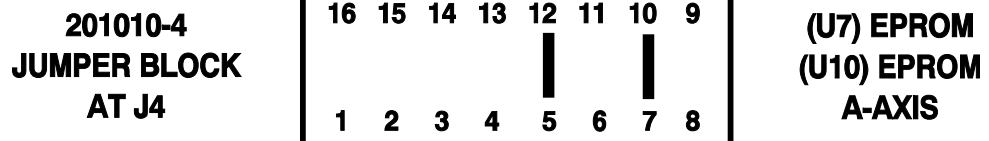
- 2) Set the axes configuration in the SETP to 4, which will select X,Y,Z,A.
- 3) Once the number of axes has been set, the A axis' ratio and brake parameters will be displayed.
- 4) Set the A axis ratio to 180:1.
- 5) Set the M60/A axis brake to YES or NO depending on whether or not the machine is equipped with a brake (the rotary table *must* have *both* a brake *and* the proper solenoids).
- 6) Exit the SETP by pressing <MANUAL> and enter the CS command.
- 7) Using service program PR,5815, set the position loop gain for the rotary table. Change the fourth line in the subroutine to a feed rate of F1000. and make sure the 360 degree move is for an A axis, i.e. A360.
- 8) Check and make sure the rotary table rotation is in the correct direction.
- 9) Verify axis brake operation by entering MDI mode and typing M60/M61.

10) Set backlash using the procedure in section 6.

11) Square up the rotary table so it is perpendicular with the X axis. Use the procedure in section 6.

#### Troyke NC-10

1) Set the jumpers on the 1010-5 card as follows:

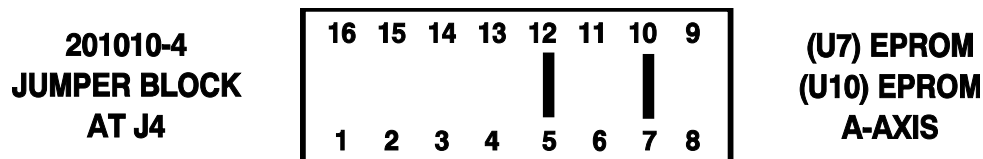


*Figure 10-16* Troyke NC-10 Jumper Block

- 2) Set the axes configuration in the SETP to 4, which will select X,Y,Z,A. Once the number of axes has been set, the A axis' ratio and brake parameters will be displayed.
- 3) Set the A axis ratio to 180:1.
- 4) Set the M60/A axis brake to YES or NO depending on whether or not the machine is equipped with a brake (the rotary table *must* have *both* a brake *and* the proper solenoids).
- 5) Exit the SETP by pressing <MANUAL> and enter the CS command.
- 6) Using service program PR,5815,set the position loop gain for the rotary table. Change the fourth line in the subroutine to a feedrate of F1000. and make sure the 360 degree move is for an A axis, i.e. A360.
- 7) Adjust the SIG2 potentiometer on the amplifier until you get a voltage of 1.660VDC at SIG2 and COM terminals of the amplifier (refer to section 6 for a full description of amplifier adjustment procedures).
- 8) Check and make sure the rotary table rotation is in the correct direction.
- 9) Verify axis brake operation using the procedure in Section 6.
- 10) Set the backlash using the procedure in section 6.
- 11) Square up the rotary table so that it is perpendicular with the X axis.

**Technara MD-200R**

- 1) Set the jumpers on the 1010-5 card as follows:

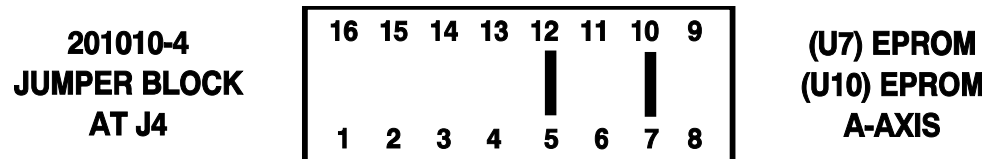


*Figure 10-17* Technara MD-200R Jumper Block

- 2) Set the axes configuration in the SETP to 4, which will select X,Y,Z,A.
- 3) Once the number of axes has been set, the A axis' ratio and brake parameters will be displayed. Set the A axis ratio to 360:1.
- 4) Set the M60/A axis brake to YES or NO depending on whether or not the machine is equipped with a brake (the rotary table *must* have *both* a brake *and* the proper solenoids). The Programmable Air Lock hydraulic brake pump unit for the 4th axis is optional.
- 5) Exit the SETP by pressing <MANUAL> and enter the CS command.
- 6) Using service program PR,5815, set the position loop gain for the rotary table. Change the fourth line in the subroutine to a feedrate of F500. and make sure the 360 degree move is for an A axis, i.e. A360.
- 7) Adjust the SIG2 potentiometer on the amplifier until you get a voltage of 1.660VDC at SIG2 and COM terminals of the amplifier (refer to section 6 for a full description of amplifier adjustment procedures).
- 8) Check and make sure the rotary table rotation is in the correct direction.
- 9) Verify the axis brake operation using the procedure in Section 6.
- 10) Set the backlash using the procedure in section 6.
- 11) Square up the rotary table so that it is perpendicular with the X axis.

**Technara MD-300R**

- 1) Set the jumpers on the 1010-5 card as follows:



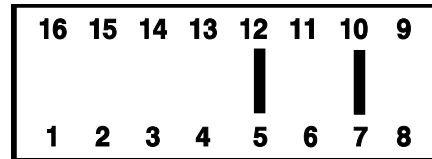
*Figure 10-18* Technara MD-300R

- 2) Set the axes configuration in the SETP to 4 which, will select X,Y,Z,A. Once the number of axes has been set the A axis' ratio and brake parameters will be displayed.
- 3) Set the A axis ratio to 360:1.
- 4) Set the M60/A axis brake to YES or NO depending on whether or not the machine is equipped with a brake (the rotary table *must* have *both* a brake *and* the proper solenoids). The Programmable Air Lock hydraulic brake pump unit for the 4th axis is optional.
- 5) Exit the SETP by pressing <MANUAL> and enter the CS command.
- 6) Using service program PR,5815, set the position loop gain for the rotary table. Change the fourth line in the subroutine to a feedrate of F500. and make sure the 360 degree move is for an A axis, i.e. A360.
- 7) Adjust the SIG2 potentiometer on the amplifier until you get a voltage of 1.660VDC at SIG2 and COM terminals of the amplifier (refer to section 6 for a full description of amplifier adjustment procedures).
- 8) Check and make sure the rotary table rotation is in the correct direction.
- 9) Verify the axis brake operation using the procedure in Section 6.
- 10) Set the backlash.
- 11) Square up the rotary table so that it is perpendicular with the X axis.

**Tsudakoma RNCV-401**

- 1) Set the jumpers on the 1010-5 card as follows:

**201010-4  
JUMPER BLOCK  
AT J4**

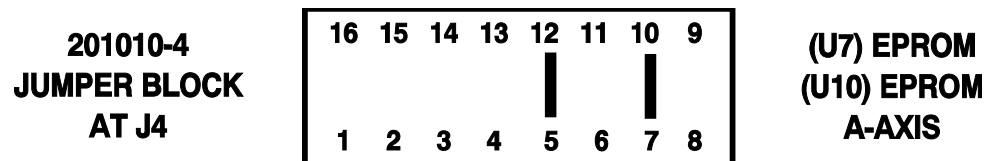


**(U7) EPROM  
(U10) EPROM  
A-AXIS**

*Figure 10-19* Tsudakoma RNCV-401 Jumper Block

- 2) Set the axes configuration in the SETP to 4, which will select X,Y,Z,A.
- 3) Once the number of axes has been set the A axis' ratio and brake parameters will be displayed. Set the A axis ratio to 180:1.
- 4) Set the M60/A axis brake to YES or No depending on whether or not the machine is equipped with a brake (the rotary table *must* have *both* a brake *and* the proper solenoids). The Programmable Air Lock hydraulic brake pump unit for the 4th axis is optional.
- 5) Exit the SETP by pressing <MANUAL> and enter the CS command.
- 6) Using service program PR,5815, set the position loop gain for the rotary table. Change the fourth line in the subroutine to a feedrate of F1000. and make sure the 360 degree move is for an A axis, i.e. A360.
- 7) Adjust the SIG2 potentiometer on the amplifier until you get a voltage of 1.660VDC at SIG2 and COM terminals of the amplifier (refer to section 6 for a full description of amplifier adjustment procedures).
- 8) Check and make sure the rotary table rotation is in the correct direction.
- 9) Verify axis brake operation using the procedure in Section 6.
- 10) Set the backlash.
- 11) Square up the rotary table so that it is perpendicular with the X axis.

**FADAL RT-175** 1) Set the jumpers on the 1010-4 card as follows:



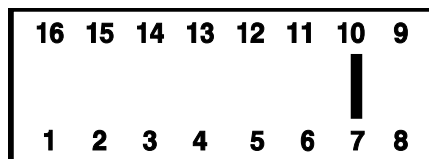
*Figure 10-20* RT-175 Jumper Block

- 2) Set the axes configuration in the SETP to 4, which will select X,Y,Z,A. Once the number of axes has been set the A axis' ratio and brake parameters will be displayed.
- 3) Set the A axis ratio to 180:1.
- 4) Set the M60/A axis brake to YES or NO depending on whether or not the machine is equipped with a brake (the rotary table MUST have BOTH a brake AND the proper solenoids). Programmable air lock hydraulic brake pump unit for the 4th axis is optional.
- 5) Exit the SETP by pressing <MANUAL> and do the CS command.
- 6) Using service program PR,5815 set the position loop gain for the rotary table. Change the fourth line in the subroutine to a feedrate of F1000. and make sure the 360 degree move is for an A axis, i.e. A360.
- 7) Adjust the SIG2 potentiometer on the amplifier until you get a voltage of 1.660VDC at SIG2 and COM terminals of the amplifier (refer to amplifier AC drive manual for a full description of amplifier adjustment procedures).
- 8) Check and make sure the rotary table rotation is the correct direction. See illustration in the FADAL Maintenance Manual for the VH-65.
- 9) Verify axis brake operation using the procedure in Section 6.
- 10) Set backlash.
- 11) Square up rotary table so it is perpendicular with the X axis.



**FADAL RT-225** 1) Set the jumpers on the 1010-4 card as follows:

**201010-4  
JUMPER BLOCK  
AT J4**

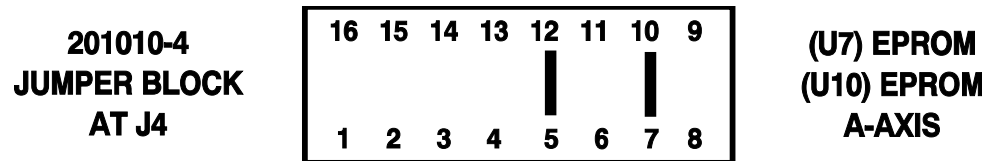


**(U7) EPROM  
(U10) EPROM  
A-AXIS**

*Figure 10-21* RT-225 Jumper Block

- 2) Set the axes configuration in the SETP to 4, which will select X,Y,Z,A. Once the number of axes has been set the A axis' ratio and brake parameters will be displayed.
- 3) Set the A axis ratio to 180:1.
- 4) Set the M60/A axis brake to YES or NO depending on whether or not the machine is equipped with a brake (the rotary table **MUST** have **BOTH** a brake **AND** the proper solenoids). Programmable air lock hydraulic brake pump unit for the 4th axis is optional.
- 5) Exit the SETP by pressing <MANUAL> and do the CS command.
- 6) Using service program PR,5815 set the position loop gain for the rotary table. Change the fourth line in the subroutine to a feedrate of F1000. and make sure the 360 degree move is for an A axis, i.e. A360.
- 7) Adjust the SIG2 potentiometer on the amplifier until you get a voltage of 1.660VDC at SIG2 and COM terminals of the amplifier.
- 8) Check and make sure the rotary table rotation is the correct direction. See the illustration in the FADAL Maintenance Manual for the VH-65.
- 9) Verify axis brake operation using the procedure in Section 6.
- 10) Set backlash.
- 11) Square up rotary table so it is perpendicular with the X axis.

**FADAL RT-275** 1) Set the jumpers on the 1010-4 card as follows:



*Figure 10-22* RT-275 Jumper Block

- 2) Set the axes configuration in the SETP to 4, which will select X,Y,Z,A. Once the number of axes has been set the A axis' ratio and brake parameters will be displayed.
- 3) Set the A axis ratio to 180:1.
- 4) Set the M60/A axis brake to YES or NO depending on whether or not the machine is equipped with a brake (the rotary table **MUST** have **BOTH** a brake **AND** the proper solenoids). Programmable air lock hydraulic brake pump unit for the 4th axis is optional.
- 5) Exit the SETP by pressing <MANUAL> and do the CS command.
- 6) Using service program PR,5815 set the position loop gain for the rotary table. Change the fourth line in the subroutine to a feedrate of F1000. and make sure the 360 degree move is for an A axis, i.e. A360.
- 7) Adjust the SIG2 potentiometer on the amplifier until you get a voltage of 1.660VDC at SIG2 and COM terminals of the amplifier.
- 8) Check and make sure the rotary table rotation is the correct direction. See the illustration in the FADAL Maintenance manual for the VH-65.
- 9) Verify axis brake operation using the procedure in Section 6.
- 10) Set backlash.
- 11) Square up rotary table so it is perpendicular with the X axis.

## Tilting Rotary Tables, 4th & 5th Axis

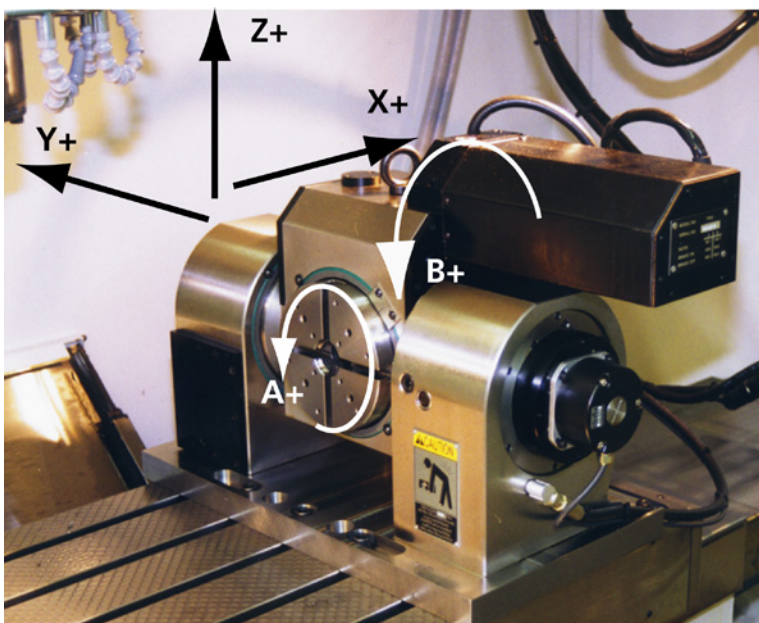


Figure 10-23 Tilting Rotary Table

### FADAL TR-65

- 1) Set the jumpers on the 1010-5 card as follows:

**A-AXIS 1010-4  
JUMPER BLOCK  
AT J4**

16	15	14	13	12	11	10	9
					1	1	
1	2	3	4	5	6	7	8

(U7) AB NOLIM  
(U10) AB NOLIM

**B-AXIS 1010-4  
JUMPER BLOCK  
AT J4**

16	15	14	13	12	11	10	9
				1		1	
1	2	3	4	5	6	7	8

(U7) AB5P95N  
(U10) AB5P95N

Figure 10-24 TR-65 Jumper Blocks

- 2) The AB NOLIM EPROM is for the A axis. It has no limits. The 15P105N EPROM for the B axis has software limits of 15 degrees positive and 105 degrees negative.
- 3) Set the axes configuration in the SETP to 5 which will select X,Y,Z,A,B. Once the number of axes has been set the A and B axes' ratio and brake parameters will be displayed.
- 4) Set the A axis ratio to 90:1.

- 5) Set the B axis ratio to 180:1.
- 6) Set the M60/A axis brake to YES.
- 7) Set the M62/B axis brake to YES.
- 8) Exit the SETP by pressing <MANUAL> and enter the CS command.
- 9) Using service program PR,5815, set the position loop gain for the rotary table.
- 10) Change the fourth line in the subroutine to a feedrate of F2000. and make sure the 360 degree move is for an A axis, i.e. A360.
- 11) Adjust the SIG2 potentiometer on the amplifier until you get a voltage of 1.660VDC at SIG2 and COM terminals of the amplifier (refer to section 6 for a full description of amplifier adjustment procedures).
- 12) Change the fourth line of the subroutine to a feedrate of F1000. and on the same line change the A360 degree move to a B-90. (Make sure the move is negative). On the next line change the A-360 degree move to a B90. (Make sure the move is positive).
- 13) With the program running, adjust the SIG2 potentiometer on the amplifier until you get a voltage of 1.660VDC at SIG2 and COM terminals of the amplifier (refer to Section 6 for a full description of amplifier adjustment procedures).
- 14) Check and make sure the rotary table rotation is in the correct direction.
- 15) Verify each axis brake operation using the procedure in Section 6.
- 16) Set the backlash.
- 17) Square up the tilting rotary table so that it is perpendicular with the X axis.

### A & B Axis Position Loop Gain (1010-5)

**Note:** Verify the gain setting through the SV command before continuing!

The A and B axis require a different program to be entered. Enter the appropriate program for the rotary table that you have (refer to the chart below).

**Table 2: Loop Gain Adjustment Program**

A AXIS PROGRAM FOR POSITION LOOP GAIN	B AXIS PROGRAM FOR POSITION LOOP GAIN
N1 L100	N1 L100
N2 M49	N2 M49
N3 A1000. ****. G1	N3 B-90. ****. G1
N4 A-1000.	N4 B90.
N5 M17	N5 M17
N6 M30	N6 M30
N7 L199	N7 L199
N8 M2	N8 M2

Replace the asterisks in the above programs with the correct feedrate for your corresponding rotary table from the table below.

**Table 3: Ratio and Feed Rates**

TABLE	AXIS	RATIO	FEEDRATE
NIKKEN	A	90:1	F2000.
TROYKE	A	180:1	F1000.
TECHNARA	A	360:1	F500.
SHIPMAN	A	180:1	F1000.
SHIPMAN	B	180:1	F1000.
TROYKE	B	360:1	F500.
FADAL VH-65	A	90:1	F2000.
FADAL RT-175	A	180:1	F1000.
FADAL RT-225	A	180:1	F1000.
FADAL RT-275	A	180:1	F1000.
FADAL TR-65	A	90:1	F2000.
FADAL TR-65	B	180:1	F1000.
FADAL TR-65 W/O SCALE	B	90:1	F2000.

Enter the commands

PR <ENTER>

Press #3 (START NEW PROGRAM) <ENTER>

- 1) Enter NEW PROGRAM NUMBER <ENTER>
- 2) Press #6 (EXIT)
- 3) From the prompt ENTER NEXT COMMAND type in IN <ENTER>

Enter the following program (PR,5815):

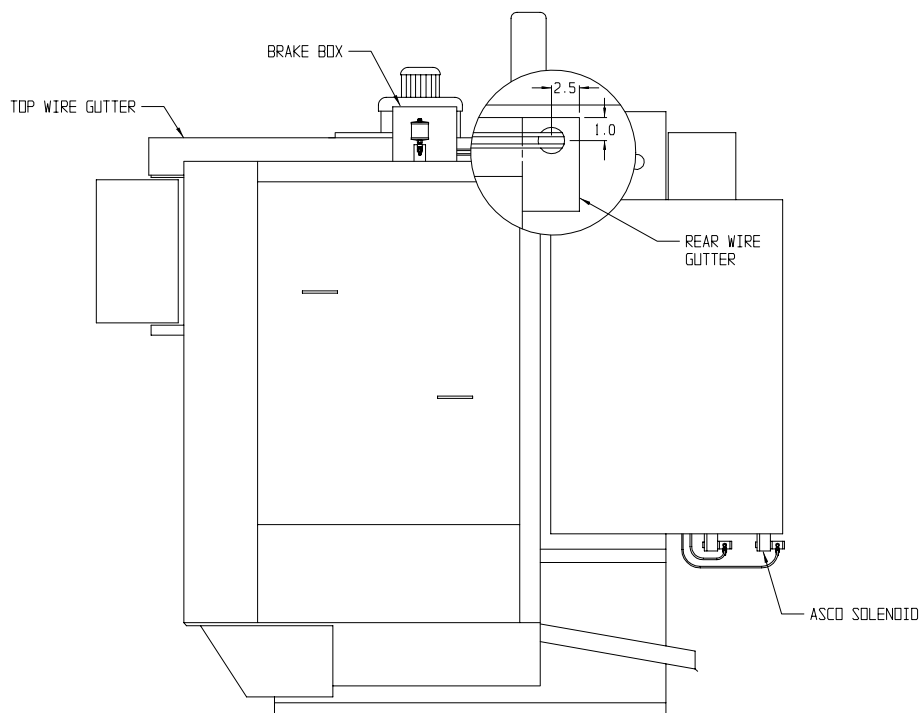
- 4) The position loop gain is adjusted by the potentiometer labeled "SIG" on the servo amplifier card (FIG -).
- 5) With the CNC CONTROL CABINET open, start the previous entered program executing (Push the AUTO key).
- 6) Set the digital voltmeter (FLUKE MODEL 27) to the DC scale. Place the black lead of the meter on the "COM" terminal of the amplifier, and place the red on the "SIG" terminal of the amplifier to be adjusted. For the amplifier with the orange connector use the 5th terminal from the front (common) and the 4th terminal from the front (SIG).
- 7) Adjust the "SIG" potentiometer on the amplifier until the meter reads 1.660 +/- .001 volts DC in both directions. When the voltage is set the following error display should read 680.

A 0.0	680 POSITION LOOP GAIN DISPLAY
B 0.0	680

---

## Hydraulic Brakes

### 4th Axis Brake Installation



*Figure 10-25* 4th Axis Brake Installation

- 1) Mount the hydraulic brake unit on top of the right panel as shown.
- 2) Drill a hole in rear wire gutter as shown.
- 3) Install a plastic wire guard around the hole so the wires and air lines do not get chaffed.
- 4) Run air lines from the hydraulic brake box, along the outside of the top wire gutter, into the hole in the rear wire gutter channel, down the inside of the CNC, out the bottom and into the ASCO solenoid.
- 5) Fill reservoir with extra light spindle oil.
- 6) Set air regulator to 20 PSI.
- 7) Neatly wire tie the air lines inside and outside the CNC box so they do not flop around.

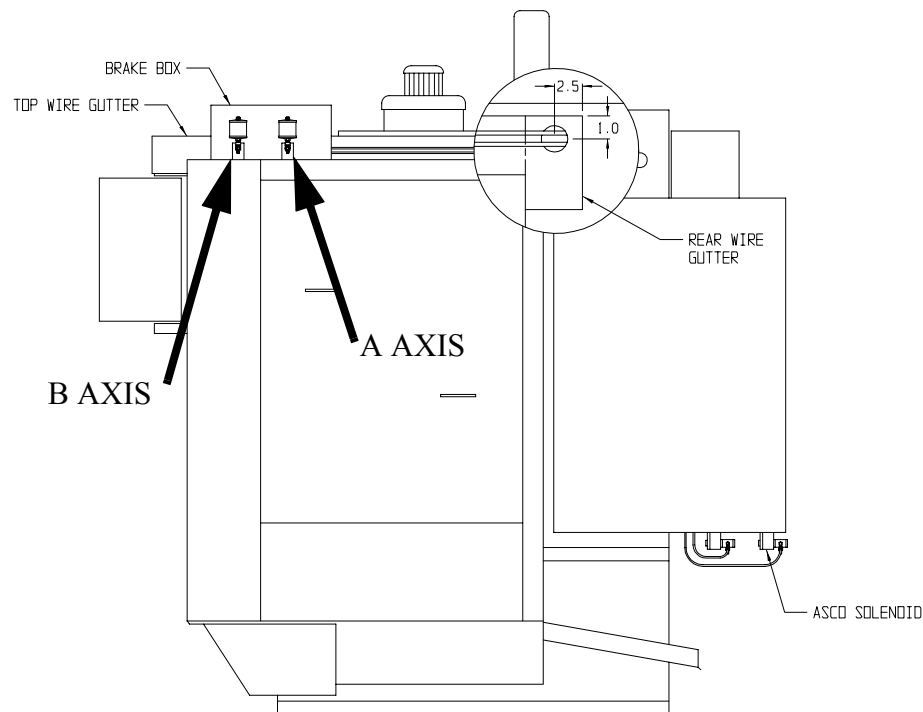
**4th Axis Brake  
Check-Out**

1) Manually check the brake operation by typing the following:

MD <ENTER>

M60 <ENTER> <START> — (A AXIS BRAKE SHOULD LOCK)

M61 <ENTER> — (A AXIS BRAKE SHOULD RELEASE)

**4th, 5th Axis Brake  
Installation**

*Figure 10-26* 4th and 5th Axis Brake Installation

- 1) Mount the hydraulic brake unit on top of the right panel as shown.
- 2) Drill a hole in rear wire gutter as shown.
- 3) Install a plastic wire guard around the hole so the wires and air lines do not get chaffed.
- 4) Run air lines from the hydraulic brake box, along the outside of the top wire gutter, into the hole in the rear wire gutter channel, down the inside of the CNC, out the bottom and into the ASCO solenoid.
- 5) Fill both reservoirs with extra light spindle oil.
- 6) Set air regulator to 20 PSI.
- 7) Neatly wire tie the airlines inside and outside the CNC box so they do not flop around.



**4th, 5th Axis Brake  
Check-Out**

1) Manually check the brake operation by typing the following:

MD <ENTER>

M60 <ENTER> <START> — (A AXIS BRAKE SHOULD LOCK)

M61 <ENTER> — (A AXIS BRAKE SHOULD RELEASE)

M62 <ENTER> — (B AXIS BRAKE SHOULD LOCK)

M63 <ENTER> — (B AXIS BRAKE SHOULD RELEASE)

**Note:** If the M function does not lock the brake on the correct axis, check the hydraulic and air lines to make sure they are plugged into the correct port.

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## Section 11: Probes & Scales

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### Probes

**MP-11 Probe** The MP-11 Probe operates by transmitting signals between the probe and the machine control via the probe cable and the interface cable. The power 12VDC is supplied from the 1060 Mother board. On machines with standard sheetmetal, the interface cable connector is mounted on the top right panel, under the wire cover. On machines with the slant sheetmetal, the connector is mounted in the right wire gutter with the logic wires. After installation, use the following steps to test the MP-11 probe:

- 1) Orient spindle, using the M19 command and insert the MP-11 probe into spindle. (The probe LED has to be facing the front door).
- 2) Plug one end of the probe cable into the probe and the other end into the interface connector on the top right panel.
- 3) At the "ENTER NEXT COMMAND" prompt type UT and press <ENTER>.
  - a. Select #4(test MP Probe) from the menu.
  - b. Press the Start key while depressing the probe sensor.
  - c. Release the probe sensor and the start key.
  - d. Press the start key again.
  - e. Wait for the CNC to display "PASSED" or "FAILURE."

**Maintenance:**

- 1) When the probe is not in use, store the probe cable in the box supplied with the probe and keep the interface connector covered by the cap attached to the connector.
- 2) Keep all components clean and free from grease and oil.
- 3) Periodically check cables for signs of damage, corrosion, or loose connections.
- 4) Treat the probe as a precision tool.

**MP-12 Probe** This probe is used for position location of a part or home position, for accuracy when machining multiple parts. The probe system operates by transmitting signals between the probe and the machine control using the Optical Module Probe (OMP) MP-12, the Optical Module Machine (OMM), and the MI-12 Interface Unit.

The power, 24VDC, is supplied by the power supply board mounted on the right side of the CNC cabinet. The OMM is mounted on the front, top, left panel of the VMC facing the spindle. The Interface Unit is mounted on the top of the CNC cabinet. The Interface Unit is factory set in Auto Start Mode. The flashing yellow LED in the OMM indicates this mode. The red LED in the OMM will be lit when the power is on and the green LED will be lit when the signal is received from the probe. To test the probe, use the same program as for the MP-11 on page 2. Make sure that when installing the probe into the spindle that the probe window is facing the OMM.

**Maintenance:**

The maintenance for the MP-12 probe is the same as the maintenance for the MP-11.

**TS-27** The TS-27 probe is used for setting tool length offsets. The probe can be mounted on either side of the table, though it is factory installed on the left side of the table to leave room for any rotary table that may be installed. The cable is mounted on the top right side of the sheetmetal and routed through the back of the machine over to the CNC cabinet.

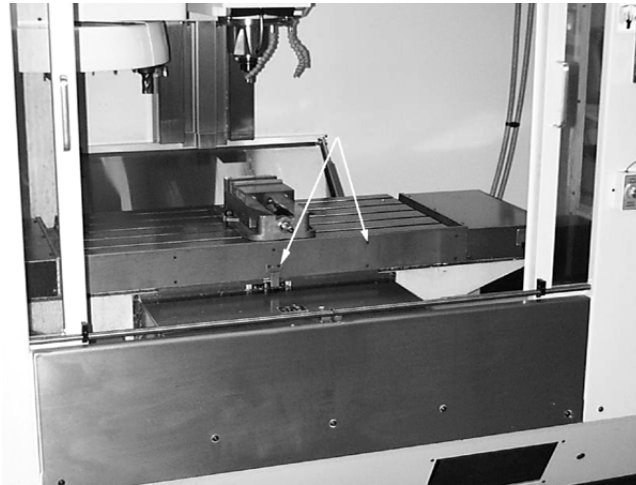
The TS-27 probe uses the same test procedure as the MP-11 and the MP-12 probes. The same maintenance procedure should also be used.

---

### Scales

#### Installing Scales

- 1) Remove the front cover plate from the table and position a .001" Indicator on the face of the table.



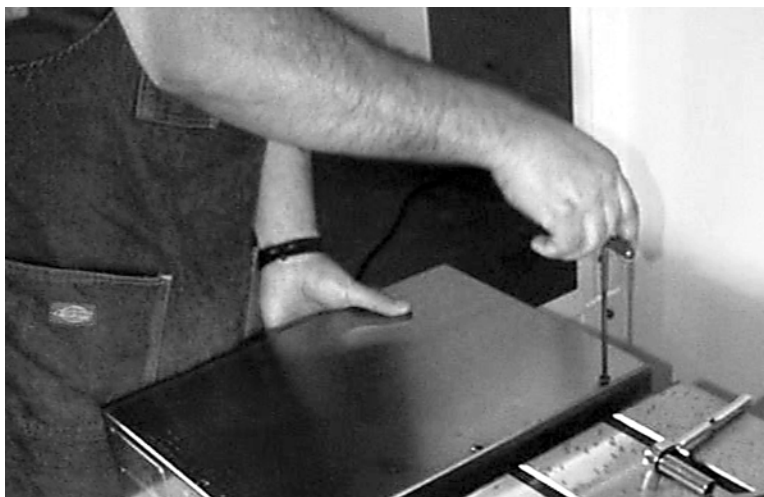
*Figure 11-1* Remove Front Cover Plate and Position Indicator

- 2) Jog the table to the maximum negative X axis travel.



*Figure 11-2* Jog Table to Maximum Negative X Axis Travel

- 3) Remove the telescoping way cover by removing three button head socap screws and two 1/4-20 cap screws.



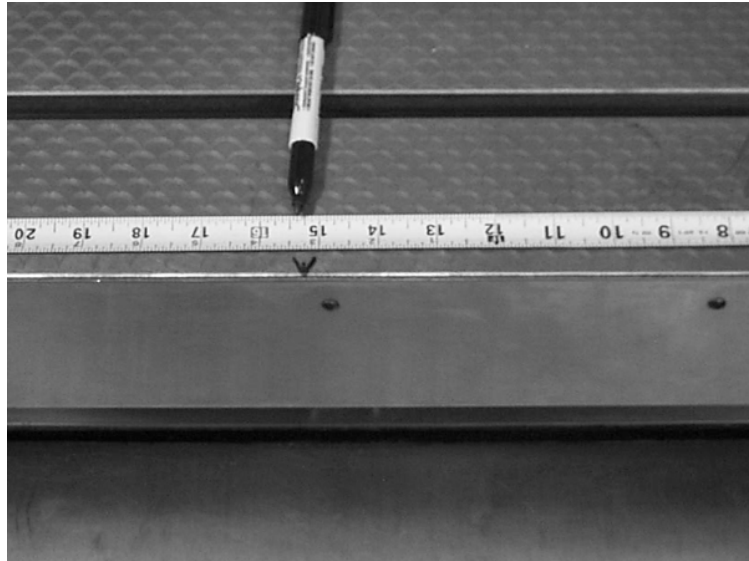
*Figure 11-3* Remove Telescoping Way Cover

- 4) Jog the table to the X axis home position.



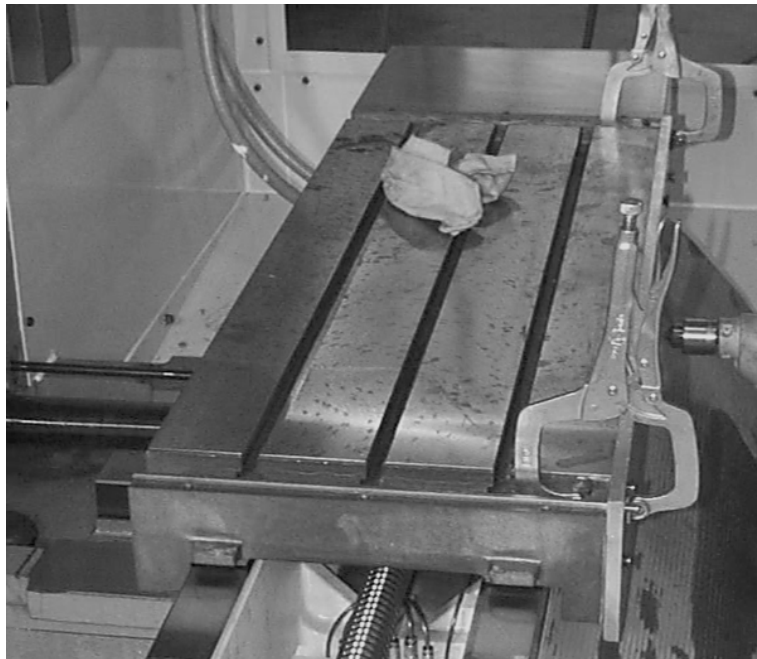
*Figure 11-4* Jog Table to X Axis Home Position

- 5) Measure and mark the center of the table.



*Figure 11-5* Measure and Mark Table Center

- 6) Install the scale template with clamps. Center the template on the table marks that were made in step 5. Verify that the alignment pins are tight against the bottom of the table.



*Figure 11-6* Install Scale Template with Clamps

- 7) Drill  $21/64$ " starting holes. [For the 6030 and 8030 drill  $3/16$ " holes, and  $1/4$ " dowel pin holes (6 total). Skip step 8.]



*Figure 11-7* Drill Starting Holes

- 8) Remove the Template.



*Figure 11-8* Remove Template



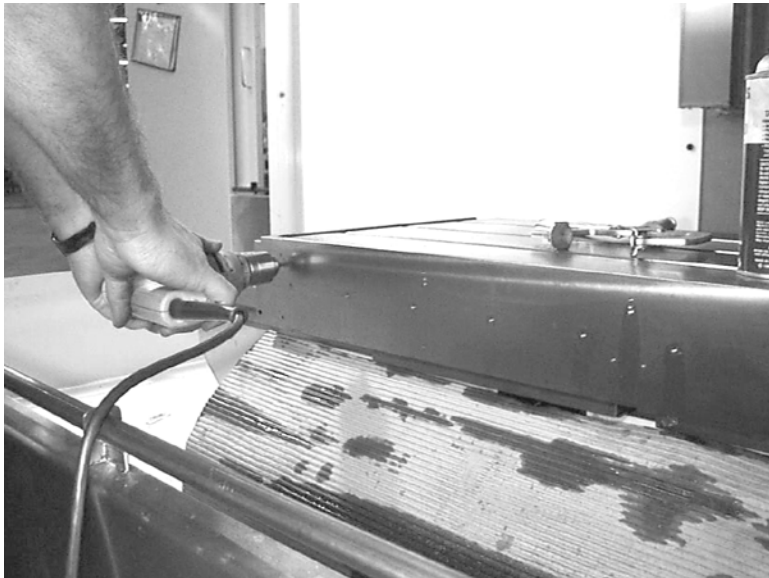
- 9) Drill the holes with  $21/64$ " drill. Drill to a depth of 1 inch. Counter sink the holes after drilling.



*Figure 11-9* Counter Sink Holes

(For 6030 and 8030 machines drill with a #3 drill for attachment bars and a  $1/4$ " drill for dowel pins.)

- 10) Apply tapping lubricant to the holes and tap them with a 10-32" tap.



*Figure 11-10* Tap Holes

(For 6030 and 8030 machines, tap with a  $1/4$ -20 tap.)

11) Clean debris from inside the holes with a air.



*Figure 11-11* Clean Debris from Holes

12) Clean all surfaces to remove lubricant and debris.



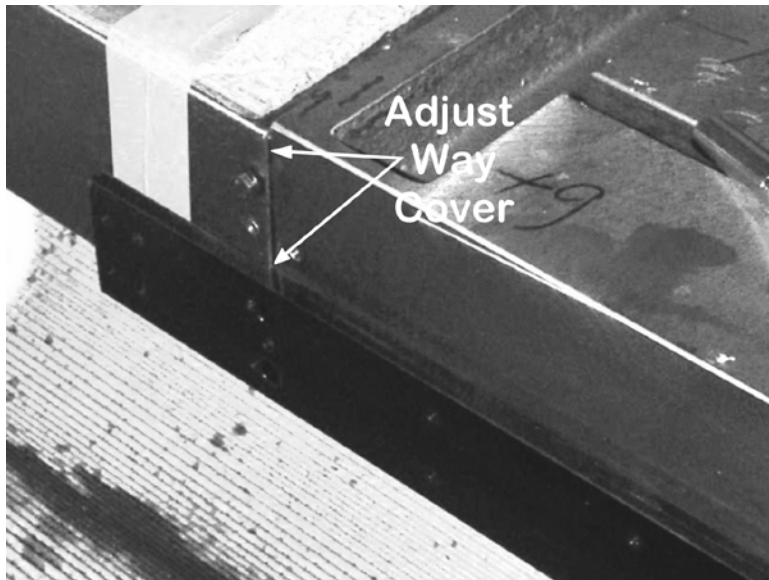
*Figure 11-12* Clean Surfaces

(For 6030 and 8030 machines only: Insert 1/4" dowel pins into the mounting plates.)



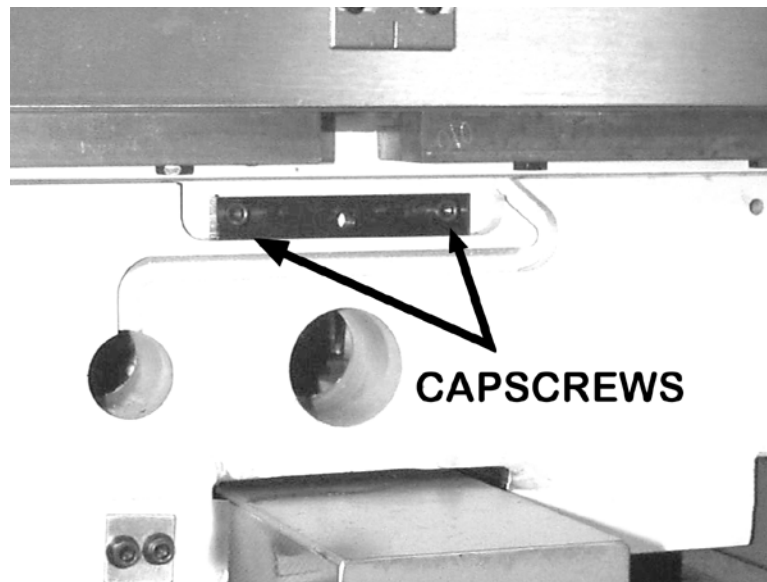
**Figure 11-13** Insert Dowel Pins into Mounting Plates of 6030 & 8030

13) Attach mounting plates to the table with 1/4-20 x 1/2" socap screws (HDW-0295). Adjust the way covers so that the plate is flush with table.



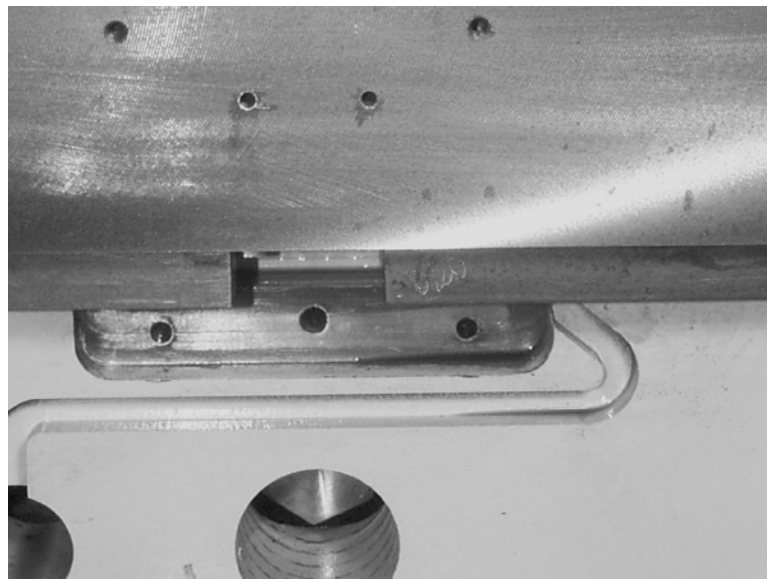
**Figure 11-14** Adjust Way Cover

- 14) Remove the cap plate from the center line of table by removing two socap screws with a 3/16" Allen wrench.



*Figure 11-15* Capscrews

- 15) Scrape paint from all areas that the scale will cover. Stone the surface lightly and clean them with a solvent.



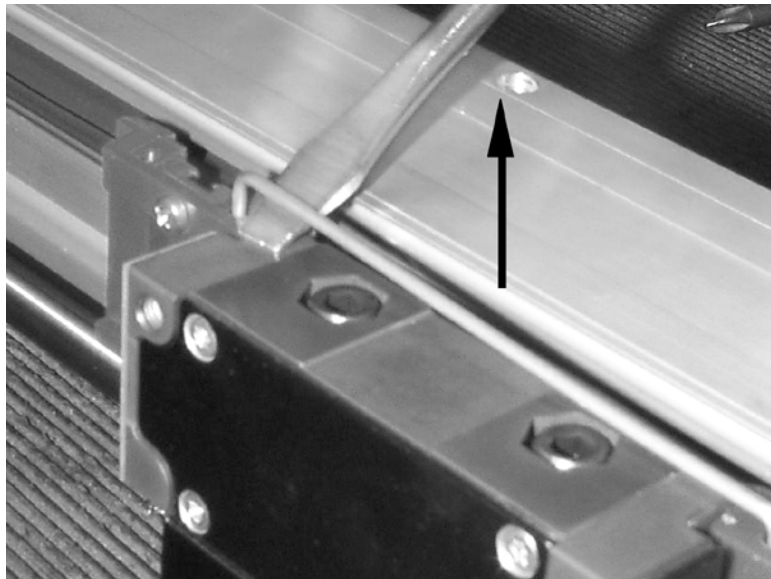
*Figure 11-16* Scrape Paint from Areas Scales Will Cover

- 16) Install the X axis scale reader mounting plate with socap screws and a 3/16" Allen wrench. Using an indicator, level the plate to within .0003".



**Figure 11-17** Install X Axis Scale Reader Mounting Screws

- 17) Remove the scale from the box. Remove the retainer clip and loosen the screws holding the packing clips.



**Figure 11-18** Remove Scale from the Box

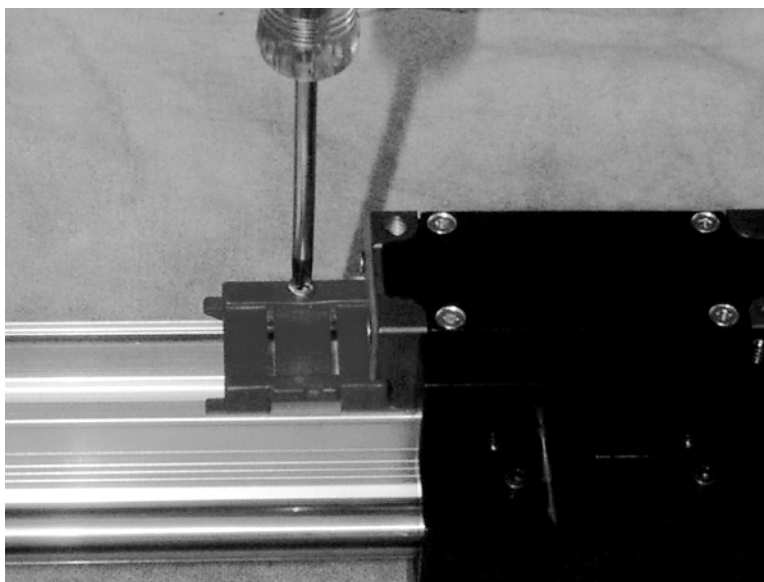


18) Remove the protective cover, located over the pin connector.



*Figure 11-19* Remove Protective Cover from Pin Connector

19) Remove the packing clips from the scale assembly.



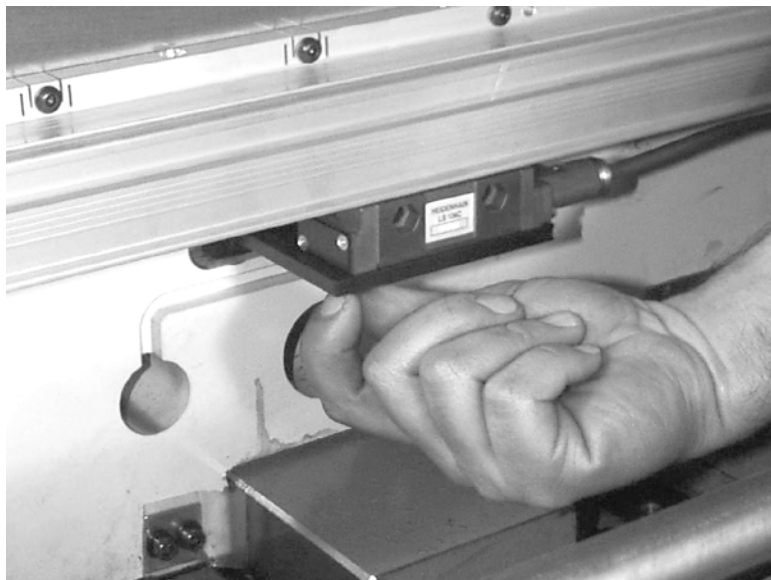
*Figure 11-20* Remove Packing Clips from Scale Assembly

- 20) Attach the scale assembly to the table with 10-32 x 3/4" button head socap screws (HDW-797) and washers (HDW-0450) using a 1/8" Allen wrench. *Do Not Tighten Securely At This Time.*



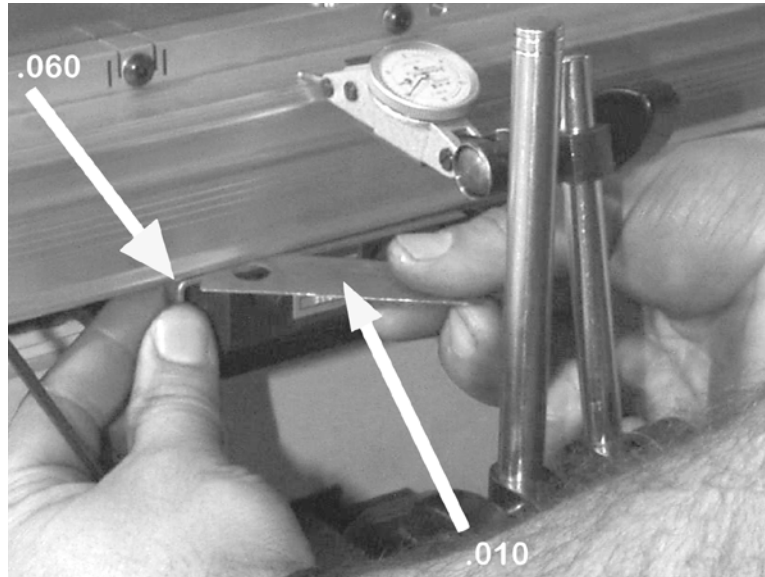
*Figure 11-21* Attach Scale Assembly to Table

- 21) Attach the scale reader to the mounting plate with two #8 socket head cap screws.



*Figure 11-22* Attach Scale Reader to Mounting Plate

- 22) Place a .060" shim between the scale and the reader. Adjust the scale so that a .010" shim cannot be inserted between the scale and the shim on the reader. Continue adjusting along the length of the scale.



*Figure 11-23* Place Shim Between Scale and Reader

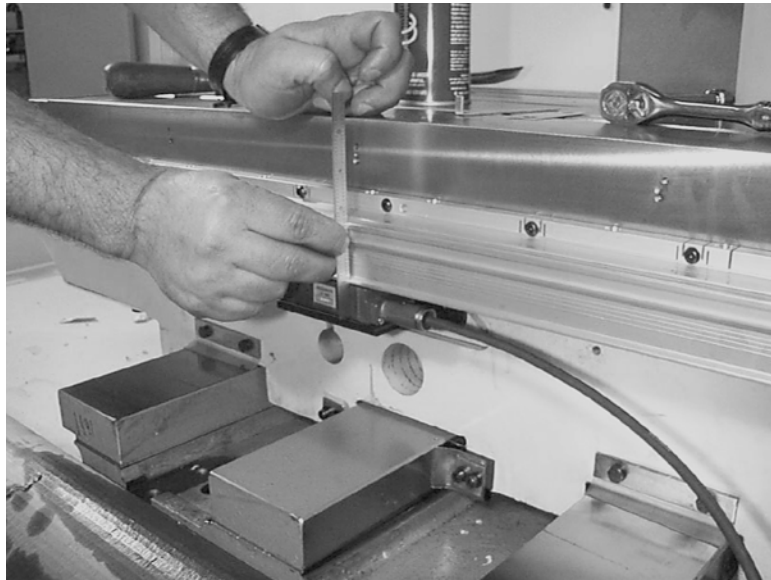
- 23) Mount the scale to the table, using a dial indicator with a magnetic base, to the center of the way. Position the indicator on the widest rib on the top side of the scale. Align the scale within .001", end to end.



*Figure 11-24* Mount Scale to Table

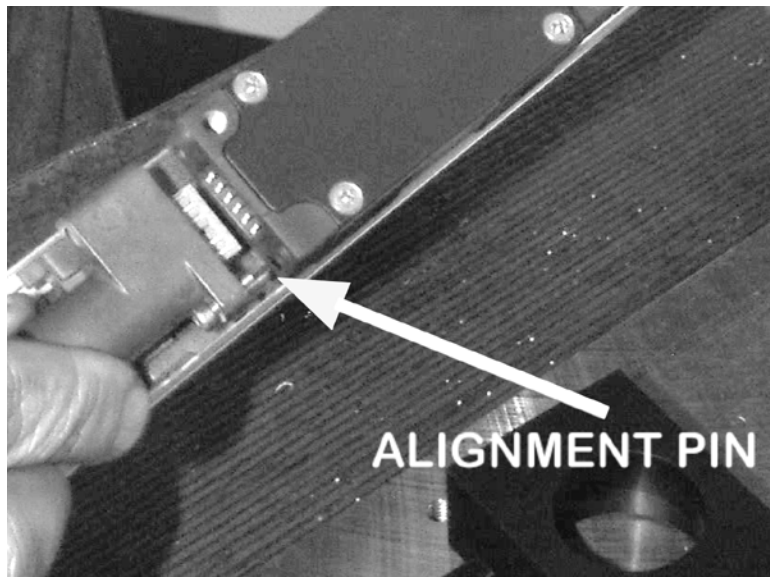


- 24) Place a straight edge against the front of the aluminum extrusion. Adjust the reader so that it is flush with the scale. Tighten the mounting screws.



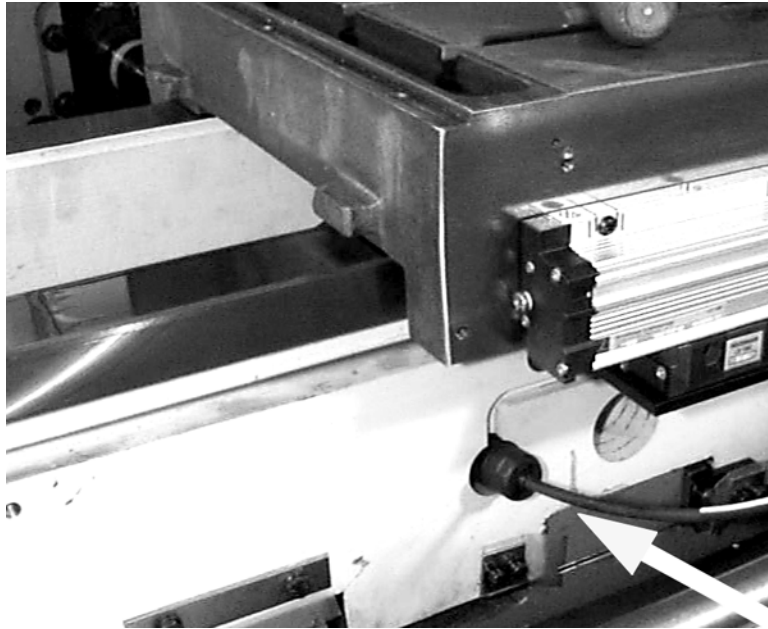
*Figure 11-25* Adjust Reader So it is Flush with Scale

- 25) Attach the cable to the scale reader with a #8 metric allen wrench. The alignment pin ensures that the cable is installed correctly.



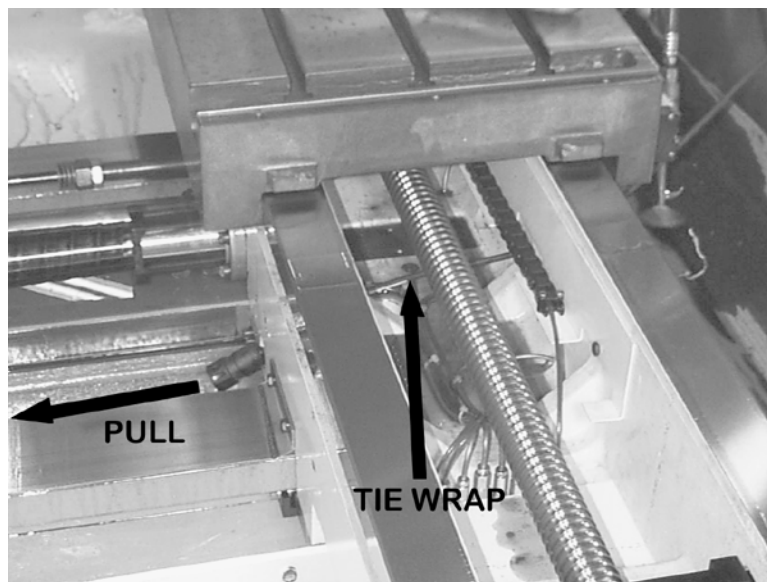
*Figure 11-26* Alignment Pin

26) Route the cable through the access hole on the saddle.



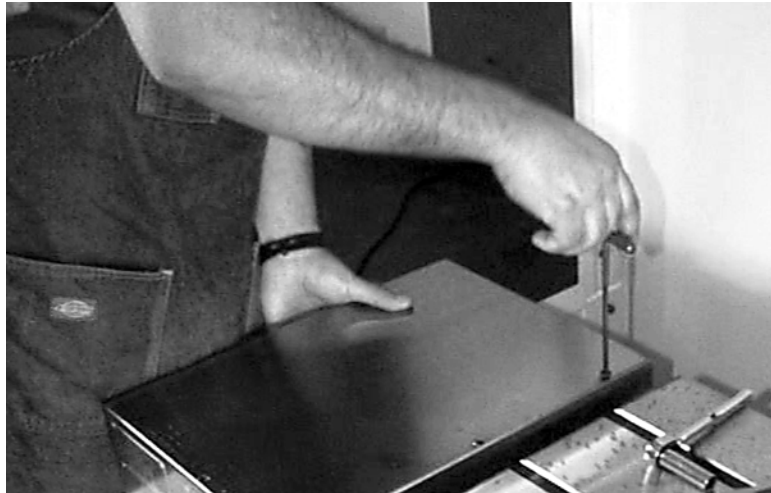
*Figure 11-27* Route Cable Through Access Hole on Saddle

27) Pull the excess cable through the saddle and tie it to the lubrication line bundle.



*Figure 11-28* Pull Excess Cable Through Saddle and Tie to Lubrication Line Bundle

28) Reinstall telescoping way cover.



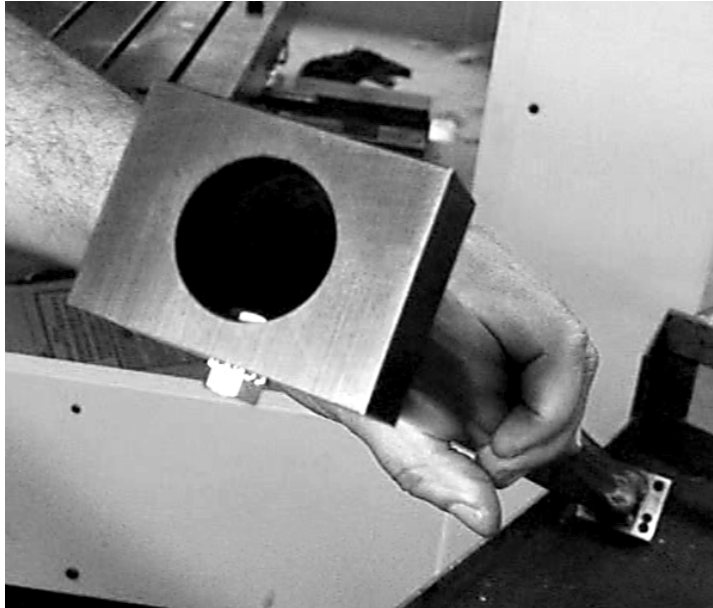
*Figure 11-29* Reinstall Telescoping Way Cover

29) Attach the axis position indicator to the scale cover with two 10-32 nylok nuts (HDW-0634). Attach the scale cover to the side of the table with five 10-32 button head socap screws (HDW-0348).



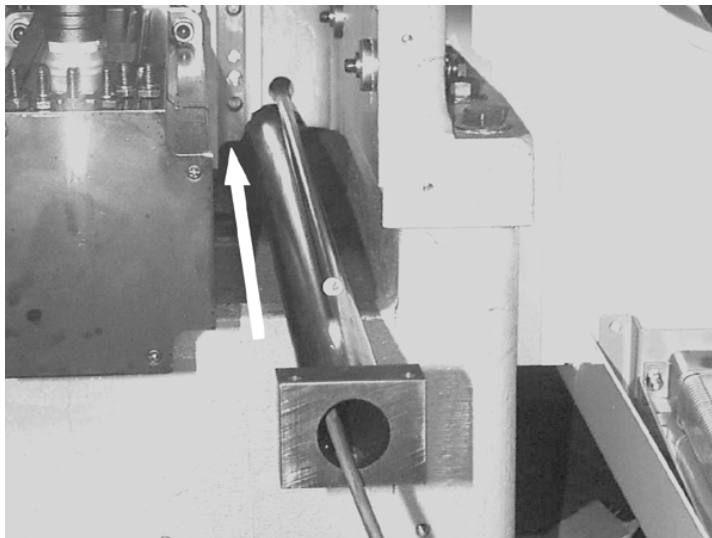
*Figure 11-30* Attach Axis Position Indicator to Scale Cover

- 30) Press the X-axis shield tube cap onto the end of the tube, fasten with 1/4-20 x 1/2" hex cap screw (HDW-0319) and hex nut KEPS 1/4-20 (HDW-0337).



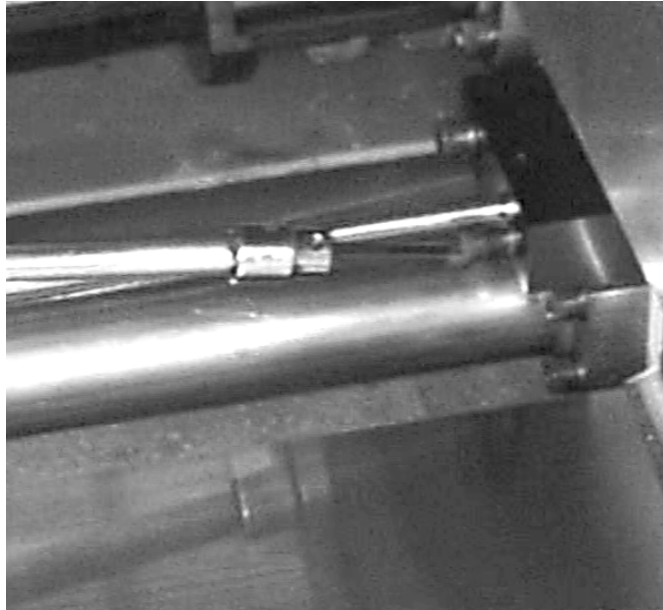
*Figure 11-31* Press X Axis Shield Tube Cap onto End of Tube

- 31) Pull the X axis cable through the shield tube, while inserting the tube through the machined opening through the column.



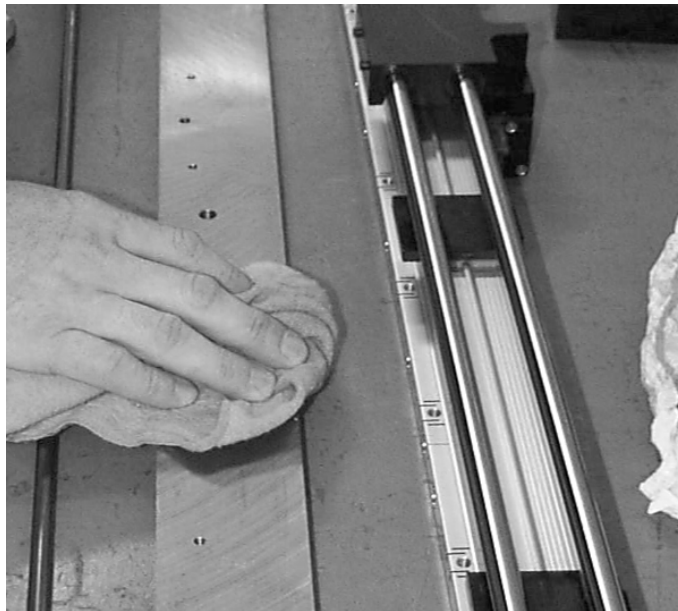
*Figure 11-32* Insert Tube Through Column

- 32) Attach the X axis shield tube to the saddle with three 5/16-18 x 1 1/4" socap screws. (HDW-0792)



*Figure 11-33* Attach X Axis Shield Tube to Saddle

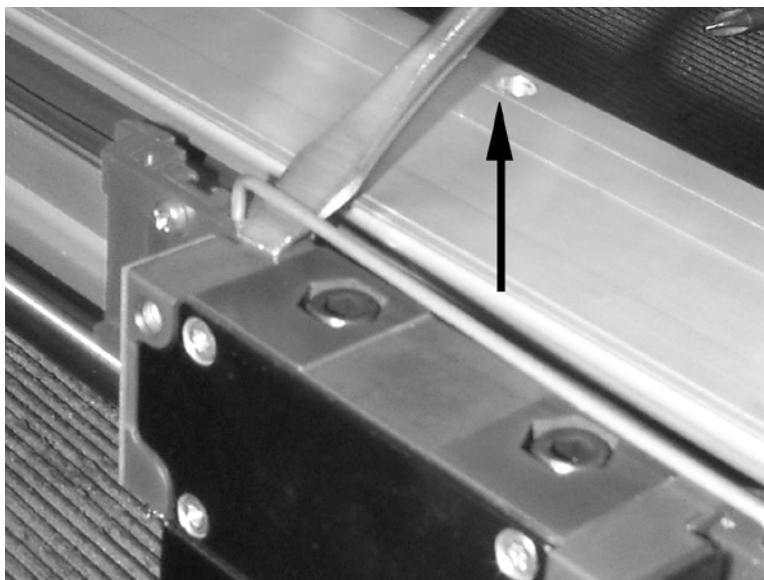
- 33) Clean the Y axis mounting plate.



*Figure 11-34* Clean Y Axis Mounting Plate

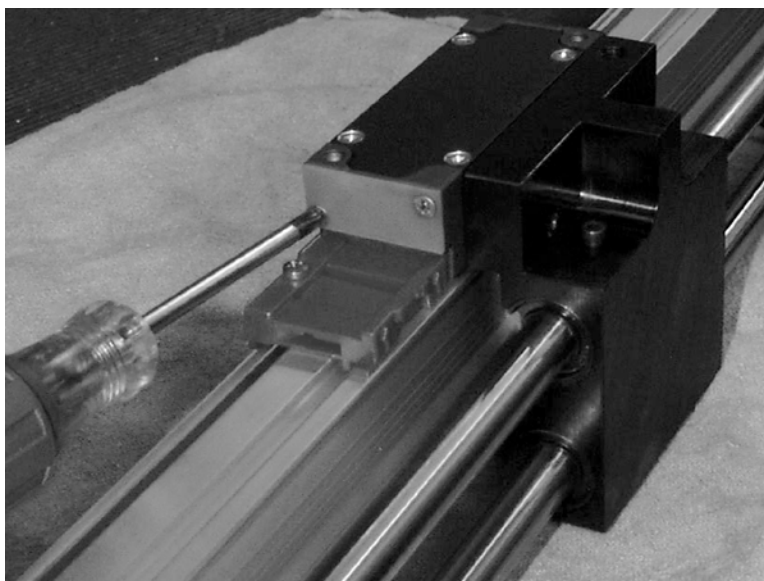


- 34) Remove the scale from the packaging. Remove the wire retainer and loosen the screws holding the plastic retainer plates.



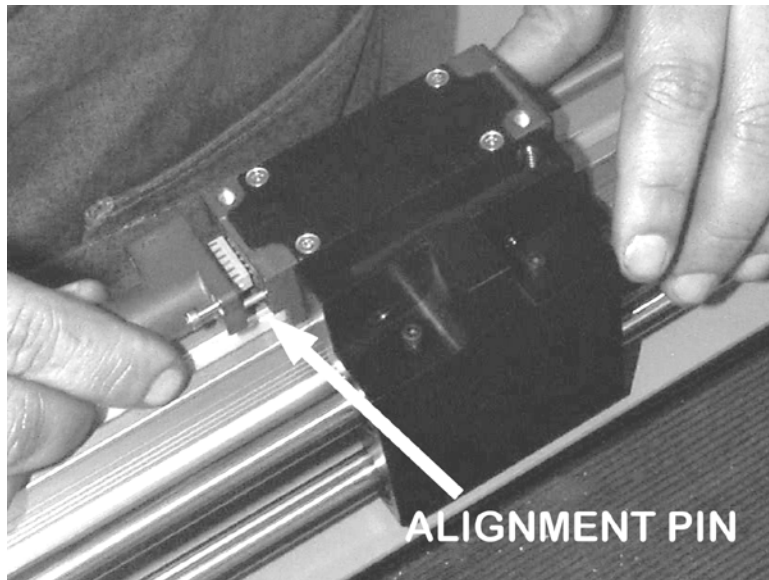
*Figure 11-35* Remove Wire Retainer and Loosen Screws Holding Retainer Plate

- 35) Remove the pin connector protective cover.



*Figure 11-36* Remove Pin Connector Protective Cover

- 36) Attach the cable to the scale reader with a #2.5 metric allen wrench. The alignment pin ensures that the cable is installed correctly.



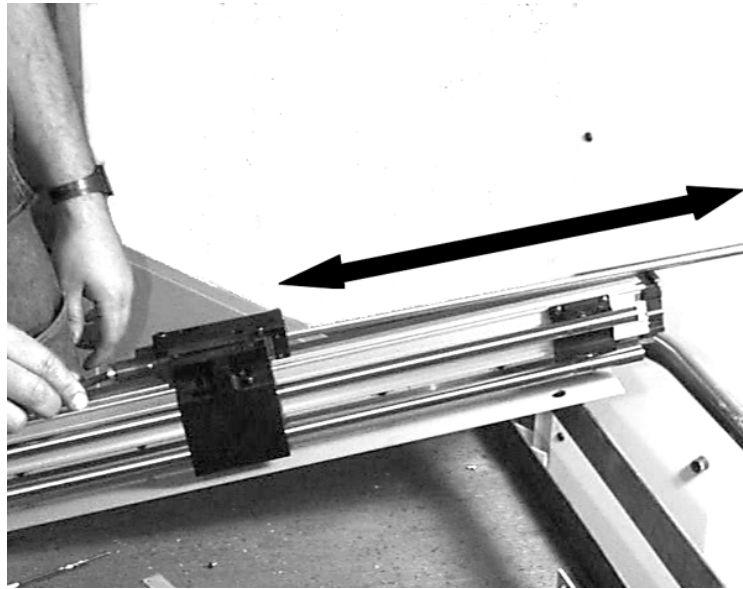
*Figure 11-37* Attach Cable to Scale Reader

- 37) Remove the packing clips from the scale assembly.



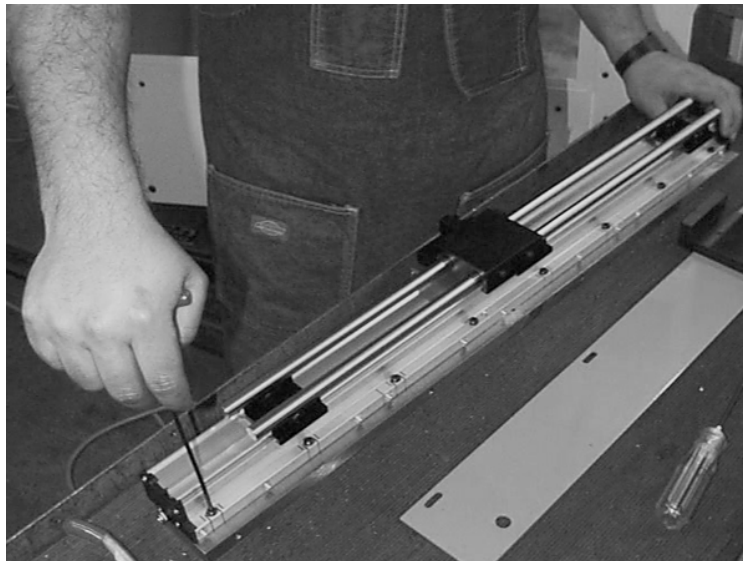
*Figure 11-38* Remove Packing Clips from Scale Assembly

- 38) Temporarily attach the throw rod to the scale reader. Visually align the rod with the scale and tighten the bracket. Remove the throw rod.



*Figure 11-39* Attach Throw Rod to Scale Reader

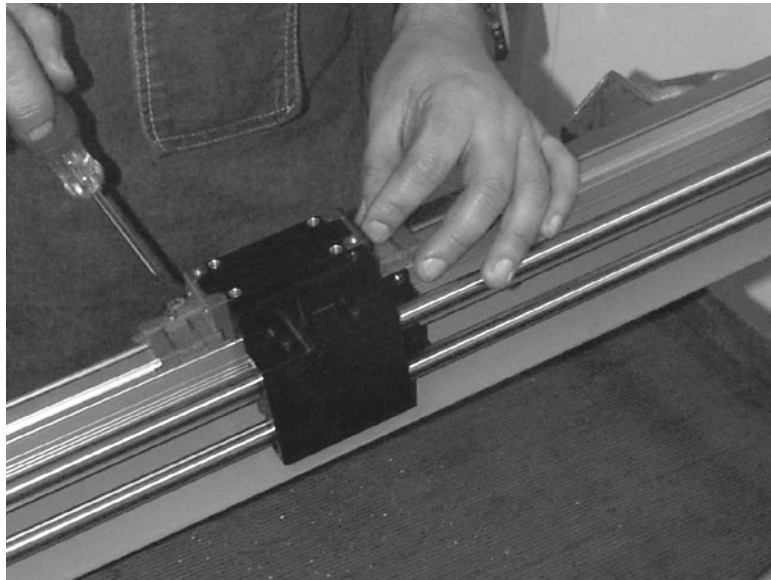
- 39) Attach the scale assembly to the mounting plate with eight 10-32 x 3/4" button head socap screws (HDW-0797) and washers (HDW-0450). While pushing the scale upward against the mounting bolts, use a 1/8" Allen wrench to tighten the screws.



*Figure 11-40* Attach Scale Assembly to Mounting Plate

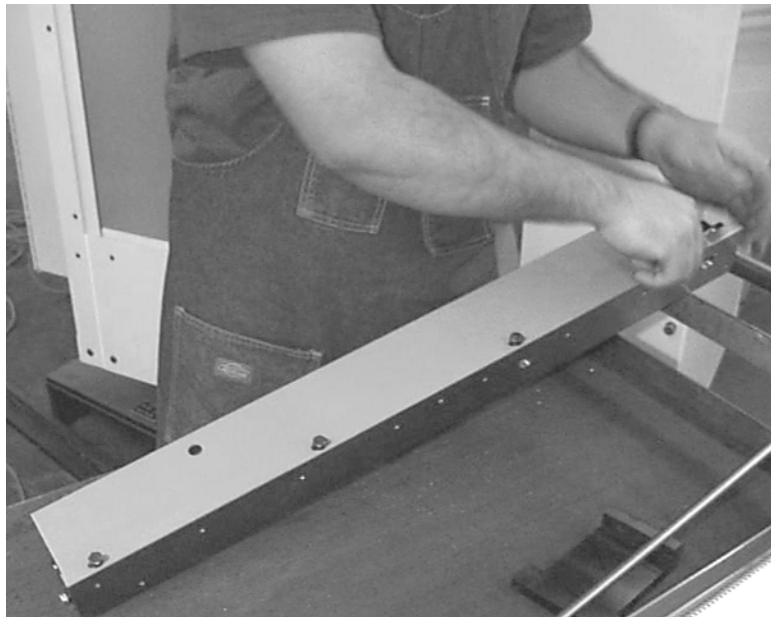


- 40) Attach the throw rod mounting bracket to the scale reader with two #8 button head socap screws.



**Figure 11-41** Attach Throw Rod Mounting Bracket to Scale Reader

- 41) Attach the cover plate to the scale using four 1/4-20 x 1/2" hex cap screws (HDW-0319) and lock washers (HDW-0279) with a 7/16" socket wrench.



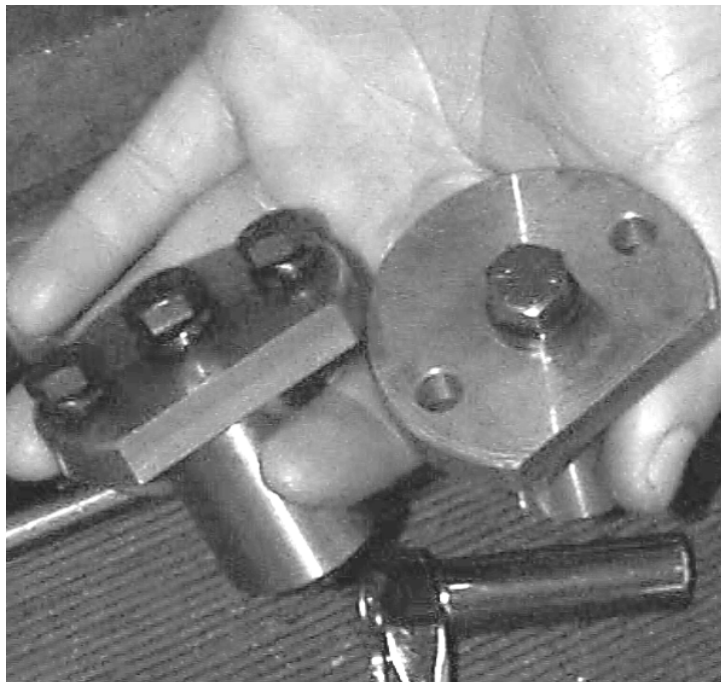
**Figure 11-42** Attach Cover Plate to Scale

- 42) Insert two 1/4-20 x 1/2" set screws into the throw rod's saddle mounting bracket.



**Figure 11-43** Insert Screw into Throw Rod's Saddle Mounting Bracket

- 43) Insert one 3/8-16 x 2 1/2" hex cap screw (HDW-0570) with one lock washer (HDW-0280) and two 5/16-18 x 3/4" hex cap screws (HDW-0575) with lock washers (HDW-0281) into the Y axis scale mounts.

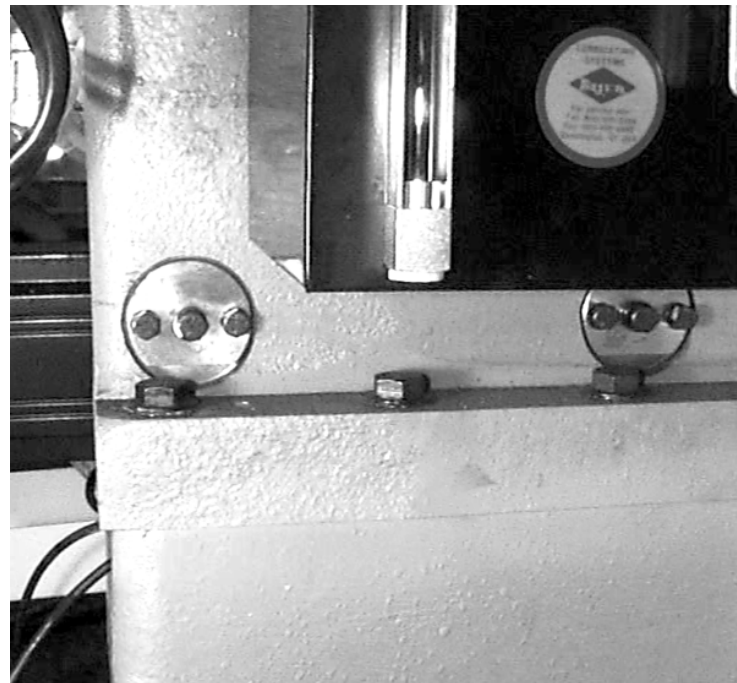


**Figure 11-44** Insert Screws and Washers into Y Axis Scale Mounts

- 44) Insert the mounts into the machined openings at the bottom of the column.  
Secure to the column with the 5/16-18 cap screws.

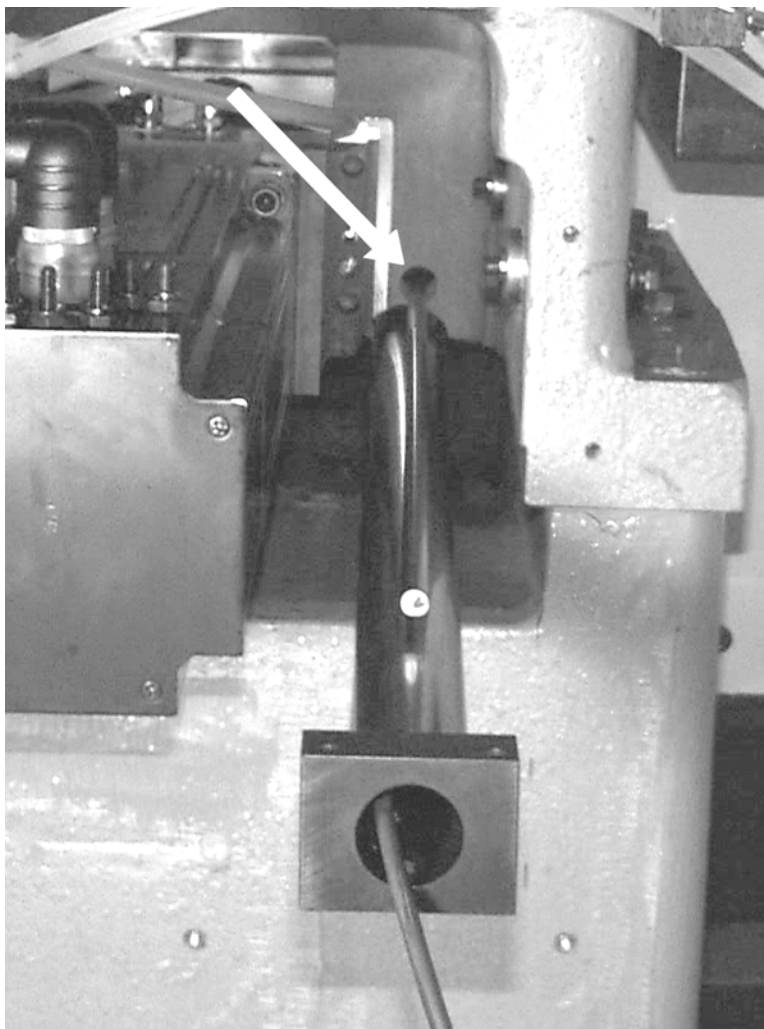


*Figure 11-45* Insert Mounts into Openings at Bottom of Column



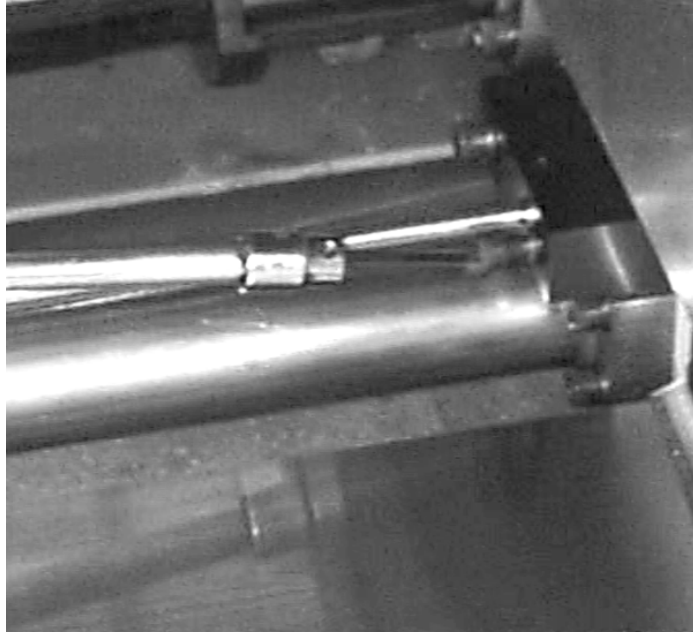
*Figure 11-46* Secure Mounts to Column

- 45) Insert the Y axis throw rod, flat end first, through the machined hole above the X axis tube.



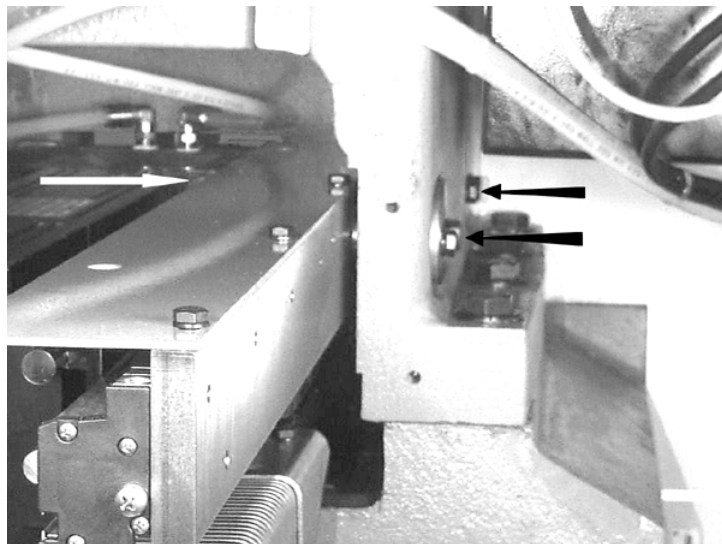
*Figure 11-47* Insert Y Axis Throw Rod Through Hole Above X Axis Tube

- 46) Attach the Y axis throw rod bracket to the saddle with two 5/16-18 x 2" socap screws (HDW-0484). Insert the throw rod into the bracket and secure the rod with the two 1/4-20 set screws.



*Figure 11-48* Attach Y Axis Throw Rod Bracket to Saddle

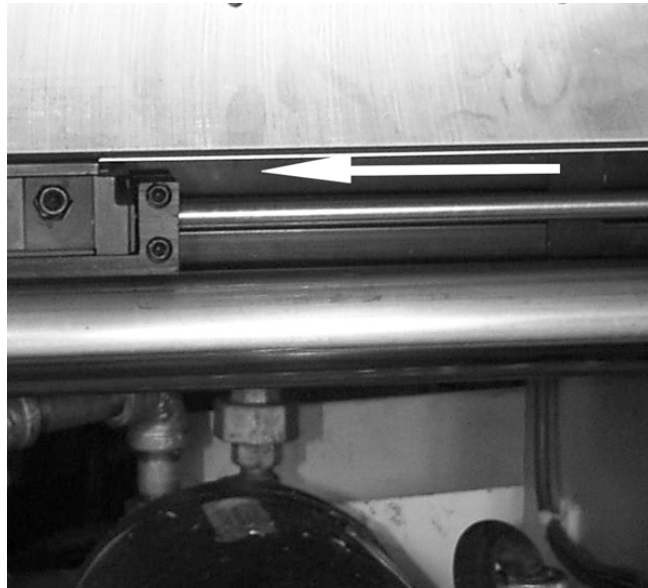
- 47) Attach the Y axis scale to the column with the 3/8-16 x 2 1/2" cap screws on the mounting pads.



*Figure 11-49* Attach Y Axis Scale to Column

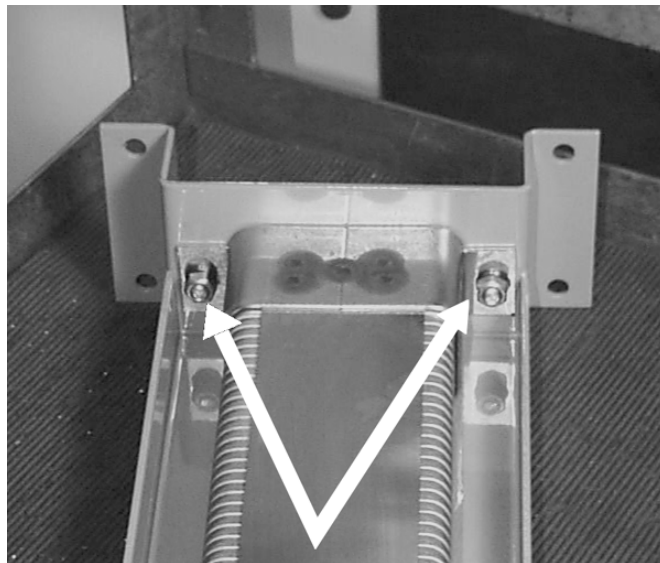


- 48) Insert the throw rod into its bracket on the scale reader and tighten the two 8-32 x 3/4" socap screws (HDW-0505) using a 9/64" allen wrench. Align the throw rod at the side and top within .005". Adjustments are made at the block attaching the rod to the saddle.



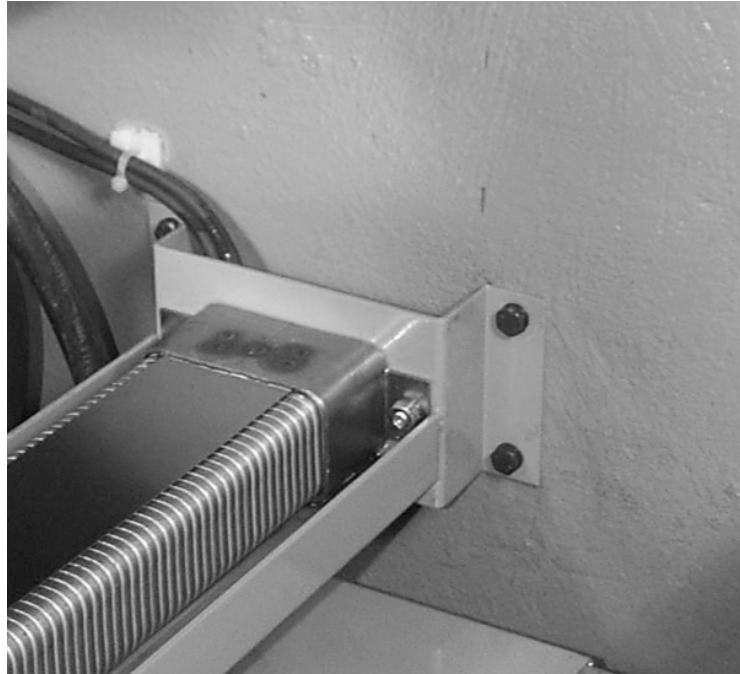
*Figure 11-50* Insert Throw Rod into Bracket on Scale Reader

- 49) Attach the flex shield to the mounting bracket with two 1/4-20 nuts (HDW-0336) and lock washers (HDW-0279).



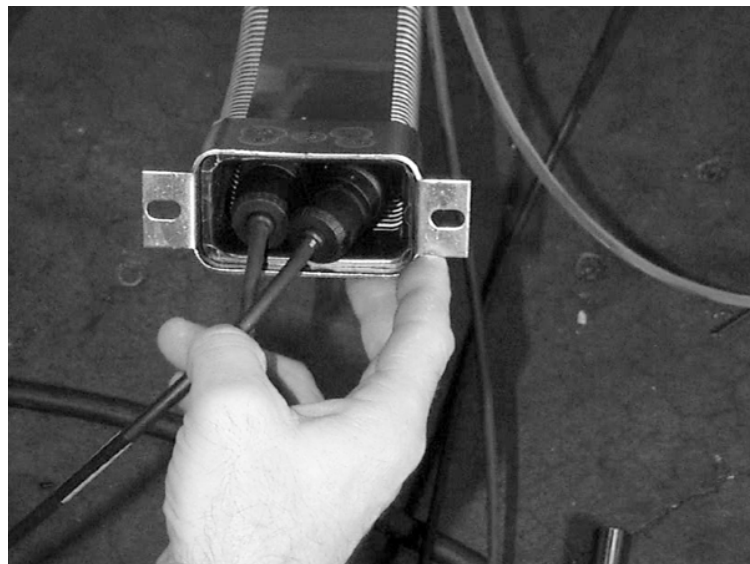
*Figure 11-51* Attach Flex Shield to Mounting Bracket

50) Attach the flex shield assembly to the base with four 1/4-20 x 5/8" hex cap screws (HDW-0581) and lock washers (HDW-0279). Drill and tap four 1/4-20 holes with template.



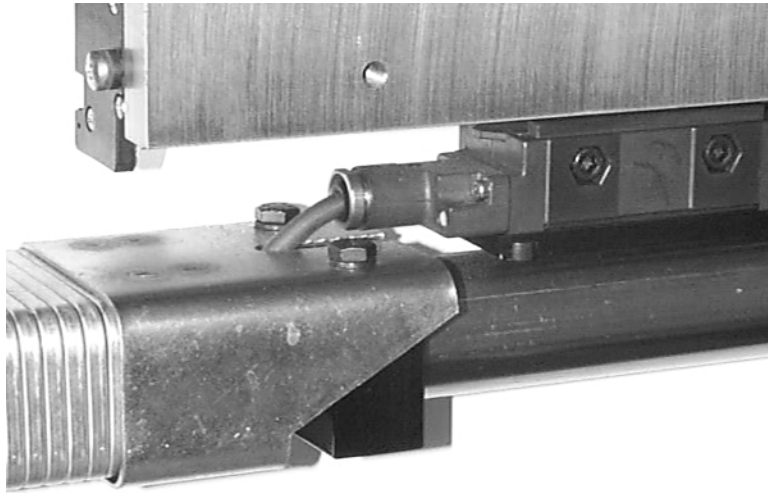
*Figure 11-52* Attach Flex Shield Assembly to Base

51) Feed the X and Y axis cables through the flex shield.

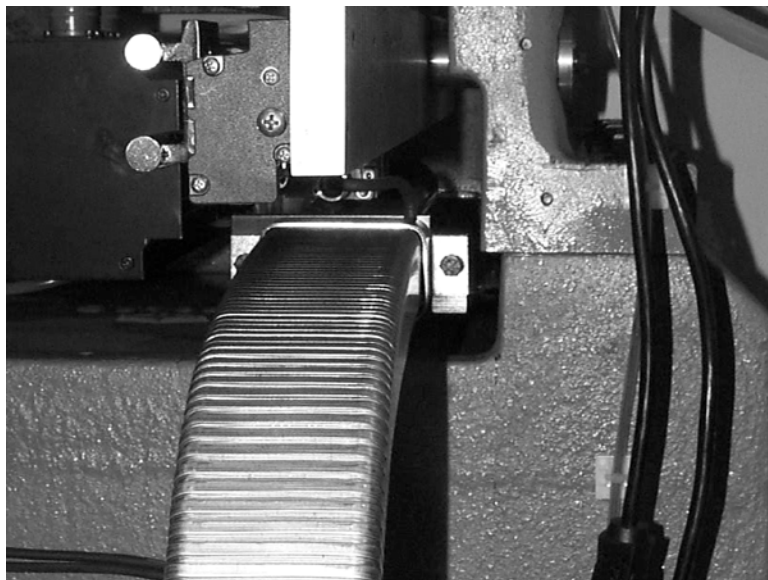


*Figure 11-53* Feed X and Y Axis Cables Through Flex Shield

- 52) Attach the end of the flex shield to the bracket on the X axis tube with two 1/4-20 x 1/2" hex cap screws (HDW-0319) and lock washers (HDW-0279).



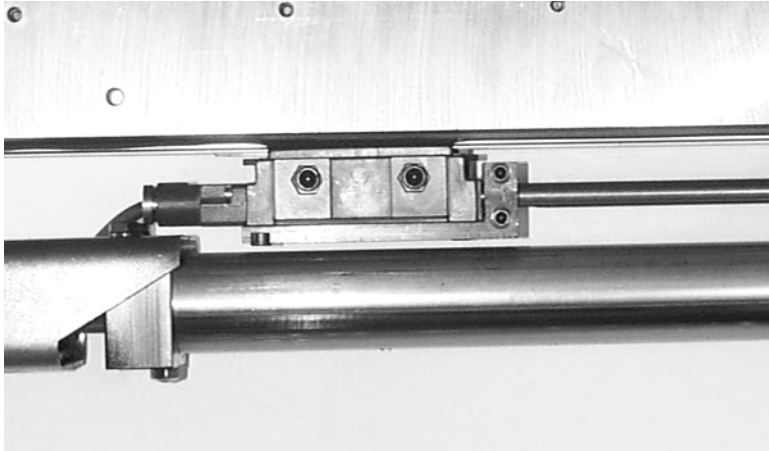
*Figure 11-54* Attach End of Flex Shield to Bracket on X Axis Tube (Side View)



*Figure 11-55* Attach End of Flex Shield to Bracket on X Axis Tube (Front View)



- 53) Check the clearance between the scale reader and X axis shield tube.  
Adjust the clearance by applying downward pressure on the tube.



*Figure 11-56* Check Clearance Between Scale Reader and X Axis Shield Tube

- 54) Route the cables to the back of the Control cabinet.



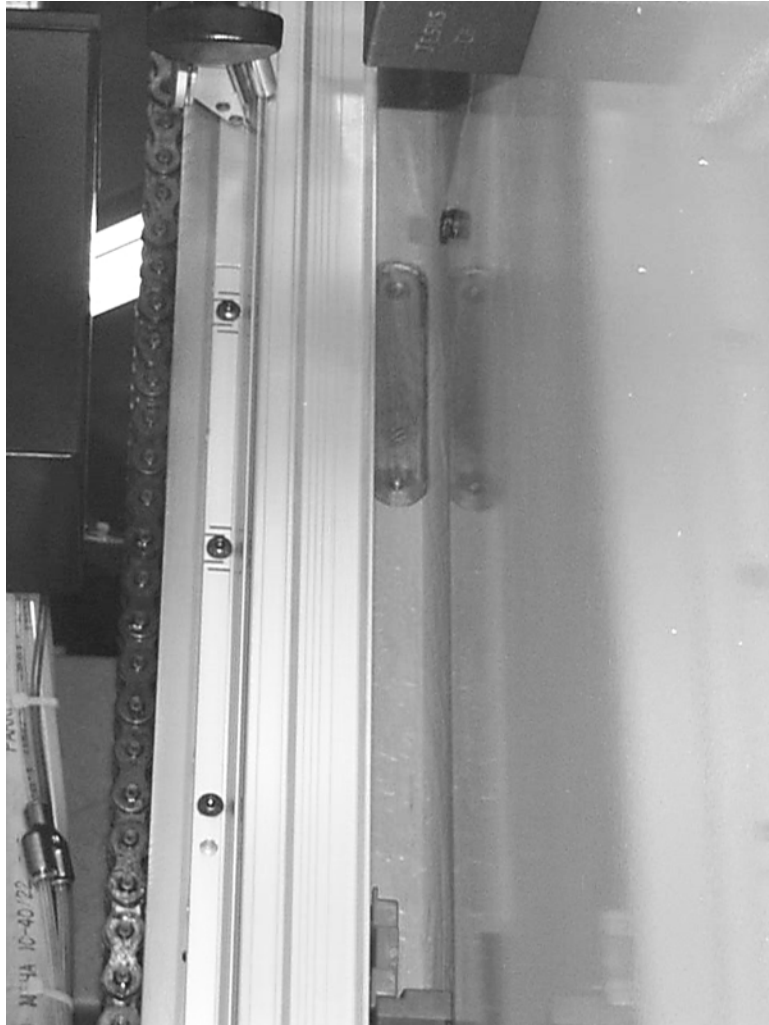
*Figure 11-57* Route Cables to Back of Control Cabinet

*(For 6030/8030 Machines: Attach a support bracket between the Y scale and the CNC junction box.)*



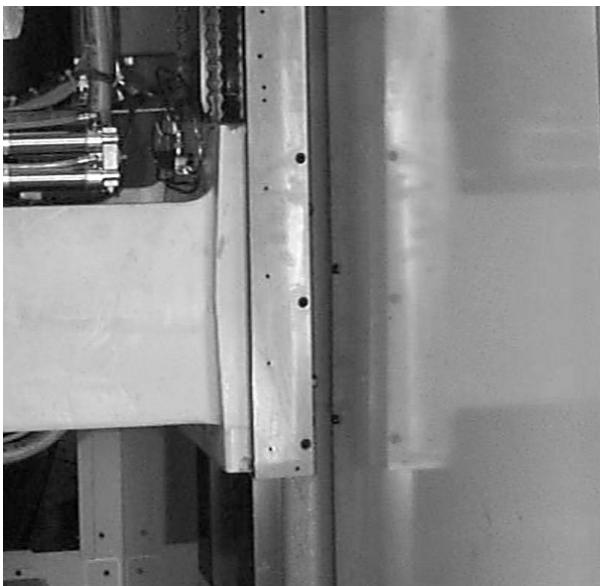
**Figure 11-58** Attach Support Bracket Between Y Scale and CNC Junction Box (6030/8030)

- 55) Scrape the paint from the mounting bracket pad on the side of the column. Stone lightly and thoroughly clean.



*Figure 11-59* Scrape Paint from Mounting Bracket, Stone Lightly, Clean Thoroughly

- 56) Attach the Z axis mounting plate to the side of the head assembly with three 5/16-18 x 2" socap screws (HDW-0484) with a 1/4" Allen wrench.



*Figure 11-60* Attach Z Axis Mounting Plate to Side of Head Assembly

57) Mount a dial indicator to the column. Place the tip of the indicator on the mounting plate.



*Figure 11-61* Mount Dial Indicator to Column

- 58) Zero the dial indicator and jog the Z axis through the full range of travel. Adjust the mounting plate until less than .005" deflection is achieved. The gib/straps may require loosening to complete the adjustments.



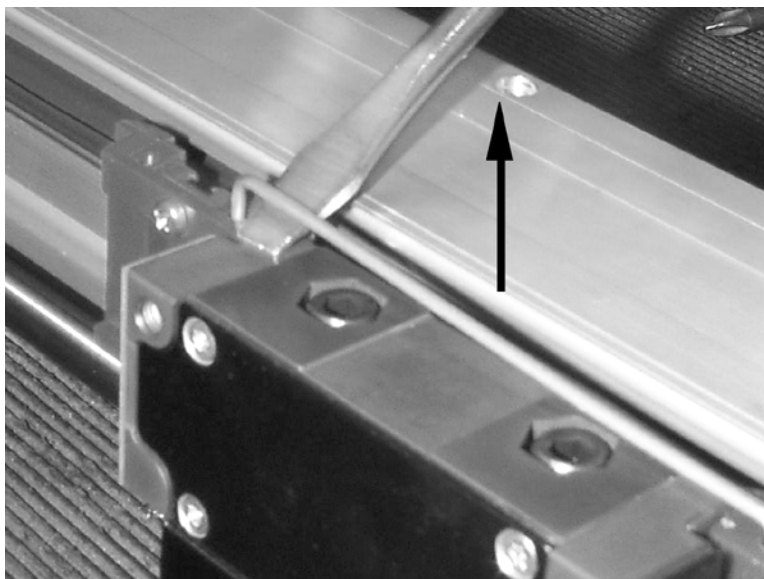
*Figure 11-62* Adjust Mounting Plate

59) Thoroughly clean the Z axis mounting plate.



*Figure 11-63* Thoroughly Clean Z Axis Mounting Plate

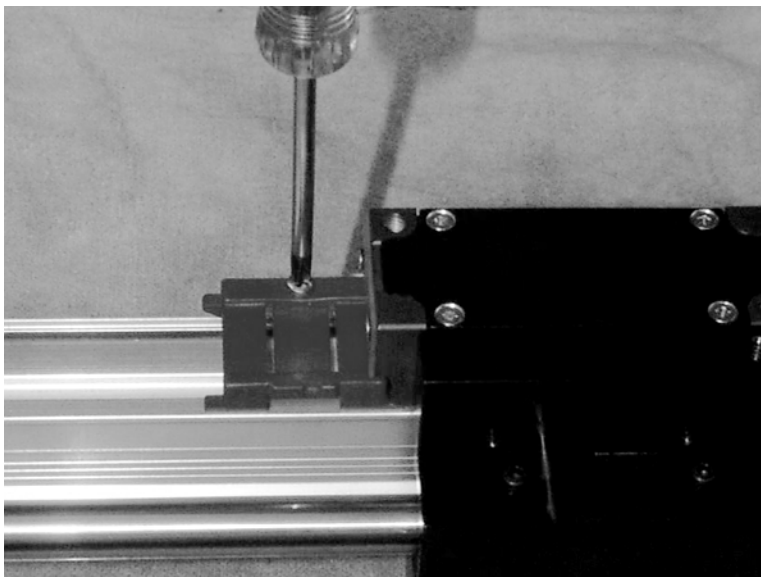
60) Remove the scale from the packaging. Remove the wire retainer clip. Loosen the screws holding the packing clips.



*Figure 11-64* Remove Wire Retainer Clip

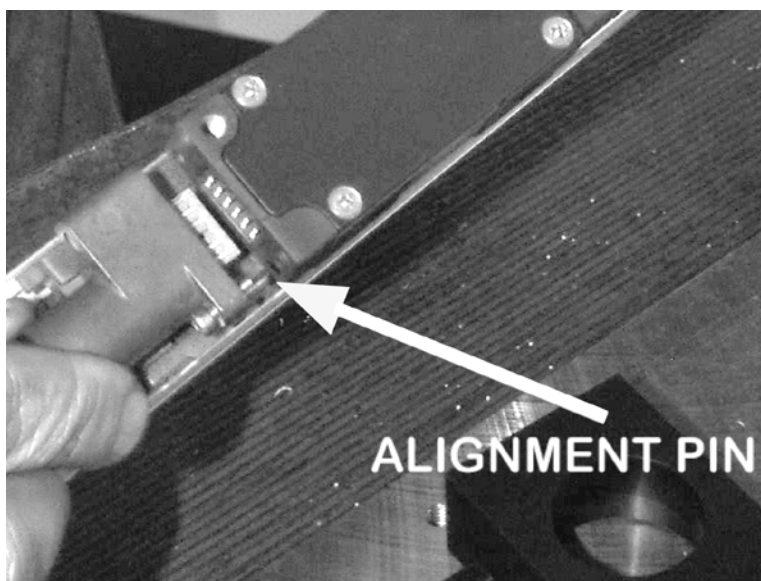


61) Remove the pin connector cover plate.



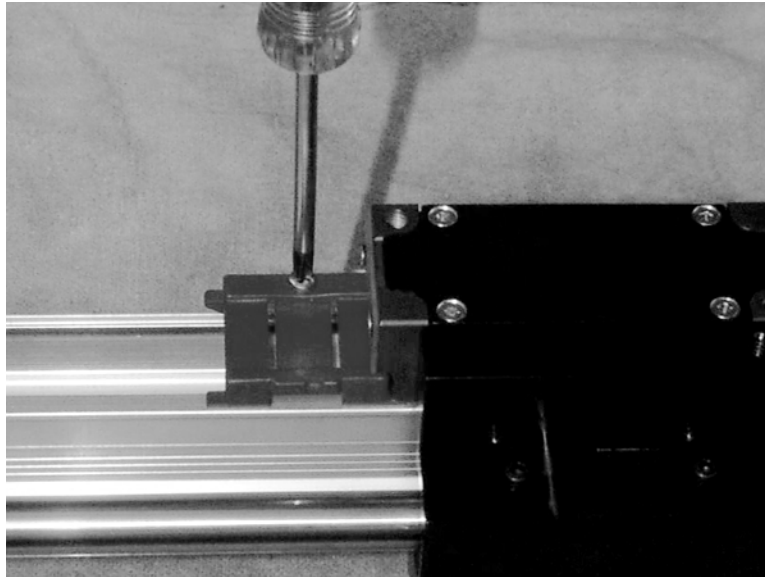
*Figure 11-65* Remove Pin Connector Cover Plate

62) Attach the cable to the scale reader with a #2.5 metric allen wrench. The alignment pin ensures that the cable is installed correctly.



*Figure 11-66* Attach Cable to Scale Reader

63) Remove the packing clips from the scale assembly.



*Figure 11-67* Remove Packing Clips from Scale Assembly

64) Attach the scale to the mounting plate with 1/4-20 x 1/2" button head socap screws (HDW-0346).



*Figure 11-68* Attach Scale to Mounting Plate



- 65) Set the dial indicator tip on the widest ridge on the scale. Zero the Z axis and mark the center of the scale. Adjust the scale so that it has less than .003" runout.



*Figure 11-69* Set Dial Indicator Tip on Scale's Widest Ridge; Adjust Scale

- 66) Attach the Z axis mounting bracket to the column with two 1/4-20 x 1 1/4" socap screws (HDW-0296), using a 3/16" Allen wrench.



*Figure 11-70* Attach Z Axis Mounting Bracket to Column

- 67) Attach the scale reader to the mounting bracket with two 1/4-20 x 1 1/2" socap screws. The reader should be evenly aligned with the Aluminum

housing. Adjust the length of the bracket by shaving material from the base if required.



*Figure 11-71* Attach Scale Reader to Mounting Bracket

68) Place the .060" shim between the scale reader and scale. Adjust the scale at the center so that the shim slides out with light friction. If the shim

cannot be slid into this area, ream the bracket mounting holes to provide the required clearance.



*Figure 11-72* Adjust Scale at Center

- 69) Attach the scale cover to the scale with three 1/4-20 x 3/8" button head socap screws (HDW-0347).



*Figure 11-73* Attach Scale Cover to Scale

## 1580 Board Setup

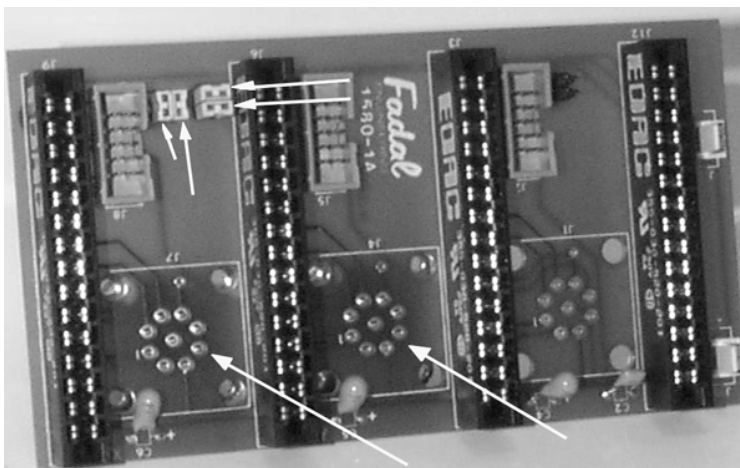


Figure 11-74 X, Y Axis Scales

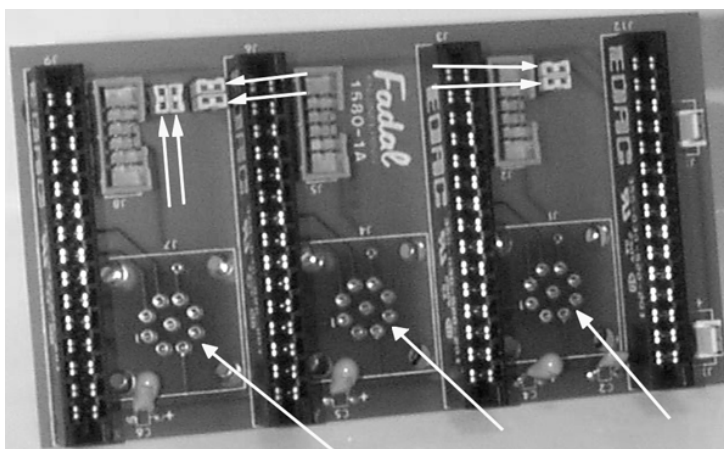


Figure 11-75 X, Y and Z Scales

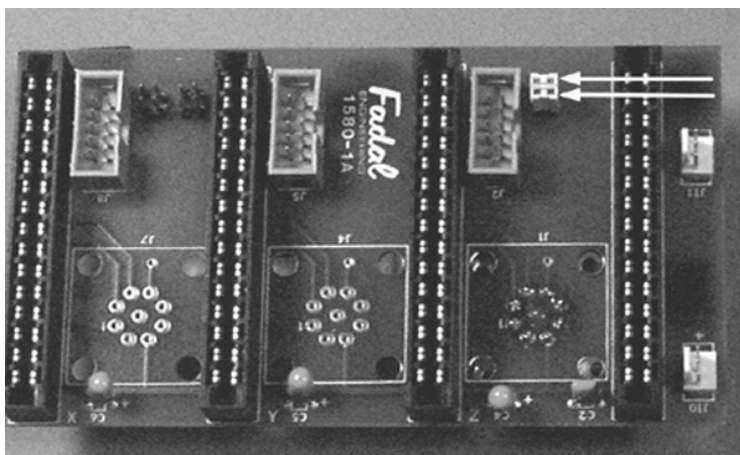


Figure 11-76



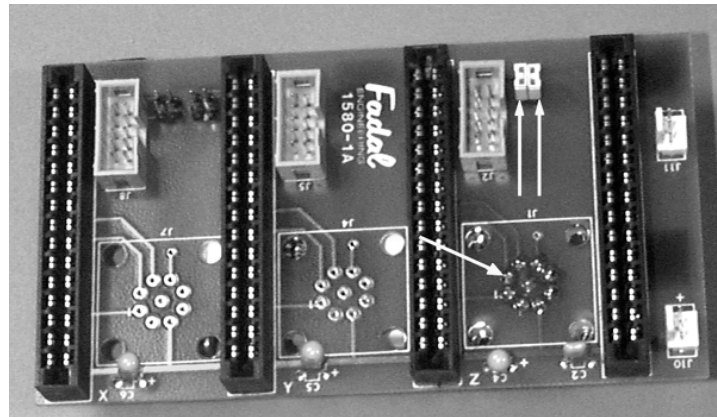


Figure 11-77

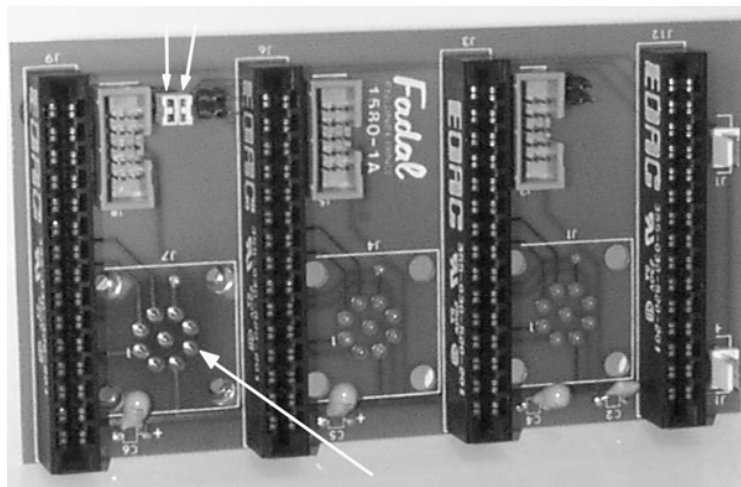


Figure 11-78

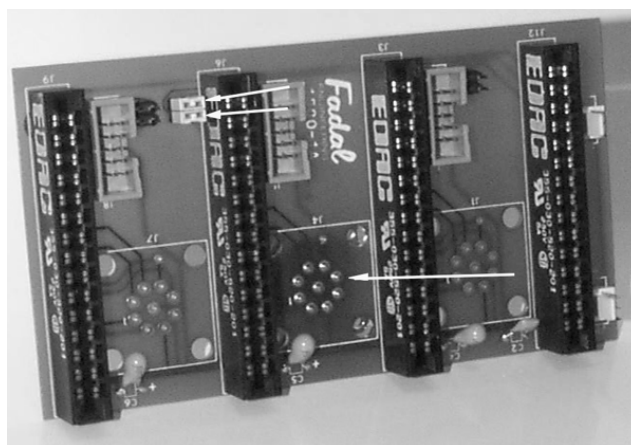
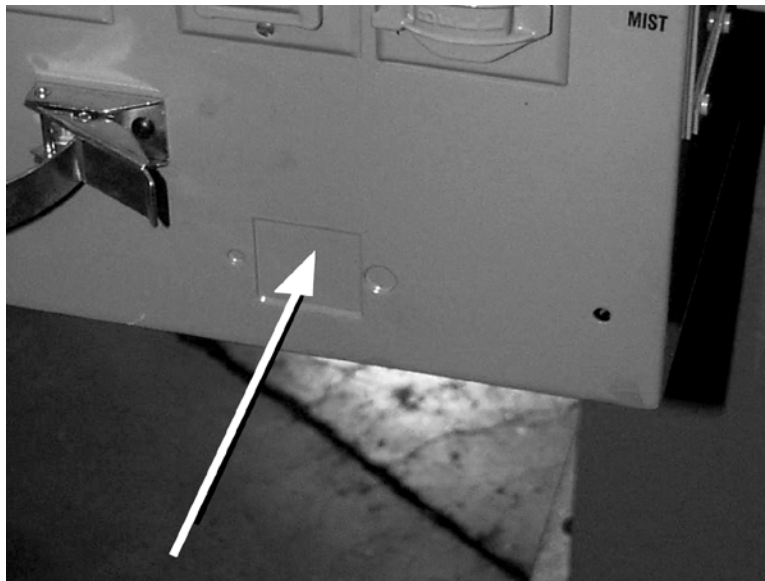


Figure 11-79

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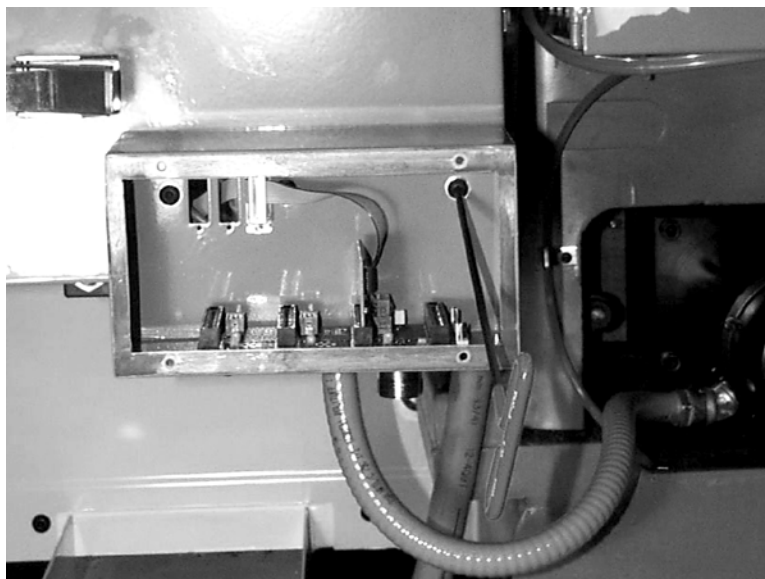
**Scale Box  
Installation / Side  
Mount**

- 1) Knockout the existing scale box access plate.



*Figure 11-80* Knockout Existing Scale Box Access Plate

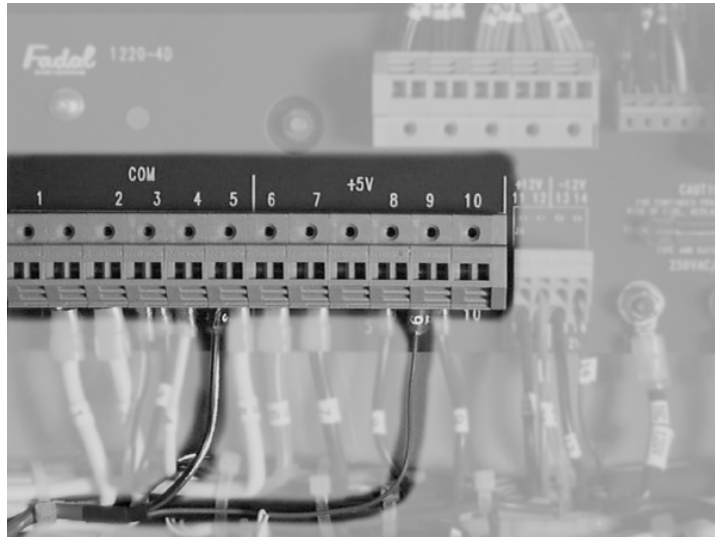
- 2) Run the ribbon cable through the opening and attach the scale junction box to the side of the control cabinet with two button head socap screws and locking nuts.



*Figure 11-81* Attach Scale Junction Box to Side of Control Cabinet

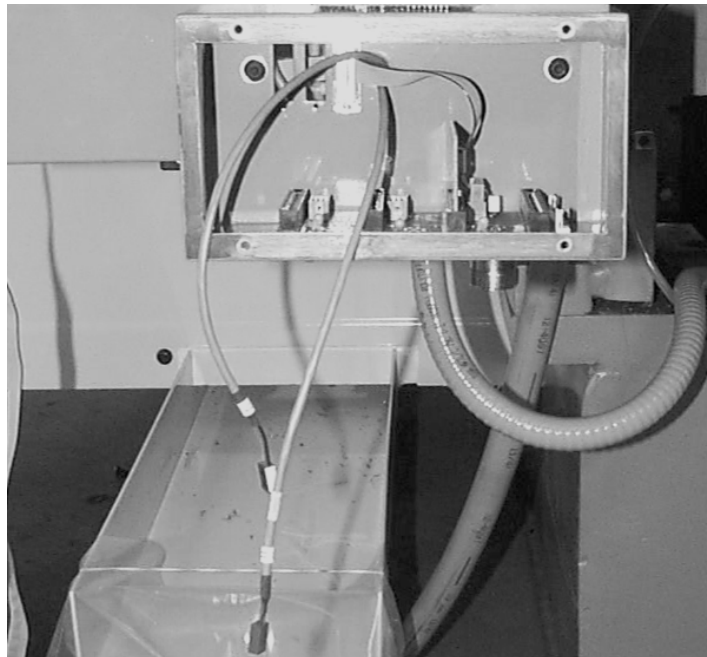


- 3) Install WIR-0506 to the terminal strip on the 1220 power supply board (#3 wire to com side, #9 wire to +5VDC side).



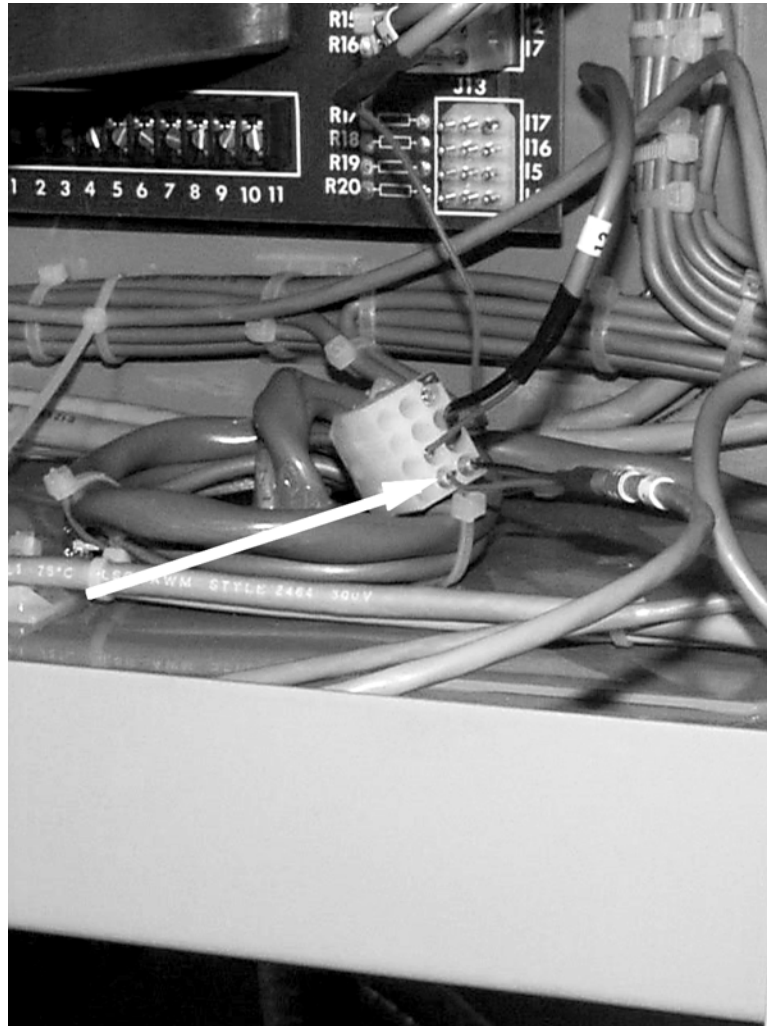
**Figure 11-82** Install WIR-0506 to Terminal Strip on 1220 Power Supply Board

- 4) Route WIR-0506 from the 1220 board to the scale box. Secure it to the existing wire bundles. Insert the end of the wire through access hole to the junction box.



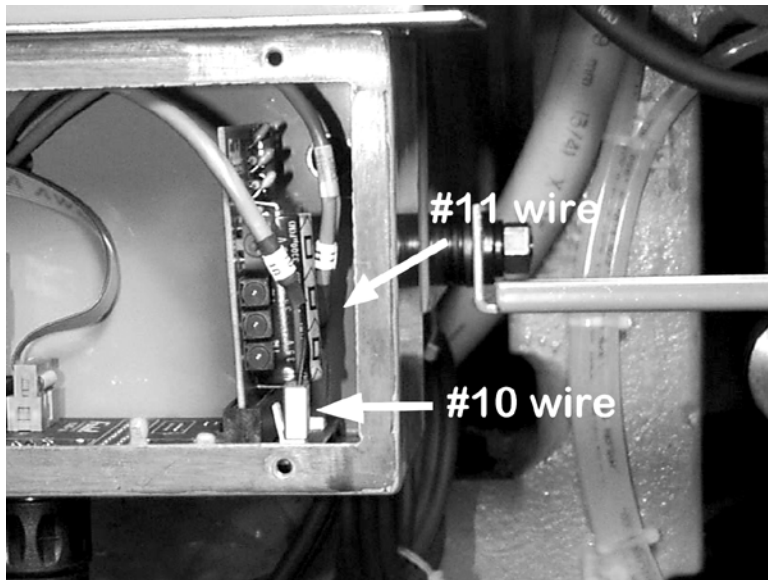
**Figure 11-83** Route WIR-0506 from 1220 Board to Scale Box

- 5) Insert WIR-0134 through the access hole. Unplug the J13 connector from the 1060 board and install the red wire to J13 #11 and the black wire to J13 #10. The lower row of J13 contains the following wires: center #11 right side #10. Secure the cable to the existing J13 wires. Plug the J13 connector into the 1060 board.



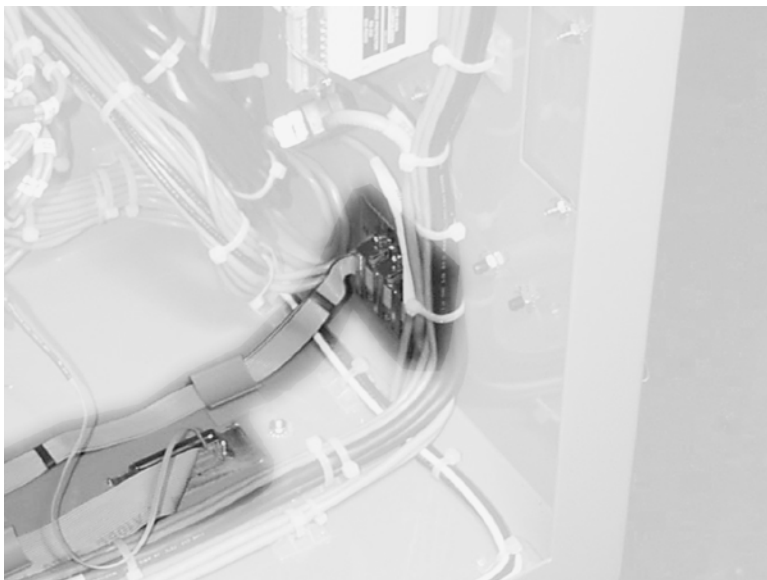
*Figure 11-84* Unplug J13 Connector from 1060 Board

- 6) Plug WIR-0506 into the J10 connector on the 1580-1A board and WIR-0134 into connector J1.



**Figure 11-85** Plug WIR-0506 into J-10 Connector; Plug WIR-0134 into J1 Connector

- 7) Plug the ribbon cable from the scale box into J6 of the appropriate axis controller card. Secure the cable to the bottom of the cabinet with self adhesive cable wire ties.



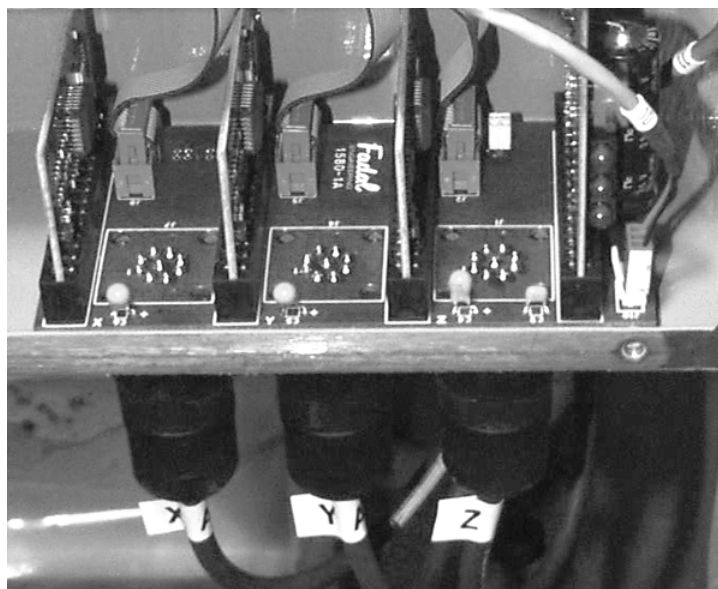
**Figure 11-86** Plug Ribbon Cable into J6 of Appropriate Axis Controller Card



*Figure 11-87* Secure Cable to Bottom of Cabinet

**Note:** Power off the machine and Lockout/Tagout the disconnect box, before attempting any work in the junction cabinet.

- 8) Insert interpolation boards into slots on the 1580-1A card. Plug the cables, from the scales, in to the bottom of the box. Insert the Scale Fault Detection board (1580-1-1B) into the slot next to the J13 and J11 plugs. All components on the boards must face the right side of the box, for proper installation.



*Figure 11-88* Insert Interpolation Boards into Slots on 1580-1A Card

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**Scale Box  
Installation / Top  
Mount**

- 1) Place a piece of paper in the top inside of the CNC cabinet to prevent debris from falling into electronic panels while drilling holes in cabinet.



*Figure 11-89* Place Paper in CNC Cabinet

**WARNING**

Wear safety glasses when using hand or power tools.

- 2) Using the scale box as a template, mark the positions to be drilled out. Mount the box towards the left and rear, on top of the CNC cabinet.



*Figure 11-90* Mark Positions to be Drilled Out





*Figure 11-91* Mount Box on Top of CNC Cabinet

3) Center punch the hole locations for drilling.



*Figure 11-92* Center Punch Hole Locations for Drilling

- 4) Drill a starting hole at each marked location.



*Figure 11-93* Drill Starting Holes

- 5) With a step drill, open the mounting holes up to  $\frac{5}{16}$ ". Open the wire hole to  $\frac{1}{2}$ ". Open the B axis ribbon scale cable opening to  $\frac{7}{16}$ ".



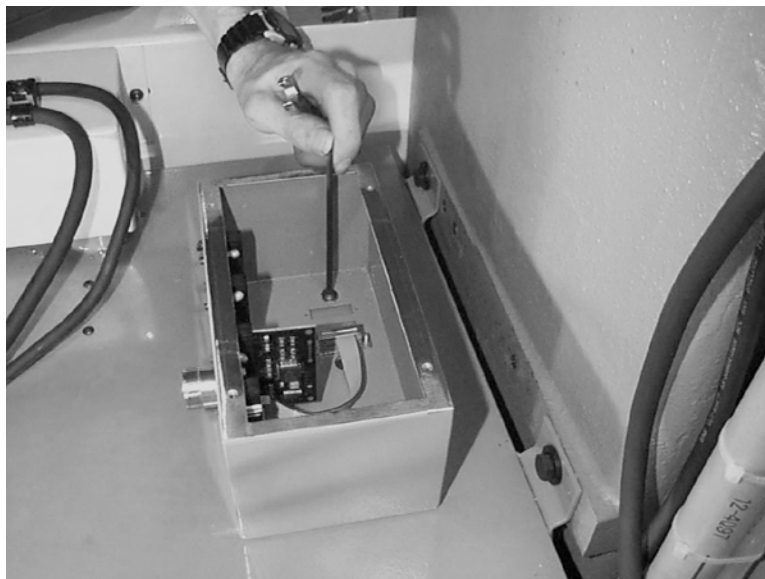
*Figure 11-94* Open Holes with Step Drill

- 6) Use a metal punch with an RS-232 die to create the opening for the fourth axis scale ribbon cable.



*Figure 11-95* Create Opening for Fourth Axis Ribbon Cable

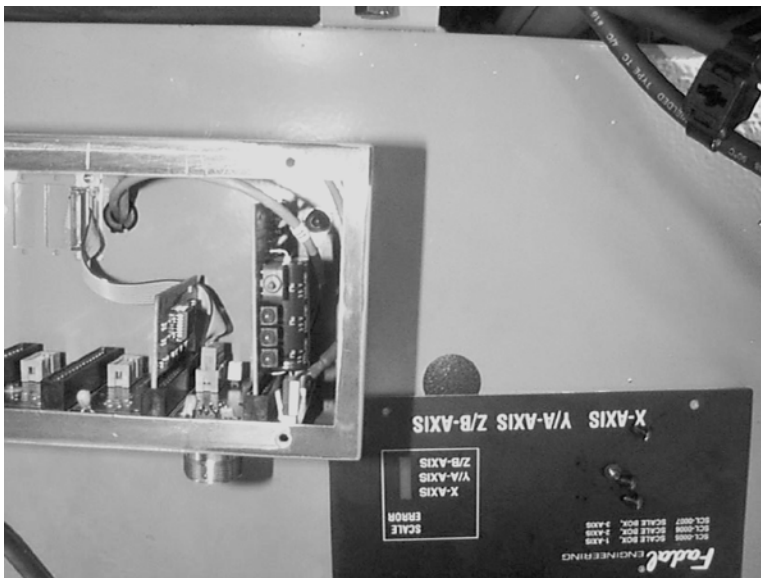
- 7) Attach the fourth axis scale box to the cabinet with two 1/4-20 x 1/2" button head socap screws and 1/4-20 KEPS nuts.



*Figure 11-96* Attach Fourth Axis Scale Box to Cabinet

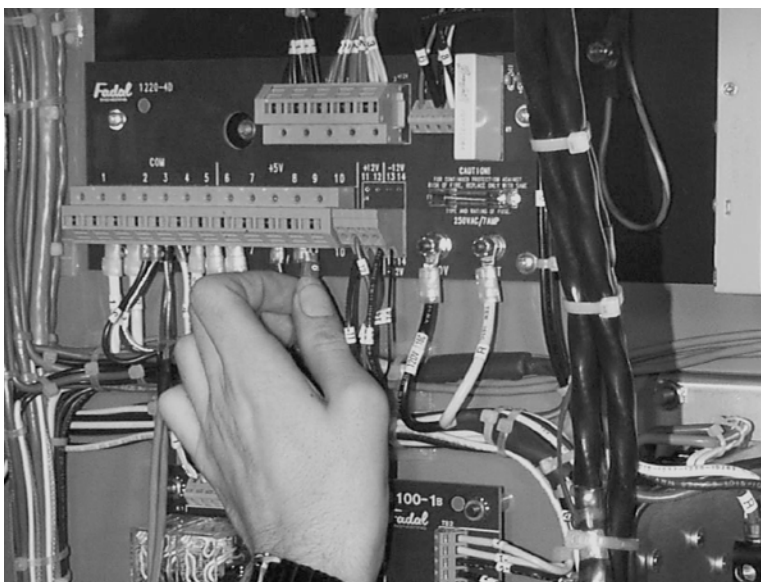


- 8) Plug the signal cable into J11 and the power cable into the J10 connection on the 1580-1a board. Install a grommet and pull the cables down through the access hole.



**Figure 11-97** Plug Signal Cable into J11 and Power Cable into J10 Connection

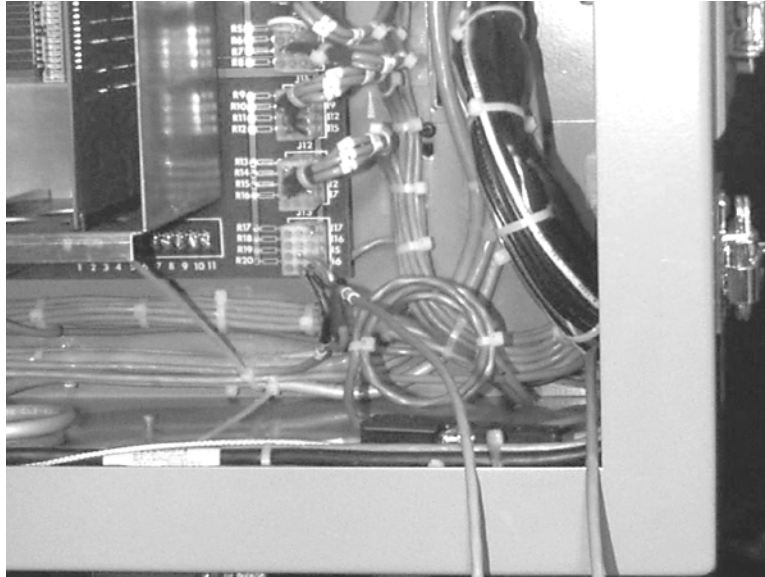
- 9) Install the power supply cable into the 1220 power supply board (#3 wire to com side, #9 wire to +5VDC side).



**Figure 11-98** Install Power Supply Cable into 1220 Power Supply Board

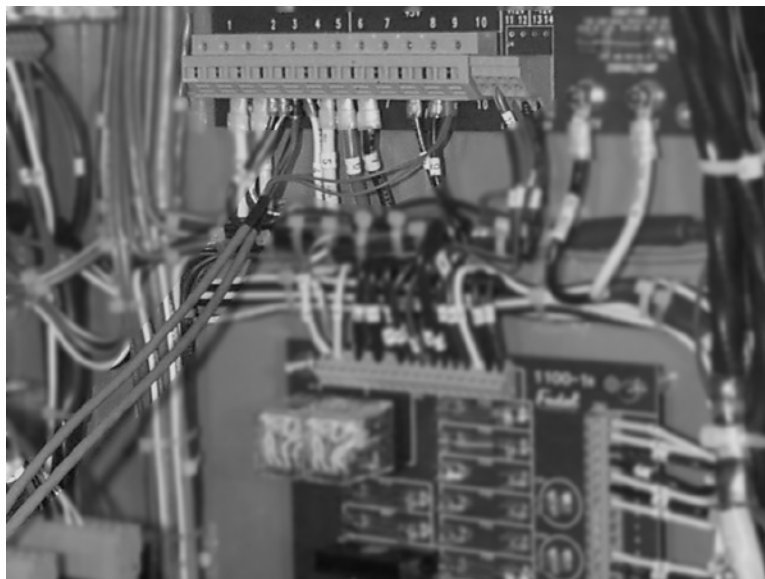
- 10) Run the scale box signal cable down the wire bundle and along the bottom of the cabinet to connector J13 at the 1060 board. Unplug J13 from the

1060 board and install the red wire to J13 #11 and the black wire to J13 #10 (Lower row of J13: center #11, right side #10). Secure the cable to existing J13 wires. Plug J13 into the 1060 board.



*Figure 11-99* Plug J13 into 1060 Board

11) Adjust all wires and secure them to the existing wire bundle.



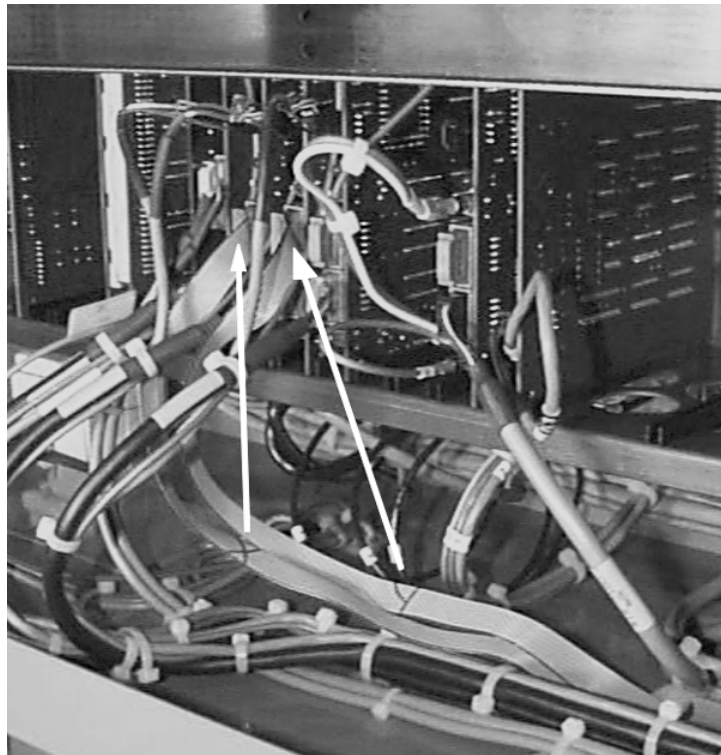
*Figure 11-100* Adjust and Secure Wires to Existing Bundle

12) Plug the 15 pin connector on WIR-0133 to the scale box connector and tighten the screws. Route the 10 pin connector end to the appropriate axis

controller card and plug it into J6. Secure the wiring to existing wire bundles.



*Figure 11-101* Plug 15 Pin Connector into Scale Box Connector



*Figure 11-102* Secure Wiring to Existing Bundles

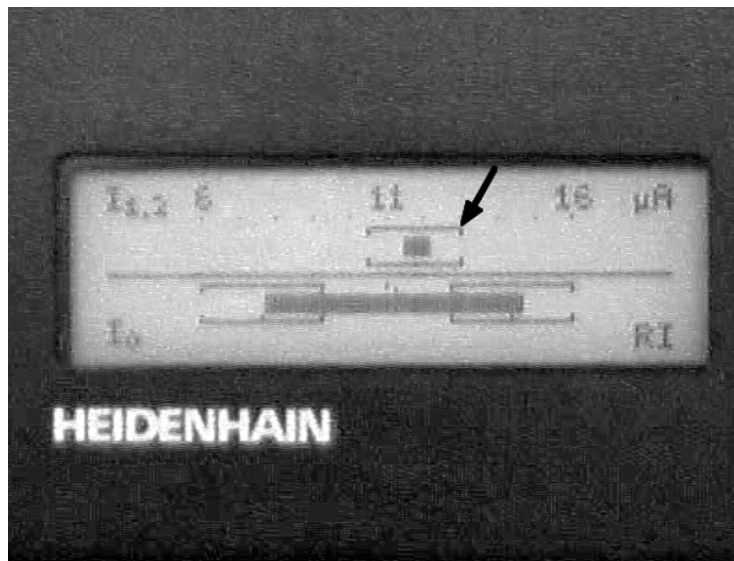
**Heidenhain Tester**

- 1) Remove the pin connector from the junction box and plug it into the scale test box. Plug the power supply into a 110 VAC outlet.



*Figure 11-103* Plug Pin Connector Into Scale Test Box

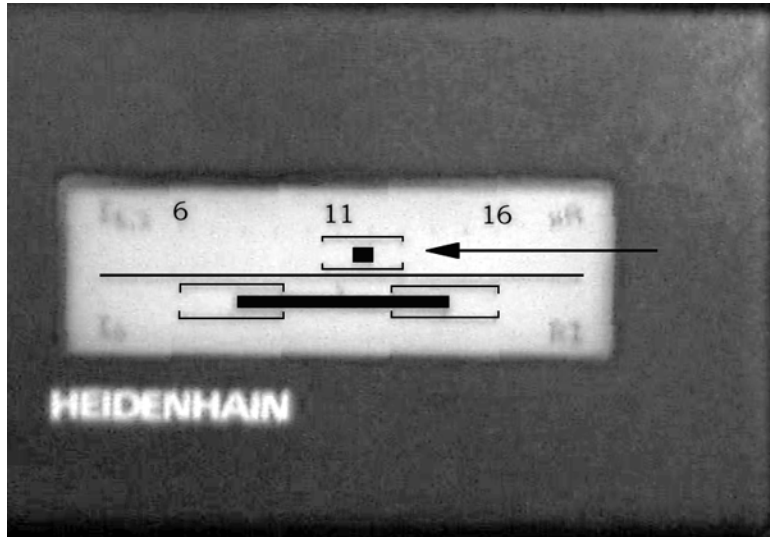
- 2) Program the axis to be tested to travel back and forth along its length, reading the upper portion of the tester window.
- 3) The outer brackets are the measurement of the amplitude of the signal. During the overall travel of the scale, the indicator of the outer brackets should be between 7 and 16. 10 to 14 is an optimal reading and 11 is the best. If the tester turns off, it is out of range.



*Figure 11-104* Indicator of Outer Brackets Should Read Between 7 and 16

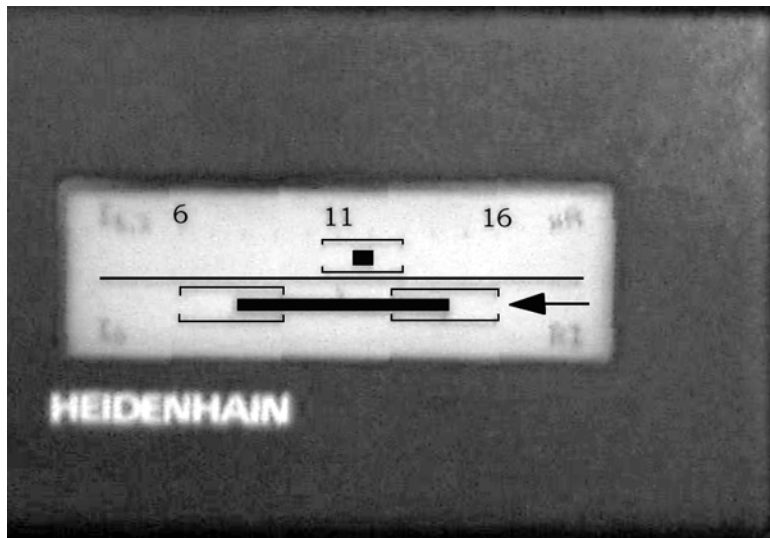


- 4) The solid bar is the amplitude ratio and phase angle (TV1 And TV2). The solid bar must be inside the brackets during overall travel of the scale. A narrow bar is better than a wide bar.



*Figure 11-105* Solid Bar Must be Inside Brackets During Overall Travel of Scale

- 5) The brackets measure the width of the reference mark. The solid bar must be within the brackets. The tester turns off if it is out of range.



*Figure 11-106* Solid Bar Must be Within Brackets

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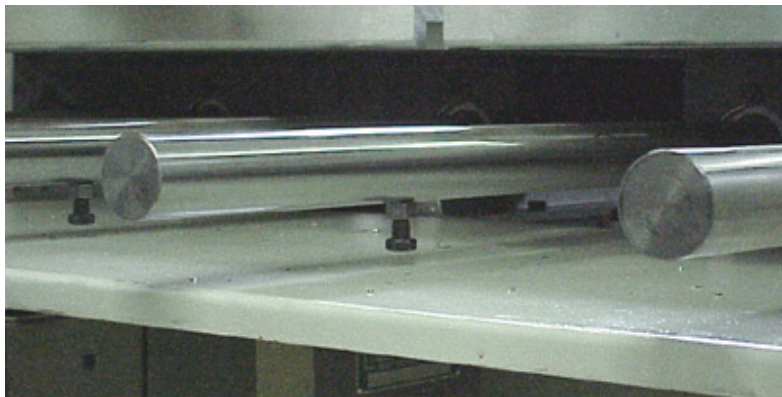
## Section 12: Pallet Changer

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### Installation of Pallet Changer

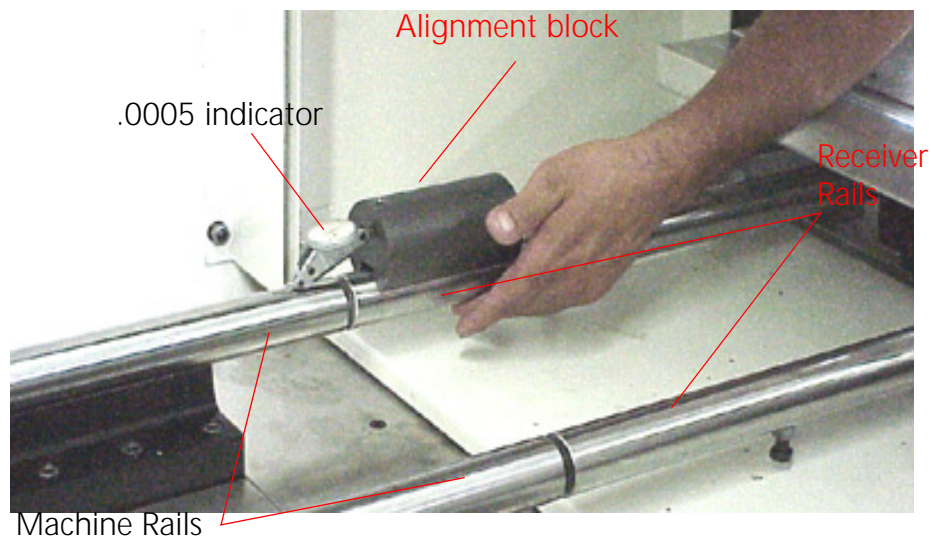
- 1) The left, front, lower edge of the base must be a minimum of 2" from the floor. Level the machine on the 1.5" leveling pads that were shipped with the machine (see the Fadal Maintenance Manual Pre-Installation/Installation Section for documentation on leveling the VMC).
- 2) Verify that the X and Y axis cold start positions are correct. The X axis must travel to X-20" and the Y axis must travel to Y-10" and Y+10". Cold start the machine.
- 3) Enter the Parameters page and select the Pallet Changer.
  - a. At the ENTER NEXT COMMAND screen, type SETP and press the ENTER button.
  - b. Press the SPACE BAR to select the second page.
  - c. Press the D button, to page down to the PALLET category. Select the number 2, which answers yes to the question "Do you have a Pallet Changer". Press the ENTER button and then press the MANUAL button to exit the Parameters page.
- 4) Verify that the rail support bolts on the Pallet Receiver are installed and are all the way up.



*Figure 12-1* Verify Rail Support Bolts are Installed and All the Way Up

- 5) Verify that the rails and the bolts are high enough to clear the VMC sheetmetal. If not, adjust the Pallet Receiver legs clockwise to raise the level of the support rails.

- 6) Move the VMC table to X=-20" and Y=10".
- 7) Open the Pallet Changer door using the UTILITIES command.
  - a. In the ENTER NEXT COMMAND mode, type UT and press the ENTER button.
  - b. Select option #5 PALLET CHANGER.
  - c. Select option #4 SERVICE UTILITY.
  - d. Select option #2 OPEN/CLOSE DOOR.
- 8) Slide the Pallet Changer receiver base into position. Line up the floor plate rails with the bolt holes on the main casting base.

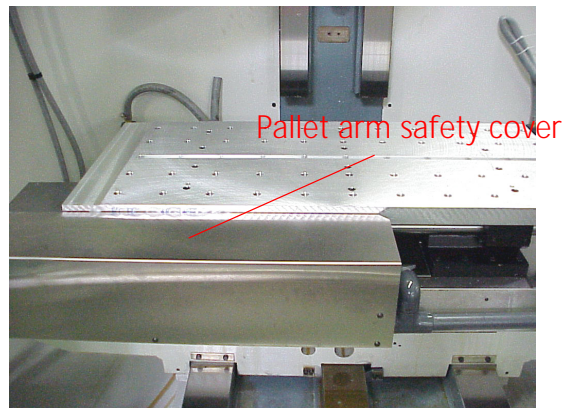


**Figure 12-2** Slide Pallet Changer Receiver Base into Position

- 9) Install the bolts for the floor plate rails. Check the alignment visually. Tighten the bolts and then break them loose.
- 10) Level the receiver base. After leveling, verify the gap between the receiver rails and the machine rails is .100" - .200" and the up and down alignment is also .100" - .200".
- 11) To align the rails side to side, move the receiver base left or right until the receiver and machine rails are aligned within .100" - .200".
- 12) Place the Alignment block on the receiver rail and the .0005" indicator on the machine rail and slide the adjustment block toward the machine. The indicator will move, indicating the up and down alignment of the rails. Adjust the receiver base legs to bring the up and down alignment of the receiver and machine rails to within .003".



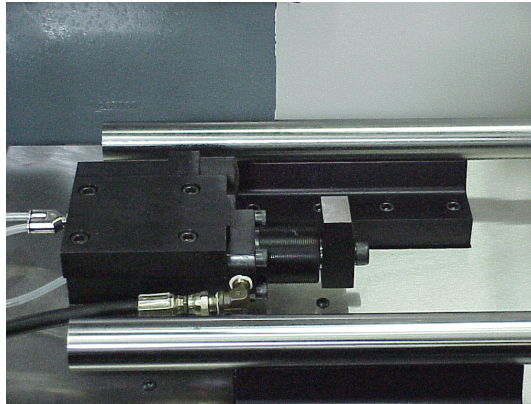
- 13) Place the Alignment block on the receiver rail and the indicator on the machine rail and rotate the adjustment block to the side. The indicator will move, indicating the side to side alignment of the rails. Move the receiver base to bring the side to side alignment within .002". Check all four rails. If one rail is out of tolerance and cannot be adjusted to within tolerance, the machine or receiver rail may need to be replaced.
- 14) Tighten the bolts on the receiver base legs. After tightening the bolts, perform a check on the alignment by using steps 12 and 13. Re-adjust if necessary.
- 15) Remove the pallet shipping brackets.
- 16) Move pallet A onto the machine by hand. Check for a smooth transition. If binding occurs, return the pallet to the receiver and check the alignment (Steps 12 and 13).
- 17) Once the A pallet travels across the rails smoothly, return it to the receiver and perform the same check on the B pallet.
- 18) Remove the pallet arm safety cover.



**Figure 12-3** Remove Pallet Arm Safety Cover

- 19) Loosen the 5/16" socket head pallet arm bolt. The pallet changer arm will drop down. Swing the arm out of the path of the pallet.
- 20) Release the clamp.
  - a. In the ENTER NEXT COMMAND mode, type UT and press the ENTER button.
  - b. Select option #5 PALLET CHANGER.
  - c. Select option #4 SERVICE UTILITY.

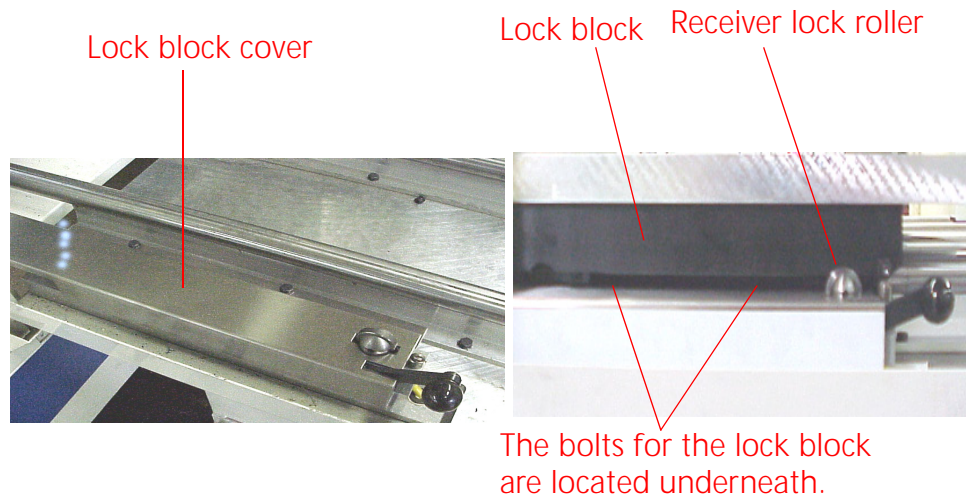
- d. Select option #1 Clamp/Unclamp.



*Figure 12-4* Release the Clamp

- 21) Pull pallet A all the way on to the machine table and use the instructions in step #20 to clamp the table in place.
- 22) Position the Pallet Changer Arm roller into the slot of the pallet. Place the roller half way into the slot. The arm should be flush with the top of the pivot pin.
- 23) Tighten the 5/16" socket head pallet arm bolt to 35-40 foot pounds.
- 24) Store pallet A.
- a. In the ENTER NEXT COMMAND mode, type UT and press the ENTER button.
  - b. Select option #5 PALLET CHANGER
  - c. Select option #4 SERVICE UTILITY
  - d. Select option #3 Store Pallet
- 25) If the pallet moves smoothly, tighten the rail slide bolts that are connected to the base.
- 26) Check pallet A and verify that the pallet is resting properly on the receiver roller. If the pallet is not resting properly on the roller, then adjust the pallet stop block position on the pallet.
- a. Remove the cover over the roller.
    - Remove the two 5/16" hex head bolts that are holding the cover in place.
    - Remove the cover.
  - b. Loosen the two 9/16" hex head bolts that are located underneath the pallet stop block.

- c. Slide the stop block until it rests properly over the roller.



**Figure 12-5** Remove Cover; Loosen Bolts; Slide Stop Block Over Roller

- 27) Jog the table back to pallet B and load pallet B.

- In the ENTER NEXT COMMAND mode, type UT and press the ENTER button.
- Select option #5 PALLET CHANGER; press the ENTER button.
- Select option #4 SERVICE UTILITY; press the ENTER button.
- Select option #8 JOG.
- Press the JOG key on the keypad and jog the Y-axis to Y= -10.
- Verify that the arm is lined up with the groove in pallet B. If the arm is not lined up with the groove, move the pallet forward or backward to allow the arm to enter the groove.
- Press the manual button to return to the utility menu. Press Option #4 LOAD PALLET.

- 28) If pallet B loaded smoothly, store pallet B and verify that the pallet stop block is resting properly on the roller. If the pallet is not resting properly on the receiver roller, adjust the positioning (refer to step #26).

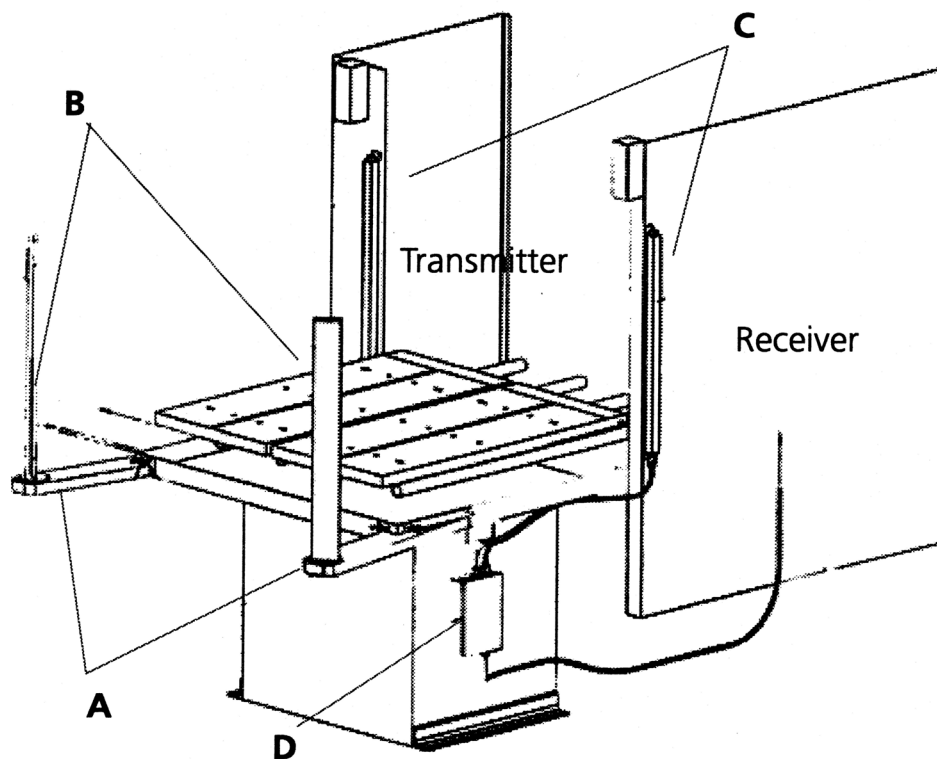
- 29) Drill holes in the concrete through the holes in the receiver base legs. Install the mounting bolts and tighten.

- 30) Verify the alignment, by performing several pallet changes using the utilities menu.

- 31) Adjust the pallet rail support bolts down until they touch the sheetmetal. Tighten the lock nut.

**Installation of Light Curtain**

- 1) Attach the front and rear base plates to the pallet receiver (A).
- 2) Fasten the front and back light curtain mirror assemblies to the front and rear base plates. Verify that both mirrors are level (B).
- 3) Attach the receiver and transmitter. Align the receiver and transmitter to the mirror heights (C).
- 4) Attach the controller junction box onto the pallet changer base. Plug the transmitter and receiver cables into the junction box (D).
- 5) Connect the controller junction box to the 1100-3 board for 120v power.



*Figure 12-6*

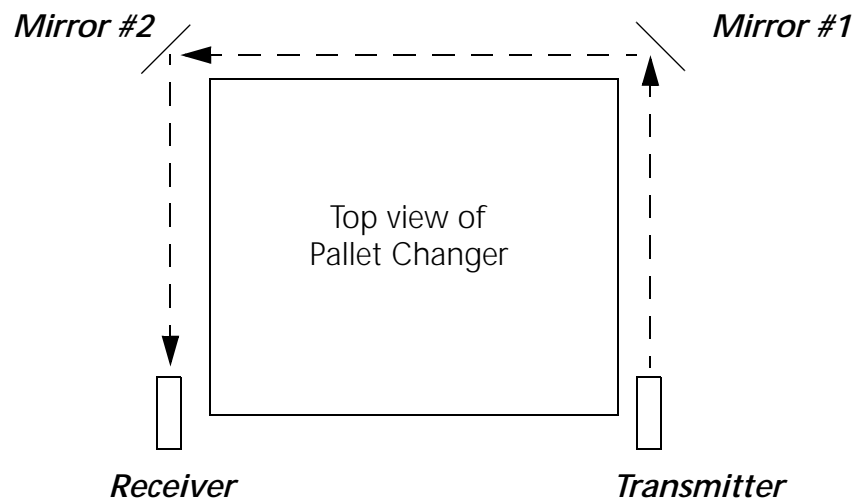
A= Front and rear base plates  
B= Front and rear mirror assemblies

C= Transmitter and Receiver  
D= Junction box

**Mirror Alignment**

**Note:** The transmitter has two lights (one red and one green) located at the top end of the unit. They represent a good alignment (green light) or a bad alignment (red light). There must not be any obstructions within the light curtain while the alignment is being set. Obstructions may keep the transmitter from aligning properly with the receiver.

- 1) Stand next to the transmitter of the light curtain and look into mirror #1.
- 2) Adjust mirror #1 until the mirror #2 can be seen.
- 3) Adjust mirror #2 until the receiver can be seen when looking in mirror #1.
- 4) Repeat the above steps while standing on the receiver side. If the mirrors are aligned properly, the transmitter will be viewed while looking in mirror #2 from the receiver side.
- 5) After the alignment has been set, look at the lights on the transmitter. The green light will be illuminated if the alignment is correct. If the alignment is incorrect, the red light will be illuminated.
- 6) If the red light is illuminated, repeat steps 1-5. Also, try adjusting the receiver or transmitter.



*Figure 12-7* Mirror Alignment

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### Setting the Sensor on the 1840 Board

**Purpose** During a pallet change, the table will move to the table limits. If there is anything blocking the progress of the Y-axis, the current of the motor will be too high. The 1840 board senses when the Y-axis motor is receiving too much current and will inhibit the pallet operation.



#### **IMPORTANT**

This procedure is for DC machines only. AC machines monitor motor overload through the axis controller card.

- 1) Install the 1840 board into the VMC.
- 2) Power on the VMC.
- 3) Enter the ENTER NEXT COMMAND mode and enter a program for testing the sensor.
  - a. Type PR and press the ENTER button.
  - b. Select option #3 START A NEW PROGRAM.
  - c. Type a program number that is not currently in the system and press the ENTER button.
  - d. Select option #6 EXIT.
  - e. Type IN and press the ENTER button.
  - f. Enter the following program:

```
N1 M49 F150. G1 G91
N2 Y5.
N3 Y-5.
N4 M99P1
```

- 4) Start the program. Press the AUTO button to start the program running.
- 5) On the 1840 board, turn the pot clockwise until the red LED is on continuously.
- 6) Turn the pot counterclockwise until the LED gives one solid blink once at the end of each move.
- 7) Stop the program.
  - a. Press the SLIDE HOLD button.
  - b. Press the MANUAL button.

- 8) Make a pallet change In the MANUAL DATA INPUT mode (do not make a pallet change from the UTILITIES menu; a pallet change from the UTILITIES menu does not utilize all of the functions of a complete pallet change).

In the MANUAL DATA INPUT mode:

- a. Turn the Rapid travel 3-position switch to 100%.
- b. Type M31.
- c. Press the ENTER BUTTON.

- 9) If the INHIBIT message is displayed on the monitor, repeat steps #3-#8.

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## Operation

The pallet changer may be operated within the program or by use of the UT (Utilities) command.

### Pallets

There are 2 pallets on the pallet changer. They are identified as Pallet A and Pallet B. Pallet A is the closest pallet to the operator.

There are 3 positions for the pallets: loaded, stored, and working.

- The **loaded** position is when the pallet is locked onto the table with the hydraulic clamp.
- The **stored** position is when the pallet is ready to be loaded onto the table.
- The **working** position is when the pallet is released from the stored position. The pallet must be moved to this position manually. Push the release lever down, to pull the table to the working position.

- 1) The pallets move on rails with circular bearings.
- 2) The pallet is locked in place on the table with a hydraulic clamp.
- 3) The clamp is released with program coding of a pallet change or through the utility menu.

### M-Functions

There are 3 M-Functions that may be used to operate the pallet changer:

- **M31 Exchange Pallets** - This function performs a pallet exchange. The pallet changer will store the current pallet and load the other pallet.
- **M32 Store and Load Pallet A** - This function is used when only pallet A is to be utilized. This exchange is performed the same as the M31 function. When pallet A is on the table, it is placed in the stored position. The machine will enter the waiting state, while the operator changes parts. When the START button is pressed, pallet A is loaded.

- **M33 Store and Load Pallet B** - This function is used when only pallet B is to be utilized. This exchange is performed the same as the M31 function. When pallet B is on the table, it is placed in the stored position. The machine will enter the waiting state, while the operator changes parts. When the START button is pressed, pallet A is loaded.

**Manual Operation**

The pallet changer is operated manually by using the UTILITIES (UT) menu. The UT menu gives the operator options to manipulate the pallets, Jog the machine, and check the sensors. To enter the UT menu:

- 1) Press the MANUAL button until ENTER NEXT COMMAND is displayed.
- 2) Type UT and press the ENTER button. When the UTILITIES menu is entered, the following options appear:

**UTILITY OPTIONS:**

1 TOOL SETTING CYCLE  
2 FIXTURE OFFSET SETTING  
3 TEST TS-20 PROBE  
4 TEST MP PROBE  
5 PALLET CHANGER  
6 CLOCKS  
7 EXIT  
ENTER OPTION NUMBER

Once the UTILITIES menu has been entered, the operator will be able to select the pallet changer option.

- 1) Select option #5 PALLET CHANGER and press the ENTER button.
- 2) The following menu will appear:

**PALLET CONTROLS:**

1 EXCHANGE PALLETS (A-B)  
2 LOAD-STORE PALLET A  
3 LOAD-STORE PALLET B  
4 SERVICE UTILITY  
5 EXIT  
ENTER OPTION NUMBER

Choosing options 1-4 will allow the operator to manipulate the pallet changer without programming the CNC. To enter an option, type the number of the option and press the ENTER button.



**Option 1:** When option 1 is selected, the following will occur:

- 1) The pallet changer door opens.
- 2) The machine enters the waiting state, and the message PRESS START TO MOVE PALLET appears at the bottom of the screen. If a table move is necessary, the X, Y, M48, F150, and G1 line of code will also appear. When the START button is pressed, the machine will move into position for the pallet change.
- 3) When the START button is pressed the hydraulic clamp is released and the pallet will move to the stored position. The table then moves into position to receive the other pallet. The pallet is moved into the load position on the table. The hydraulic clamp is engaged and the door is closed.
- 4) The PALLET CONTROLS menu is displayed.

**Option 2:** If pallet B is on the table, this option works just like option 1. If pallet A is on the table, the machine stores pallet A.

- 1) The pallet door will open.
- 2) The table moves to the position for storing pallet A.
- 3) The machine stores pallet A.

**Option 3:** If pallet A is on the table, this option works just like option 1. If pallet B is on the table, the machine stores pallet B.

- 1) The pallet door will open.
- 2) The table moves to the position for storing pallet B.
- 3) The machine stores pallet B.

**Option 4:** When this option is selected, the following menu appears:

**PALLET SERVICE UTILITY**

- 1 CLAMP/UNCLAMP
- 2 OPEN/CLOSE DOOR
- 3 STORE PALLET
- 4 LOAD PALLET
- 5 MOVE TO TABLE A
- 6 MOVE TO TABLE B
- 7 DISPLAY SWITCHES
- 8 JOG
- 9 EXIT
- ENTER OPTION NUMBER

**Option 1:** This option toggles the hydraulic clamp on and off.

**Option 2:** This option opens and closes the pallet door.

**Option 3:** The table must be in position to store the pallet (X=-20., Y=-10. or X=-20., Y=10.). When the table is in position, the following will occur:

- a. The door will open.
- b. The machine will enter the waiting state and display the message PRESS START TO MOVE PALLET.
- c. When the START button is pressed, the pallet moves to the stored position on the receiver. While moving to the stored position, the message STORING PALLET... is displayed. If the pallet is already stored, the message STORING PALLET... PALLET IN STORAGE will appear and the control returns to the command mode.

**Option 4:** This option is only used when the table is empty. The table must be in position to load the pallet (X=-20., Y=-10. or X=-20., Y=10.). When the table is in position, the following will occur:

- a. The door will open.
- b. The machine will enter the waiting state and display the message PRESS START TO MOVE PALLET.
- c. When the START button is pressed, the pallet moves to the loaded position on the receiver. While moving to the loaded position, the message LOADING PALLET... is displayed. If the table is not aligned, the message LOADING PALLET... RAILS NOT ALIGNED will appear and the control returns to the command mode.

**Option 5 & 6:** These options will move the table to the position of either pallet A or pallet B. If there is a pallet on the table, the machine will only move the table to the position of the pallet that is on the table. After storing a pallet with option 3, these options can be used to move the table back and forth between pallet A and B.

**Option 7:** This option will display the status of all the switches applicable to the pallet changer. The following will be displayed:

**PALLET SWITCHES:**

LEFT  
RIGHT  
ALIGNED  
A  
B  
OPEN  
CLOSED  
INHIBITED  
PUMP ON  
MOVING LEFT  
MOVING RIGHT  
OPENING  
UNCLAMPED  
PRESS A KEY TO EXIT

**Option 8:** This option allows the operator to jog the machine in any axis. After selecting this option, the control will display the message PRESS JOG TO CONTINUE OR MANUAL TO EXIT. Press the JOG button and the JOG function will be enabled.

**Option 9:** This option will exit the current menu.

---

**Maintenance  
Schedule****Each Part Cycle**

- 1) Use an M20 in the program to make it automatic. Frequent washing out of chips prevents them from building up into difficult-to-remove piles.
- 2) Blow away any chips that may lodge underneath Pallet in Hydraulic Arm groove.

**Daily Maintenance**

- 1) Put both Pallets away onto stand. Put tool in spindle. Wash down interior with coolant hose nozzle, using care to keep splash away from Automatic Tool Changer, Head assembly, or any wiring connections.
- 2) Clean chips from trough behind Table and Saddle, and on Sliding.
- 3) Guard, and inspect between front Y-axis way cover and front of machine for chip buildup.
- 4) Remove screen/tank cover over fluid tank, and clean screen protecting pumps.
- 5) Using tool, check for any chip buildup in tank ahead of screen.
- 6) Check tank reservoir fluid level, and refill as necessary.
- 7) Check Waylube level, refill with Castrol Magna BD68, Shell Tonna V68, or Mobil Vactra #2.
- 8) Check for air pressure. Single regulators should be set for 80PSI. Dual regulators should be set at 80PSI on the left gauge, and 90-100PSI maximum on the right gauge.
- 9) Move X-axis to either side, and flip over outer X-axis way cover. Inspect for chip buildup, and clean. Check for waylube presence on both X-axis ways. Inspect Z-axis and Y-axis as well.
- 10) Check pressures/vacuum on Coolant-Thru pump filter and replace filter, if necessary.

**Weekly Maintenance**

- 1) Check Hydraulic Fluid level for Pallet Clamp on top of machine. Use Mobil DTE Heavy Medium.
- 2) Remove Hydraulic Arm pump cover, and inspect Hydraulic Arm system, refilling fluid if necessary.
- 3) Check Hydraulic Arm chain tension by push/pull on arm.

- 4) Remove Head Cover, and inspect fluid lines for Hi/Lo Idler assembly, refilling, if necessary.
- 5) Remove all tools from tool changer, and clean out any chip buildup found. When returning tools to ATC, inspect retention ring tension on tool holders for excessive looseness, replacing rings, if necessary.
- 6) Disconnect front Y-axis way cover from saddle, and check for chip buildup.
- 7) Inspect under Y-axis motor for chips, and clear out drain ports under Y-axis ways nearest the column.

**Monthly Maintenance**

- 1) Carefully remove pallets, and grease rail bearings, using care not to damage lip seals.
- 2) Remove spindle motor top filter cover, and inspect filter. Replace, if necessary.
- 3) Inspect Pallet Roller latch system for both Pallets on stand.
- 4) Check Pallet Lift Door for smooth operation.
- 5) Inspect Chiller cabinet for low fluid in container, should be 1/2 to 3/4 full.
- 6) Inspect Chiller recirculation pump filter, and clean as needed.
- 7) Blow air into top of Chiller louvers to clear out dirt collecting on condenser.
- 8) At bottom of rear cabinet, remove fan filter screen and clean.
- 9) Inspect front door rollers, tightening as necessary.
- 10) Check door interlock system for proper operation.
- 11) Remove head cover and inspect belts, and check for any Coolant-thru system leaks.
- 12) Inspect all cables, hoses, and tubing for looseness, or damage.

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## Section 13: Chip Removal Devices

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### HydroSweep™

**WARNING**

**When operating the HydroSweep™ make sure hands, feet and clothing are clear of all moving parts.**

**Maintenance  
Schedule****Each Part Cycle**

- 1) Make certain that the HydroSweep unit is cycled before every part change, or run at least 20 minutes per hour run time. Use an M20 in the program to make it automatic. Frequent washing out of chips prevents them from building up into difficult-to-remove piles, and clears drum from chip buildup.
- 2) Clean away any chips that may lodge in rear trough at bottom of Y-axis sliding tray.

**Daily Maintenance**

- 1) Wash down interior with coolant hose nozzle, using care to keep splash away from Automatic Tool Changer, Head assembly, or any wiring connections.
- 2) Wash out HydroSweep drum, clearing any chips from inside. Inspect behind HydroSweep Ram for any stray chips blocking return slot.
- 3) Clean chips from behind Table and Saddle, the Sliding Guard, and behind the Sliding Guard near the Y-axis ballscrew. Inspect between the front Y-axis way cover and the front of the machine for chip buildup.
- 4) Remove the screen/tank cover over the fluid tank, and clean the screen that is protecting the pumps.
- 5) Using a shovel, check for any chip buildup in the tank ahead of the screen.
- 6) Check the tank reservoir fluid level, and refill as necessary, using only coolant with anti-foam inhibitors.
- 7) Check the Waylube level, refill with Castrol Magna BD68, Shell Tonna V68, or Mobil Vactra #2.

- 8) Check the air pressure. Single regulators should be set for 80PSI. Dual regulators should be set at 80PSI on the left gauge, and 90-100PSI maximum on the right gauge.
- 9) Move the X-axis to either side, and flip over the outer X-axis way cover. Inspect for chip buildup, and clean. Check for waylube presence on both X-axis ways. Inspect Z-axis and Y-axis as well.
- 10) Check the pressures/vacuum on the Coolant-Thru pump filter and replace the filter, if necessary.

**Weekly Maintenance**

- 1) Remove the Head Cover, and inspect the fluid lines for the Hi/Lo Idler assembly, refilling, if necessary.
- 2) Remove all tools from the tool changer, and clean out any chip buildup in the ATC. When returning tools to the ATC, inspect the retention ring tension on the tool holders for excessive looseness. Replace rings, if necessary.
- 3) Disconnect the front Y-axis way cover from the saddle, and check for chip buildup.
- 4) Inspect under the Y-axis motor for chips, and clear out drain ports under the Y-axis ways nearest the column.

**Monthly Maintenance**

- 1) Remove the spindle motor top filter cover, and inspect the filter. Replace, if necessary.
- 2) Inspect all HydroSweep nozzles for chip clogging.
- 3) Inspect the Chiller cabinet for low fluid in the container. The level should be 1/2 to 3/4 full.
- 4) Inspect the Chiller recirculation pump filter, and clean as needed.
- 5) Blow air into the Chiller louvers to clear out dirt collecting on the condenser.
- 6) At the bottom of the rear cabinet, remove the fan filter screen and clean.
- 7) Inspect the front door rollers, tightening as necessary.
- 8) Check the door interlock system for proper operation.
- 9) Remove the head cover and inspect the spindle belts. Also, check for any Coolant-thru system leaks.
- 10) Inspect all cables, hoses, and tubing for looseness, or damage.



The above maintenance procedures may be performed by the customer's maintenance crew.

### 6-Month Planned Maintenance

This should be performed by the Fadal Planned Maintenance Crew semi-annually.

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#### Auger, Chip Removal System



#### WARNING

When operating the Auger make sure hands, feet and clothing are clear of all moving parts.

#### PCB-0197 Auger Control & Door Interlock Monitor Board 1310-0C

#### Terminals

The terminal connections for the 1310-0C are identical to the 1310-0A.

The 1310-0C does have two additional connectors (J103 and J104) which are for future use. These connections do not change the functioning of the board.

#### Software

1310-0C requires Auger software version 2.21 or later.

#### Inputs

There are three door interlock switches monitoring the left access panel, the right access panel and the front door respectively. Each switch has a normally open and a normally closed contact. Each switch and each contact are monitored separately. These inputs are J4 pins 1-12.

The 120 VAC Emergency Stop circuit from the 1100-1 TB1-10 goes to pin 7, the control switch for the Auger or Wash Only is at J3 pin 2. The start/stop switch input is at J3 pin 1.

#### Outputs

The logic level outputs are external slide hold (J3 pin 13), and an additional external slide hold at J103 and J104.

A 120 VAC output to control the spindle contactor is at J1 pins 9 and 10.

The 230 VAC 3-phase for the motor is at J2 pins 1-3.

#### Power

The board requires +5V and COM (J3 pins 11 and 12). If these inputs are reversed, the diode will short out the board, preventing damage to the circuitry.

120 VAC is also required for operation (J1 pins 1 and 6).

230 VAC 3-phase is required for the auger motor (J2 pins 5-7).

### Operation

The 1310-0C monitors the interlocks for the three doors. If any door is open, an External Slide Hold is sent to the CNC control. If one circuit of the switch indicates door closed but the other indicates door open, a door open condition will be assumed by the board. The External Slide Hold is sent immediately when a door is opened. In addition, after a 5-10 second delay that allows time for a controlled stop, the spindle contactor will be de-energized and removes power to the spindle drive; the delay is adjustable within the range of 5 seconds minimum to 10 seconds maximum by the Delay Adjust potentiometer (R148). An Emergency stop will also de-energize the spindle contactor after the delay.

J103 and J104 are for future use. J103 pin 1 is identical to J3 pin 13 (active low output to generate External Slidehold). J103 pin 2 is an active high External Slidehold. J104 are Doors Closed signals which will change with the Doors Closed LED (D110). J104 pin 1 is active high (sourcing) and J104 pin 2 is active low (sinking).

When the Auger button on the front of the machine is pressed, the Auger will start and then after a few seconds the washdown cycle will begin. The length of the washdown cycle is determined by the setting of the potentiometer next to the auger button. When the washdown cycle is complete the pump will be turned off for 20 seconds and then the washdown cycle will repeat. Pressing the auger button a second time will turn off the auger and washdown.

If the Auger/Wash switch is in the Wash position, the auger will not come on and only one washdown cycle will be performed.

If the auger becomes blocked it will reverse for five seconds and then start forward again. If this occurs four times in a row the auger will stop and the Fault LED will be set. A manual reset of the 1310-0C will then be required.

If the auger is running backwards, the problem is most likely at the power input to the machine. Never reverse any 3-phase wiring to correct direction until you have verified whether one motor is running backwards or all the 3-phase motors are running backwards. (Axis and spindle motors are not dependent on the phasing of the input power because they are variable speed).

**Indicators (LEDs)**

The LEDs on the 1310-0C are slightly different than the 1310-0A:

There is only one green LED (D110) for the doors. It will be on only if all doors are closed and all circuitry is indicating doors closed.

There is a separate red LED for each door circuit (one for the normally open of each door and one for the normally closed of each door). The red LED will be on if that circuit is indicating a door open condition.

There is a yellow LED for each door. This indicates a fault condition in a door circuit (i.e. one circuit indicating door open but the other indicating door closed). This LED will flash whenever the door is opened or closed because the two circuits do not change state at the exact same instant. The flash is normal.

There are two red LEDs for the External Slidehold outputs. D116 indicates the status of J3 pin 13 and J103 pin 1. D117 indicates the status of J103 pin 2. The LEDs light when the output is active. J3 pin 13 and J103 pin 1 are active low. J103 pin 2 is active high. J103 is for future use.

A green LED has been added for the status of the spindle solid state relay. It will light when the output for the spindle contactor is on. In other words, it will light when all the doors are open and will go out 5-10 seconds after a door is opened.

The HEART LED indicates normal operation of the 1310-0C. It will be blinking whenever the microcontroller is running. It will be off when a door is open or when the VMC is in Emergency Stop.

The FAULT LED is lit whenever a major fault occurs: repeated overloads, overcurrent, etc. When this LED is on the 1310-0C board must be manually reset (S1).

The FWD LED will be on when the auger is moving in the forward direction.

The REV LED will be on when the auger is moving in the reverse direction. The OVERLOAD LED will flash when there is an overload. There are always "overloads" when the motor first starts due to the initial starting current. These "overloads" in the first 200 milliseconds will be ignored by the microcontroller. After the initial starting time, any overload will cause the motor to reverse.

The OVERCURRENT LED lights when there is a very large overcurrent such as a short or major fault. This LED will be lit when the board initially powers up. The microcontroller will reset it shortly after the Heart LED begins blinking. An

extended motor overload condition will also set this LED; however such a condition should never occur because the microcontroller will respond first.

### **Daily and Weekly Safety Tests for Door Monitor**

To ensure proper functioning of safety circuits, the following tests should be performed on a regular basis.

#### **Daily**

- 1) Close all doors. Make sure VMC is not in emergency stop.
- 2) Start Auger.
- 3) Start spindle at slow speed.
- 4) Open front door.
  - a. The Auger will should stop automatically.
  - b. The spindle should stop immediately (fully stopped from any speed in less than 5 seconds). Five to ten seconds after the door is opened, the spindle contactor will open (the five to ten second delay allows the spindle to come to a controlled stop).
- 5) Close front door. The spindle contactor will immediately reenergize.

#### **Weekly**

- 1) Close all doors. Verify that the VMC is not in emergency stop.
- 2) Open the cabinet containing Door Interlock Board (1310-0C) and examine LEDs and relays on the 1310-0C board.
  - Heart LED should be blinking.
  - Red door LEDs should be off.
  - Yellow door LEDs should be off.
  - Green "Doors Closed" LED should be on.
  - Red Slidehold LEDs should be off.
  - Estop relay (K7) should be on (LED lit).
  - Green "Spindle Enable" LED should be on.
  - "Spindle" relay for spindle contactor (K5) should be on (LED lit).
- 3) Press the Emergency Stop switch.
  - Heart LED should stop blinking.
  - E-stop relay should go off immediately.
  - The Auger should stop immediately and auger contactor release.
  - Spindle Enable LED and Spindle relay should go off after 5 to 10 seconds. Spindle contactor should then release.

- 4) Release the Emergency Stop switch and clear the emergency stop condition by pressing Jog.
- 5) Open the front door.
  - Heart LED should stop blinking.
  - Front door red LEDs should be on.
  - Green “Doors Closed” LED should be off.
  - The yellow LED for the front door should flash at the instant the door is opened.
  - Spindle Enable LED and Spindle relay should go off and Spindle contactor should release after 5 to 10 seconds.
- 6) Close the front door and open left side door.
  - Heart LED should stop blinking.
  - Left door red LED's should be on.
  - Green “Doors Closed” LED should be off.
  - Yellow door LED should flash at the instant the one door is closed and when the other door is opened.
  - Spindle Enable LED and Spindle relay should go off and Spindle contactor should release after 5 to 10 seconds.
- 7) Close the left side door and open right side door.
  - Heart LED should stop blinking.
  - Right door red LED's should be on.
  - Green “Doors Closed” LED should be off.
  - Yellow door LED should flash at the instant the one door is closed and when the other door is opened.
  - Spindle Enable LED and Spindle relay should go off and Spindle contactor should release after 5 to 10 seconds

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### Chip Conveyor

#### Installation Procedure

- 1) Place the chip conveyor in the coolant tank.
- 2) Measure the height to the top of the conveyor sheet metal (should be approximately the height of the coolant tank).
- 3) Set the machine height (the machine should be on the small leveling pads) to slightly above the height established in step 2 above.
- 4) Slide the coolant tank/conveyor underneath the machine.

- 5) Slide the coolant tank/conveyor so that conveyor is against the left side of the sheet metal (Figure 13-1).



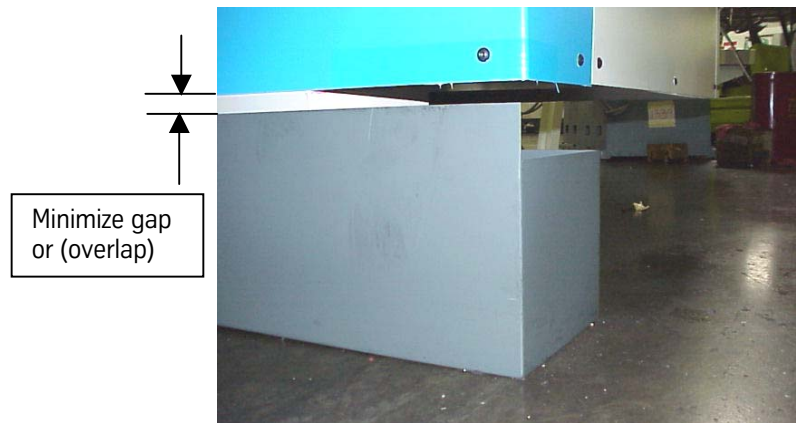
*Figure 13-1*

- 6) Slide the coolant tank/conveyor so that the face of the sheet metal coolant tank is slightly in front of the machine sheet metal (it should overlap the machine sheet metal), Figure 13-2.



*Figure 13-2*

- 7) Adjust the machine height (during leveling and installation) to minimize the gap (or overlap) between the coolant tank face and the machine sheet metal, Figure 13-3.



*Figure 13-3*

- 8) Coolant, wash down and flood pumps are connected per normal installation/setup.
- 9) A standard 55 gallon drum can be positioned underneath the conveyor discharge to collect the chips.

#### **Chip Conveyor Power and Controls**

- 1) The chip conveyor requires 220 volt single phase power.

Note: The conveyor must be plugged into the provided outlet on the VMC which is dedicated for the chip conveyor.

- 2) The control (Figure13-4) has 3 operating positions:

Forward	-Controls the forward motion of the conveyor belt
Stop/Reset	-Shuts off the conveyor
Reverse	-Reverses direction of the conveyor belt (for clearing jams)

- 3) The control also has a variable speed control for the belt speed. The belt speed can be controlled from 2.60 ft./min. to 10.80ft/min. (See Figure 13-5).



Figure 13-4



Figure 13-5

### Pre-Startup Safety Inspection



- 1) At the initial running, confirm the following before turning power on.
  - a. Inspect for and remove any article other than material (chip, etc.) to be transported on conveyor link belt portion.

#### **WARNING**

**Make sure hands, feet and clothing are clear of all moving parts.**

- 2) Confirm the direction of rotation by turning switch on for about two seconds.
  - a. If motor rotates in reverse, correct electrical connection.
- 3) Run conveyor continuously while machine tool is exhausting chips.

### Stopping the Chip Conveyor on US and CE Machines

On US machines, hitting the VMC Emergency Stop will stop all machine operations including the chip conveyor.

On CE machines, hitting the VMC Emergency Stop, opening the front door, or switching off an Estop switch at the conveyor chute will stop the chip conveyor.

**Note:** The Estop switch at the chute stops only the conveyor; it has no effect on the VMC.

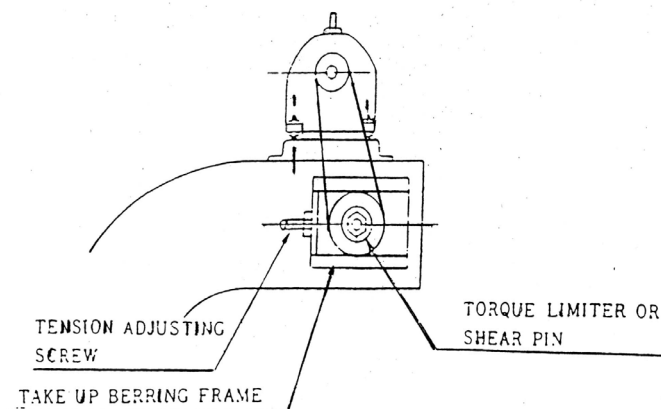
### Restarting the Chip Conveyor

When the chip conveyor is stopped, it must be restarted at the chip conveyor control by switching it off, and then on again. Closing the front doors on a CE machine or resetting the Estop switch will not restart the chip conveyor.

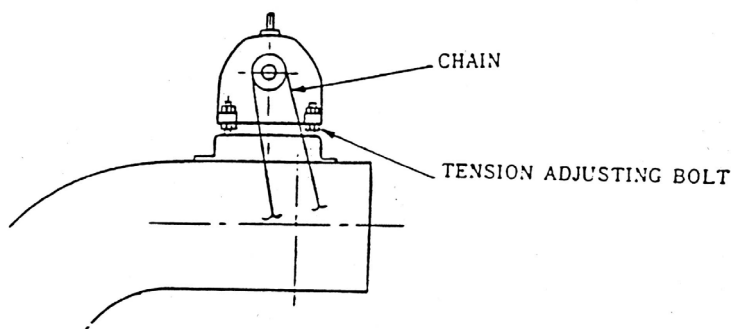


## Observance and Inspection

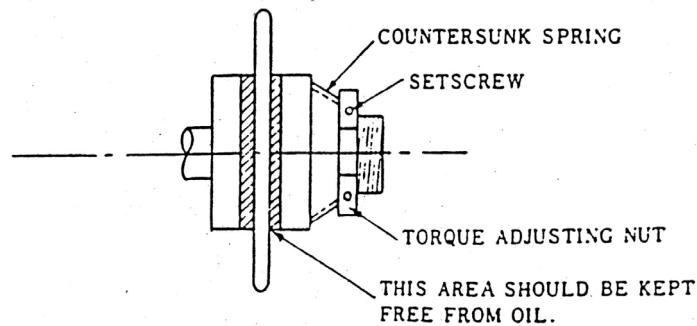
- 1) Maintain oil level in the speed reducer at specified level; check at least once a year.
- 2) Keep correct tension of conveyor chain by adjusting take-up bearing. (Obtain equal tension on both right and left hand conveyor chains by adjusting screw.)



- 3) Check roller chain between motor and conveyor for proper alignment and correct tension.



- 4) The greatest care should be exercised to keep friction surface of torque limiter free from oil when lubricating roller chain.



- 5) Lubricate conveyor chain and roller chain every 150 Hours.

**Cause of Trouble and  
Corrective Action**

- 1) Problem: Inoperative when unloaded
  - a. Slip of torque limiter
    - Cause: Incorrect adjustment of torque limiter  
Solution: Tighten nut for torque adjustment
    - Cause: Large part lodged in conveyor  
Solution: Reverse and remove part
- 2) (Special design)
  - a. L.S. for slip detection is activated
    - Set detector correctly
- 3) Problem: Shear pin is broken or not installed
  - a. Solution: Replace or install shear pin
- 4) Problem: Thermal relay is tripped
  - a. Solution: Restart thermal
- 5) Problem: Breaker is gone
  - a. Solution: Set breaker
- 6) Problem: Inoperative when loaded
  - a. Solution: Motor is overheated
- 7) Problem: Thermal is working overloaded
  - a. Solution: Reduce to normal load

- 8) Problem: Slip of torque limiter
  - a. Cause: Incorrect adjustment, of torque limiter
    - Solution: Adjust torque. To specified value
- 9) Problem: Shear pin is broken
  - a. Cause: Overloaded
    - Solution: Reduce to normal load
  - b. Cause: Weak pin
    - Solution: Replace with correct shear pin
- 10) Problem: Irregular operation (knocking condition)
  - a. Cause: Incomplete tension
    - Solution: Stretch belt again to normal condition
- 11) Problem: Abnormal noise
  - a. Cause: Out of oil
    - Solution: Check and fill oil
  - b. Cause: Broken bearing
    - Solution: Replace with new bearing

**Maintenance  
Schedule Chip  
Conveyor**

Please carry out daily, monthly, and yearly inspection according to the following directions.

**Daily Inspection**

- 1) Always keep oil in the speed reducer at the specified oil level.
- 2) Check motor for abnormal operation, i.e. noise, heat excessive current, etc.
- 3) Lubricate conveyor chain and roller chain every 150 hours.
- 4) Discard chips on the surface of the belt and inside of frame (place a rag on the belt and reverse until the rag is discarded).

**Monthly Inspection**

- 1) Change oil at 100 hours initially, every 1,500 to 2,000 hours thereafter.
- 2) Check motor for abnormal operation, i.e. noise, heat excessive current, etc.
- 3) Keep correct tension of conveyor chain by adjusting take-up bearing.
- 4) Check roller chain between motor and conveyor for proper alignment and correct tension.
- 5) The greatest care should be exercised to keep friction surface of torque limiter free from oil when lubricating roller chain.
- 6) Lubricate conveyor chain and roller chain every 150 hours.

**Yearly Inspection**

- 1) Carry out all monthly inspection items.
- 2) Pull out belt and clean inside of frame.
- 3) Check for worn out parts inside of frame and belt assembly and replace with new if necessary.
- 4) Check bolts for looseness.
- 5) Check friction disk for abrasion, and replace if necessary.

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## Section 14: General Information

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### Helpful Formulas

**Temperature**      Degrees Fahrenheit (F) =  $(9/5 \times \text{degrees C}) + 32$   
Degrees Celsius (C)      =  $5/9 \times (\text{degrees F} - 32)$

**Conversion Factors**      Inch (in) = millimeter x 0.03937  
Inch (in) = centimeter x 0.3937  
Millimeter (mm) = inch x 25.4  
Centimeter (cm) = inch x 2.54  
Liter = gallon (U.S.) x 3.7854  
Gallon (U.S.) = liter x 0.2642  
Bar = Pounds per Square Inch (psi) x 0.0689  
Pounds per Square Inch (psi) = Bar x 14.5  
Newton-metre (N/m) = pound/foot x 14.5939  
Pound/foot = Newton-metre (N/m) x 0.0685  
Newton-metre (N/m) = ounce-inch x 0.00706  
Ounce-inch = newton-metre (N/m) x 0.1416

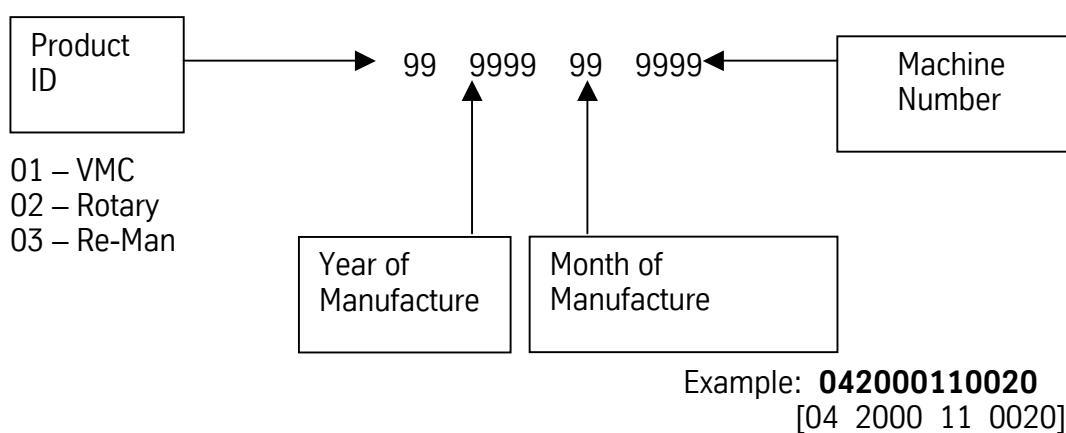
**Electrical References**      Formulas from Ohm's Law  
Amperes (I) = Volts (E) / Resistance (R)  
Resistance (R) = Volts (E) / Amperes (I)  
Volts (E) = Amperes (I) x Resistance (R)  
Single-Phase  
Kilovolt-Amperes (KVA) =  $(\text{Volts} \times \text{Amperes}) / 1000$   
Three-Phase  
Kilovolt-Amperes (KVA) =  $(\text{Volts} \times \text{Amperes} \times 1.73) / 1000$

**Expansion Coefficients**      Formula  
Expansion amount =  
Coefficient x distance x degree of temperature change (Fahrenheit)  
Coefficients  
Steel      = .00000633  
Cast Iron      = .00000655  
Aluminum = .00001244

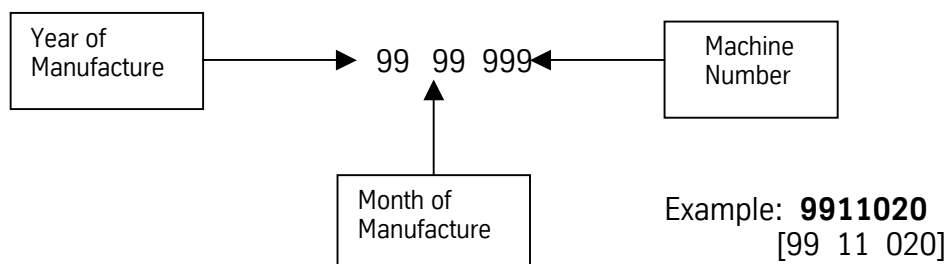
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### Fadal Machining Centers Serial Numbers

The new serial number scheme is as follows:



For reference the old serial number scheme:



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**Communications  
Troubleshooting**

For communication problems several factors must be examined. Review the environment, then check the file, the VMC, the cables, the computer, and finally the computer's communications software. Any one of these systems can propagate a communication problem.

**Environment**

In areas where lightning strikes are common, communications can be interrupted when or after lightning has struck a power line. The lightning may affect the memory of the CNC control, which would then have to be zeroed from the DI mode. It is suggested to call a service person or see the maintenance manual for this zeroing procedure.

- An RS-232 surge suppressor adds protection in this kind of environment.

**File**

- 1) Has the file ever successfully been transmitted to the VMC before? If the file has been transmitted before, has it recently been edited and has something been introduced into the file? Use an editor or word processor which will show hidden characters. If hidden characters are present in the file, remove them.
- 2) If the file has not been successfully transmitted, use an editor or word processor which will show hidden characters. If hidden characters are present in the file, remove them.
  - a. The only accepted characters allowed before the initial percent sign are DNC, DNCX, or TA,1. In addition, no O words are allowed in DNC mode.  
Example:  
DNC  
%
  - b. A two-second dwell is required between the DNC command and the first percent symbol (%). If the software being used to transmit the program cannot support this dwell time, remove the DNC, DNCX, or TA,1 command from the file and type the command at the VMC before starting file transmission.
- 3) When a file is posted for a paper tape, or when a paper tape is read and placed on a disk, it may have leader characters before the initial percent sign — they need to be removed.
- 4) If some of the file can be transmitted, but some of it cannot, check for syntax errors.
  - a) Examine the area in the file for syntax errors and repair them.  
For example, double motion words or missing words are syntax errors.

Example:

X1.23 X4.5 — Double motion words

-Y2.3 — Incorrect placement of - (minus)

534 — No word at all

- Use the TA,1,1 command for program transmission so that the control will halt transmission and display the line where the syntax error occurs.
- 5) If a word processor or editor is used to write the program, it must be saved in a text only format. Some processors will add formatting characters to the file which will disallow communications.

#### **VMC**

- 1) Check to see if the grounding wires are properly attached.
  - a. The only proper and acceptable primary ground is a single continuous copper wire attached from the ground bus in the junction box of the VMC to the main power box of the building. A green sticker in the junction box further expounds the grounding requirement. Any other methods of grounding, such as grounding to the conduit, or to a ground rod, are not acceptable and will lead to communication problems. See the Pre-Installation section for grounding procedures.
  - b. Check to see if the screws attaching the ground wire to the VMC are tight at both ends.
  - c. The ground wire of the RS-232 DB25 plug on the inside of the CNC control cabinet must be attached from the RS-232 port to the inside of the CNC control cabinet. This wire is attached to pin #1 of the DB25 plug, and is used to shield the cable at the VMC end ONLY (see the FADAL VMC Users Manual for proper pin configuration).
  - If the paint has not been removed from this area, scrape the paint away and re-attach the wire.
- 2) Check the cable from the RS-232 port on the inside of the CNC control cabinet to the 1030 board.
  - a. Sometimes this cable will work itself out of the plug. Press the plug into the board to confirm a good connection.
  - b. Examine the cable for cuts or kinks and replace it if there is evidence of damage.
- 3) For VMCs with a phone modem, make sure that the DB25 plug on the inside of the CNC control cabinet is NOT plugged into the back of the



modem — if it is, it will interrupt normal communications through the RS-232 port.

- 4) Use the mirror plug to test the 1030 board. The mirror plug is stored in the bottom of the CNC control cabinet when the VMC is shipped. The plug is a DB25 plug with no wires coming from it. On the inside of the plug, pins 2 and 3 are crossed to complete the communications path. Plug the mirror plug into the RS-232 port on the outside of the back of the CNC control cabinet.
  - a. Use the diagnostics mode to complete the test.
    - 1) Move to the cold start position.
    - 2) From the command mode type DI then press ENTER.
    - 3) Type G0 3000 and press ENTER to enter the test menu.
    - 4) Press 4 to select the RS-232 (1030) test.
    - 5) Select a baud rate (generally the baud rate used in normal communications).
    - 6) Observe the screen.
  - Numbers next to the word TESTING should be changing constantly. If this occurs, the 1030 board has passed the test.
  - The numbers at the end of the other sentences should all be zero. If any numbers appear at the end of these sentences it is an indication that the 1030 board is faulty (assuming the cable was checked in step (2) above). **Note:** The 1030 is rarely faulty.
  - If the diagnostics test passes, then it is safe to conclude that the VMC is not at fault for a communication problem.
  - 7) Press the manual button to end the communication test.
  - 8) Power off the VMC, wait 10 seconds, then power on again.
- 5) Has the proper baud rate been selected at the VMC?
  - a. The CD,# command is used to select a baud rate. The MU command has a list of each baud in the menu, or see the users manual for the same list.
  - b. The SETP command, for the VMC parameters, can be used to select a baud rate as default. The CD,# command will temporarily override the selection in the SETP parameter page.

- Cables**
- 1) Verify that all connections between the communications cable and both the VMC and the computer are firmly seated, including surge suppressors, gender changers, and couplers. Pick up the cables and physically confirm that each connection is properly together.
    - Loose cable connections are one of the most common causes of communication problems.
  - 2) If a switch box is used, determine if the switch is in the proper position.
    - a. Examine the cable connections to see if they are in the correct ports.
    - b. Turn the switch handle back and forth a few times. Sometimes the contacts are corroded and turning the handle will temporarily correct the problem.
    - If turning the handle corrects the problem, it is suggested to clean the contacts or replace the switch box with a new one.
  - 3) If the cable is coiled because the cable is too long, it is suggested to get a shorter cable. The coiling may cause intermittent problems. The shorter the cable the less chance a parity error will occur.
  - 4) Check to see if the cable is draped over fluorescent lights or wrapped around or connected on the high-voltage line for the power to the VMC or other machines. This can cause RF noise and inductive voltages on the cable, and communications will be interrupted from time to time.
    - a. Welding machines and EDM machines close to the VMC or the cable will also cause communication problems. These machines also cause RF noise which interrupts communications.
  - 5) Open the DB25 plugs to see if the solder on the pins have been applied properly. Cold solder joints for these wires will need to be soldered again.
  - 6) Check to see if the wires are connected to the proper pins. See the Communication section of the User Manual for the proper pinout. Confirm that, with shielded cable, pin one is connected to the shield at the VMC side only. Pin one cannot be connected at the computer side.
  - 7) If straight cable is used then a null modem is required. A null modem cable can be purchased from the FADAL Parts Department (part # 4537), or from any computer store. A null modem is a short portion of cable or ribbon cable that has pins 2 and 3 crossed. The crossover and the proper jumpers on each end can be found in the Communication section of the User Manual.

- a. If a null modem is used that was supplied from FADAL, the switch must be in the outward position away from the cable.
- 8) Use the mirror plug test as described in step 4 of the VMC section above to test each section of cable from the VMC to the computer, replacing any section that fails.
- 9) What is the length of the cable?
  - a. The longer the cable the slower the baud rate must be. The faster baud rates may work for the longer cables, but the chance of losing information increases, the faster the baud. Try using a slower baud rate, and if this works better, this may be the best solution. However this also may indicate an IO port at the computer with low voltage. See the Computer and Computer IO Port section below.

#### **Computer and Computer IO Port**

- 1) Is the cable plugged into the proper port in the back of the computer?
  - a. Some ports are marked COM or SER — these are the proper ports.
  - b. If the ports are unmarked, a COM or serial port will be the male gender port (the port with the exposed pins — the female gender port will have sockets).
  - A gender changer plug may be needed if the gender on the cable will not plug into the proper COM or serial port.
- 2) Is the port active?
  - a. Is the cable on the inside of the computer cover attached to the port?
  - b. Check the voltage across pins 2 and 7 while transmitting a file (use a file large enough to allow time to check the voltage while the transmission is in progress). With the positive lead on pin 2 and the negative on pin 7, the voltage should range between 10 and 12 volts. Any voltage below 10 volts could result in interrupted communications.
  - A FLUKE meter (or equivalent) used to measure voltage must be set to AC to obtain a reading.
- 3) When the computer was set up, did any interrupts interfere with the communications port?
  - A qualified computer setup person will be able to confirm that the port is free of other interrupts.

- 4) If an IBM-compatible computer has a serial mouse, is the mouse plugged into the proper port?
  - a. Usually the serial mouse is used in COM1 or serial port one.
  - Move the mouse to COM1 and the VMC cable into COM2 and try to communicate again.
  - If the mouse is not to be used during the DNC process, remove the mouse software commands from the CONFIG.SYS and/or AUTOEXEC.BAT file(s), and then reboot the computer. (CAUTION: Only a person familiar with altering these files should perform this operation, as these files are necessary for startup of an IBM-compatible computer. Refer to the DOS manual for any questions regarding these files and how to properly modify them.)
- 5) Some screen saver software can interrupt communication, change the baud rate, or transmit an odd hidden character, when the screen saver starts to display. Remove or disable the screen saver software and try to communicate again.
- 6) The quality of the IO board must be considered. Multipurpose IO boards are usually not recommended. High quality boards dedicated to only IO functions are recommended. DigiBoard and Quad Tech are examples of companies which produce high quality IO boards. These boards are specific to the operating system used by the computer—one board is used for DOS, another for Windows, and another for micro channel (IBM PS/2). These boards usually test 12 volts across pins 2 and 7 at the computer, for the best quality transmission.
  - A FLUKE meter (or equivalent) used to measure voltage must be set to AC to obtain a reading.
- 7) If a network board is installed in the computer, the computer technician who installed the board must check for conflicting interrupts and IO addresses.
- 8) The FADAL Assist software has in its utility menu an RS-232 tester. Use the mirror plug in the port and follow the instructions on the screen for test number one.

**Software**

- 1) Check the communication parameters in the software.
  - a. TA, DNC, and PU (using Xon/Xoff)
    - Baud rate - This is variable and it must match the baud rate set at the VMC with the SETP command or with the CD,# command.

- Parity - E (Even)
  - Data Bits - 7 (Seven)
  - Stop Bits - 1 (One)
  - EOB (End Of Block) - CR,LF (ASCII 13,10)
  - Starting and ending character - % (ASCII 37)
  - Xon/Xoff (Software handshaking) disabled for TA  
enabled for DNC and PU
  - Hardware handshaking - disabled
- b. DNCX (using XMODEM)
- Baud rate - This is variable and it must match the baud rate set at the VMC with the SETP command or with the CD,# command.
  - Parity - N (None)
  - Data Bits - 8 (Eight)
  - Stop Bits - 1 (One)
  - EOB (End Of Block) - CR,LF (ASCII 13,10)
  - Starting and ending character - % (ASCII 37)
  - Packet Data Bytes - 128
  - Hardware handshaking - disabled

For more information, see the file XMODEM.DOC on FADAL's Bulletin Board.

- 2) Use DOS to send a file, bypassing the communications software in the computer. If this works, the software is in doubt.
  - a. From the DOS prompt type the following two DOS commands (shown in bold):

**MODE COM2:2400,E,7,1**                      MODE port:baud,parity,data bits,  
stop bits

MODE = DOS command (followed by a space)  
port = COM2  
: = : (the : is required DOS syntax)  
baud = 2400  
, = , (the , is required DOS syntax)  
parity = Even  
, = , (the , is required DOS syntax)  
data bits = 7  
, = , (the , is required DOS syntax)  
stop bits = 1

TYPE **C:\CNCDATA\PN1234.NC>COM2**    TYPE pathnamefilename>port

TYPE        =    DOS command (followed by a space)

pathname = C:\CNCDATA\      substitute the drive-and directories where  
the file being sent to the VMC is stored.

filename = PN1234.NC      substitute the name of the file sent to the VMC

> = > (the > is required DOS syntax to redirect file to COM2)

port = COM2

- Note: Before typing these two lines, the VMC should be in the TA,1 mode ready to receive the program at 2400 baud.
- Refer to the DOS manual for answers to additional questions about the DOS commands used here.

3) Running DOS-based software from Windows may not work for communications.

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## Thermal Expansion

### Overview

Thermal expansion is a natural occurrence in materials subject to heat, and there are several sources of heat in any machining operation. In addition, different materials react to heat at different rates, and different subsystems of the VMC react to specific machining operations to different degrees, further complicating matters. Finally, some machining practices designed to save time may actually aggravate the expansion problem. Fortunately, there are a number of ways in which the unwanted effects of thermal expansion can be reduced to acceptable tolerances.

### Recognizing Thermal Expansion

Changes in positioning can have many causes, and correctly identifying the cause is the key to solving the problem. Thermal expansion has a unique 'signature' which can aid in recognizing it as the culprit in a given situation. Position changes that are due to thermal expansion occur gradually over time, and continue to move in one general direction at a more or less constant rate. The best way to combat thermal expansion is to accept the inherent nature of it in a machining operation, and to take corrective measures, like those suggested in this document, ahead of time.

### Accuracy and Repeatability

It should be noted that when accuracy and repeatability are quoted for a machine, thermal expansion is not considered. These values are measured and recorded only when the machine and all of its components are thermally stable, usually by limiting test repetitions and time duration so that thermal

growth does not have a chance to come into play. For example, a typical industry test for linear repeatability involves only seven to ten moves away from and back to a position.

### Expansion Coefficients

The rate of expansion of any particular material, due to temperature, can be measured. This rate of expansion is referred to as the expansion coefficient, and is measured per degree per inch. Using this rate of expansion, and the temperature of the material, the effects from heat can be predicted.

Material	Location / Usage	Expansion Coefficient
Steel	Ball Screws, Spindle, Fixtures, Sub Plates, Tooling, part stock	.00000633
Cast Iron	Head, Table, Column, Glass Scales, part stock	.00000655
Aluminium	Fixtures, Sub Plates, part stock	.00001244

Formula: coefficient \* distance \* degrees of temperature change = expansion amount

For example, if a nut is 23 inches from the motor mount and the temperature of the screw has changed 20 degrees, the screw length would have expanded .0029118 inches ( $.00000633 * 23 * 20 = .0029118$ ).

### Heat Sources

It comes as no surprise that the primary source of heat in machining is friction; however, some of the sources of friction, and all of the areas affected by a given friction source, may not be readily apparent. Additionally, the effects on the ambient temperature from various heat sources in the machine shop are often overlooked.

### Friction

The most obvious heat source from friction is the cutting of material itself. Heat is transferred to the chips, which then can transfer their heat to the table. Heat is also transferred to the tool, and then to the spindle, and then to the head. Finally, heat is transferred to the part material itself, and from there to any fixture or sub plate holding the blank.

Movement of the table, and of the head, also generates heat from the friction. The ball screws turning produces friction between the nut and the screw, heating the screw and causing expansion, with the Y axis of the machine experiencing more thermal expansion than the X axis because the Y axis is moving more weight than the X axis. The movement of the table on the ways produces friction which can increase the expansion of the ball screws.

**Ambient  
Temperature**

The general temperature of the shop environment will affect the machining process, but the most significant effect will be seen when temperature differences are created. Sunlight on a VMC will cause the side of the machine in the sun to expand at a different rate than the side in the shade. Radiant heat sources, such as ovens or hydraulic pumps, will heat the side of the VMC closest to them significantly more than the side furthest from the radiant heat source, causing uneven expansion. Cooling vents without diffusion gratings can blow cooler air onto one area of the VMC than another area, once again causing uneven expansion.

The goal is to surround everything with an even temperature. A shop at 90 degrees will experience more thermal expansion than a shop at 70 degrees, but a shop at 70 degrees with an air conditioning vent blowing directly on the VMC will experience more problems with uneven thermal expansion.

**Machining Practices**

There are a few machining practices that can aggravate thermal expansion, or its perceived effects, and deserve special mention. One is the use of rapid moves in a CNC program, which can vastly increase the friction, and therefore the thermal expansion, on the ball screws. The obvious drawback of reducing rapid moves is a slower production rate, however, this may be compensated for by increased accuracy and reduced scrap rates.

Another practice is using ceramic (or other) cutters without coolant and allowing the chips to sit on the table. The chips absorb the majority of the heat from the cutting process, and then transfer this heat to the table, causing the table to expand independently from any other part of the VMC.

A third practice is the use of cutting oil in place of water-soluble coolant. Although cutting oil does reduce friction at the surface of the cut, coolant does a much better job of carrying away the heat of the cut and minimizing the effects of thermal expansion resulting from that heat.

Yet another practice that deserves mentioning is machining parts at temperatures significantly different from those at which the parts are inspected. If the inherent expansion of the part material from the heat of the machining process is outside tolerance once the part has cooled to inspection temperatures, the problem can only be resolved by correcting for the heat generated during machining so as to keep the part material closer to inspection temperatures while the part is being machined. Along those same lines, it is important to use a gauge at approximately the same temperature as the temperature at which the gauge was calibrated.

Finally, the use of blanks for which the outside dimensions have been established prior to cutting is another practice which aggravates the effects of



thermal expansion. Since the blank is going to expand locally from the heat of cutting, the actual distance from edge to feature may change.

### **Non-Uniform Expansion**

#### **Material Differences**

The differing rates of expansion by unlike materials further complicate the problems created by the heat generated in the machining process. This applies both to parts stock, like aluminum, and to fixtures and sub plates, often also made of a material like aluminum. Aluminum's coefficient of expansion is nearly twice that of steel or cast iron (the primary VMC materials), which means the aluminum will expand nearly twice as much as the ball screws, head, spindle, or table.

#### **Fixtures / Sub Plates**

Fixtures or sub plates of material other than the steel/cast iron of the VMC will cause the greatest problems in this area, unless the bottom of the fixture or sub plate is flat within .001° (please note that "parallel" is not the same as "flat", and flatness is the key in this area). For example, a sub plate made of aluminum has an expansion coefficient nearly double that of the table to which it is secured. If the flatness is not within .001", the heat of the machining process causing the sub plate to expand at twice the rate of the table will result in the sub plate actually bending the VMC's table. This will cause binding which will both affect position accuracy and cause undue wear on the mating surfaces under the table.

#### **Machine Assemblies**

Various assemblies of the VMC itself will be affected by different sources of heat in the machining process, and the effect of each assembly on positioning will vary accordingly.

For instance, the head will expand from two heat sources, the spindle heat and the ambient temperature. The effects of thermal expansion in the head will be seen in the directions of the Y axis and the Z axis, but not in the X axis, with the Y axis expanding away from the column (toward the operator) and the Z axis expanding down toward the table. Meanwhile, the Y axis itself will be expanding away from the column due to the expansion of the ball screw, which will compensate for the effect of the head's expansion in the same direction.

The ball screws will expand due to the friction of the nut. The effect will increase with the distance of the nut from the motor mounts (the effective length of the screw), and will be in the direction away from the motor mounts. Thermal growth of the ball screws is independent of growth in the head or the table.

The spindle experiences heat not only from the actual cutting, which is transferred through the tool, but also from its bearings. The spindle also

transfers most of this heat to the head, and the thermal growth is reflected in the head position, as mentioned above, and is independent of changes in the ball screws or table.

The table receives most of its heat secondhand, through the heat of the nut, the heat from the part (through the fixture or sub plate), and the heat carried by hot chips that lay on the table. Because of its large size, the table seems less affected by the heat of machining. It will expand, but it takes longer to heat or cool the entire table. In addition, the use of coolant tends to stabilize the temperature of the table at or close to coolant temperature.

A machining operation using rapid moves and low spindle speeds, with additional cooling at the part through FADAL's servo coolant subsystem, will generate much more thermal expansion in the ball screws, and hence the X axis and Y axis, than will be seen in the Z axis from the spindle or in the part material from the cutting. An operation using very high RPM spindle speeds with slower interpolated moves would experience more Z axis expansion, but would experience less expansion in the X axis and Y axis, and might actually experience less expansion in the part material because the high rate of chip removal carries much of the heat away from the part.

Each machining operation has a unique combination of factors that apply to predicting and managing the thermal expansion inherent in machining. Finding the right solution is a matter of combining various approaches, many of which are outlined in the pages that follow.

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## Solving the Thermal Expansion Problem

### General Considerations

A simplified description of the thermal environment in machining would state that heat is generated through friction, and also input through ambient factors. That heat is transferred among the system components, and is either removed from the system through radiation, convection and evaporation, or absorbed by the components of the system (part, fixture, VMC).

In its simplest form, any solution designed to combat thermal expansion must reduce friction, reduce ambient influences, or increase heat removal through radiation, convection or evaporation. A complementary approach is to simply compensate for the changes brought on by thermal expansion. In a real life situation, a balance of approaches is required.

### Ambient Sources

**Sunlight** Do not allow direct sunlight on the VMC. Window shades that diffuse sunlight can be acceptable, but any source of warmth that only heats one side of the VMC at a time will cause uneven warming and further complicate thermal considerations.

**Cooling Systems** Diffusion gratings on air conditioning vents can be used to prevent any air from directly blowing on the machine or part. Again, an unevenly heated part or machine will cause the heated, or cooled, portion of the part or machine to expand at rates different from the rest of the part or machine.

**Radiant Heat** If an operator can detect the radiant heat from other devices, a protective wall needs to be erected between the machine and the device radiating the heat. This type of heat source will cause the machine to heat up on one side and cause uneven expansion.

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### Binary Numbers

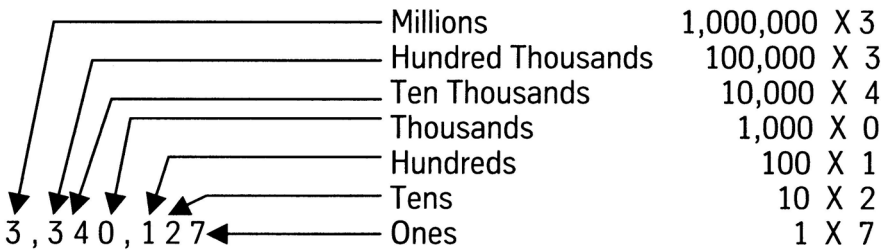
There are some mathematical concepts that will aide the troubleshooting process. The first discussion will be number systems.

**Number Systems** We all use the **Decimal System** or base 10, which is based on ten so when ten (10) counts are reached the next one causes a carry to the next column and each count in this column has a value of 10 times the previous column. Each place has a value ten times greater than the next place to the right. We use ten numerals (0 to 9) for this system.

	One Hundred Twenty-eight	128 X 1
	Sixty-four	64 X 0
	Thirty-two	32 X 0
	Sixteen	16 X 1
	Eight	8 X 0
	Four	4 X 0
	Two	2 X 1
	One	1 X 1
1 0 0 1 0 0 1 1		
		128
		+ 16
		+ 2
		+ 1
	Decimal equivalent total	147

The other numbering systems work the same way; they just have different base numbers. By having a different base number, they also have a different number of numerals and the columns have different weights.

The **Binary System** or base two (2) is the basic system used by computers. Each place has a value twice as great as the next place to the right. Two numerals or digits (0 and 1) are used and they are referred to as “bits”.



To determine the decimal value, add the results of each column (column value multiplied by column weight).

Computers use binary number systems because they have two distinct states. The two states are variously called true and false, high and low, ON or OFF, or “1” and “0”. Two different voltage levels are used to represent the two states.

**Binary Coded Decimal (BCD)** is a numbering system used to represent a decimal number using a group of four (4) bits.

**Hexadecimal (Hex)** is a numbering system using base sixteen (16). This is a very common number system in computers. It uses sixteen (16) numerals 0 to F to represent the numbers.

The following are examples of the numbering system provided to show the differences.

Decimal	Binary	Binary Coded Decimal	Hexadecimal
0	0000 0000	0000 0000	0 0
1	0000 0001	0000 0001	0 1
2	0000 0010	0000 0010	0 2
3	0000 0011	0000 0011	0 3
4	0000 0100	0000 0100	0 4
5	0000 0101	0000 0101	0 5
6	0000 0110	0000 0110	0 6
7	0000 0111	0000 0111	0 7
8	0000 1000	0000 1000	0 8
9	0000 1001	0000 1001	0 9

10	0000 1010	0001 0000	0 A
11	0000 1011	0001 0001	0 B
12	0000 1100	0001 0010	0 C
13	0000 1101	0001 0011	0 D
14	0000 1110	0001 0100	0 E
15	0000 1111	0001 0101	0 F
16	0001 0000	0001 0110	1 0
17	0001 0001	0001 0111	1 1
18	0001 0010	0001 1000	1 2
19	0001 0011	0001 1001	1 3
20	0001 0100	0010 0000	1 4

---

### Binary Number Groupings

Since the Binary Numbering System is the one used by computers there is a need to define the grouping of binary numbers.

**Bit** – one (1) binary location or digit.

**Nibble** – four (4) bits or binary locations.

**Byte** – eight (8) bits or binary locations.

**Word** – Sixteen (16) bits or binary locations.

**Double Word** – Thirty-two (32) bits or binary locations.

These grouping are used for many reasons. The most common are Data, Addressing and Status.

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### Reading Status Group

Reading a status in a computer can be very helpful for troubleshooting. Status is usually a byte or a word. The status is normally represented in hexadecimal. To demonstrate how a status byte is decoded, the command 1 byte in the diagnostics – display switches will be used. Each binary bit in the status byte will represent one relay in this case. Because Fadal uses negative logic, a value of zero (0) turns the relay on (activates it). B0 is the right-most bit. Each Hexadecimal digit is representing four (4) binary bits.

B0 = M68/M69

B1 = High range Idler

B2 = Unused

B3 = Drawbar / Geneva / Slide Enable

B4 = Drawbar

B5 = Air indexer

B6 = Coolant 1 On

B7 = Coolant 2 On

For example if the command 1 displayed “BD” then the binary equivalent would be “1 0 1 1 1 1 0 1”. To decode remember that “0” is On. In this example, B1 the high range idler would be On and Coolant 1 would be On.

---

## VMC Maintenance

**Cabinet Fans** The fans in the cabinets must be functioning properly. The purpose of the fans in the cabinets is to cool the electronics and to move the heat out the vents. An excessive amount of heat in the cabinets, from clogged holes or nonfunctional fans, will transfer to the column and cause it to expand, as well as damaging the electronics. On a regular basis, remove and clean the vent hole grates, as the vents occasionally become clogged with dust or other particles, and inspect the fans to see that they are working.

**Lubrication** Lubrication is essential for the free motion of the table, saddle, and head, as well as for the nut on each ball screw. Each way must be lubricated, and the ball screws greased, to minimize both the wear on the machine and the excess heat generated by friction. The lubrication system must be inspected and serviced regularly. Inspect all of the ways to confirm that each way is getting lubricated. The lubrication system may need to be flushed by a qualified service person to remove any contaminants on the inside of the tubes and joints.

## Machining Practices

**Warm Up** The first step in combating thermal expansion effects is also the simplest. Run the machine through a series of moves, at feeds and speeds equivalent to what will be encountered in the production run, long enough to reach an equilibrium; that is, where the amount of heat being generated is balanced by the amount of heat being removed (via convection, evaporation, or absorption through expansion of material). After that point is reached, the effect of thermal expansion in the VMC stabilizes, and the only corrections needed are for the expansion of the part material as each successive part feature is machined. Locate fixture offsets and establish tool length offsets after the machine has attained the optimum operating temperature. Avoid using moves or spindle speeds that exceed those used in the part program.

In addition to running a warm up routine at the beginning of the production shift, the same kind of routine can be run during breaks. This will maintain the VMC at operating temperature, especially the two subsystems that heat up or cool down the most (the spindle and the ball screws).

**Rough Cut / Cool  
Down / Finish Cut**

A complement to the warm up of the VMC is the use of a rough cut to remove most of the material from the part. Although the part material heats up, the material can then be cooled to a stable temperature. Then, a series of finish cuts can complete the part in a short time, so that the material doesn't have time to expand beyond acceptable tolerance.

This process is also effective for inspecting parts. By cooling the part prior to the finish cuts, the temperatures at final cut and at inspection can be brought closer. In this situation, the target temperature should also be close to the temperature at which the gauge is calibrated.

**Monitoring Position  
Changes**

The home position of the part will change as the temperature of the screws change. The operator can follow the home position changes throughout the production run and change the fixture home position and offsets accordingly.

**Coolant**

Using soluble and synthetic coolants that are mixed with water is the single most effective factor in removing the heat generated during cutting. Coolant is formulated specifically to absorb a great deal of heat within its molecular structure without having to radiate that heat onto the next material it contacts. Cutting oils are formulated for cutting, and lack the cooling quality of soluble and synthetic coolants mixed with water. Flood coolant is a better choice than either mist coolant or cutting oils because it benefits the cutting process in addition to providing heat removal.

The temperature of the coolant can be conditioned further through any of a few simple actions. Bags of ice floating in the coolant tank can be used to maintain the temperature. Pumping the coolant through a radiator, or through a copper coil in the coolant tank, or through a copper coil placed in a small refrigerator can all be used to condition the temperature of the coolant.

One side benefit of coolant is its cooling effect on the table as well as the part. As it is splashed around, the coolant's direct contact and its evaporation tends to keep the table at or near the temperature of the coolant, directly compensating for the effect of hot chips falling on the table. If the coolant temperature is being conditioned through some of the steps just mentioned, the thermal stability of the table benefits even more.

**VMC Options**

There are several options that can be added to a standard VMC to help manage the thermal expansion problems.

**Probe** A probe in the spindle can be used as a part of the program to discover what adjustments are required to compensate for thermal expansion. The probe can be used to pick up the new home position at the beginning of each program, or even at various times within the program. A probe can quantify the rate of expansion in the Z axis and a change can then be made to the tool table. The probe can also track the Y axis and X axis growth and, by using a macro, the fixture offsets can be altered without operator intervention. Because the amount of expansion differs depending on where the fixture is located on the table, each fixture should be relocated with the probe. A consideration when using a probe is that if a chip is in the spindle or on the probe's holder the probe will indicate an incorrect position.

**Glass Scales** Because they are independent from the ball screws, glass scales are more nearly accurate in positioning the table, but they are affected by thermal expansion themselves (generally from ambient temperature), and they cannot combat the expansion of the head. Keeping direct sunlight off of the scale covers and maintaining the ambient temperature to plus or minus one degree from a target temperature should allow glass scales to perform well. Still, other steps must be taken to minimize the effects of thermal expansion on the head, the spindle, and the part material itself. Glass scales are a good solution in a situation with multiple fixtures when a probe is not used.

**Coolant Through Spindle** FADAL's Coolant Through Spindle option is designed to work in conjunction with specific tooling (with a hole in the center) to allow coolant to be pumped deep into the part, where normally coolant does not reach. This significantly improves the rate at which heat is removed from the area of the cut, reducing the expansion of the part material. In addition, there is less heat to be transferred through the tool to the spindle and the head, so expansion of the spindle and the head is also significantly reduced, improving Z axis positioning and accuracy.

**Cooled Ball Screws and Spindle** The only effective way to greatly reduce the thermal expansion of the ball screws is to provide coolant through the center of the screws. Building on the Coolant Through Spindle concept, machines equipped with this feature pump a fluid through the screws and the spindle. A refrigeration unit, coupled to a thermostat, is used to control the temperature of the fluid, which consequently conditions the temperature of the screws and spindle as the fluid flows through them.



**Conclusion** Thermal expansion is a natural occurrence in any machining operation, and, when ignored, can significantly impact accuracy and positioning. By identifying and eliminating unwanted heat sources, by calculating or measuring expansion effects and altering positioning accordingly, by performing regular maintenance on the VMC, and by adopting the machining practices outlined above, the effects of thermal expansion can be reduced. For higher accuracy requirements, several options can be added to a standard VMC to further reduce expansion effects. Thermal expansion itself is unavoidable, but its undesirable effects can be eliminated.

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## Section 15: Diagnostics

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### Diagnostic System Commands

To enter the Diagnostic System, enter the DI command. The Diagnostic System recognizes the following commands:

**Table 1: Diagnostic Commands**

COMMAND	DESCRIPTION
CE	Clears error message(s) under DE (94.1H-3 or later)
DE	Display last 48 error messages
DS	Display switch values
X	Terminate DS mode and exit
G 0 3000	Enters the diagnostic menu

The Diagnostic System may be exited by pressing “ENTER” alone without typing a command.

### DS - Display Switches

This command causes the continuous display of switch feedback and CNC status data. The display is updated 3 times per second. The display will be continuous until the “X” command is entered. Once in the “DS” mode, the maintenance engineer may return the CNC to the normal command mode by depressing “ENTER” without first typing a command (or by simply depressing “ENTER” twice in succession). The data display will continue during the execution of normal machine functions, however, it is not recommended that the CNC be left in the “DS” mode during the actual machining of production parts. The “DS” mode is terminated by entering the Diagnostic System via the “DI” command and then issuing the “X” command. The switch status values are displayed as zero if the switch is open and as one if the switch is closed. Counts are displayed as two digit hexadecimal numbers. A description of the display follows:

**Note:** All numbers are displayed in Hexadecimal. Refer to General Information Section- Binary Numbers and Reading a Status Group.

**Table 2: Display Switches**

DISPLAY	DESCRIPTION
DISPLAY	DESCRIPTION
ATCXTNDD	Switch closes when the ATC slide is extended
ATCTURET	Switch closes momentarily when the ATC turret motion is complete. May not be seen because closure may occur between screen updates.
ORIENSP	Switch closes when the spindle is at the proper angle for orientation.
ATCHOME	Switch closes when the ATC slide is fully retracted.
ATCFAULT	Switch closes when the ATC is subjected to excessive up or down forces.
DRAWBAR	Switch closes when the drawbar cylinder is pressurized.
OIL LEVEL	Switch closes when the oil level is low for waylube and spindle lube reservoir.
HIGH IDLER	Switch closes when the idler wheel is retracted. (Low range engaged).
LOW IDLER	Switch closes when the idler wheel is retracted. (High range engaged).
PROBE	Switch is open when probe switch is engaged.
SLIDE HOLD	Switch is open when doors are closed (external slide hold).
COMMAND1 Refer to Hex to Binary table	Each binary bit commands one solid state relay. A value of 0 turns the relay on. B0 is the rightmost bit.  B0= M68/M69 B1= High range idler B2= Unused B3= Drawbar/Geneva/Slide Enable B4= Drawbar B5= Air indexer B6= Coolant 1 ON B7= Coolant 2 ON

Table 2: Display Switches

DISPLAY	DESCRIPTION
COMMAND2 Refer to Hex to Binary table	Each binary bit commands one solid state relay. A value of 0 turns the relay on. B0 is the rightmost bit.  B0= Unused B1= Low range idler B2= M62/M63 B3= M66/M67 B4= Turret motor ON B5= Turret motor reverse B6= Spindle coolant pump B7= M64/M65
COMMAND3 Refer to Hex to Binary table	Each binary bit commands one solid state relay. A value of 0 turns the relay on. B0 is the rightmost bit.  B0= Orientation B1= ATC Slide motor ON B2= ATC slide motor REVERSE B2= ATC slide motor REVERSE B3= Way lube pump B4= Limit switch override B5= M60/M61 B6= Axis amplifier ON/OFF B7= Spindle lubricator ON
(MEMORY)	Contents of the memory location specified with the DS command. For example DS A5A5 will cause the display of the contents of memory location A5A5 (A5A5 is a hexadecimal address).
LASTMFUN	The BCD value of the last M-function.
MFUNFDBK	The M-function feedback data from user attached devices.
INT1-CNT	Running count of CRT screen update clock interrupt.
INT2-CNT	Running count of 100 ms clock interrupts.
INT3-CNT	Running count of axis controller interrupts.
INT4-CNT	Running count of RS232-C port interrupts.
INT5-VAL	Last data from keyboard (ASCII with B7=1)
INT6-CNT	Running count of geometric algorithm interrupts.
INT7-CNT	Running count of Emergency stop interrupts.
SPARE-3	Probe feedback switch
SPARE-6	Air indexer feedback switch #2
SPARE-7	Air indexer Feed back switch #1

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**Menu Diagnostics****WARNING**

Some of these tests are intended for Fadal factory use only. Use only those tests that the Maintenance technician has been trained to use. Call the Fadal Service Department for more information.

AVAILABLE IN SYSTEMS 89.1I (and above)

One of the new features available to the 89 series software is the diagnostics menu. This feature is useful in testing the 1400-2 or higher CPU card, Ram Expansion, RS-232 Port, Video, Axis Controllers, Clocks, and the Mill Interface. Although the tests are designed not to affect memory it is still a good idea to make sure all the programs on the machine are backed up before testing.

To begin, at the prompt "ENTER NEXT COMMAND" enter the following commands:

```
DI <ENTER>  
G O 3000 <ENTER>
```

After entering the above commands, the first of 5 menus will appear. The space bar switches between each menu and the MANUAL key is used to abort a test (Hold this key down until the computer aborts a test).

**Menu Page 1****Function 1 = EPROM CHECKSUM (1610-1)**

Reads the eproms on the 1610 MODULE CARD. After performing the checksum, the result is displayed. This test displays four to six 1 byte numbers. They should be all zeros. If they are all zeros, the test counter is incremented and the test is repeated. The message "CHECKSUM ERROR" is displayed and the test stops if the checksum is not zero. A failure with the test would indicate a bad CPU card or MODULE.

**Function 2 = RAM TEST (1400)**

Performs a write/read test to the 1400 CPU memory. This memory is used by the CPU for such things as parameters, offsets, execution buffers, general usage of the CPU.

While the test is running the current memory segment is displayed as follows:

```
SEGMENT 6 or 4  
SEGMENT 7 or 5  
SEGMENT 8  
PASSED TEST #### TIME(S)
```

The message “MEMORY FAILURE” would appear and the data that failed is displayed. A failure with this test indicates the 1400 card needs to be replaced.

### **Function 3 = RAM EXPANSION TEST (1460)**

Tests is the same as function 2 except it searches for the available memory expansion. Checks up to 422K.

```
SEGMENT 9
SEGMENT A
SEGMENT B
SEGMENT C
SEGMENT D
SEGMENT E
PASSED TEST ##### TIME(S)
```

If the card is present, it is tested automatically the same as function 2. When a card is not found the message “NOT PRESENT” appears next to the segment number. Refer to the Attached Optional Devices Section for setting the memory card to the proper segment (1460-2 has no jumper settings).

**Note:** A more thorough RAM test is available on MENU PAGE 5.

### **Function 4 = RS-232 TEST (1030)**

Tests the RS-232 port. You must install the test plug supplied by FADAL (located in the main cabinet) or jumper pins 2 and 3. After selecting the baud rate number, the CNC sends and receives a continuous flow of characters until an error has occurred or the manual key is pressed. There are two procedures that can be performed with this test.

- 1) Install the plug directly in the back of the CNC and cycle the test. This checks the machine for a possible failure with the ribbon cable, wiring or the S-100 (1030) card.
- 2) Install the test plug at the computer's end of the cable. This will check not only the cable but also the environment. A bad cable, solder connection or an electrical noise problem could cause the first test to pass and the second test to fail.

### **Function 5 = NON-DESTRUCTIVE LOOP TEST**

Causes all tests to be continuously performed until a failure has occurred or the manual key is pressed.

Program memory checksum (menu page 3) and all functions on menu pages 4 and 5 will not execute during the loop test.

**Menu Page 2      Function 1 = KEYBOARD TEST**

Tests the keyboard by echoing the key to the screen. Pressing the JOG key allows the hand wheel to be tested.

**CAUTION!**      Check SETP parameters after performing this test.

**Function 2 = START CNC**  
DO NOT USE

**Function 3 = 1010-4 AXIS CONTROLLER DIAGNOSTICS**  
INTENDED FOR FADAL USE ONLY!

**Function 4 = START MOS**  
INTENDED FOR FADAL USE ONLY!

**Function 5 = ZERO MEMORY**  
On the 1400-2 writes zeros to segments 6,8,9,A,B,C,D,E. On the 1400-3 writes zeros to segments 4,5,8,9,A,B,C,D,E.

**WARNING:**

This will clear all memory SETP, backlash user programs, tool and fixture information.

**Menu Page 3      Function 1 = VIDEO TEST (1420)**

This test has two functions.

- 1) A testing of the video ram, which you will see as a quick flicker on the screen. If a failure is reported then there is a possible failure on the 1420-1 (video board) or the 1030-1 on the -3 system.
- 2) A visual test. The screen should show a repeating pattern of characters. If the pattern is not repeating then there is a possible failure on the 1420-1 (video board) or the 1030-1 on the -3 system.

**Function 2 = 1010-1 OR 1010-4 AXIS CONTROLLER TEST**

Tests all the axes, X, Y, Z, A, B, and C. If an axis slot is not populated then the No Response counter will be incremented. If an axis slot is populated and either the No Response counter or the Failure counter has been incremented then there is a possible failure of that card (computer interface 1030) or even possible failure of the CPU. Note that the expected and the received checksum the spindle card is F0 and 80 respectively.

**Function 3 = TEST THE CLOCKS (1020)**

All three of the VMC's clocks will be tested with this function. Interrupt 6 counts from -200 to 0 and then interrupts, interrupt 2 interrupts after approximately



0.1 seconds, and interrupt 3 interrupts after approximately 0.3 seconds. Therefore, as interrupt 1 counts to 0 interrupt 3 should count to about 6 (Note that the counting doesn't have to be perfect but should be in the general area). A message should appear if an interrupt is not counting properly. A failure could indicate a problem with the clock card or communication problem with the computer interface or CPU.

To exit this test you must wait till the exit message "... PRESS MANUAL TO STOP TEST" appears. At the time of the exit message press the manual key to exit the test.

**Function 4 = TEST MILL INTERFACE CARD (1040)**

Checks the mill interface. The pass counter will be incremented with each successful pass. Otherwise, a failure message will appear, which possibly indicates a 1040 failure. This test only checks the communication portion between the 1040 and 1030 to 1400.

**Function 5 = PROGRAM MEMORY CHECKSUM**

Calculates a four byte checksum of all the current programs in memory. This checksum is used to verify that the memory has not been changed during a power on/off test or during a long period of time with the power off.

**Menu Page 4****Function 1 = FILL MEMORY WITH A PATTERN**

INTENDED FOR FADAL USE ONLY!

**Function 2 = CHECK MEMORY FOR PATTERN**

INTENDED FOR FADAL USE ONLY!

**Function 3 = ENABLE/DISABLE REMOTE DIAGNOSTICS**

INTENDED FOR FADAL USE ONLY!

**Function 4 = ECHO RS-232 PORT DATA**

The CNC's back serial port will act just like a test plug. It will echo back any data that it receives on the port.

**Function 5 = DESTRUCTIVE RAM TEST**

INTENDED FOR FADAL USE ONLY!

**Menu Page 5****Function 1 = COUNT INT1, INT2 AND INT6**

INTENDED FOR FADAL USE ONLY!

**Function 2 = FULL DAC WITH INT6 COUNT 0FED4H**

INTENDED FOR FADAL USE ONLY!

**Function 3 = QUARTER DAC WITH INT6 COUNT 0FED4H**  
INTENDED FOR FADAL USE ONLY!

**Function 4 = TEST ENCODERS (1010-4)**  
Tests any encoder connected to a 1010-4 axis card. AC Machines.

**Function 5 = TEST ADC**  
INTENDED FOR FADAL USE ONLY!

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### Clamp-on Ammeter Testing

#### Tooling Required: ExTech AC/DC Clamp-On Ammeter

The purpose of the procedure is to monitor the amount of current that the axis motor is using to transverse the slide. The ExTech AC/DC Clamp-On ammeter can be used as an indicator for various problems, including: ballscrew alignment, gib and/or gib straps adjustments, insufficient or incorrect waylube, and to check for tightness of the limit stop at the axis limit.

#### Gib and Gib Strap Verification

This procedure should only be done to check gib and gib strap adjustments for binding. It is not intended to be a replacement for the procedure outlined in the Maintenance Manual.

- 1) Set the Clamp-On Ammeter to the following selections: ON, DC, 200A and adjust the display to 00.0 with DCA ZERO ADJ.
- 2) Attach the ExTech AC/DC Clamp Meter over the brown wire on the axis amplifier to be checked. Ensure that the jaws remain closed when hanging from the wire. Be careful not to touch the DCA ZERO ADJ. knob, as the readings will be distorted.
- 3) Jog the axis to the + (plus) limit.
- 4) Enter one of the following into MDI, adjusting values to reflect the total travel of this axis. For example, VMC4020 has the values of X=40, Y=20, Z=20.
  - a) G1 F25. G91 X?\_ M49
  - b) G1 F25. G91 Y?\_ M49
  - c) G1 F25. G91 Z?\_ M49
- 5) Monitor the display on the Clamp Meter while traversing along the axis and record the average reading. note that the current reading may rise 1 or 2 amps near the ends from ramping.

- 6) Normal readings for Millimeter ballscrews range from 4 to 6. 5 amps and for Inch ballscrews the range is from 1 to 2.5 amps. 6030 & 8030 4 to 6, 7 amps max.
- 7) For higher than normal readings, check the following items:
  - a) Is the proper waylube being used, and the waylube system operating properly? Refer to the Machine Maintenance Section.
  - b) Do the ways have the proper amount of waylube?
  - c) Loosen the gibs slightly and rerun the above test. Are the new readings less than the original readings? If yes, repeat again until the readings no longer change.

**Ballscrew Alignment**

- 1) Set the Clamp-On Ammeter to the following selections: ON, DC, 200A, and adjust the display to 00.0 using the DCA ZERO ADJ.
- 2) Attach the ExTech AC/DC Clamp Meter over the brown wire on the axis amplifier to be checked. Ensure that the jaws remain closed when hanging from the wire. Be careful not to touch the DCA ZERO ADJ. knob, as the readings will be distorted.
- 3) Jog the axis to the + (plus) limit.
- 4) Enter one of the following into MDI, adjusting values to reflect the total travel of this axis. For example, VMC4020 has the values of X=40, Y=20, Z=20.
  - a) G1 F25. G91 X-\_. M49
  - b) G1 F25. G91 Y-\_. M49
  - c) G1 F25. G91 Z-\_. M49
- 5) Monitor the Ammeter display while traversing along the axis. The readings should not vary more than 2 amps for Millimeter ballscrews and 1 amp for Inch ballscrews.
- 6) Watch for variations as either end is approached. If higher than normal values, check and adjust ballscrew alignment.
- 7) If the ballscrew is realigned, then readjust backlash and retest.

**Limit Stop Check**

- 1) Set the Clamp-On Ammeter to the following selections: ON, DC, 200A and adjust the display to 00.0 with DCA ZERO ADJ.
- 2) Attach the ExTech AC/DC Clamp Meter over the brown wire on the axis amplifier to be checked. Ensure that the jaws remain closed when hanging from the wire. Be careful not to touch the DCA ZERO ADJ. knob, as the readings will be distorted.

- 3) Jog the axis to the + (plus) limit.
- 4) Enter one of the following into NMI, adjusting values to reflect the total travel of this axis. For example, VMC4020 has the values of X=40, Y=20, Z=20.
  - a) GI F25. G91 X\_. M49
  - b) GI F25. G91 Y\_. M49
  - c) GI F25. G91 Z\_ M49
- 5) Check the reading on the meter when the axis has reached the limit and stopped. Normal readings should be no higher than 2 amps than the average? current reading along the travel of the axis. Refer to AXIS LIMIT STOP, MECHANICAL ADJUSTMENTS, in the Axis Drive Systems Section.
- 6) Now, check the opposite direction wire by clamping the meter on the WHITE wire at the amplifier output.
- 7) Enter one of the following into MDI, adjusting values to reflect the total travel of this axis. For example, VMC4020 has the values of X=40, Y=20, Z=20.
  - a) GI F25. G91 X\_. M49
  - b) GI F25. G91 Y. M49
  - c) GI F25. G91 Z\_. M49
- 8) Check the reading on the meter when the axis has reached the limit and stopped. Normal readings should be no higher than 2 amps than the average current reading along the travel of the axis. Refer to AXIS LIMIT STOP, MECHANICAL ADJUSTMENTS, in the Axis Drive Systems Section.

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### Test Cut Procedure

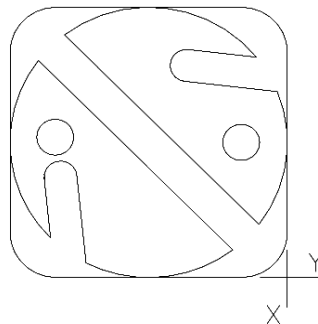
- 1) Use program **5836**
- 2) Install test cut block in center (T) slot, and center under spindle. Pull block forward and tighten bolts.
- 3) In MDI type **S600. M3 M49. <ENTER>** Turn spindle on to establish RPM of spindle turn spindle off using spindle off key.
- 4) Insert tool with edge finder in spindle and turn on spindle with **SHIFT-- SPINDLE ON KEYS.**
- 5) Jog Z down to the front edge of part and set edge finder **by jogging Y-axis plus or minus.**

- 6) Jog Z up away from part.
- 7) Turn spindle off.
- 8) Do not move Y axis. In MDI type **Y.1GO** <ENTER>.
- 9) At enter next command type **SETY** The Y-axis is now set.
- 10) Turn on spindle with **SHIFT-SPINDLE ON KEY**.
- 11) To set X axis, jog to right side of part and jog down Z axis, making sure not to hit edge finder on top of part when jogging. Set X axis the same way that Y axis was set.
- 12) Turn off spindle. Do not move X axis in MDI type **X-.1GO** <ENTER>.
- 13) At enter next command **TYPE SETX**. The X axis is now set.
- 14) Remove tool with edge finder from spindle. Install tool with cutter in spindle.
- 15) Use a **1.00 INCH BLOCK** to set the Z tool height. Set block on top of part. Jog Z down until the Z just touches the block. At the ENTER NEXT COMMAND prompt, type **sl,12** <ENTER>.
- 16) At ENTER NEXT COMMAND type **H0** <ENTER>.
- 17) At ENTER NEXT COMMAND type **DT** <ENTER>.
- 18) Type # **1**.
- 19) Then #**12** <ENTER>.
- 20) Change to **.48 TOOL DIAM.**
- 21) Change tool length by -.001.
- 22) Press #1 to accept.
- 23) Set spindle pot and feed rate pot to 100%.
- 24) At enter next command type **AU,28,75** <ENTER> and start program.

**VMC Test Cut**

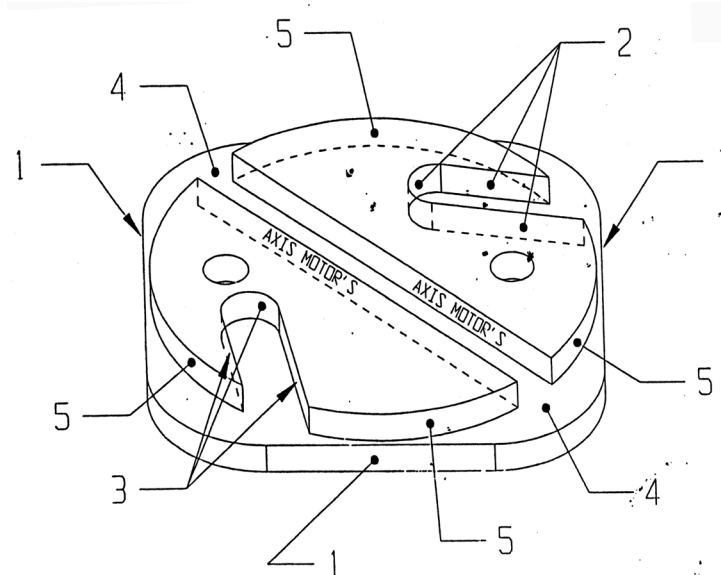
- 1) Push test part towards back of fixture.
- 2) Home position:  

X - as shown below  
Y - as shown below  
Z - coldstart position
- 3) Program 5836 (TA,2).
- 4) Set tool length 1" above part (SL,12). Tool length may have to be altered if top of part doesn't get cut.
- 5) Use 1/2" diameter 4 flute carbide endmill. Set tool diameter at .480 for initial cut (lower tool diameter if recut is necessary).
- 6) Edit program as indicated below (if necessary).
- 7) Start program @ N28 and stop @ N75. (AU,28 <ENTER>)



VMC	RPM <small>EDIT N28</small>	FEEDRATE <small>EDIT N31, N42, N55, N68</small>
2216 3016 4020	10,000	50 IPM
5 10 15	7,500	32 IPM
6030 8030	10,000	25 IPM

## VMC Test Cut Part



- 1) Belts
- 2) X Motor
- 3) Y Motor
- 4) Belt / End Mill/Spindle Preload Spindle Motor Washer
- 5) Comp./Bad Axis Motor

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## Section 16: Troubleshooting

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### Error Messages

#### **Absolute Mode Required at N =**

The CNC must be in the G90 (absolute) mode during all probe functions. Probe function L9101 is programmed in the G91 (incremental) mode.

#### **Amplifier Fault on Axis**

This occurs at power on if the control does not detect an axis that should be operational. This is often seen when the A axis is not in use and the dummy termination plug has been installed. If the dummy termination plug is installed, this message can be disregarded.

If this message appears for any of the other axes (X, Y, or Z), then power off to check the motor overload relays. Power on and if the message appears again, call the service department, noting the error message number.

Power off the machine before checking fuses, relays, and circuit breakers. The motor overload relays can be recognized by their white reset buttons. They are located in both control enclosures. The white button must be pressed to reset a relay.

This message also appears when the EMERGENCY STOP button has been pressed. The operator must release the EMERGENCY STOP button and press the JOG button to reset the amplifiers. (Pressing in the EMERGENCY STOP button disconnects the axis amplifiers. This is why this message appears when the button is pressed.)

#### **Arm Must Be Left**

Before a pallet change can occur, the arm must be completely to the left with the pallet on the table. The feed back on the arm is being read at this time.

#### **Array Exceeds Allowable Number**

This message will appear when the number on the array exceeds the expected amount. This amount varies from variable to variable. For example, H(99) is acceptable, H(102) is not.

**ATC Failure**

Check to see if the Z axis alignment was properly set at cold start. The automatic tool changer has failed to respond to an M6 or the TC,1 command. Try a power off and power on. If this does not help check the fuses.

The fuses F5, F6, F7, and F8 should be checked to see if they are burned out. Circuit breakers 1 and 2 (if they are present) should be pressed to see if they have been tripped.

Power off the machine before checking fuses, relays, and circuit breakers. If this does not help, call the service department.

If this message appears with the turret in the extended position, it may be an indication that the sensor for turret extension is faulty. Call the service department.

**ATC Turret Failure**

Check to see if the Z axis alignment was properly set at cold start. Then check to see if anything is caught between the sheet metal guard and the turret. If not, this could be an indication that the sensor for turret rotation is faulty.

The fuses F5 and F6 should be checked to see if they are burned out. Circuit breaker 2 (if it is present) should be pressed to see if it has been tripped.

Power off the machine before checking fuses, relays, and circuit breakers.

**ATC Will Not Move to Position**

Check to see if the Z axis alignment was properly set at cold start. An attempt is made to make a tool change and something prevents the turret from going all the way out to the spindle. Check the tracks that allow the turret to slide out to the spindle. Sometimes chips stick to the track and prevent the rollers from rolling on the track.

When this message appears use the command SETCS then the command HO which will bring the tool to the Cold Start position. It is important to visually check the axis indicator markers to see if they are aligned; if not, jog the table until the markers are aligned. Use the command CS, then answer Yes (Y) to the "move to home?" question. This will bring the tool to the part's home position and enable the operator to begin running the program in AUTO again.

It is also possible that the turret extended sensor is faulty.

Fuses F5, F6, F7, and F8 should be checked to see if they are burned out. Circuit breakers 1 and 2 (if present) should be pressed to see if they have been tripped.

Power off the machine before checking fuses, relays, and circuit breakers.

**Attempted Division by Zero**

In a macro statement, a division by zero was attempted.

**Attempted SQR of a Negative Number**

In a macro statement, a square of a negative number was attempted.

**Attempt to Change CRC Side Without G40 at N =**

This message will occur when attempting to switch from G41 to G42, or vice versa, on a linear move. However, switching from one to the other is permitted during circular interpolation.

**Attempt to Change Tool While in CRC Mode, N =**

This message occurs if a G41 or G42 is used in the program and a G40 code does not appear before an M6 code. The G40 cannot be on the same line with M6. An M6 will not cancel CRC.

**Attempt to Switch Plane During CRC**

G40 must be in effect (CRC must not be on) when changing planes. The default plane selection is G17. If CRC is in effect and a code to change to another plane (G17, G18, G19) is used, this message will appear in the block where the plane selection was called. G40 must be in effect (CRC must not be on) when changing planes.

**Axis Controller Does Not Respond During Power Up Sequence**

This is an indication that there is a communication problem between the CPU (1400) board and the axis controller (1010). Note error number and call the service department.

**Axis Controller Does Not Respond to NC**

This is an indication that there is a communication problem between the CPU (1400) board and the axis controller (1010). Note error number and call the service department.

**Axis Data Transfer is Stalled**

This message is the result of a data transfer problem between the 1030 card and a 1010 card. This message does not represent a serious problem and should only be reported to the service department if it is persistent. Please note error number.

**Axis Does Not Respond**

This is possibly a problem with the 1010 card for the stated axis. Try a power off and a power on. If this does not help, call the service department.

**Axis Fault(s) as Follows**

This appears when the EMERGENCY STOP button is pressed, a motor overload relay is tripped, or the machine places itself into the Emergency Stop mode. If any message or error number is presented on the screen, record this message and number and report them, if needed, to the service department.

Release the EMERGENCY STOP button if necessary, then press the JOG button which will reset the machine. If the machine does not reset, call the service department.

If the EMERGENCY STOP button is not depressed, then power off the machine and press the reset buttons of the motor overload relays to see if they are tripped.

The motor overload relays can be recognized by their white reset buttons. They are located in both control enclosures. The white button must be pressed to reset a relay.

If the machine stalls for one reason or another, the control places itself into the Emergency Stop mode. Press the JOG button and jog the tool out of the stalled position.

An axis fault also occurs during an emergency stop because the control removes the power to each of the axis servo amplifiers as a safety feature. The control then analyzes the situation and, as a part of the report, shows a servo amplifier fault, a result of having removed power to the amplifiers.

**Axis Overflow**

The axis controller detected an overflow situation. Power off the machine at the main power switch wait ten seconds, and turn the power on again. If this problem is persistent, call the service department.

**Bad Circle OR Missing G at N**

This can indicate an incorrect starting position for the circle, an incorrect ending position, or an incorrect description of the arc center location relative to the starting position of the circle.

This can also indicate that the circle is programmed in absolute or incremental and the G90 or G91 codes are incorrect.

**Bad Data or No Tool Dia.**

This occurs when an H word (in format 1) or the D word (in format 2) is missing in the program. When a program uses cutter radius compensation (CRC) or a fixed subroutine, an H word or D word must be specified.

This also occurs when no diameter value is placed in the tool table when using Fixed subroutines L94NN, L95NN, L9601, L9701, L9801, L9901. A DIAMETER VALUE MUST BE USED.

When the fixed subroutine for engraving (L9201) is used, the Z depth and the R2 variable must be included in the line. See the Users Manual for the correct format. If the R0 variable is not specified, it is assumed as R0+0. If the R1 variable is not specified, it is assumed as R1+1.

**Bad Fixture No.**

Fixtures are numbered E1-E48. This message is displayed when a fixture offset is programmed with a value greater than 48. Format 2: G54-G59 and E6-E48 are used.

**Bad Interpolation Type at N**

Check to see what type of move is intended for this block. G1, G2, and G3 are the interpolation codes; G1 is for linear moves and G2 and G3 are for circular moves.

**Bad R Field**

This occurs during input from the keyboard or through the RS-232 port (from an offline computer) when the R0 was typed incorrectly. Example: If R0 is typed (R with the letter O) or R with no zero (0) is typed (R-.05 is accepted but not R.05 or R+.05).

Correct the line in the CNC; or correct the line in the text editor and send the program again.

**Bad R1 Using L91 at N =**

The R1 parameter is not present in the block containing L9101, or it is present with an improper value. L9101 has 9 possible functions that are defined by the R1 parameter; R1+1. through R1+9.

**Bad T Word at N =**

This message occurs during a SUM command. It indicates that the T word value is larger than the tool changer capacity.

**Bad Z or R0 in Canned Cycle Call, N =**

This is a programming error due to the position of the R plane relative to the Z axis position when initializing a fixed (canned) cycle.

Problem:

- 1) The R plane is described to be above the I plane.

- 2) The R plane is described to be below the final Z depth.
- 3) The final Z depth is described to end above the I or R planes.

**Solution:**

Check to see if the program has the correct positioning mode (G90 or G91), and check for correct signs and decimal point placement.

**Note:** The H code might not be in the program.

**Calculated Radius Error Of**

This is a programming error possibly due to a G90 or G91 code missing, or being in the wrong place. (EXAMPLE: Giving absolute positions while still in incremental). Also, check the end point description, the beginning position, and the arc center description (I, J, and K), or radius designation.

This message does not appear during the Auto mode. It appears when using the SUM command (SU).

**Cancel CRC Before G50.1 OR G51.1 AT N =**

Before using CRC (G41, G42), mirror the desired axes (G51.1). Also, turn CRC off (G40) before canceling mirror image (G50.1).

**Cancel CRC Before N =**

The control requires the G40 code to cancel cutter radius compensation before the line number listed. See the cutter radius compensation section for suggestions.

**Cancel Z Axis Mirror Before Tool Change at N**

The G50.1 code must appear on a separate line before the M6.

**Cannot Return from Subprogram or Subroutine****Calling Line Cannot Be Found**

This is a background editing error message. The line that called the subprogram or subroutine was deleted or cannot be found.

**Cannot Start Directly in a Subprog.**

A mid program start must begin from the main program. If it is necessary to start the program in a subroutine, the COPY command can be used to copy the subroutine to the main program as many times as the subroutine will be repeated. The programmer or operator can now do a mid program start to where the subroutine was copied into the main program. After the part is complete, delete the copied portion and run the program as before.

Another method to start the program in a subroutine is to use the AUTO command. Enter AU,# (see AUTO command in the Operators Manual), where # is a sequence number in the subroutine. The control will process the program from the beginning of the program up to the number specified then start execution of the program.

**Char. Size or Depth Exceeds 2.5 In.**

Characters that are higher than 2.5 inches cannot be engraved using the Engraving mode (L9201).

**Check Emergency Stop Switch and Motor Overload Relays**

If the EMERGENCY STOP button (switch) is not pressed, it is necessary to check the motor overload relays.

Power off the machine before checking fuses, relays, and circuit breakers. The motor overload relays can be recognized by their white reset buttons. They are located in both control enclosures. The white button must be pressed to reset a relay.

Also, check the brake relay fuse (F17) to see if it is burned out. It is advised to power off the machine when checking the fuses or motor overload relays.

**Check Spindle Lube, Way Lube and Air Pressure**

When this message is displayed, it is necessary to check the way lube level, spindle oiler level, and the air pressure gauge. It is advised to check these oil levels at least once a day.

**Clear an Emergency Stop Condition**

An emergency stop condition was invoked. To clear, press the JOG key. Wait 2 seconds for the amplifiers to be reset, then continue.

**Command Error**

This occurs because a SET (parameter) command was typed in improperly. Refer to the Users Manual or use the menu of the control to help with any command format. The following is a list of available SET commands: SETH, SETX, SETY, SETZ, SETA, SETB, SETCS, SETTO, SETP.

**Command Prohibited by the Key Lock**

With the key lock in the horizontal position, editing commands (CH, CO, DE, IN) cannot be used.

**CRC Called With No Tool Assigned at N =**

This happens when the programmer has turned CRC on without an H word in the program.

**EXAMPLE: Format 1:**

N1 G41	
N2 H1	This is incorrect.
N1 H1	
N2 G41	This is correct for Format 1 only.

**Format 2:**

N1 H1	
N2 G41	This is incorrect.
N1 H1 D1	Diameter must be for Format 2 programming and
N2 G41	is acceptable for Format 1 programming.

This is a common error in one tool programs when the Z axis is set with the tool at the gauge point. Assign an H word with no tool length offset (only a tool diameter) in the tool table.

**D or H Too Large**

The control maintains a table of 99 tool diameters and 99 length offsets. The control will only accept H words and D words up to 99.

**Data Transfer Fault**

For this error, it is important to note which axis the transfer fault is on and report it to the service department. Please note the error message number. There is a data transfer problem between the 1030 card (slot 8) and the 1010 card for the stated axis.

**DNC Mode**

This message appears after DNC is typed at the control. The VMC is then ready for DNC operation and is waiting for CNC code from the RS-232 port.

**Door Began to Close While Arm was Moving**

This message will occur if the door begins to close during a pallet change. The feedback of the door may need adjustment or there may have been a drop in air pressure.

**Do You Want to Move to the Last Home Position?**

This is not an error message but it appears each time the operator uses the CS command and a home position is established (SETH) in memory.

**Do You Want to Reinitialize Memory?**

This prompt is accessed by reinitializing the memory via the RI command. A 'Y' response zeroes the memory of the CNC.

**WARNING**





All program data is deleted from memory. After the memory is reinitialized, a cold start must be performed.

**Do You Want to Zero Tool Table?**

This prompt is accessed by reinitializing the memory via the RI command. A 'Y' response zeroes the tool offset table.

**WARNING**

All tool diameter and length offsets are deleted from memory.

**Do You Want to Zero Fixture Offsets?**

This prompt is accessed by reinitializing the memory via the RI command. A 'Y' response zeroes the fixture offset table.

**WARNING**

All fixture offsets are deleted from memory.

**Dry Run Option \_\_\_\_ is in Effect**

The selected dry run option (1, 2, or 3) is displayed prior to automatic execution. See the Users Manual or the Run Time Menu for the appropriate option definition.

**Duplicate Name**

No two programs in the library can be identified by the same number. When copying an existing program assign an unused number to the new, or copied program. Use option 2 (display program numbers) of the PR menu to determine which numbers have been used.

**Duplicate or Bad Prog. Name**

This will occur if a program is being input through the RS-232 port and the program has an O word in the first line that is a duplicate of an existing number in the program library. Use option 2 (display program numbers) of the PR menu to determine which numbers have been used. Change the O word to one not being used, or remove it. Then send the program out to the control again.

If the program currently active in memory has an O word in the first line, the program will be moved into the program library when the new program is transferred through the RS-232 port. If the program currently active does not have an O word in the first line, the program will be deleted when the new program is transferred.

**Dwell, Hit Start to Interrupt**

This message is displayed when a G04 (dwell) is executed by the CNC. You can interrupt the dwell time and continue program execution by pressing the START key.

**E Word May Only Be Used With G0 or G1 N =**

Fixture offsets cannot be on the same line with a circular move (G2, G3).

**Emergency Stop - Take Appropriate Action**

An emergency stop has occurred. If the emergency stop button is depressed, turn it clockwise until it returns to its normal position. Press the JOG button and the message WAIT 2 SECONDS, THE AXES ARE BEING RESET. If this message persists, call the service department.

The appropriate action to take:

- 1) Release the EMERGENCY STOP button if it has been pressed.
- 4) Press the JOG button which resets the amplifiers if the problem has been resolved.
- 5) Type HO and press ENTER, then after the waiting message appears press START (see note).
- 6) The operator may now resume the running of the part.

**Note:** It is not necessary to move the axes to their Cold Start position or establish the part home again unless the message, JOG AXES TO HOME POSITIONS, THEN ENTER THE CS COMMAND appears.

**Enter Again or Hit Manual to Exit**

This message comes up when inserting program coding at the keyboard (using the IN command) or when in Manual Data (MD) and Change (CH) mode. It is referring to the line just typed. Something was not acceptable, for example the letter O for the number zero (0) or anything else not correct. The control is still on the line with the problem, so retype the entire line.

**Enter Command SETP and Set the Machine Parameters**

The SETP procedure will ask questions regarding the machine and certain preferences. If any of the questions are not clear, call the service department for help.

**Enter Command MU to See the Menu**

This happens when a command is typed incorrectly. Either it is an unrecognizable command or a comma was omitted.

This message is only a suggestion. It is not necessary to go to the menu to use a command. The menu is there to remind the operator of the command format.

**Error**

This message is a program input error. It is displayed when a program block containing an error is transmitted to the CNC via the RS-232. It appears at the time the error is received. Therefore, list the program at the control to display the last block of code received. The following block of code in the program, which was not received, is in error. This normally is caused by back to back alpha characters, which must be separated by numeric characters. Also, a 0 could be typed as an O.

**Error in User Program, 'SUM' to See Message**

See the Operator Manual for instructions on using the SUM (SU) command. This message will occur when the control lists an error message in the Auto mode, and the operator persists in running the program by pressing the START or AUTO button. This message will appear when the line in which the error exists is at the top of the stack of lines to be executed.

**Error N Word Exceeds 99999**

This error occurs when the sequence number is larger than 99999. The sequence number must be between .001 and 99999.

**Error While Processing Block**

This is an indication that there may be a problem with the CPU board.

- 1) Send the machine back to cold start alignment markers.
- 7) Power off the machine's main power, wait 15 seconds and power on the machine.
- 8) Cold start then run the program again.

If this error repeats:

- 1) Save all the programs and offset information currently in memory. Write down the present home position.
- 9) Send the machine back to cold start alignment markers.
- 10) Use the command RI and answer Yes (Y) to all the questions.

If the above does not work please call the Service representative in your area.

**Error(s) Reading Tape**

While the control is inputting a tape or program with the TA command, error option 2, this message appears after input is complete. If the TA command and error option 1 is used (TA,0,1 or TA,1,1) the input of the program would have been stopped if an error in the program is detected.

If errors are detected, list the program and look for missing line numbers to find which lines the control did not accept. Use the IN command to insert the missing lines where needed.

**File Overflow**

This message could mean that the program has too many G codes and M codes on the same line.

It could also mean that during CRC, there were too many blocks that the control had to look beyond for the next compensated move (comment lines, Z moves, G code and M code lines, and dwells).

This message may also appear if a fixed cycle is in effect when attempting to initiate cutter radius compensation.

**Fixture Offset Out of Range**

This message occurs when an E word value in the program exceeds 48 or in Format 2 exceeds G54 - G59 or exceeds E1 - E48.

**Fixture Offset Must Be Applied With G0 or G1**

Fixture offsets cannot be applied on lines with circular interpolation (G2 or G3).

**G28 and G29 Used With Cutter Radius COMP at SEQ**

Before the control can execute the codes G28 or G29, the program must turn CRC off (G40).

**G31 Used With an Incompatible Word or Mode**

Only G1, P and F are allowed with a G31. No other codes are supported. CRC, mirror image, rotation and drill cycles are not allowed during the execution of a G31 code.

**G45-G48 & G52 are Not Allowed With Rotation. N =**

Codes G45-G48 and G52 are incremental offsets. Rotation can only be used in the Absolute mode. Therefore, these codes are not allowed.

**G91.2 is Not Allowed in Format 1**

The machine is in format 1 with the G91.2 code in the program. The G91.2 code can only be used in format 2. In format 1 you must remain in the Incremental mode when G91.1 is coded.

**G92 Cannot Be Used in CRC Mode. N =**

The G92 code should be used in a line before CRC is turned on. The code G92 can only be used after a G40 (G40 is a default code).

**G92 Must Be Only G Code in Block**

There can be no other G codes in the line with a G92. The program does not need to be in absolute (G90) to use the G92 code.

**GNN is an Unsupported G Code At N**

The G code displayed is not a supported code of the FADAL CNC 88.

**Helical Move Too Short, N =**

(See error message HELICAL RISE TOO STEEP)

**Helical Radius Too Small, N =**

(See error message HELICAL RISE TOO STEEP)

**Helical Rise Too Steep, N =**

The radius of the circle and the helical rise are radically different in length (usually the rise is much longer in comparison to the radius).

Also, depending on the programmed feed rate, the control may or may not be able to handle the situation. Reducing the feed rate in the program usually helps.

**I, J or K Must Be Specified at N =**

This message is displayed when an X, Y, or Z is used with an R0 without a G2 or G3. Full circles must use the direction around the circle and either the I, J, or K. See the circular interpolation section for more details.

**Illegal O Word**

This error occurs during program input via. the RS-232. The O word must have a value of 1 through 9999. No other character or symbol is allowed.

**Illegal G Code During G91.1 Mode at N =**

This message appears when an illegal G code is programmed while in G91.1. See the Users Manual for acceptable G codes.

**Improper Use of Canned Subr.**

This message may appear for the following reasons:

- 1) No tool diameter in the tool table.
- 11) The programmer omits a required R word from the subroutine.
- 12) The programmer does not cancel a fixed cycle with a G80, G28, G29, M6, G49, or H0 before using a fixed subroutine, except for L93 (bolt hole).
- 13) Using L96 - L99, if R1 variable is equal to the radius of the tool. The R1 variable is used for the radius on the corner of the tool (fillet radius), not the

tool radius. For example, a 1.0 diameter end mill with a .125 corner radius, the R1 variable will be R1+.125, and the tool diameter entered in the tool table will be 1.0.

- 14) The G41 or the G42 code has not been canceled with a G40 before using a fixed subroutine.

### **Inches Mode Required - Operator Must Set**

The CNC is in the Metric mode (SETME), and the program has a G20 or G70 code to verify that the control is in the Inches mode. To run this program, the operator must set the CNC to the Inches mode by entering the SETIN command.

### **Incompatible G Codes at SEQ**

Some codes, even though they are modal and from different groups (families), are incompatible with one another. Break up the grouping of G codes on the line by moving some of them to the line just before or after the line they are presently on. This message is also displayed when any G code is on the line with a G53.

#### **EXAMPLE:**

N20 G1 F20.	
N21 G8 G41 X.5	The G41 and the G8 are incompatible.
Move the G8 to the line with the G1.	
N20 G1 G8 F20.	This is correct.
N21 G41 X.5	

### **Increment Divided By Two**

If renumbering causes a line in the program to be greater than 99999, the increment for renumbering is divided by two and renumbering is resumed.

All the lines or program blocks must have sequence numbers. The NU command is used to renumber the lines in the program by the increment specified in the first parameter. For example, entering NU,5 will renumber the lines, incremented by five. If program is large, renumber by 1.

### **Increment Too Large**

This occurs when the increment parameter of the program input (IN) command causes the sequence numbers to exceed 99999 or a typing error in the program has given a value too large. Example: X-123456789.

### **Increment Too Small**

This alarm occurs when the increment parameter of the program input (IN) command is less than .001 Example: IN, 0.00001

**Input Xmodem Transmit Block Missed Error**

This occurs when a packet has been missed or came out of order during XModem transmission.

**Jog Axes to Home Positions, Then Enter the CS Command**

This message appears at power on. If the axes are at the Cold Start position (machine home), enter the CS command. The operator needs only to jog the axes if they are not at the Cold Start position.

This message also appears when the tool changer crashes and the AUTO button is pushed or the MD command is used. However, the operator does not have to jog to Cold Start. Use the SETCS command to reference the Cold Start position, then enter HO to return the axes to home, and when the axes are back at the Cold Start position, visually check, and enter the CS command.

SETP will also make this message appear. If the operator used the SETP command at the part home, handle the situation in the same way as suggested for a tool changer crash (see above).

**Look Ahead Was Canceled By Operator**

This indicates the NO LOOK AHEAD buffer option of the Run Time Menu has been selected. The CNC processes only one block at a time, while displaying only two blocks of the program on the screen. This option can be selected or canceled using the Run Time Menu by typing MU in the Automatic mode.

**M, S, T Lockout is in Effect**

This message indicates the M function, Spindle, and Tool change lockout option of the Run Time Menu has been selected. In this mode, M function, Spindle or Tool Change commands will not be performed during Dry Run. This option can be selected or canceled using the Run Time Menu by typing MU in the Automatic mode.

**M Function Too Large at N =**

M functions cannot exceed a 2 digit value. See the Users Manual or the menu (MU) for a list of the accepted M functions.

**Main Prog. Not Found**

This is a programming error. There are subroutines written in the beginning of the program without an M30. M30 is used to separate the subroutines from the main program. Insert the M30 in the proper place. See the Users Manual for the accepted format for subroutines.

The M30 code on the first line of the program and a subroutine heading (L100) on the next line will also cause this error message to appear.



```
N1 O1 (START OF PROGRAM
N2 (ACCEPTABLE PROGRAM EXAMPLE)
N3 L100 (SUB #1)
N4 X1.
N5 *
N6 L200(SUB #2)
N7 L105
N8 M46
N9 X-5.Y-1.
N10 M47
N11 *
N12 L300 (SUB #3)
N13 G91
N14 L204
N15 L104
N16 G90
N17 *
N18 M17 ——— This ends the last subroutine.
N19 M30 ——— This separates the subsection from the main program.
N20 *
N21 (MAIN PROGRAM)
```

**Memory Error, Reload Program**

This is a memory error. Turn the machine's main power off. Then power on and reload the program. If this does not work, save all the programs in the memory (PU,3) and use the RI command, answering Yes (Y) to all the questions. After using the RI command, load the programs back into the control.

**Memory Error, Respond With Y to Delete Bad Blocks**

There is a possible hardware problem when this message appears.

If the operator answers Yes (Y) to this question, the control may delete some of the program in memory. Answer Yes (Y) only if the program in memory can be replaced (if the program is stored on paper tape or on computer disk). Answer No (N) if the program needs to be saved.

Turn the machine's main power off. Then power on and reload the program. If this does not work, save all the programs in the memory (PU,3) and use the RI command, answering Yes (Y) to all the questions. After using the RI command, load the programs back into the control.

If this does not help, call the service department.

**Metric Mode Required - Operator Must Set**

The control, at power on, is in the Inches mode. The Metric mode must be turned on by using the SETME command.

This message will appear if the G21 or G71 code is present in the program to verify that the Metric mode has been turned on by the operator.

**Motor Overload**

This is an indication that something has stalled or overheated a motor, and is associated with an emergency stop (see EMERGENCY STOP).

**Move Exceeds Axis Limit at N =****Check Program and Tool or Fixture Offsets**

The most common reason this message appears is because of either a missing or an extra G90 or G91 code. This message will appear only when the control is in the Auto mode or Manual Data (MD) mode. This message will not appear in the Sum mode (SU).

When the control is executing the program, processing of the program is ahead of the current line that is being executed. If, while processing the program, the control detects an over travel situation, execution of the program will stop immediately.

The setup person may have to consider moving the fixture to another location on the table. The program may be correct but the fixture is set up incorrectly. The programmer can provide information to the setup person, indicating how close to the axis limits the fixture can be located.

**Move Turret to Tool 1 and Enter SETTO Command**

When this happens, the head will be above the tools in the turret, with the turret ready for loading. Move the turret using the turret CW or CCW buttons so that the tool designated to be tool #1 is under the spindle, and remove tool #1 from the turret. Press the JOG button. The head will stay where it is (4" above the Z axis CS position), and the turret will move back to its home position. Now use the command SETTO to establish this turret position as #1. Use the HO command or jog the head down to the Z axis CS position. Next use the command TC,1 to reopen the turret. Replace tool #1 in the turret and press the MANUAL button to bring the head down over tool #1.

**Next Entry is Out of Range**

This message is displayed by entering pitch error compensation for the ball screw when an entry exceeds the maximum allowable difference of 9 (See Survey command in the Axis Drive Systems Section). For example, if an entry is 15 and the next consecutive entry is 0, the difference is greater than 9.

**No Angle, the Points Are the Same**

The calculated angle, of either function 3 or 4 of L9101, is the same as the expected angle.

**No Memory Available for New Program**

When this occurs, the operator will have to remove (delete) as many programs as necessary from the program library to input another program from the RS-232 port.

The standard memory capacity is an equivalent of 277 feet of paper tape. FADAL distributors have a memory expansion board available that increases the memory capacity to 1205 feet of paper tape.

**No Other Words Allowed With O Word**

If program coding is used on the first line of the program along with the O word, this message appears. A comment is allowed with an O word and is used to identify each program in the library. The first sixteen characters of this comment are shown when the program library menu displays the programs in memory.

**EXAMPLE:** N1 O1 G0 G90 (P/N 1234) — This line is incorrect.  
N1 O1 (P/N 1234) — This line is correct.  
N2 G0 G90

**No Parameters or Parameters Corrupted  
Machine Defaults Used**

This message occurs most commonly after the memory has been zeroed from the DI diagnostics mode. This will also occur if there is a memory error. Enter the machine parameters with the SETP command. The parameters to use are usually found recorded on a check off sheet on the inside door of the pendant.

**No Response From Axis**

This happens when powering on the machine and the CPU (1400) does not get a response from the axis controller (1010).

If this message appears for the X, Y, Z, A, or B axes, power the machine's main power off and then on again. If this does not help, call the service department.

**No Touch or Incompleted Point at N =**

The move that causes the probe to touch the part was completed without a touch. Increase the length of the move so that the probe touches. Also, you must activate the selected probe by coding an M64 for an MP8 probe, or an M65 for a TS20.

**Note Error Then Hit Manual**

When the programmer is inputting a program through the RS-232 port (using the command TA,1,0 or TA,1,1), the input will be terminated if the control detects a bad programming word (EXAMPLE: O for 0, or double letters (XX1.5), etc.).

The programmer will have to edit the program at the computer or Teletype before inputting the program again.

The control will ignore all errors in the program and continue input by using the error option 2, with the TA command (EXAMPLE: TA,1,2). An error count is given at the end of transmission. If there were errors detected, list the program to find missing line numbers. If the lines are numbered in sequence before transmission of the program, look for the numbers that are out of sequence. After the numbers have been located use the IN command to insert the missing lines.

#### **Number Out of Range**

This message appears when a number of twelve digits or greater is typed in. This error may be detected by the machine after making a calculation. The calculated number may be out of range. Macro calculation less than .0001.

#### **Offset Entry Error**

This message is displayed using the Utility (UT) command, by pressing the MANUAL key when the CNC prompts you for a tool diameter. It is also displayed by entering a diameter value that is too large.

#### **Only Block Skip Allowed With Macro**

The only non macro command allowed with a macro line is the block skip character.

#### **Only M3, M4 & M5 Are Allowed With M6 at N =**

This message appears when the M6 is coded with an M function other than an M3, M4 or M5. The unacceptable M function must be moved to another line.

#### **Only Z, L, R & F Words Allowed**

This message appears when the programmer uses the fixed subroutine L9201 for engraving, and has programmed other words in the line with the L9201 other than Z, L, R, and F.

#### **Orientation Failure**

Visually check the air pressure, it must be between 80 and 90 PSI. If this problem persists call the service department.

**Out of File Space, a File Compression is Being Tried**

This message informs the programmer that the memory of the control is almost full. It usually is displayed when editing the active program in memory, or during program input via the RS-232. This does not destroy any portion of the program. A file compression organizes the memory so that unused portions are made available. The NE command will perform a file compression before prompting you with a (Y or N) to delete the current program. Also, a file compression is performed by deleting the current program using option 5 from the PR menu.

It is always best to retry the command that caused this message to appear. After the compression, the command will often work the second time.

If unwanted programs are stored in the program library, remove them to create more room in memory. If there is only one program in memory, try to reduce the size of the program by removing unnecessary comments and making full use of all modal codes. Create subroutines for repetitive portions of the program wherever possible. The program may have to be broken up into separate operations.

The standard memory capacity is an equivalent of 277 feet of paper tape. FADAL distributors have a memory expansion board available that increases the memory capacity to 1205 feet of paper tape.

**O Word Out of Range**

This occurs using the program input (IN) command when typing an O word greater than 4 digits. O words must be an integer of 1 through 9999.

**Pallet Disabled in Parameters**

This message occurs when a pallet changer command or code is used and the SETP parameters indicate no pallet changer exists on the machine.

**Pallet in Storage**

This message occurs when there is an attempt to store a pallet where a pallet already is stored.

**Pallet Not Fully Stored**

This message occurs when the time to store a pallet exceeds the allotted time. The feedback on the arm may need to be adjusted. Call the service department for assistance.

**Pallet Must Be Clamped**

This message occurs when both pallets are in storage and a command is given to make a pallet change. One of the pallets must be loaded and clamped on the table before a pallet change can occur. The feedbacks for pallet loaded and pallet stored are being read at this time.

**Parameter Error**

After a command is entered and a comma is typed, the control is expecting a parameter. If a parameter is not typed before pressing the ENTER button, this error message appears.

**EXAMPLE:** AU, — This is a parameter error.

**Note:** If the operator is not using a parameter, for instance, the second and third out of a possible four, the parameters can be omitted when the fourth parameter is typed in.

**EXAMPLE:** AU,50,,,1 — This is acceptable.

Also if the DE command is used to delete a line that does not exist, or the CO command is used to copy lines that do not exist, this message appears.

**Parity Error**

This message appears during input through the RS-232 port and is caused by several factors.

- 1) Unshielded cable is used, and the cable is subject to electrical noise.
- 15) The baud rate is too fast for the length of cable used.
- 16) There is a failure in the RS-232 port (hardware problem).
- 17) There may be a problem with the computer that is sending the program.

**Parity Error During DNC**

This occurs during DNC transmission of data. (See the error message PARITY ERROR)

**Please Put an O Word at the First of the Current Program  
The Following Programs Are in Memory**

To use the PR command, the active program must have an O word and a number in the first line. The number must be different than the other numbers in the program library. This is why it lists the other programs in memory.

**EXAMPLE:**        N.1 O43 (P/N 34-765)        Here, a line was inserted  
                      N1 G0 G90 S10000 M3       before N1 using the command: IN,.1

A comment can be added to the line with the O word. These comments help identify the program.

**Points Are on Same Line at N =**

The 3 touch points of L9101 function 1, are on the same line. Check the program for positioning errors.

**Possible Probe Over Travel**

During the UT command, this error occurs for two cases. The first is when the Z axis home position is set below the Cold Start position and the tool change is made to the Probe. The second is when there is a positive offset value used, and the tool change is made to the Probe.

**Position Limit**

This message will occur when the program has instructed the tool to move out beyond the axis limits. When the tool moves beyond the axis limit the CNC issues an emergency stop.

The machine will stop at the line which caused the over travel.

**Press Y to Keep This Position****Press N to Return to Last Position**

These messages appear after jogging while in Slide Hold or Single Step modes. See the Users Manual for the proper application of the Jog Away feature.

**Probe Test = Failure**

Testing the probe by using the Utility (UT) command failed. Verify that the probe was properly interfaced. If an MP8 or MP9 is being tested, be sure the 9 volt battery has a charge. Also remove any obstructions between the probe (transmitter) and the collector unit (receiver).

**Problem Positioning Slides to Zero**

This error only occurs during Cold Start. When the Glass Slides are not aligned close enough to the indicators during Cold Start. Place the machine in Jog and manually align the Cold Start indicators more accurately.

**Program Does Not Exist  
Retry or Hit Manual to Exit**

This happens when the selected program number does not exist in the program library. Enter a program number that does exist, or press the MANUAL button, and then use the PR command again to display the programs that are stored in memory (option 2).

The programmer may have put an O-1 or an O.1 as a program number. The number will show up when the programs are displayed in the library but the control will not be able to retrieve the program. If the operator uses the PU,3 command and presses the EMERGENCY STOP button when the lost program is being displayed on the screen, that program is now active in memory and can be edited. Delete the bad O word, from O-1 or O.1 (which appears as 1000 when it is listed in PR) to O1.

**Program Not Found**

This message is displayed when the PA command is used to display the active program, and no program is active. Use the PR command to activate the desired program stored in memory.

**Program Block Not Found**

This message is displayed when the LI command is used to list selected blocks of the active program, and the selected blocks are not found or the program is not active. View the program by using the PA command.

**P Word Too Large**

The P word for referencing a line number using M99 is too large of a value. Line numbers can not exceed 99,999.

**Reset the Emergency Stop Switch**

The EMERGENCY STOP button has been pushed. Turn the button clockwise until it is released and then push JOG.

**Resolver Fault or Scale Error**

This message may occur in three cases as follows:

- 1) A failure of the resolver.
- 18) An axis runaway during power on.
- 19) A large Scale or Motor error, indicating a possible scale failure.

**IMPORTANT**

Report this to the service department when this message appears. Do not run the machine when this message appears.



**Rails Not Aligned**

This message occurs when the rails for the pallet changer are not aligned or the feedback switches need adjustment. Call service department for adjustment.

**Return Pallet to the Load Position**

This message occurs when a pallet change is attempted and the other pallet is away from the load position. The operator must slide the pallet into the load position before the other pallet on the table can be changed. The feedback from the pallet loaded and pallet stored are being read at this time.

**Rotary Axis Move Too Long. N =**

The maximum incremental rotary move for one block is 1080.00 degrees. If it is necessary to go further, break up the move into several blocks.

**RS-232 Error During DNC**

This error only occurs during DNC operations. It may occur while using 9600 baud to DNC. Slow the baud rate.

It may also indicate line noise or the possibility of dropped characters. These would indicate a possible problem with the RS-232 cable or the communications port. Check the cable and communications port and retry DNC.

A failure of the CPU may cause this error also. If the above corrections are unsuccessful, contact the maintenance department.

**Scale Error**

A scale error has been detected. The LEDs in the scale interface box in the back of the machine will indicate which axis gave the error. Call the service department.

**See Menu for New CD Format**

The CD command is different for some versions of software. See the menu for these changes.

**Sequence Number Too Large**

This occurs using the Program Input (IN) command when the 'From' parameter is specified greater than the maximum allowable number. Sequence numbers can not exceed 99,999.

**Sequence Number Too Small**

This occurs using the Program Input (IN) command when the 'From' parameter is less than the minimum allowable number. Sequence numbers can not be less than .001.

**Servo Amplifier Fault**

This message appears when the EMERGENCY STOP button is pressed. The operator must pull the button out (for '85 and older models) or turn it clockwise (for '86 to present models) and then press the JOG button to reset the amplifiers. If the amplifiers do not reset, call the service department.

**Single Step**

This message identifies the control is in the Single Step mode. Should the green START button be pressed when in this mode, the following program block is executed.

The feed rate potentiometer affects all axis motion.

At the end of each block, the operator can press the JOG button and jog away from the current position without aborting the operation. Program execution can be continued at the new location, or the axes can be returned to the position at which the Jog function was initiated.

To exit single step, press the AUTO button for continuous block execution.

**Slide Hold**

Pressing the SLIDE HOLD button stops all axis motion. The distance to finish the move is presented under the blinking SLIDE HOLD message.

It is possible to press the JOG button and jog away from the current position while in the Slide Hold mode without aborting the operation. Program execution can be continued at the new location, or the axes can be returned to the position at which the Jog function was initiated.

To exit from the Slide Hold mode, the operator must press the START button, if in single step, or press the AUTO button for continuous block execution.

**Spindle Controller Does Not Respond**

Please note error number and see list at the end of this chapter. This simply could be a problem that occurs when the operator is powering on the machine. Turn the machine's main power off. Press the motor overload relay button, and then power on again. If this does not help call the service department with the error message and number.

The motor overload relays can be recognized by their white reset buttons. They are located in both control enclosures. The white button must be pressed to reset a relay. Call service department first.

**Spindle Controller or Driver Fault**

Please note error number and see list of Emergency Stop Error Messages at the end of this chapter. This message is displayed if the spindle was commanded to turn on after an emergency stop without pressing the JOG button to reset the amplifiers.

If this message appears when not in the Emergency Stop mode, please take these steps to help the service department analyze the problem:

- 1) Look at the air pressure gauge and write down the current air pressure (do not change it at the machine!)
- 20) Check to see if the belts are on the pulleys.
- 21) Do not turn the power off.
- 22) Call the service department and report this problem (while the machine is on).

**Spindle Controller Software Update is Required**

The current software module (1610) detected spindle software that was not compatible. Call the service department.

**Spindle Driver Fault**

This is the result of the air pressure being too low while the spindle is on. Air pressure should be set between 80 and 90 PSI. Visually check the air pressure and start the program over again. If the air pressure is not the problem, power off the machine and check the motor overload relays to see if they have been tripped.

The motor overload relays can be recognized by their white reset buttons. They are located in both control enclosures. The white button must be pressed to reset a relay.

**Spindle Failure While Tapping**

If the spindle stops while in G74, G75 or G84 modes, this message will appear. Problems such as a dull tap, undersized hole, poor tapping lubricant or a shallow hole must be eliminated. The programmer may want to consider thread milling as an alternative to tapping. Call the service department if this is persistent.

**Spindle Failure During Reversal**

This will occur when an M3 and an M4 are in the same line. If the spindle stops while in G74, G75 or G84 modes, this message will appear. Problems such as a dull tap, undersized hole, poor tapping lubricant or a shallow hole must be eliminated. The programmer may want to consider thread milling as an alternative to tapping. Call the service department if this is persistent.

**Spindle Has Failed to Turn On**

Either the Hall Effect Switch on top of the spindle pulley has not recognized that the spindle is turning, or the spindle actually has not turned on and there is another problem. Call the service department.

**Spindle Fault Line**

The spindle inverter has detected a fault. See the fault number on the inverter and report this to the service department.

**Spindle Motor Temperature Fault**

Check to see if the spindle fan is on. If it is not, turn machine's main power off and check the fuse for the spindle fan (F24). Allow time for the spindle motor to cool down and attempt to run the machine again. If this message persists, call the service department.

**Spindle Would Not Stop**

The spindle would not stop in the designated amount of time (12 seconds). If this message is persistent, call the service department.

**Stack Overflow**

This message should be reported to the service department. It is caused by excessive stacking of keyboard commands.

**Subr. Does Not Exist**

This message indicates that a subroutine was called that is not in the subroutine section of the program. Check to make sure that the subroutines were numbered properly.

This message also appears if the G66 code is used on a line that does not have a subroutine call on it.

**Subr. Nesting Error**

This is a message that occurs when a subroutine heading (L0100) is entered after the M30 code. This message will also occur if a Fixed Cycle is still active (use a G80 to cancel) or G68 (rotation) is still active when a tool change or end of program is coded (use a G69 to cancel).

**EXAMPLE:**

N20 M17  
N21 M30  
N22 L200

This is not permitted after an M30.

**Tape Input Terminated**

This message reports to the operator that the tape or program input process is complete.

**Tape is Good**

When verifying a punched tape, this message appears if the tape is accepted.

This message also appears if no errors are detected in transmission when the TA command is used.

**Temperature Fault**

For any temperature fault, the operator must check the cooling fans; if they are not operational, turn the machine's main power off and check the fan fuses (F23, F24, F27, and F28).

If this message is persistent, call the service department.

**Temporary Conflict With Auto**

This message occurs when background editing is being used. The edit just made is in the area where auto is currently executing from. The change will be made when auto is out of that area.

**The Axis Controller is Not a 1010-4**

(See Survey in the Axis Drive Systems Section)

**The Survey Contains Errors, Please Review**

(See Survey in the Axis Drive Systems Section)

**The Survey Was Not Written to the Axis Controller**

(See Survey in the Axis Drive Systems Section)

**There is No Survey**

(See Survey in the Axis Drive Systems Section)

**Thread Lead Not Specified at N =**

Fixed cycles G74, G75 and G84 need a Q word in the line that represents the decimal thread lead of the tap (see the Users Manual for the proper format). If the Q word is omitted this message will appear.

If the programmer uses the fixed cycles G74, G75 or G84 and does not cancel the cycle with any of the following codes: M6, G28, G29, G49, G80, H0, this message will appear at the next Z move.

**Too Many Blocks For Gap**

This happens when the CO (copy) command is used and there are too many lines being copied between existing lines in the program.

Use the NU (renumber) command and copy again, now that the program is renumbered.

**Too Many M Functions at N =**

This error occurs when another M function is coded with the M17 or M30. These two codes must be the only M function on the line.

**Too Many Consecutive Non Motion Blocks**

This error message appears if a program contains over sixteen consecutive comment blocks (with no program coding in the lines).

A solution to this is to put coding between the comment lines or put comments on lines with program coding. This way the program can have comments on every line.

Comment blocks in the beginning of the program can be placed in an unused subroutine. This way the control never reads the lines when executing the program, but the operator can list the program and read the comment lines.

**Too Many Parameters**

Commands have associated with them a certain number of parameters. If more parameters are typed in than allowed, this message appears.

**EXAMPLE:** AU,50,,,1, or AU,50,,,3,1

Refer to the Users Manual, or the Menu (MU) on the control for the correct format of each command.

**Too Many Subr. Calls**

Nesting can only be seven deep. If the program goes further than seven deep, this message appears.

**Tool Breakage Detection = Failure at N =**

When the TS-20 touch probe is used for tool breakage detection, this error indicates the program line that the broken tool is detected at. Replace the tool and continue the program.

**Tool Diameter Too Large at N =**

This is displayed in cutter radius compensation when the programmed move is smaller than the radius of the cutter.

- 1) Check the tool diameter entered in the tool table to see if it was entered correctly.
- 23) Check the program to see if it contains any typographical errors.
- 24) If the intention was to make a rough pass using a larger tool diameter than the finish pass tool diameter, the smallest programmed inside radius, on the part, should be as big as the tool radius (half the tool diameter) entered for the roughing pass.
- 25) Check the math work to see if it is correct, and was transferred correctly to the program.

When debugging a program that uses cutter radius compensation use a zero diameter in the tool table when running the program or when using the SUM command for the first time. Then put the tool diameter in the tool table and try it again. This will make the debugging process easier.

**Tool Offset Not Allowed During Z Mirror**

If mirroring the Z axis is desired, first call up the tool length offset, then code the G51.1 Z0. The H word must be on a line in the program before the G51.1 Z0.

**Tool NN is in the Spindle**

Identifies the current tool that is in the spindle. This is displayed when entering the program execution (AU) and the Manual Data Input (MD) modes, and is also listed in the tool table display (DT).

**Tool Number Too High**

The starting tool number of the utility (UT) tool setting cycle must not exceed that of the tool changer capacity.

**Tool Turret Location is Not Set**

Rotate the tool turret so that tool #1 is adjacent to the spindle and then type SETTO.

**Transfer Error, Please Retry**

(See Survey command in Maintenance Manual)

**Trouble Reading the External Slide Hold Switch**

The feedback from the external slide hold switches is erratic or inconsistent. This is an indication that the external slide hold switch system is faulty. Call the service department.

**Type A Y To Ignore, Or Turn Power Off And Then On Again**

This error message appears only after the message AXIS CONTROLLER DOES NOT RESPOND DURING POWER UP SEQUENCE.

This is an indication that there is a communication problem between the CPU and the axis controller. Call the service department.

**Undefined Macro Error**

This message will appear when situations during a macro execution cause the system to fail, but there is no specific error or message associated to the situation.

**Wait 2 Sec., The Axis Drivers Are Being Reset**

This message occurs when the JOG key is pressed after an axis fault. The control returns to the Command mode after 2 seconds. The axis drivers are reset and the machine can continue normal operation.

**Waiting**

In the Waiting mode, the operator has the choice of pressing either the START or AUTO button to execute automatic motion. Or, the operator can press the MANUAL button to exit to the Command mode.

**Waiting On Air Valve**

When this occurs, the control is waiting on a signal from one of the air valves indicating that the valve has completed its job - usually air pressure to the machine has dropped below 80 PSI.

If this message persists, call the service department.

**Warning Possible Gouge at N =**

Generally caused by math errors in the program. The CNC has processed a move that possibly could cause the cutting tool to damage the part. The error usually is not large enough to make any noticeable difference on the machined part. Therefore, only a warning is displayed. If there is a noticeable difference, review your program math.

**Way Lube Pressure Switch Failure**

Check the way lube oil level if this message appears.



**Writing Error, Wait 2 Min. and Retry**

(See Survey in the Axis Drive Systems Section.)

**X, Y, or Z Move Must Be Specified at N =**

Probe function #1 (L9101) has been programmed without an axis specified for the given plane. For example, if probing is to be used in the XY plane (G17), X and/or Y must be programmed in the same block as L9101 R1+1. Z can be used if in the ZX (G18) or YZ (G19) plane.

**You Cannot Delete the Program That is Currently Active**

To delete a program in memory, it must be in the library. Use the PR command and switch the program currently in memory with a program in the library. The program can then be deleted. If there are not any programs in the library, use option 3 to start a new program. This will put the currently active program in the library and the program can then be deleted.

Or just simply use the DE command and delete starting from the first block in the program to the last.

**You Have a Version Upgrade or Memory Has Been Corrupted  
Memory Needs to Be Zeroed**

This occurs when the control detects that a new module has been inserted. See the Maintenance Manual for proper zeroing procedures. This may also occur because of a memory error and the memory needs zeroing.

**You Must Enter the Backlash Table**

The CNC does not have a valid backlash table. Enter the backlash for each axis by using the BL command. The backlash set at the factory is documented on the inside surface of the pendant door.

The backlash information is retained by the battery backed memory card. If this message appears again, after the BL command has been used, call the service department.

**Your Version of CNCMAIN Needs to Be Updated**

The control has detected an incompatibility with the CNC memory manager software on the 32MP pendant. Call the service department for an update.

**Z, Q, or F Missing in Canned Cycle Call, N =**

See the Users Manual in the fixed cycle section for the proper format for each fixed cycle.

**Z & M6 Lockout is in Effect**

This message indicates the Z axis and Tool Change Lockout option of the Run Time Menu has been selected. In this mode, Z axis movement and tool change commands will not be performed during Dry Run. This option can be selected or canceled by using the Run Time Menu.

**Z Axis Must Be at Cold Start for TC,1**

Check to see if the Z axis alignment was properly set at cold start. The operator cannot use the TC,1 command unless the Z axis is at the Z axis CS position. Use the HO command or jog the axis to the Cold Start (Z0).

If the SETZ command has been used, first use the HO command to bring all axes home, then enter the SETCS command. Jog the Z axis to Z0 and then use the command SETH so the X and Y home position is not lost. The TC,1 command can now be used to open the tool changer. If necessary return the Z axis to the previous setting and use the SETZ command.

(See the error message JOG AXES TO HOME POSITIONS if the tool changer crashes).

---

**Emergency Error Codes**

Error numbers help discern the location of the problem the axis or spindle is reporting. The error number will follow a message to call the service department and report the error number on the screen to correct the problem.

**Error Numbers From the Axis or Spindle Controller****[ 1 ] NO MOTOR FEEDBACK**

This error appears during power up, when no motor feedback (either resolver or encoder) is detected by the axis controller.

**[ 2 ] ENCODER NOT RESPONDING**

This error appears during the rigid tap operation. If the encoder feedback is interrupted during the spindle operation then the spindle operation is halted.

**[ 3 ] LOGIC JUMPER INCORRECT OR COMMAND SIGNAL MISSING OR MOTOR-TACH CONNECTION INCORRECT**

This error appears during power up. An incorrect motor—tach—jumper configuration or failed component may cause the axis to run away in the opposite direction of the command signal. Axis operation is halted.

**[ 4 ] ENCODER IS NOT 1024 LINE**

This error appears during power up, and only applies to axes with encoder(1024 line) as motor feedback. The axis controller will count the encoder lines in one revolution of the screw and compare it to the expected count of 1024

**[ 5 ] NO INDEX MARK DETECTED**

This error appears during the cold start process, if the index mark of the axis primary feedback device, encoder or scale, is not detected.

**[ 6 ] SWITCH 1 DISABLED**

Currently not used.

**[ 7 ] RIGID TAP PRECYCLE ENCODER COUNT PROBLEM**

This error appears during the rigid tap precycle process, when the spindle feedback is not within tolerance.

**[ 8 ] SPINDLE MAGNET NOT DETECTED OR SPINDLE NOT TURNING**

This error appears during spindle operation if the spindle magnet is not detected for any period longer than 3 seconds.

**[ 9 ] SPINDLE FAULT LINE DOWN**

This error appears any time the axis card no longer detects the fault line signal from the inverter, or the signal strength has dropped below 10V, indicating a possible inverter fault.

**[ 10 ] ENCODER AND MAGNET NOT RESPONDING OR SPINDLE NOT TURNING**

This error appears during spindle operation if both the encoder feedback and the spindle magnet are not detected for any period longer than 3 seconds.

**[ 11 ] FOLLOWING ERROR CANNOT BE SCALED FOR COMMAND SIGNAL**

This error appears when the signal strength of the following error, after scaling, exceeds the maximum allowable command signal.

**[ 12 ] MOTOR OVERLOAD — STEP COMMAND CHECKSUM ERROR**

This error appears at the completion of a move, when the actual move by the axis controller is not equal to the move commanded by the CPU.

**[ 13 ] MOTOR OVERLOAD — FOLLOWING ERROR > OVERLOAD FACTOR**

This error appears when the following error exceeds the overload factor, which is a user-defined parameter that sets, in motor turns, the maximum allowable following error for the axis operation.

**[ 14 ] MOVE TRANSFER FAULT — BUFFER INDICATOR NOT SET**

This error appears prior to executing the first step command of a move command, if the flag indicating completion of the move transfer process is not set.

**[ 15 ] TIME OUT ERROR — RIGID TAP PRECYCLE TEST**

This error appears during the rigid tap precycle process, if the spindle rotation is interrupted or the spindle magnet is not detected within the allowable time.

**[ 16 ] TIME OUT ERROR — RESOLVER RESPONSE**

This error appears any time the resolver “zero-crossing” pulse is not detected within the allowable time (4-10 milliseconds). This pulse is hardware-generated every 1 millisecond.

**[ 17 ] BAD READING ON RESOLVER PORT**

This error appears if the value of resolver “counts”, read from the resolver port when the “zero-crossing” pulse is detected, is too large, indicating possible failure of the resolver cables, 1010-4 card, or the resolver itself. Also caused by severe motor vibrations.

**[ 18 ] AMPLIFIER FAULT LINE DOWN**

This error appears any time the axis card no longer detects the fault line signal from the amplifier, or the signal strength has dropped below 10V, at least 5V indicating a possible amplifier fault.

**[ 19 ] STACK OVERFLOW — OVERLOADED WITH STEP COMMAND**

This error appears if the stack on the axis card, used to store CPU commands until they have been serviced, overflows.

**[ 20 ] MOVE TRANSFER FAULT — MOVE SETUP INCOMPLETE**

This error appears when an axis move command is not properly transferred to the axis card, as indicated by a checksum comparison between what the CPU sent and what the axis card received.

**[ 21 ] UNEXPECTED INTERRUPT**

This error appears if the interrupt currently being processed is not an expected interrupt, and therefore cannot be serviced, indicating possible failure of the 1010-4, 1030, or main CPU.

**[ 22 ] BAD SCALE READING**

This error appears if the feedback from the scale port is outside allowable limits, indicating possible failure of the EXE box, scales, cables, or 1010-4 card. Also caused by severe motor vibrations.

**[ 23 ] MOTOR OVERLOAD DURING STAND-BY MODE**

**SEE ERROR CODE 13 ABOVE**

**[ 24 ] MOTOR OVERLOAD DURING RAPID MODE**

**SEE ERROR CODE 13 ABOVE**

**[ 25 ] MOTOR OVERLOAD DURING CONTOURING MODE  
SEE ERROR CODE 13 ABOVE**

**[ 26 ] MOTOR OVERLOAD DURING JOG MODE  
SEE ERROR CODE 13 ABOVE**

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**Troubleshooting  
Checklist RS-232  
Communications**

**If no  
communications  
occur:**

Use this procedure to determine which device or cable is not functioning properly. At the end of each step check to see if communications are possible.

1. If a switch box is used, determine that the switch is in the proper position.
  - Turn the switch handle back and forth a few times. Sometimes the connections are corroded and turning the handle will TEMPORARILY correct the problem.
2. Check to see if all cable connections are firmly connected.
  - Loose cable connections are the MOST COMMON cause of communications failures.
3. Check to see that the phone modem cable on the inside of the control cabinet is disconnected from the back of the phone modem in the modem sleeve. Some machines do not have a phone modem in the sleeve.
  - The phone modem WILL interfere with communications through the RS-232 port.
4. The machine must be properly grounded. Follow the grounding instructions on the green label inside the main disconnect box to confirm the grounding connections.
5. Check to see if the communication parameter settings in the software of the computer are set properly.
  - a. Baud rate - This is variable, depending on the default setting at the machine established in SETP or with a CD,# command
    - Sometimes a computer can communicate at the lower baud rates (600 or 1200) and not at the higher baud rates (2400 - 9600). The customer should try a lower baud rate as a temporary solution.
  - b. Parity - Even

- c. Data Bits - Seven
  - d. Stop Bits - One
  - e. EOB (End Of Byte) - CR,LF (ASCII 13,10)
  - f. Starting and ending character - % (ASCII 37)
  - g. Xon/Xoff (Software handshaking) - disabled for TA or PU, enabled for DNC
  - h. Hardware handshaking - disabled
  - i. The IO port number (RS-232 or serial port) on the computer must be identified (i.e.,COM 1, COM2, COM3 or COM4).
6. Determine that the IO port on the machine is functioning properly. Exercise the port by putting a mirror plug in the port and sending a character out. which should then be received back again.
- The mirror plug, found in the control cabinet of the machine, is a DB-25 plug with pins 2 and 3 crossed, and is usually shipped with the machine. or can be ordered from our parts department.
- a. Put the mirror plug in the RS-232 port of the machine.
  - b. Move to the cold start position and go into the diagnostics mode.
  - c. From the command mode type DI then press the enter button. Then type GO 3000 (G zero, space, three thousand) then press the enter button. A menu will appear, then select number four by pressing the 4 button. A second selection will appear. Select the baud rate that is desired for the test by pressing one of the numbers.
  - d. Numbers next to the word TESTING should be changing constantly.
  - e. The numbers at the end of the other sentences should all be zero. If any numbers appear at the end of these sentences an error on the IO port has occurred and indicates a problem with the port.
  - If this test fails the S100 board is bad or the cable on the inside of the control cabinet is faulty or it is not plugged in properly. Change the S100 board and cable if needed. Note: It is our experience that the S100 board and inside cable rarely need to be changed.
  - f. This test can be repeated with each section of cable plugged into the machine leading up to the computer. This will test the integrity

of each section. A gender changer may be needed to plug in the mirror plug in some sections.

- If a switch box is used in the chain of cables, it must be checked also. Check it in the same manner that the cables were checked.
- 7) After thoroughly checking the machine and the cables it can be safely concluded that something in the computer is at fault.
- Introducing another computer into the line of communication is a quick way to determine if the computer in question is faulty.
    - a. A mouse or network board, screen savers, and other software running concurrently in the host computer, may interfere with communications. Check the IRQ and DMA settings in the computer for conflicts with the values assigned to the IO port.
    - b. The output voltage of the IO board across pins 7 and 12; when transmitting a program, should be between 10 and 12 VAC.
    - c. The file being sent may have something wrong with it. Incorrect syntax in a line of code may interrupt transmission.

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**Troubleshooting Charts**

Chart 1	Quick Checkout
Chart 2	Automatic Tool Changer
Chart 3	Spindle Driver
Chart 4	Axis Control
Chart 5	Repeatability
Chart 6	Computer
Chart 7	Axis Motor Runaways
Chart 8	Baldor SWE0 Spindle Drive
Chart 9	Z200/Z300 Spindle Drive
Chart 10	Keyboard
Chart 11	Finish Problems
Chart 12	Bad Power / Bad Voltage
Chart 13	Rotary Heads A Axis
Chart 14	FADAL TR65 Rotary Heads A & B Axis
Chart 15	Tsudakoma 301 Rotary Heads A & B Axis
Chart 16	Servo Coolant Control
Chart 17	Circle Roundness
Chart 18	Error Codes Reported by Axis Card
Chart 19	Serial Port Communications
Chart 20	FADAL Servo Indexer
Chart 21	Positioning Problems
Chart 22	Scale Problems
Chart 23	Rigid Tap
Chart 24	M-Function



### CHART 1 QUICK CHECKOUT PROCEDURE

9-20-95

DASHED SYMBOLS  
APPLY TO CE NORM  
EUROPEAN MACHINES  
ONLY

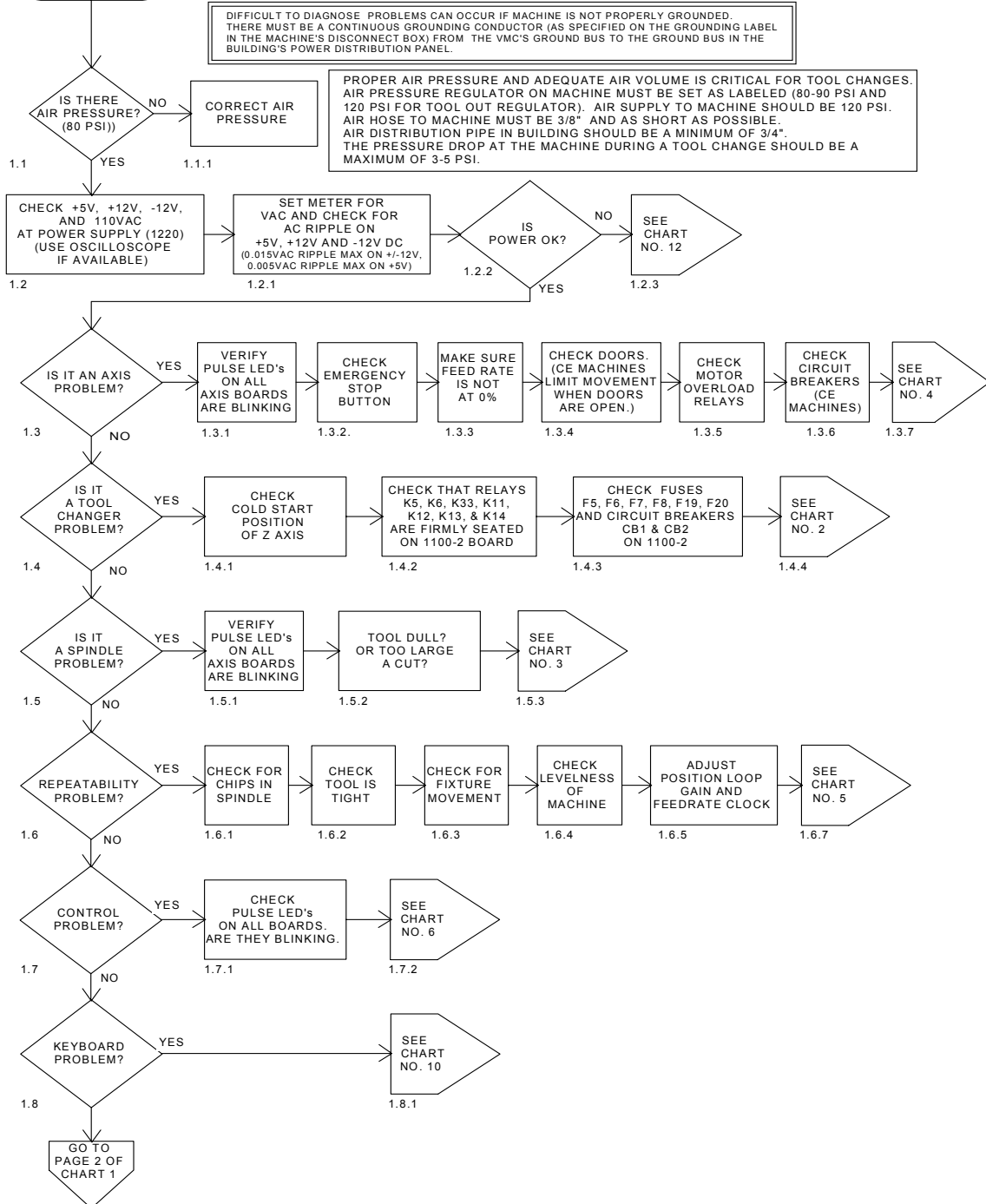
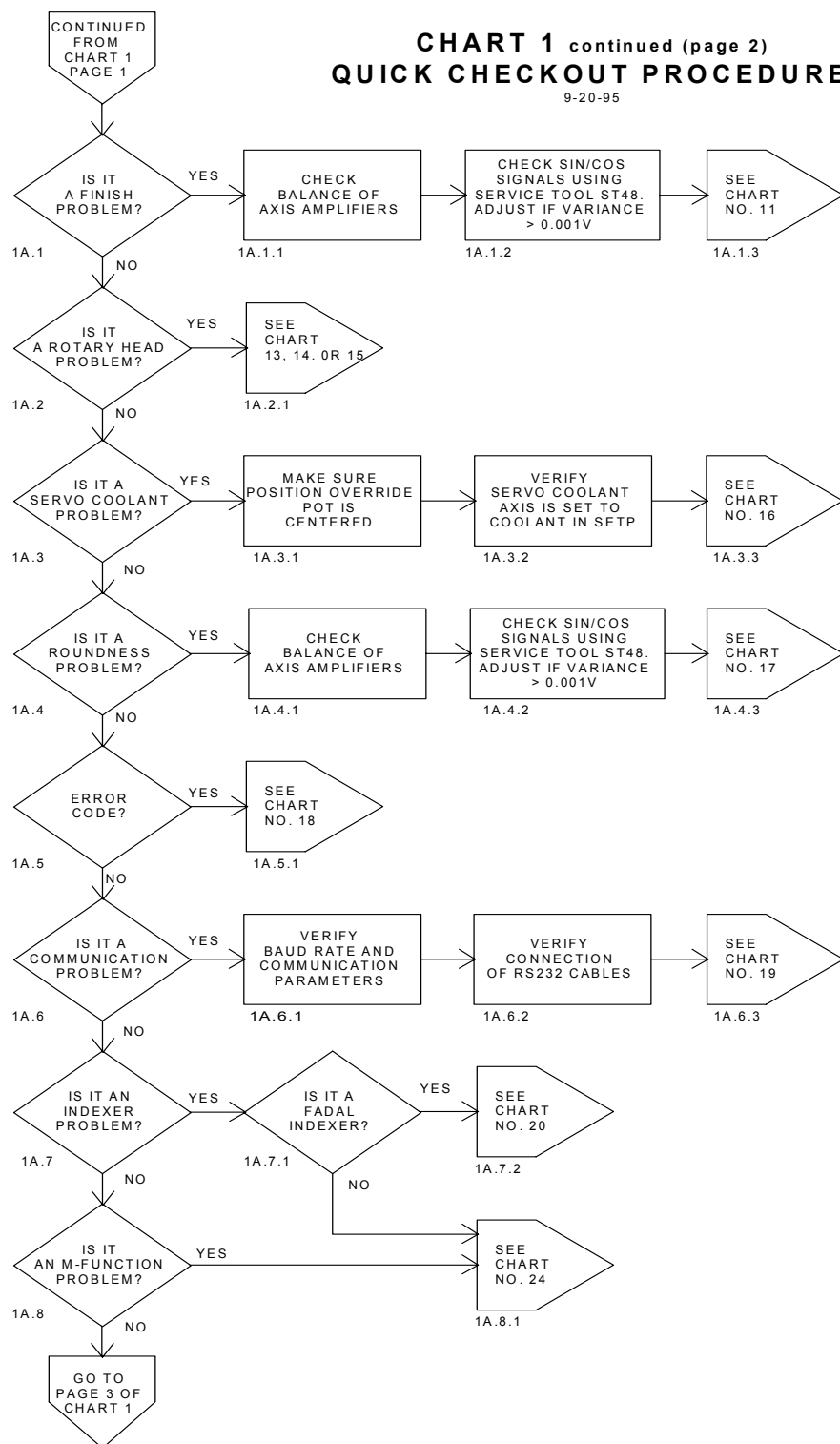
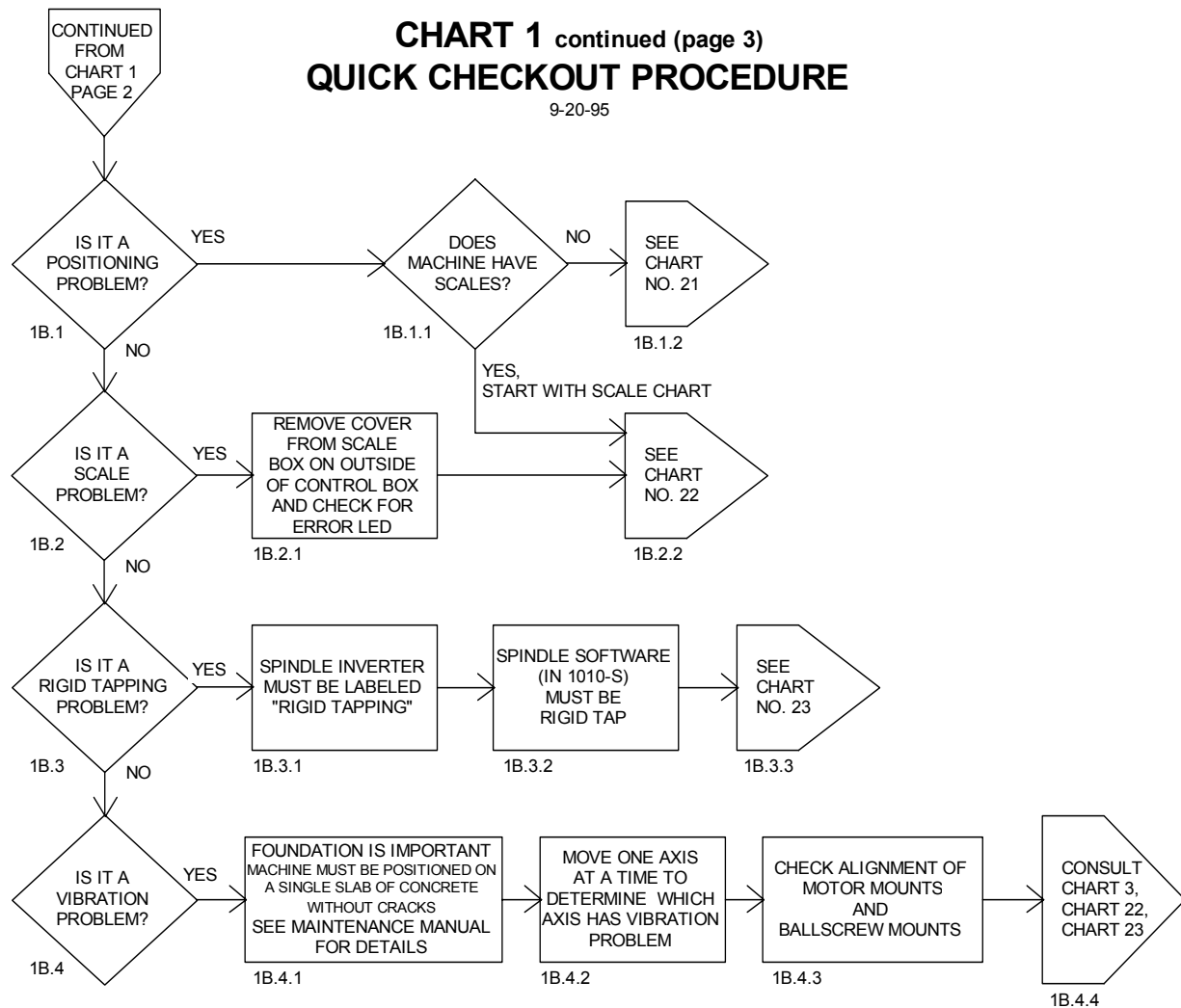


Figure 16-1 Quick Checkout Procedure



**Figure 16-2** Quick Checkout Procedure (Continued)



*Figure 16-3* Quick Checkout Procedure (Continued)

**CHART 2**  
**AUTOMATIC TOOL CHANGER**

10-18-95

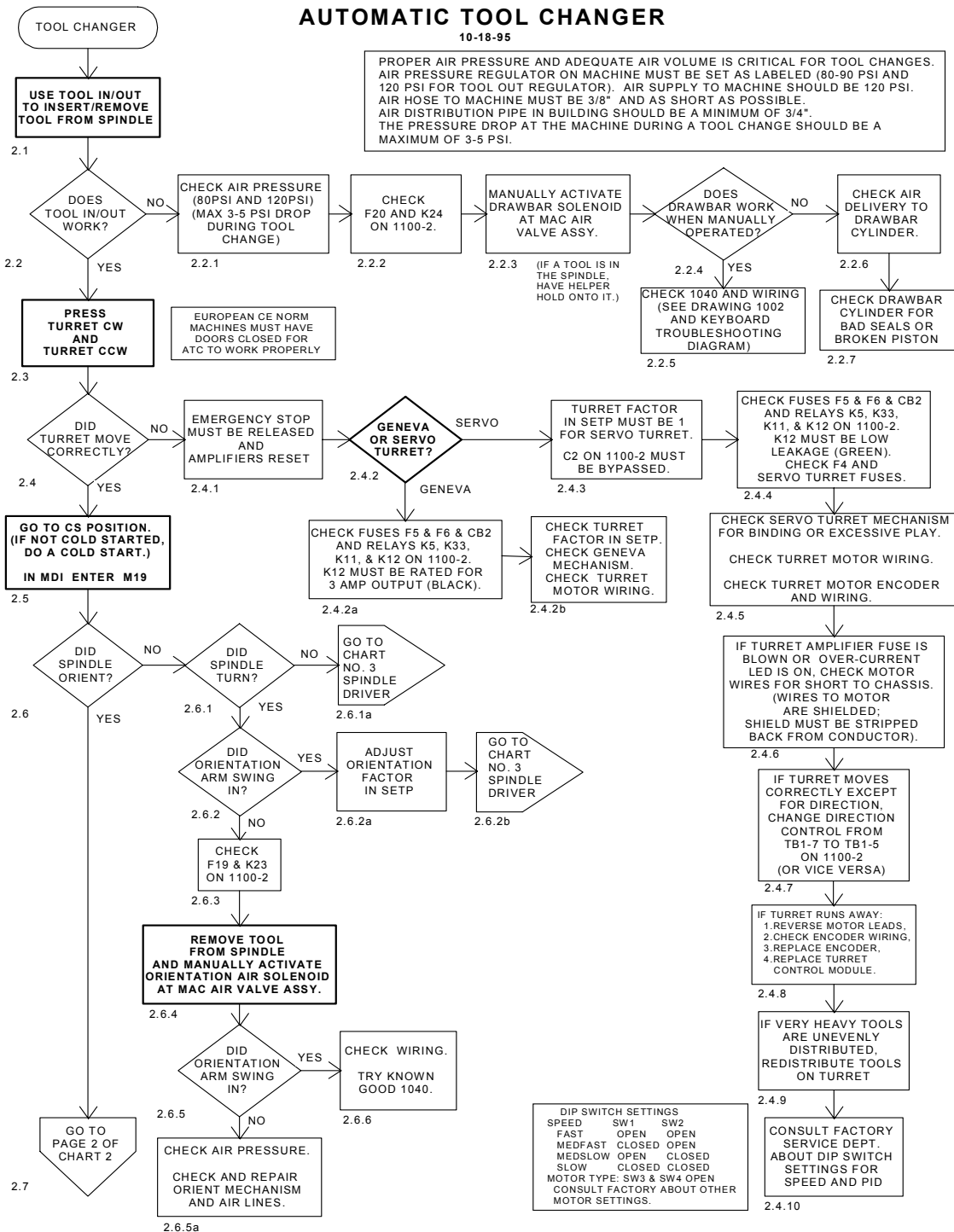
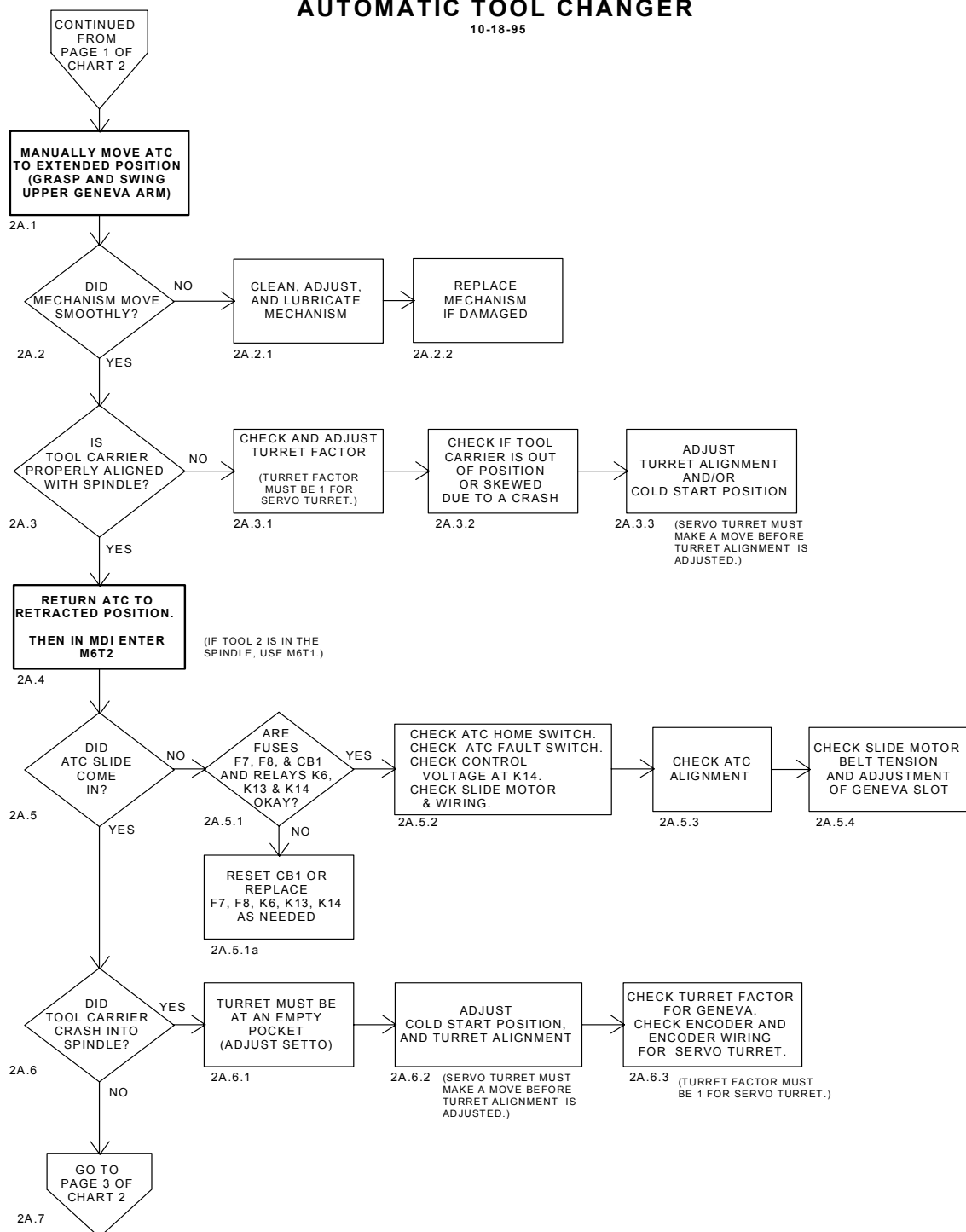


Figure 16-4 Automatic Tool Changer

**CHART 2** continued (page 2)  
**AUTOMATIC TOOL CHANGER**  
 10-18-95



*Figure 16-5 Automatic Tool Changer (Continued)*

### CHART 2 continued (page 3) AUTOMATIC TOOL CHANGER

10-18-95

PROPER AIR PRESSURE AND ADEQUATE AIR VOLUME IS CRITICAL FOR TOOL CHANGES. AIR PRESSURE REGULATOR ON MACHINE MUST BE SET AS LABELED (80-90 PSI AND 120 PSI FOR TOOL OUT REGULATOR). AIR SUPPLY TO MACHINE SHOULD BE 120 PSI. AIR HOSE TO MACHINE MUST BE 3/8" AND AS SHORT AS POSSIBLE. AIR DISTRIBUTION PIPE IN BUILDING SHOULD BE A MINIMUM OF 3/4". THE PRESSURE DROP AT THE MACHINE DURING A TOOL CHANGE SHOULD BE A MAXIMUM OF 3-5 PSI.

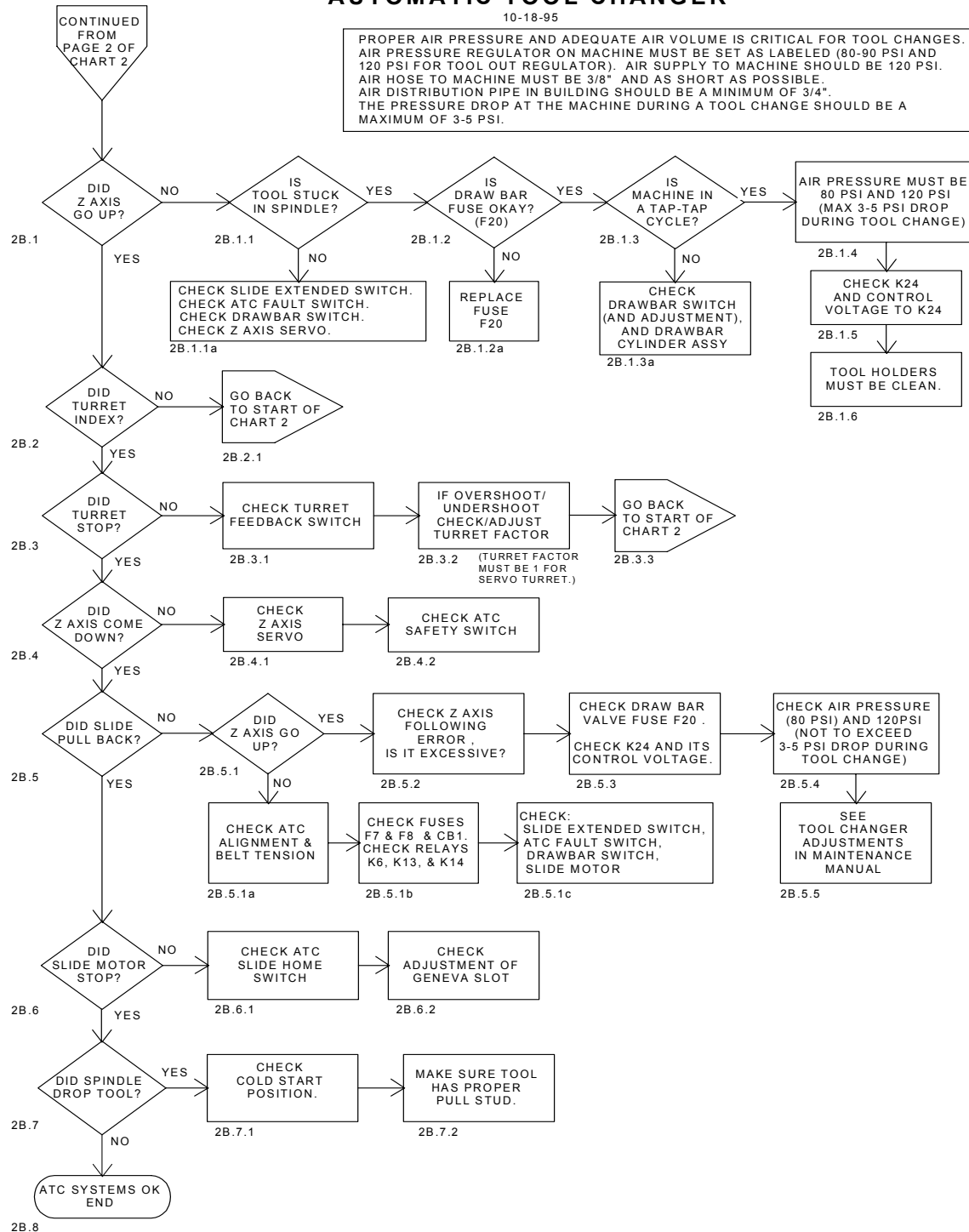


Figure 16-6 Automatic Tool Changer (Continued)

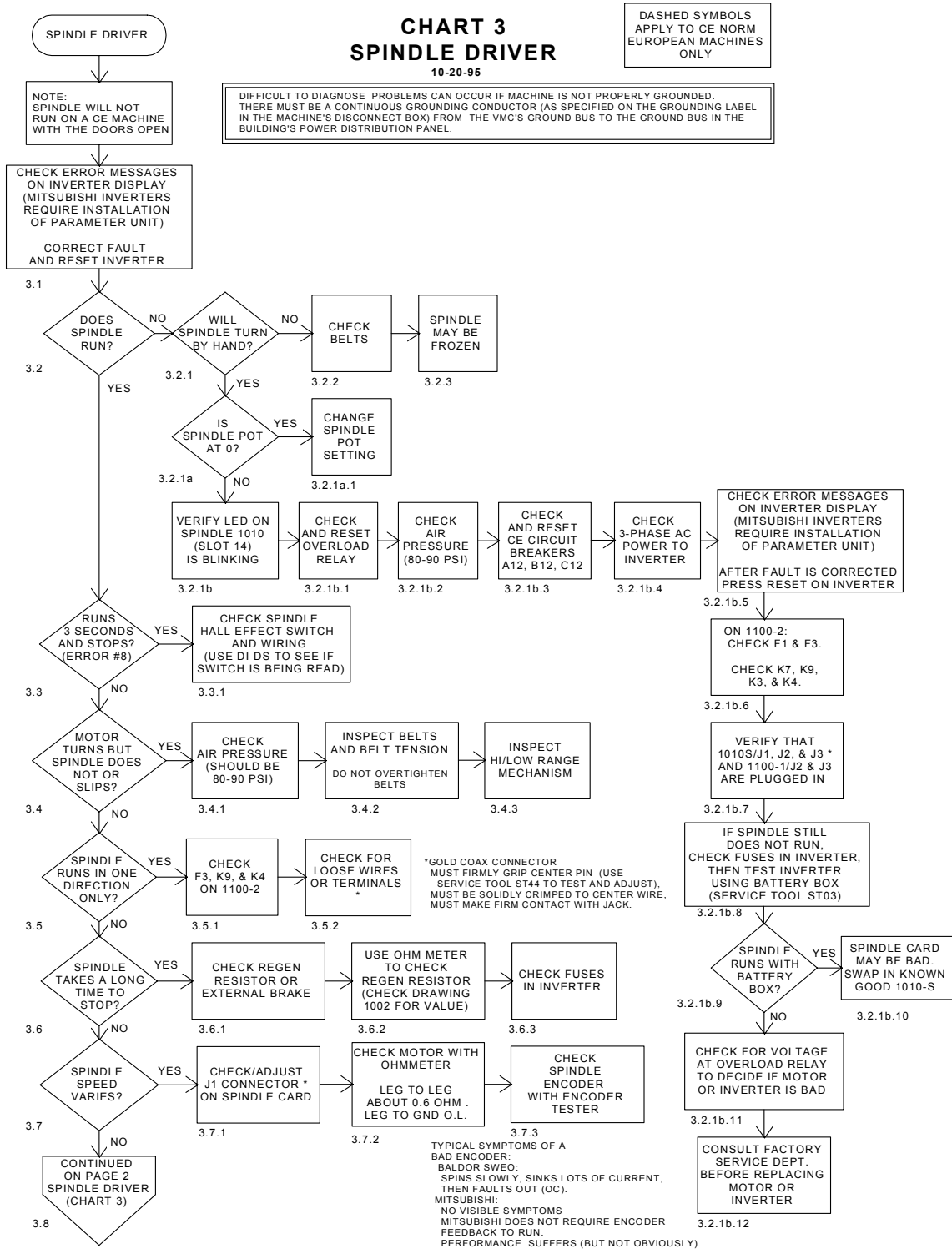
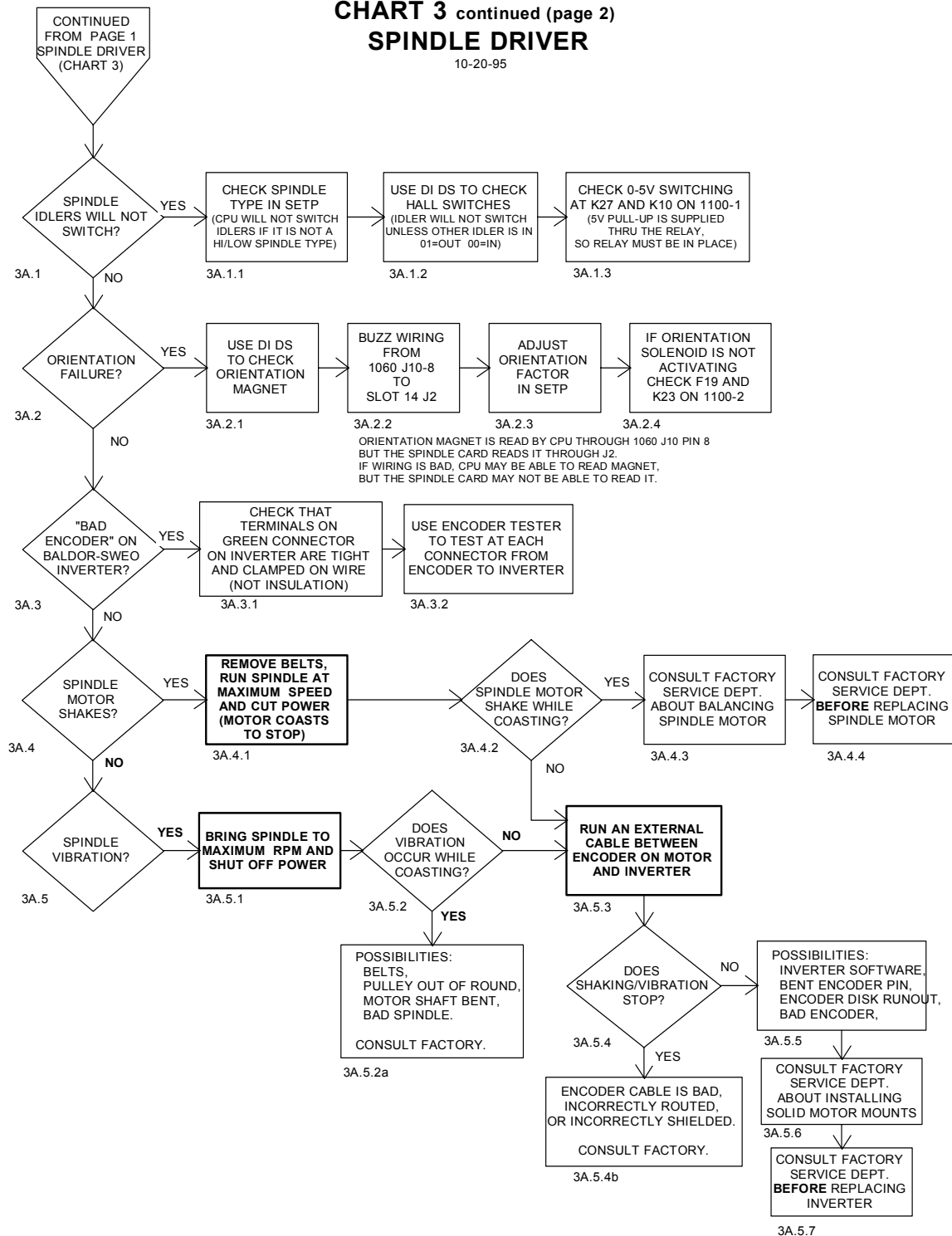


Figure 16-7 Spindle Driver

**CHART 3 continued (page 2)**  
**SPINDLE DRIVER**

10-20-95



*Figure 16-8* Spindle Driver (Continued)



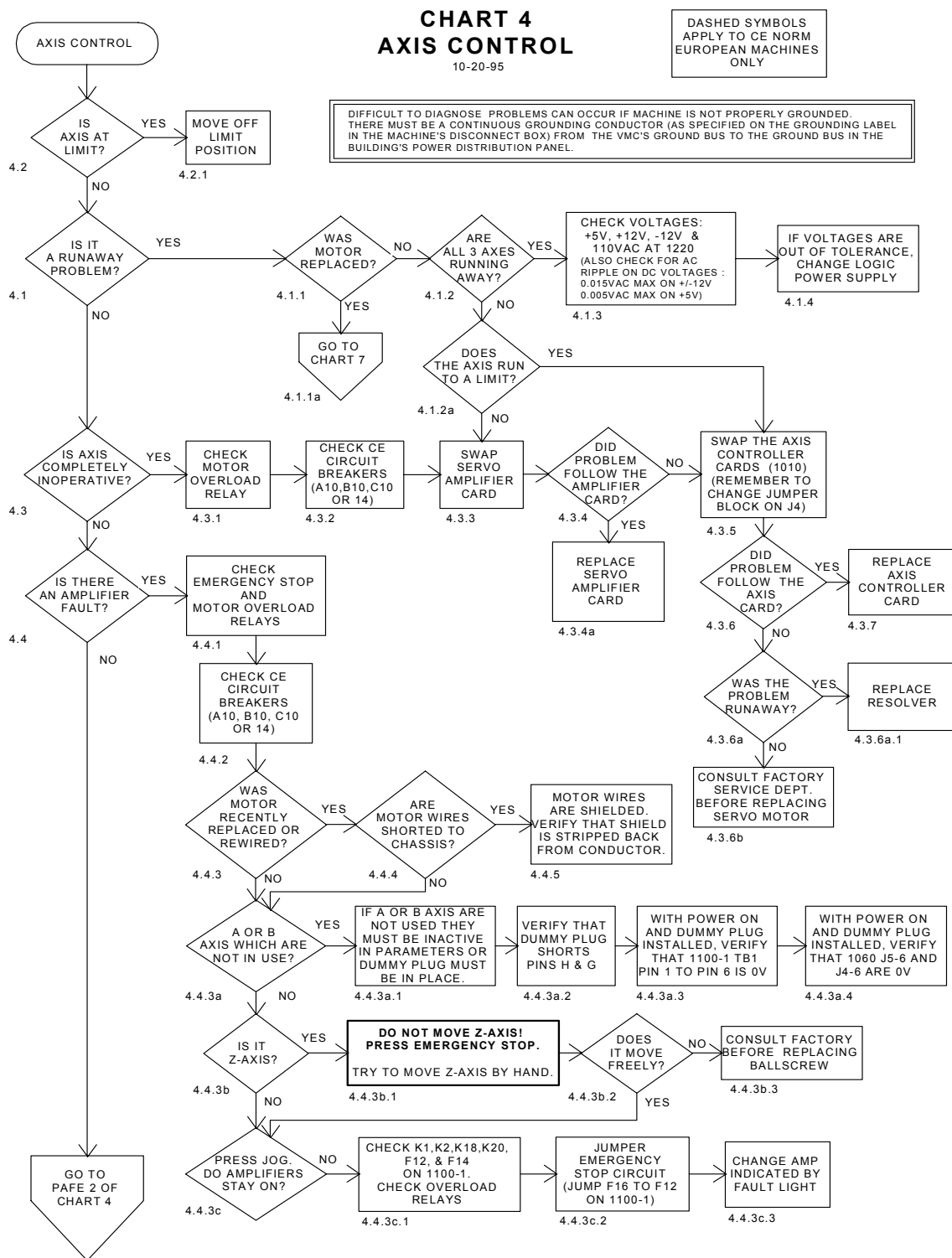


Figure 16-9 Axis Control

CHART 4 continued (page 2)

## AXIS CONTROL

10-20-95

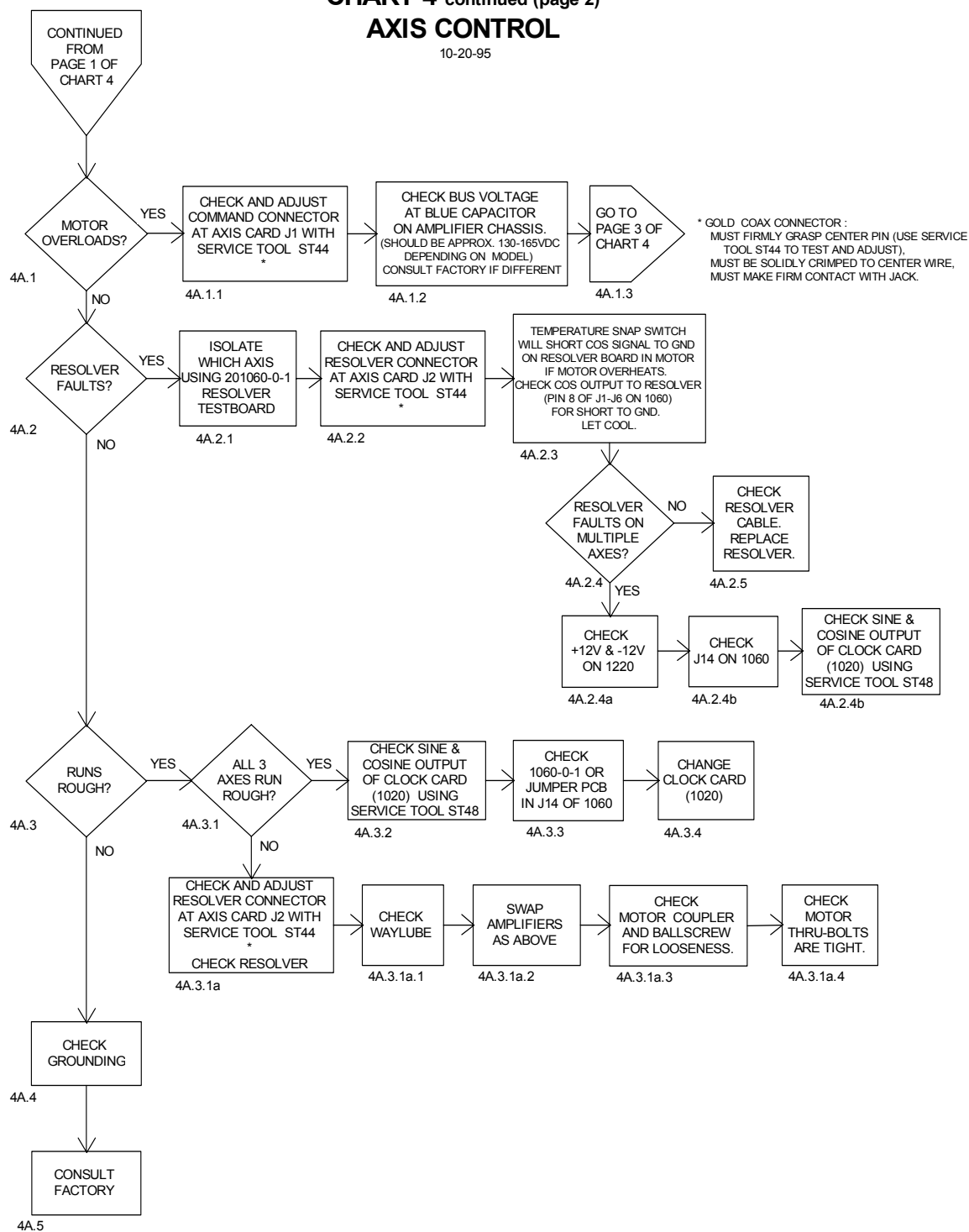


Figure 16-10 Axis Control (Continued)

## CHART 4 continued (page 3)

## AXIS CONTROL

6-15-95

## MOTOR OVERLOADS

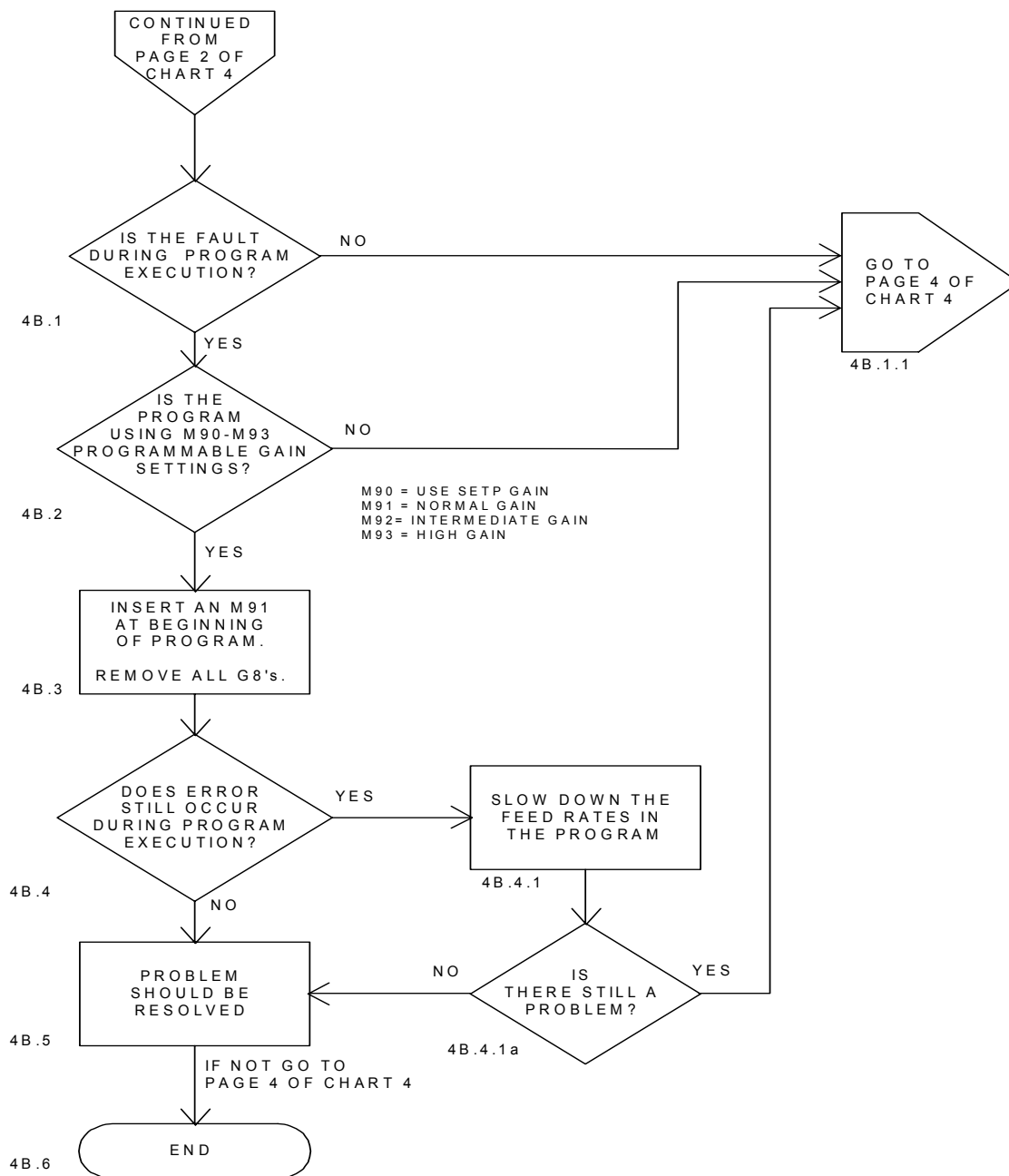


Figure 16-11 Axis Control (Continued)

## MOTOR OVERLOADS

## CHART 4 continued (page 4)

## AXIS CONTROL

6-15-95

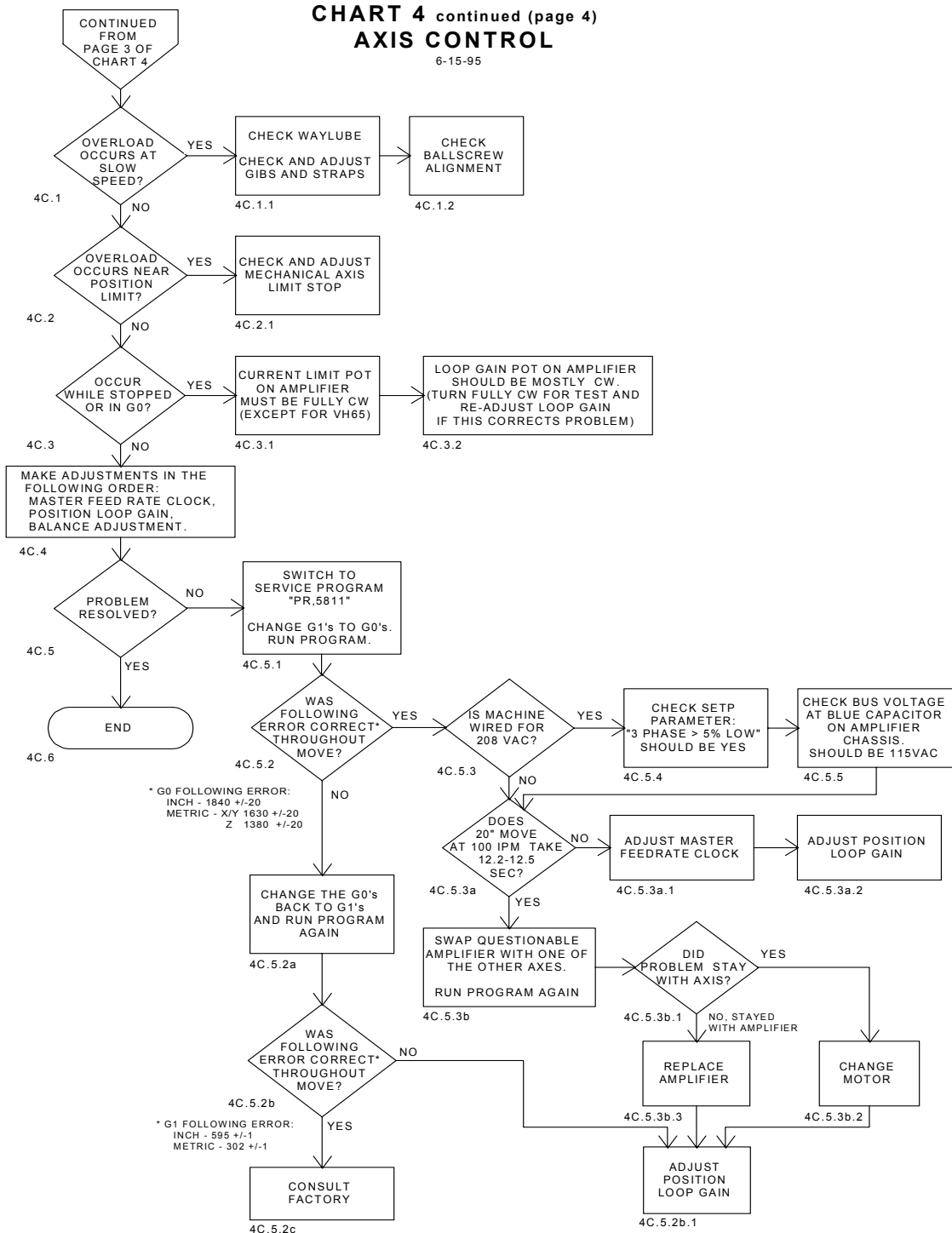


Figure 16-12 Axis Control (Continued)

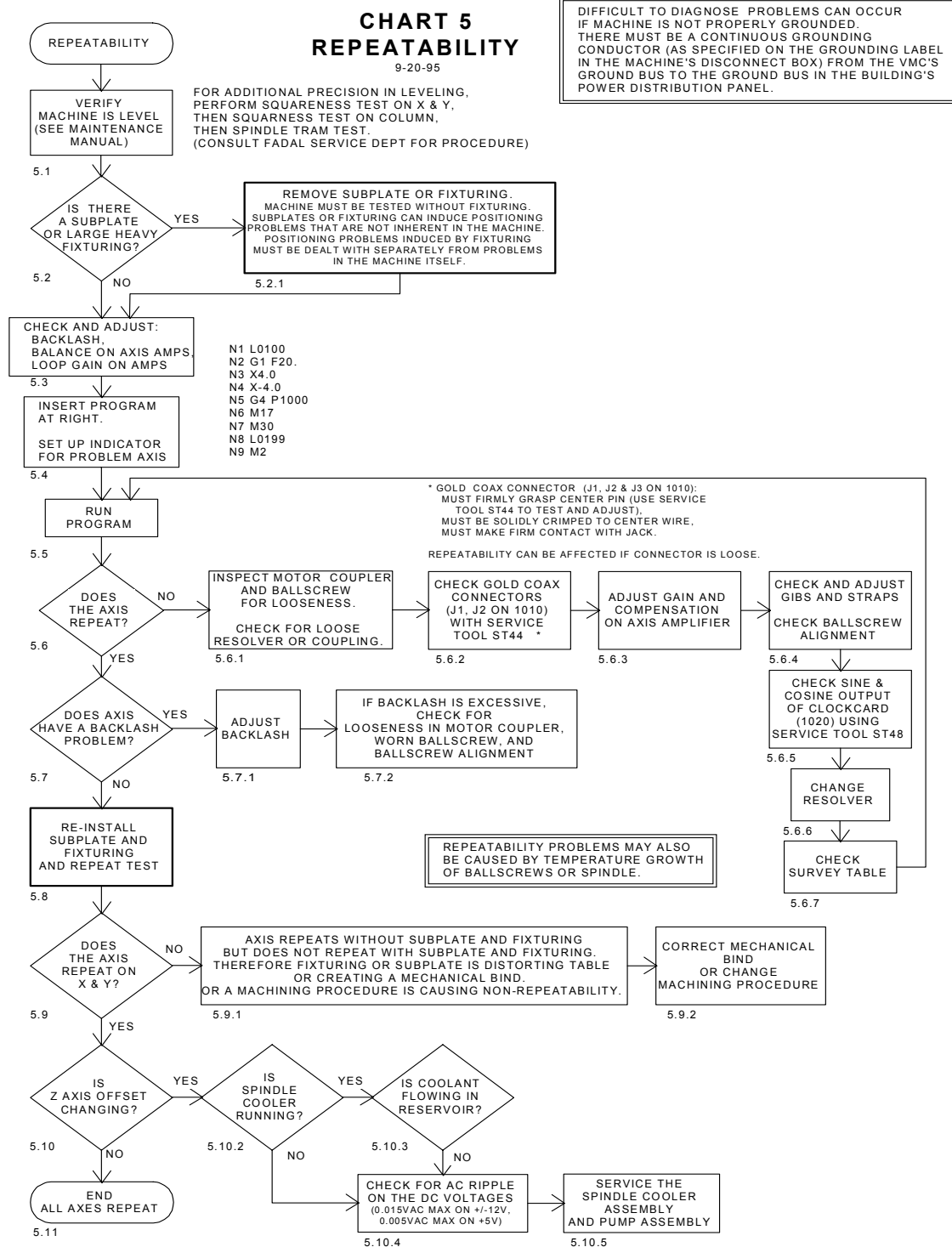


Figure 16-13 Repeatability

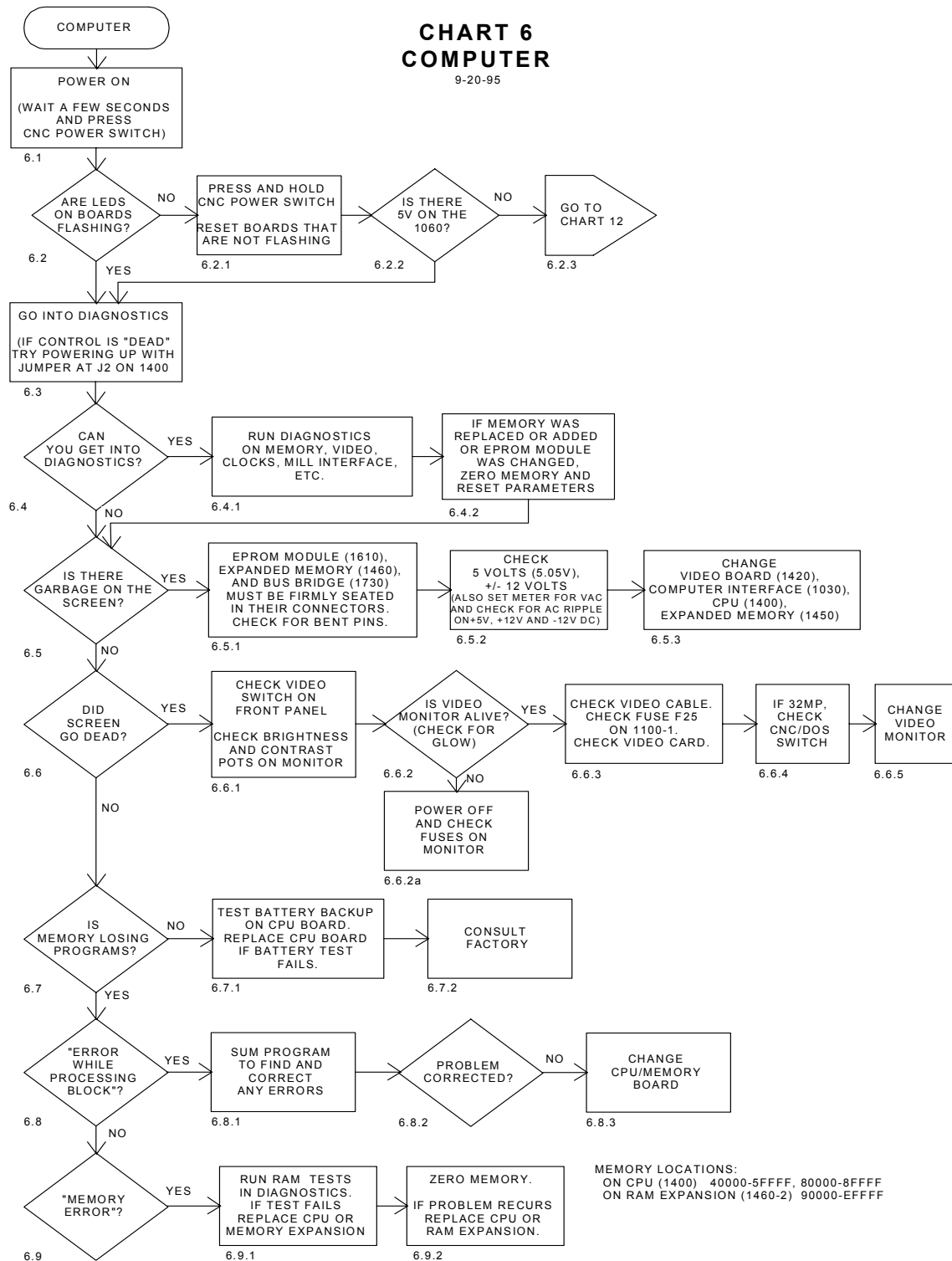


Figure 16-14 Computer

## CHART 7 AXIS MOTOR RUNAWAYS

6-15-95

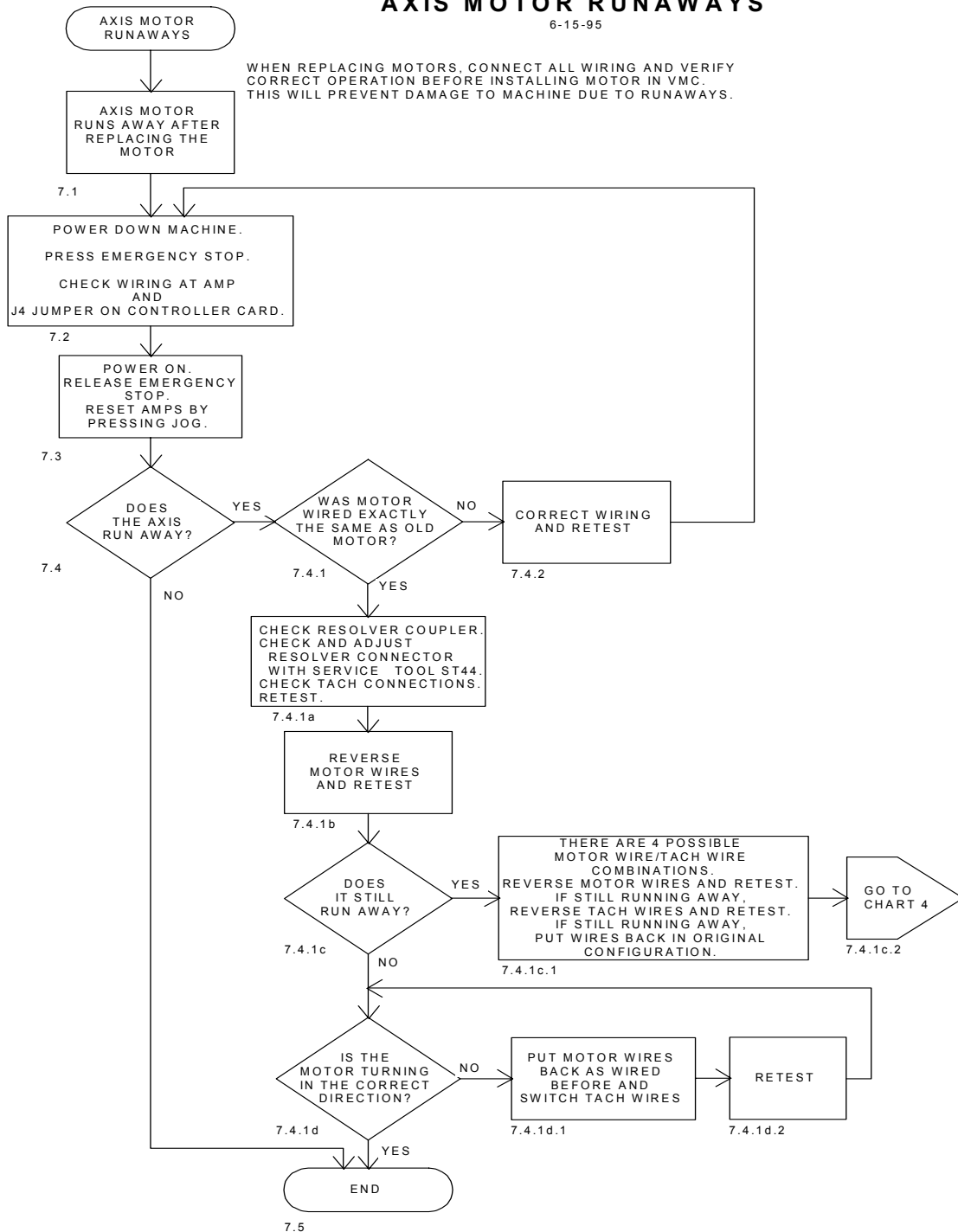


Figure 16-15 Axis Motor Runways

**Table 1: Baldor SWE0 Spindle Drive Error Messages**

DESCRIPTION	ALARM DISPLAY
This fault occurs when the main bus supply voltage has gone too low, even momentarily.	DCLO
This fault occurs when the main bus supply voltage has gone too high, even momentarily.	DCHI
These faults are usually the result of an excessive load on the drive output. The fault condition can be permanent, occurring when the drive is enabled, or intermittent, occurring randomly during normal operation.	PH-1 PH-2 PH-3
Motor is over temperature.	OH E
Baldor SWE0 drive is over temperature.	OH C
Overspeed on the motor has been detected.	OSP
The Baldor SWE0 power supply has momentarily experienced a reduction of the +/- 15 volts below allowable levels.	15DC
Spindle motor has overloaded.	OL
Spindle motor is not properly connected, to torque.	I LO
Drive cannot follow the speed command within the error band setting.	F. ERR
Parameters need to be reloaded.	PAR
Power has been interrupted.	UP
EPROMs have faulted.	PROG

**Table 2: Z200/Z300 Spindle Drive Error Messages**

DESCRIPTION	ALARM DISPLAY
Inverter output current exceeded the overcurrent limit during acceleration.	EOC1
Inverter output current exceeded the overcurrent limit during constant speed operation.	EOC2
Inverter output current exceeded the overcurrent limit during deceleration.	EOC3
Braking regenerative power from motor exceeded the regenerative overvoltage limit.	EOVT
Electronic thermal relay in the inverter was activated (current is below 150% of preset current).	ETHM
Electronic thermal relay in the inverter was activated (current is over 150% of preset current).	ETHT
Instantaneous power failure protective function was activated.	EIPF
Temperature of transistor heatsink exceeded the specified limit.	EFIN
Brake transistor fault detection.	E BE



Table 2: Z200/Z300 Spindle Drive Error Messages

DESCRIPTION	ALARM DISPLAY
Stall preventative function was activated during constant speed operation and stopped the motor.	EOLT
Memory in the inverter is corrupted.	E PE
Inverter input voltage fell below the specified limit.	EUVT
Overcurrent due to earth fault on the inverter output side.	E GF
Externally installed thermal relay activated (overheat).	EOHT
Built-in optional unit connection failure during operation	EOPT

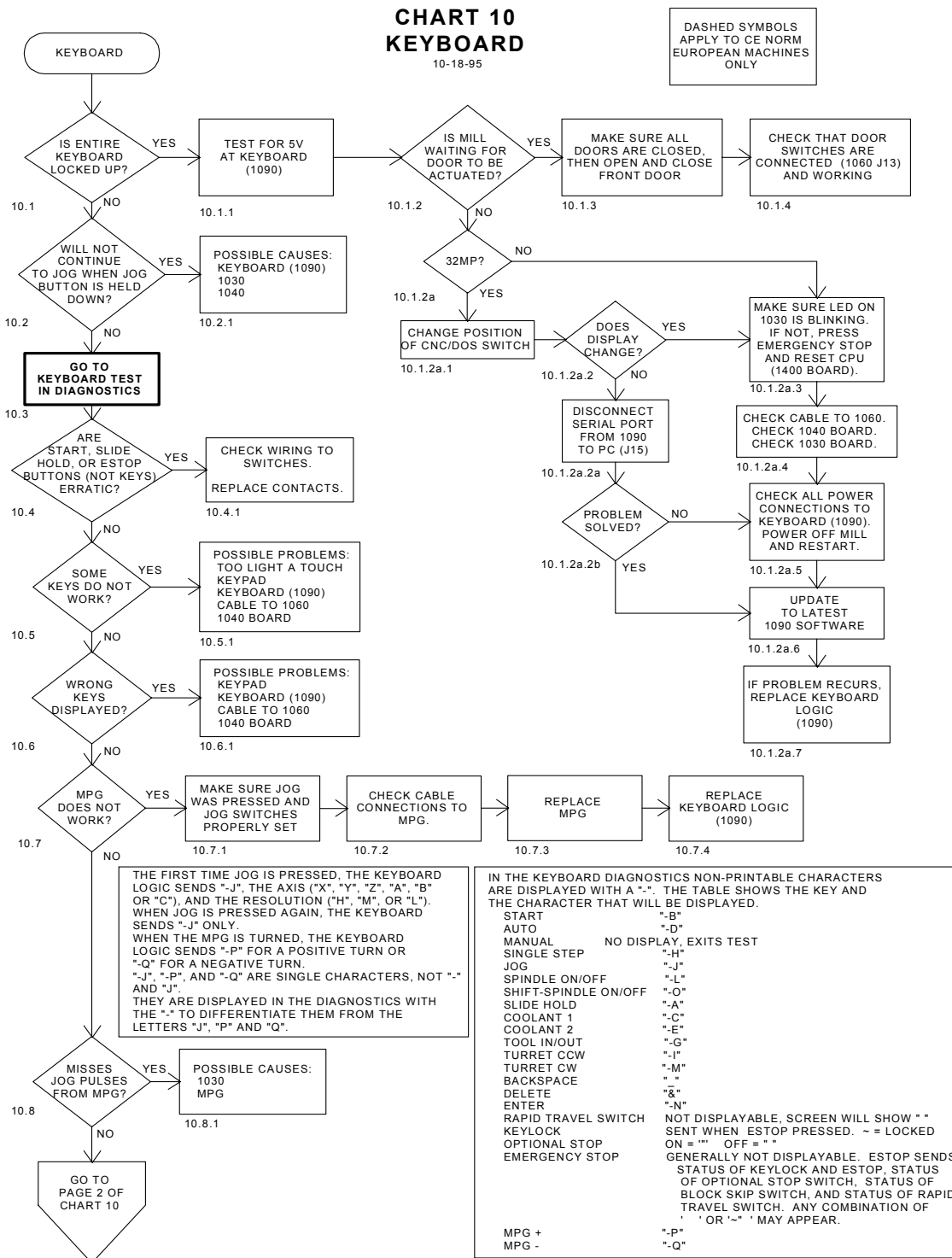


Figure 16-16 Keyboard

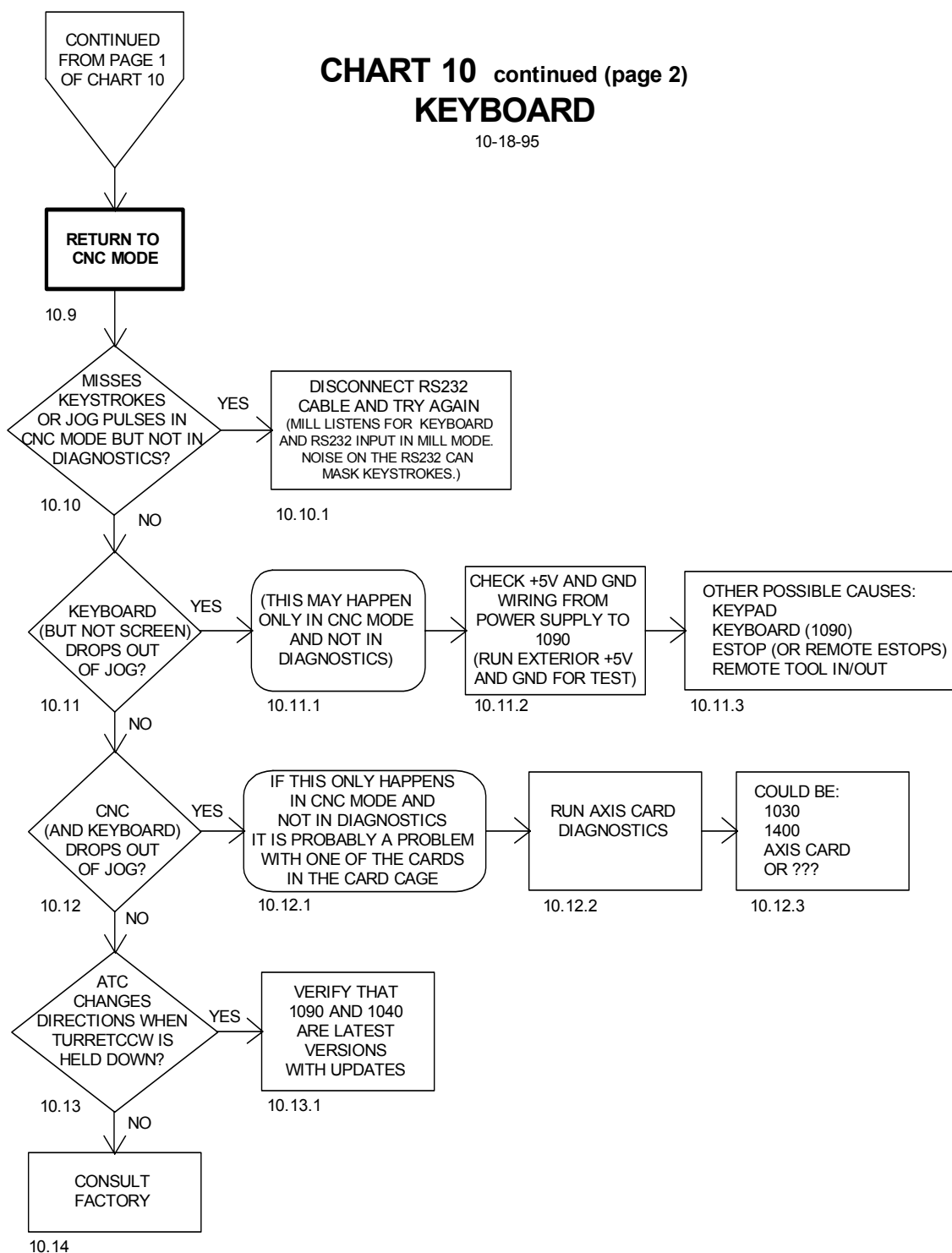


Figure 16-17 Keyboard (Continued)

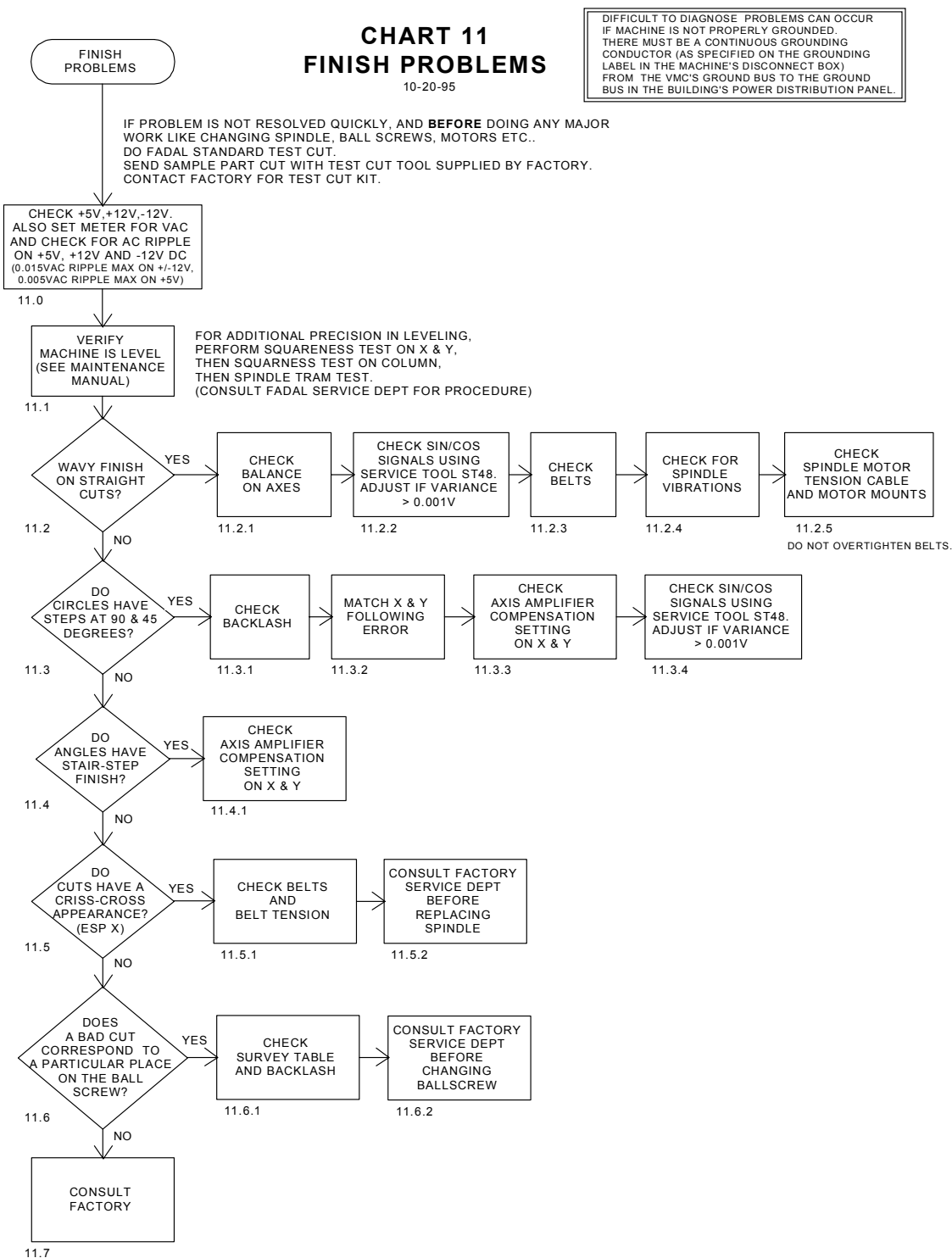


Figure 16-18 Finish Problems

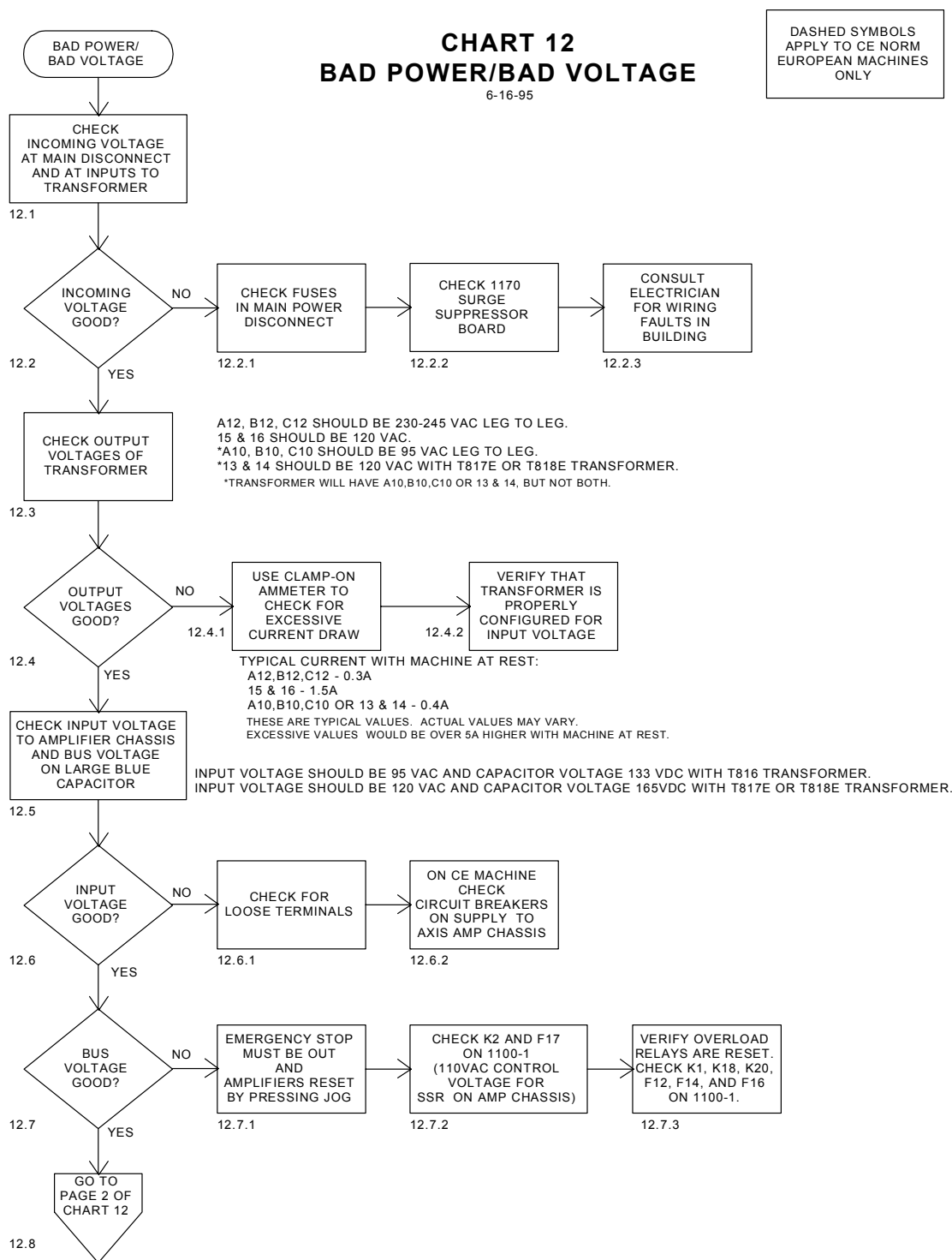
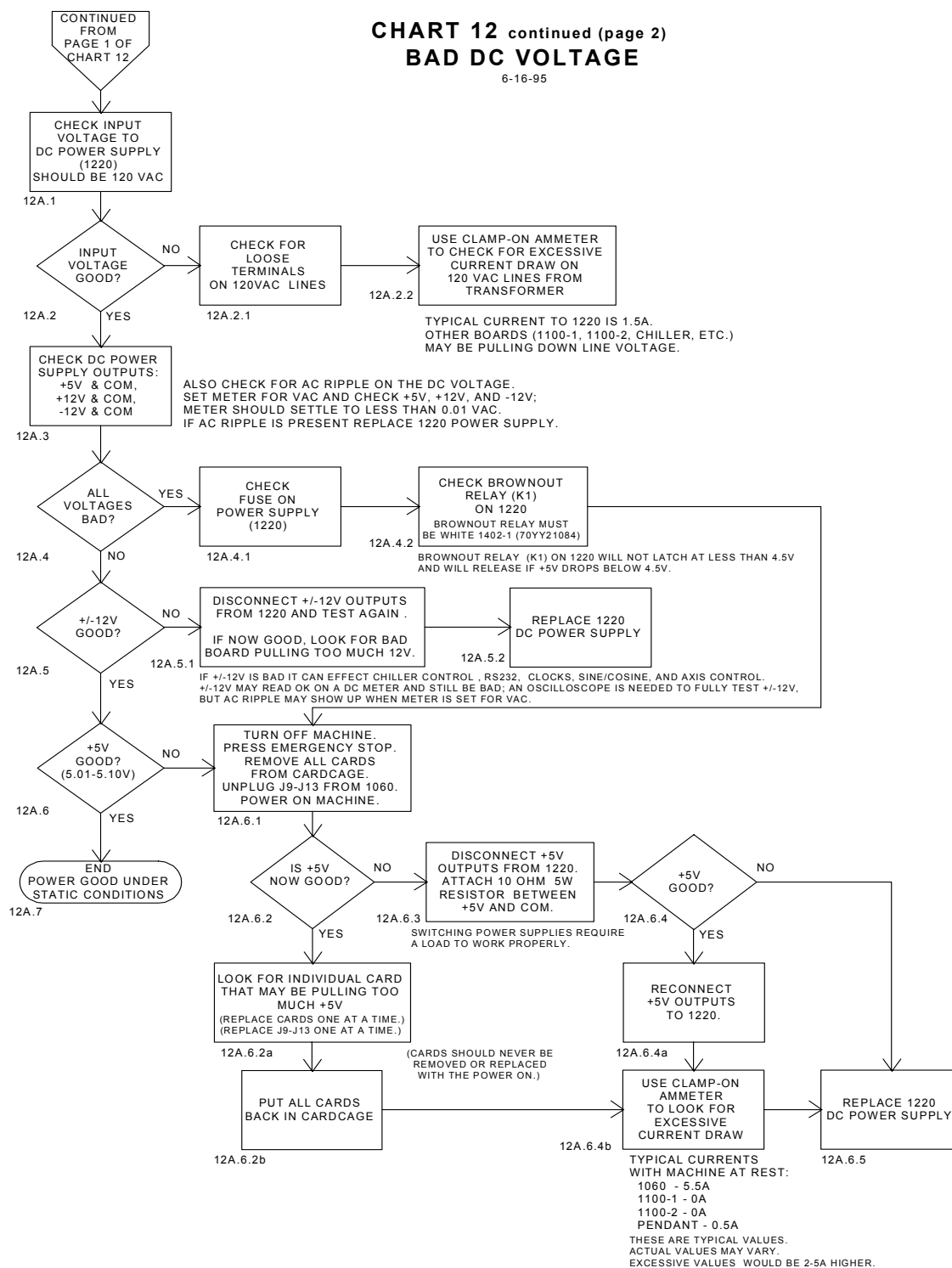


Figure 16-19 Bad Power/Bad Voltage

**CHART 12 continued (page 2)**  
**BAD DC VOLTAGE**

6-16-95



**Figure 16-20** Bad DC Voltage (Continued)

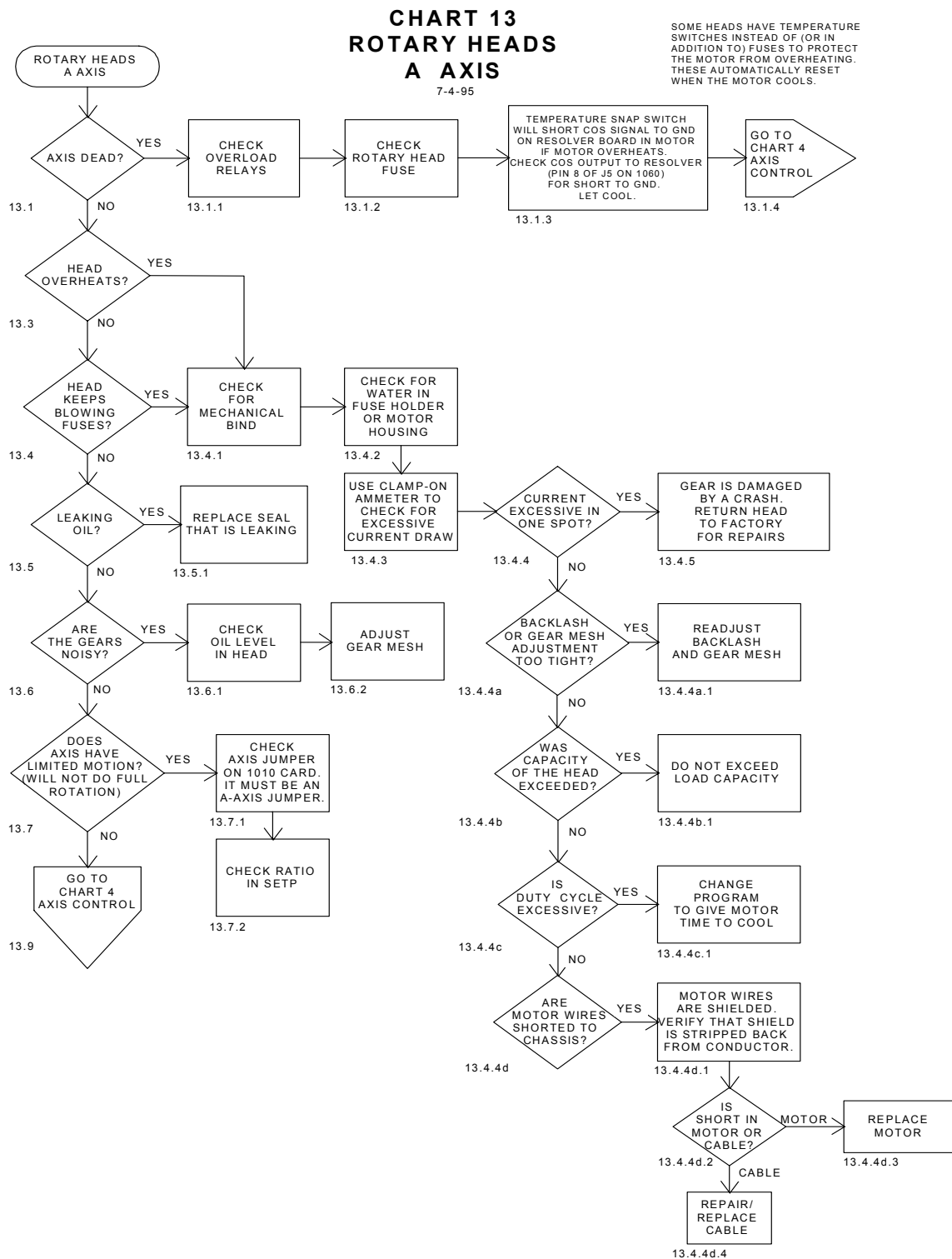


Figure 16-21 Rotary Heads A Axis

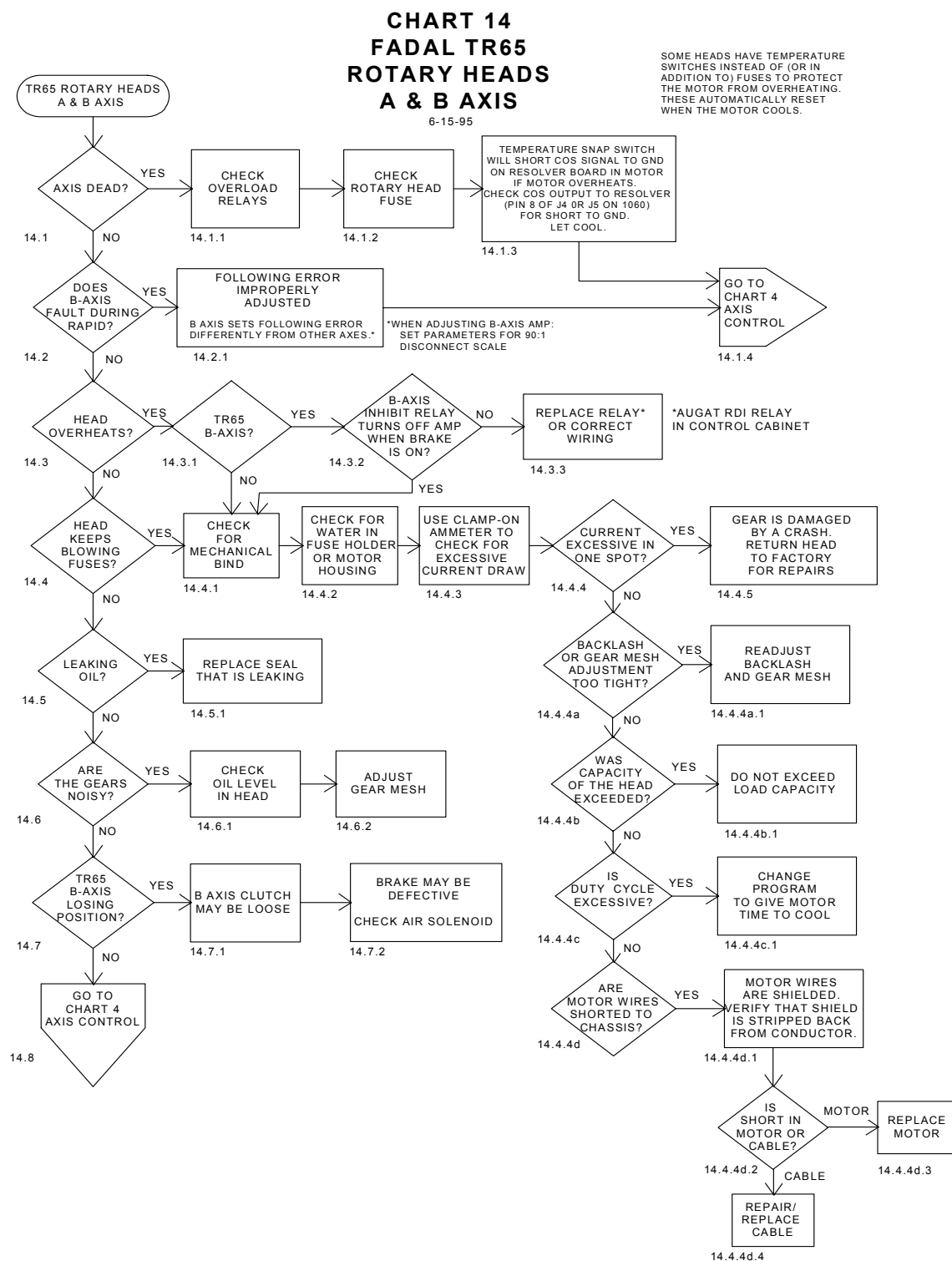
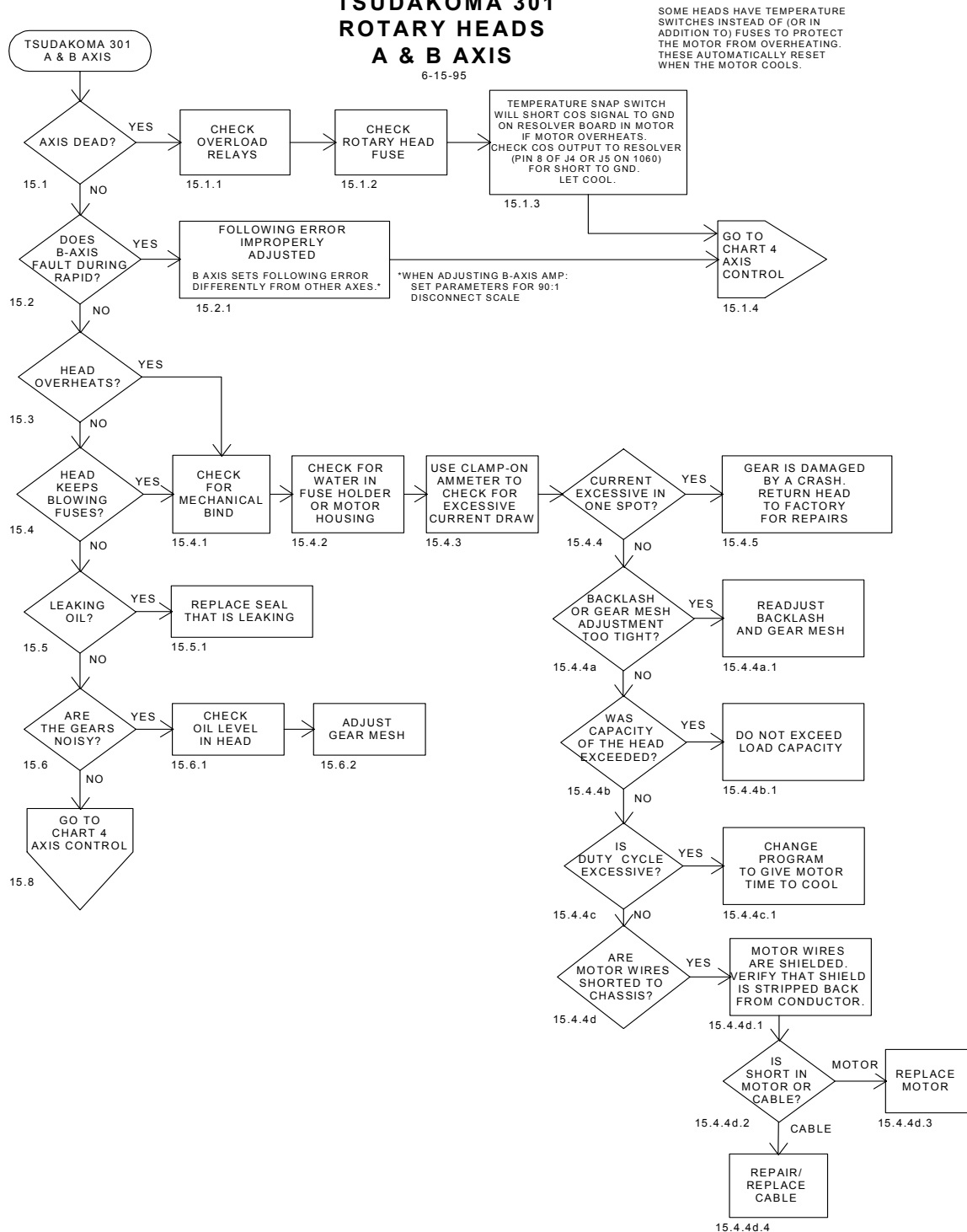


Figure 16-22 TR65 Rotary Heads A &amp; B Axes



## 6-15-95



**Figure 16-23** Tsudakoma 301RotaryHeads A & B Axes

## CHART 16 SERVO COOLANT CONTROL

12-5-95

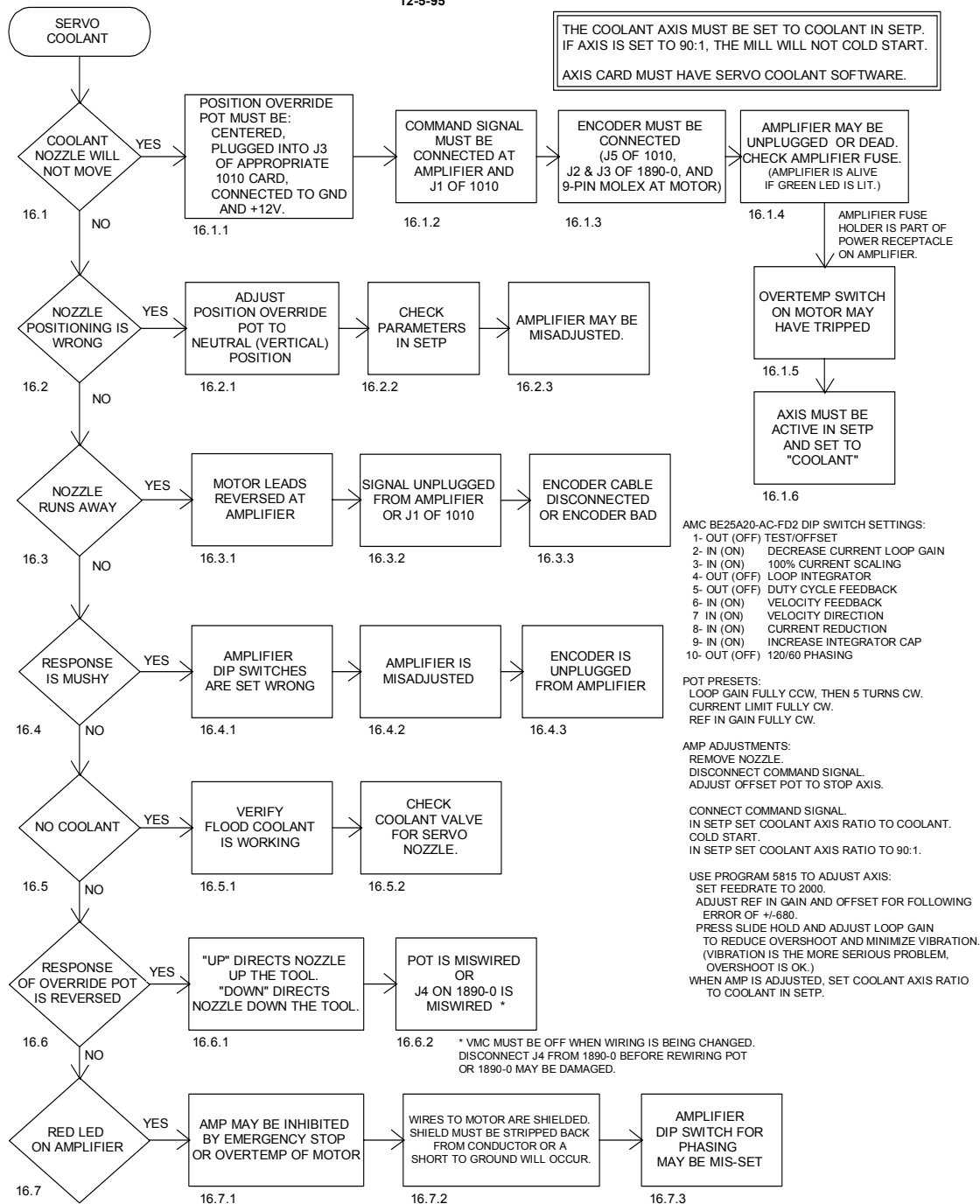


Figure 16-24 Servo Coolant Control

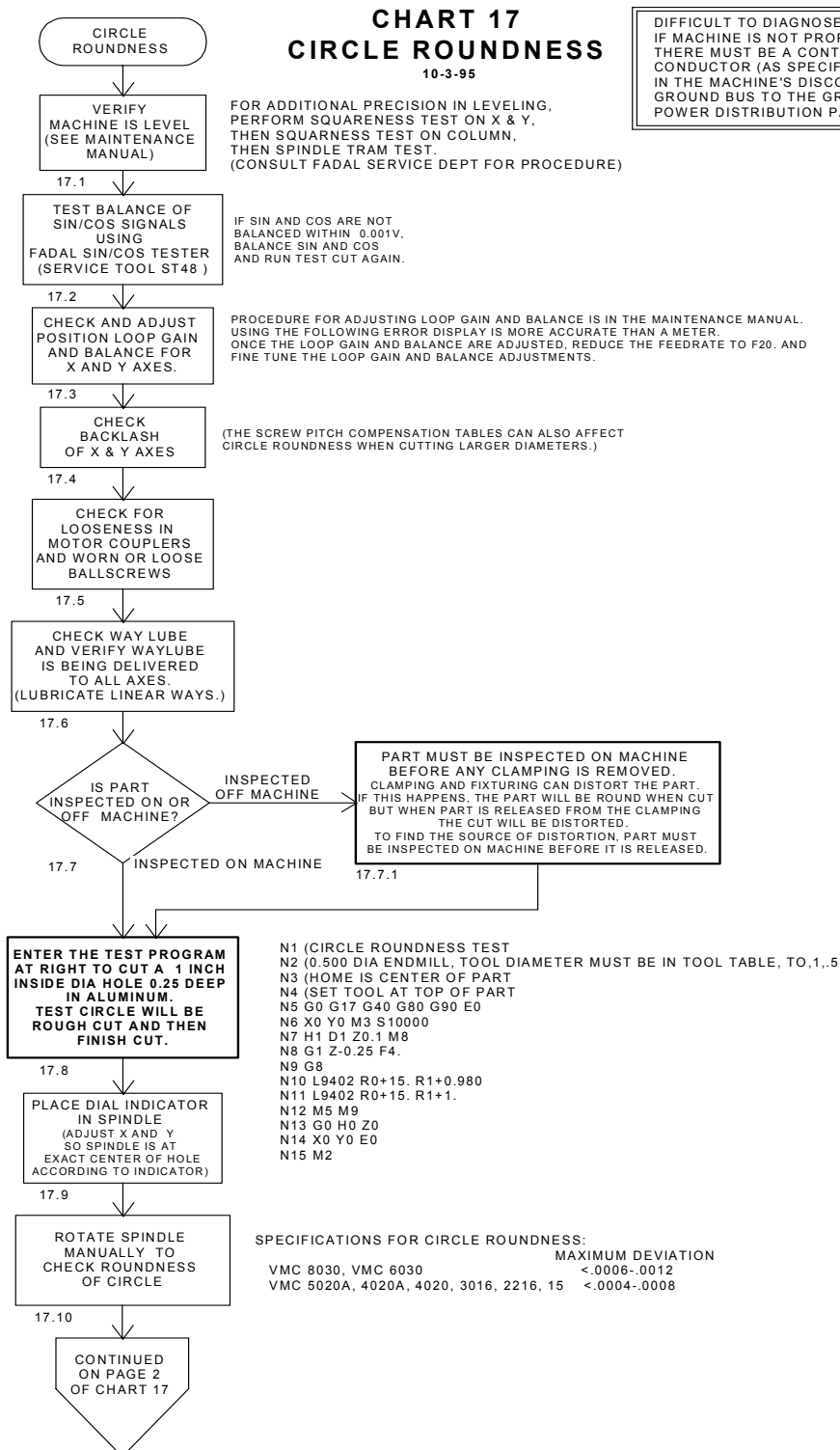
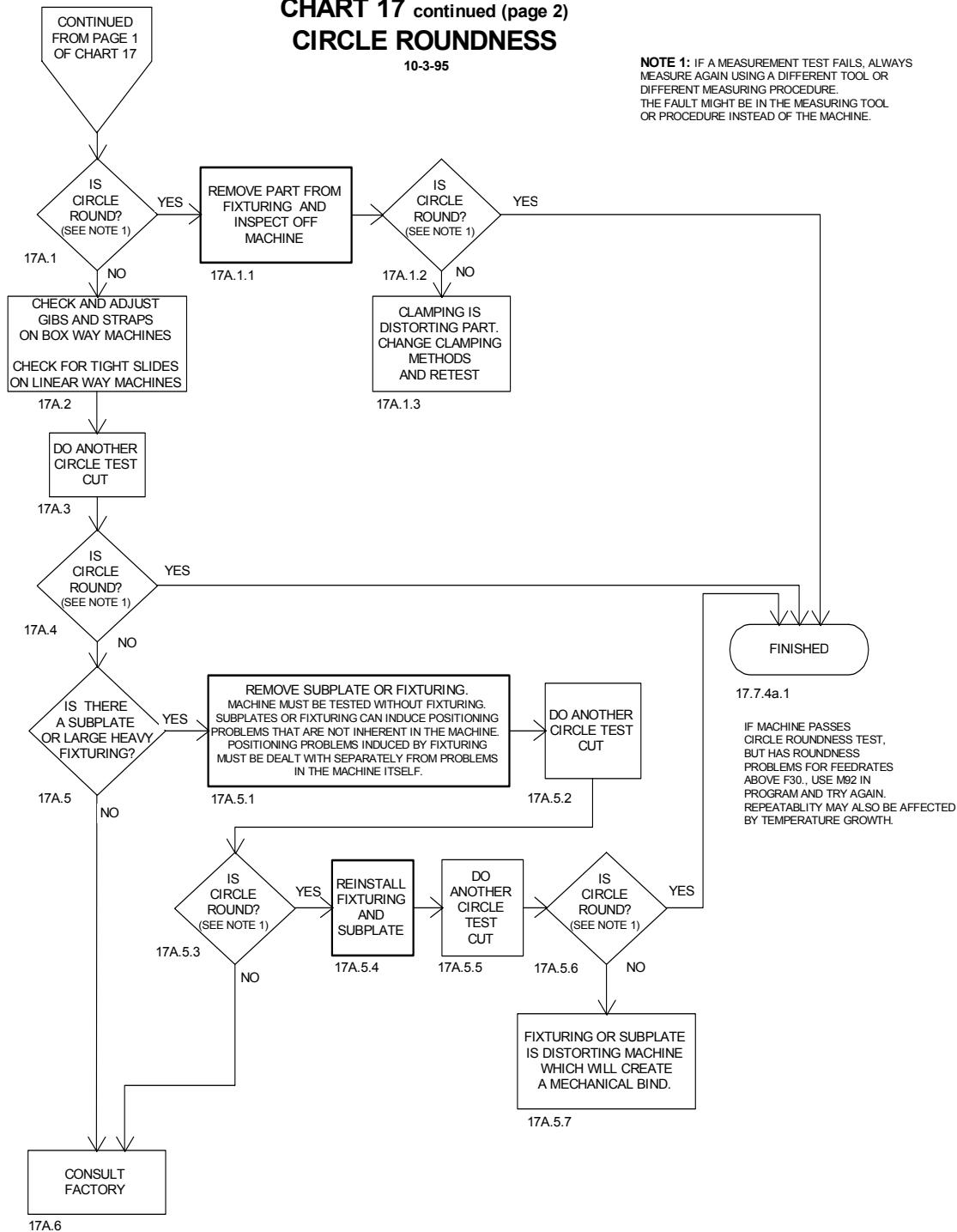


Figure 16-25 Circle Roundness

# **CHART 17 continued (page 2)** **CIRCLE ROUNDNESS**

10-3-95

**NOTE 1:** IF A MEASUREMENT TEST FAILS, ALWAYS MEASURE AGAIN USING A DIFFERENT TOOL OR DIFFERENT MEASURING PROCEDURE. THE FAULT MIGHT BE IN THE MEASURING TOOL OR PROCEDURE INSTEAD OF THE MACHINE.



**Figure 16-26** Circle Roundness (Continued)

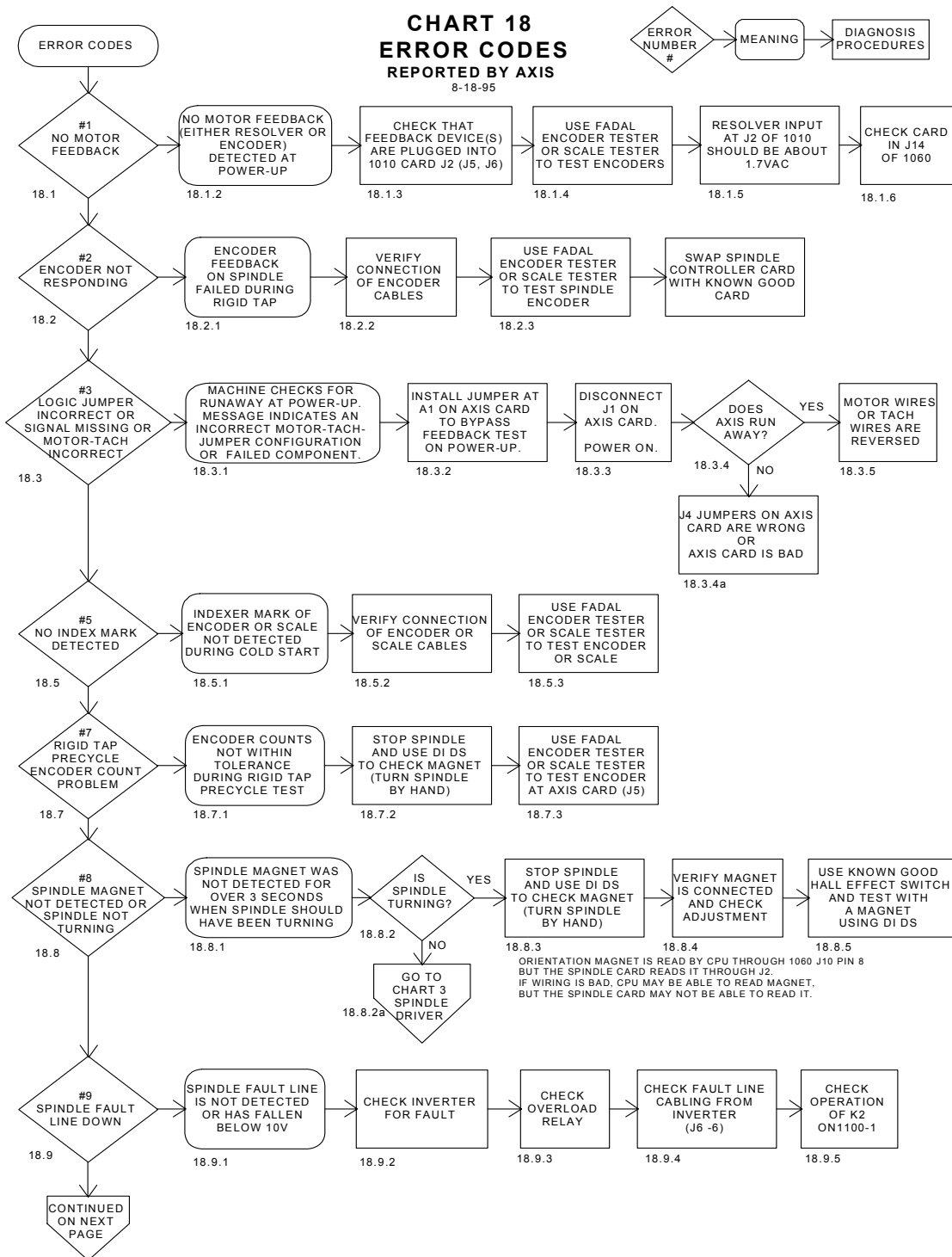


Figure 16-27 Error Codes

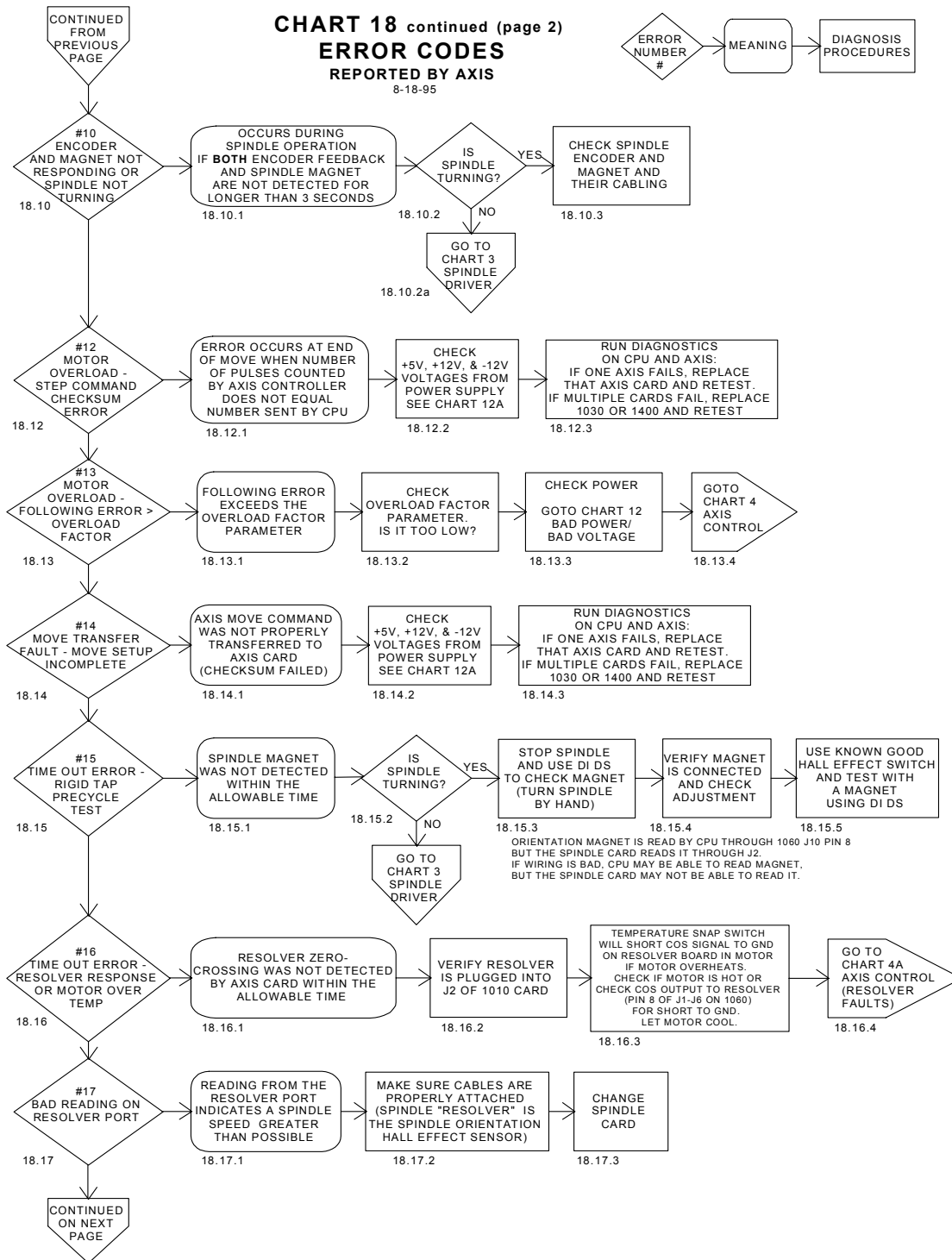


Figure 16-28 Error Codes (Continued)

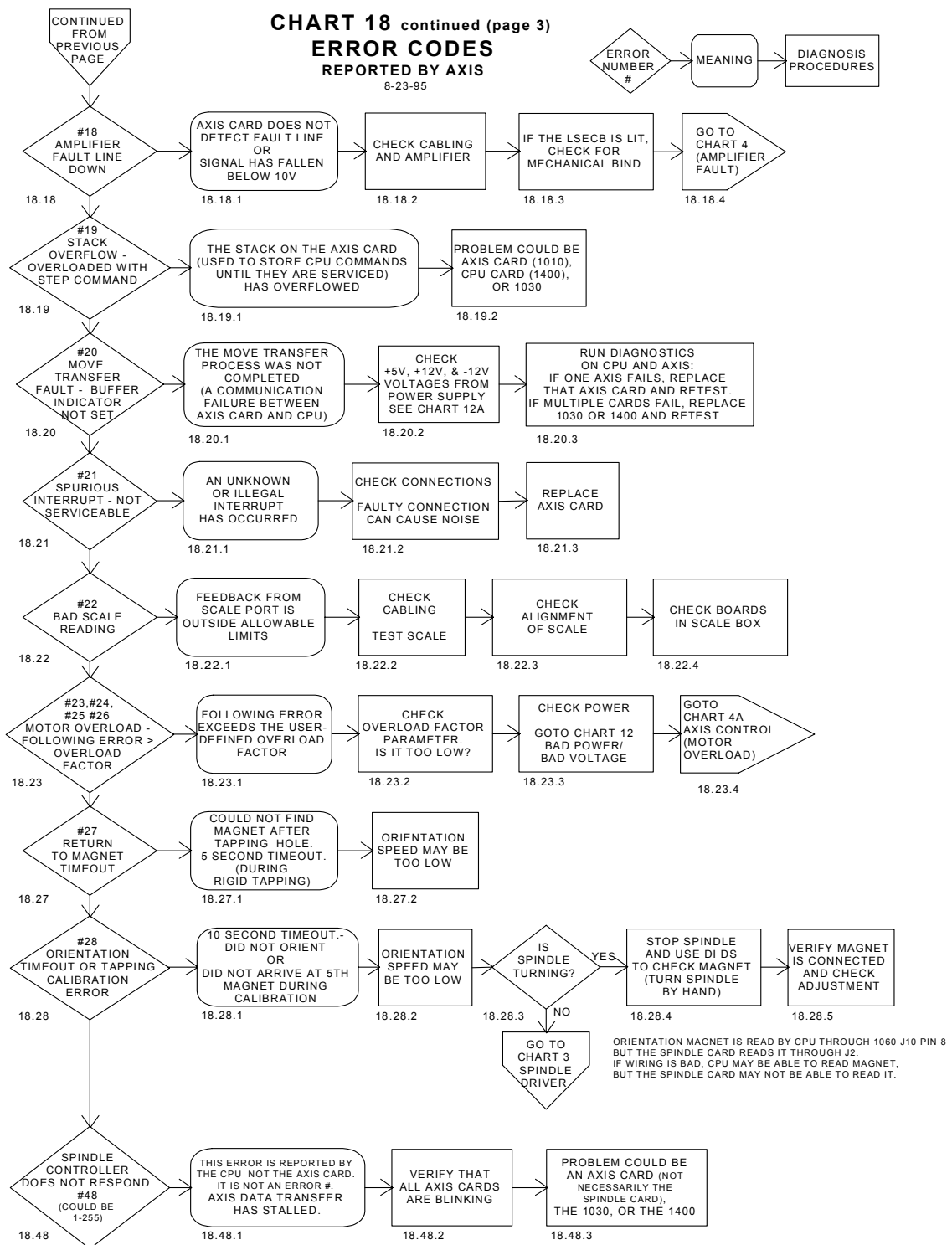
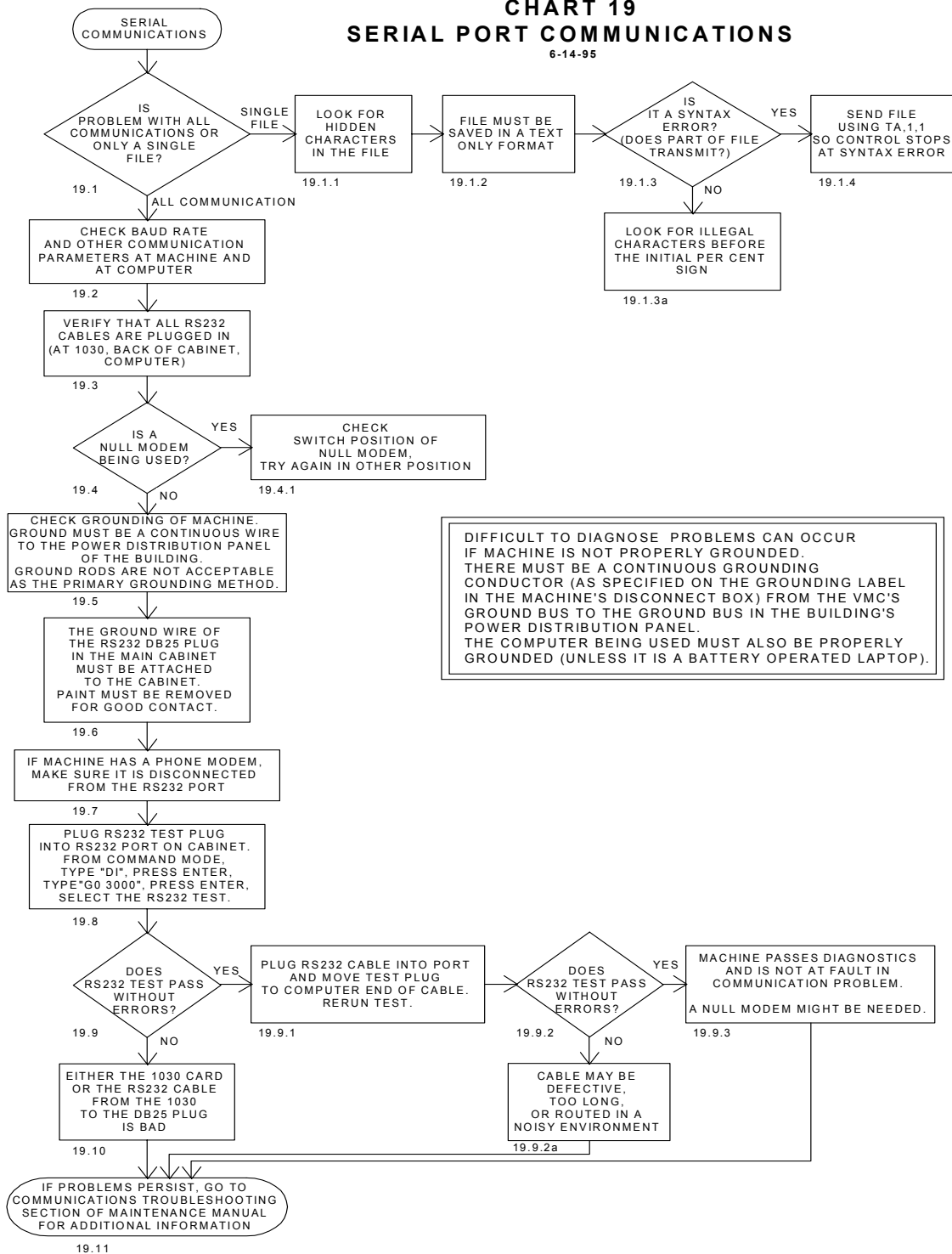


Figure 16-29 Error Codes

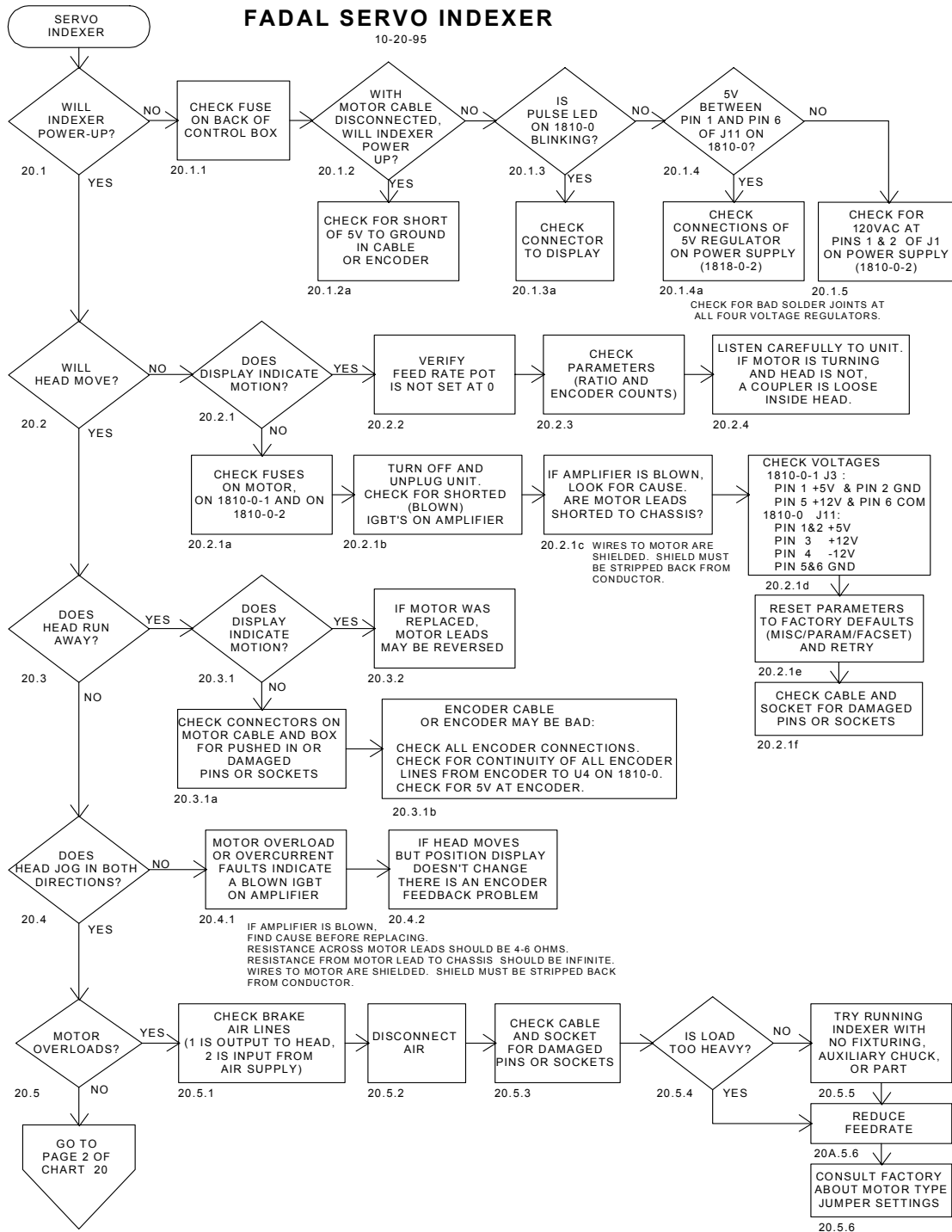
**CHART 19**  
**SERIAL PORT COMMUNICATIONS**  
6-14-95



*Figure 16-30* Serial Port Communications



**CHART 20**  
**FADAL SERVO INDEXER**



*Figure 16-31 Servo Indexer*

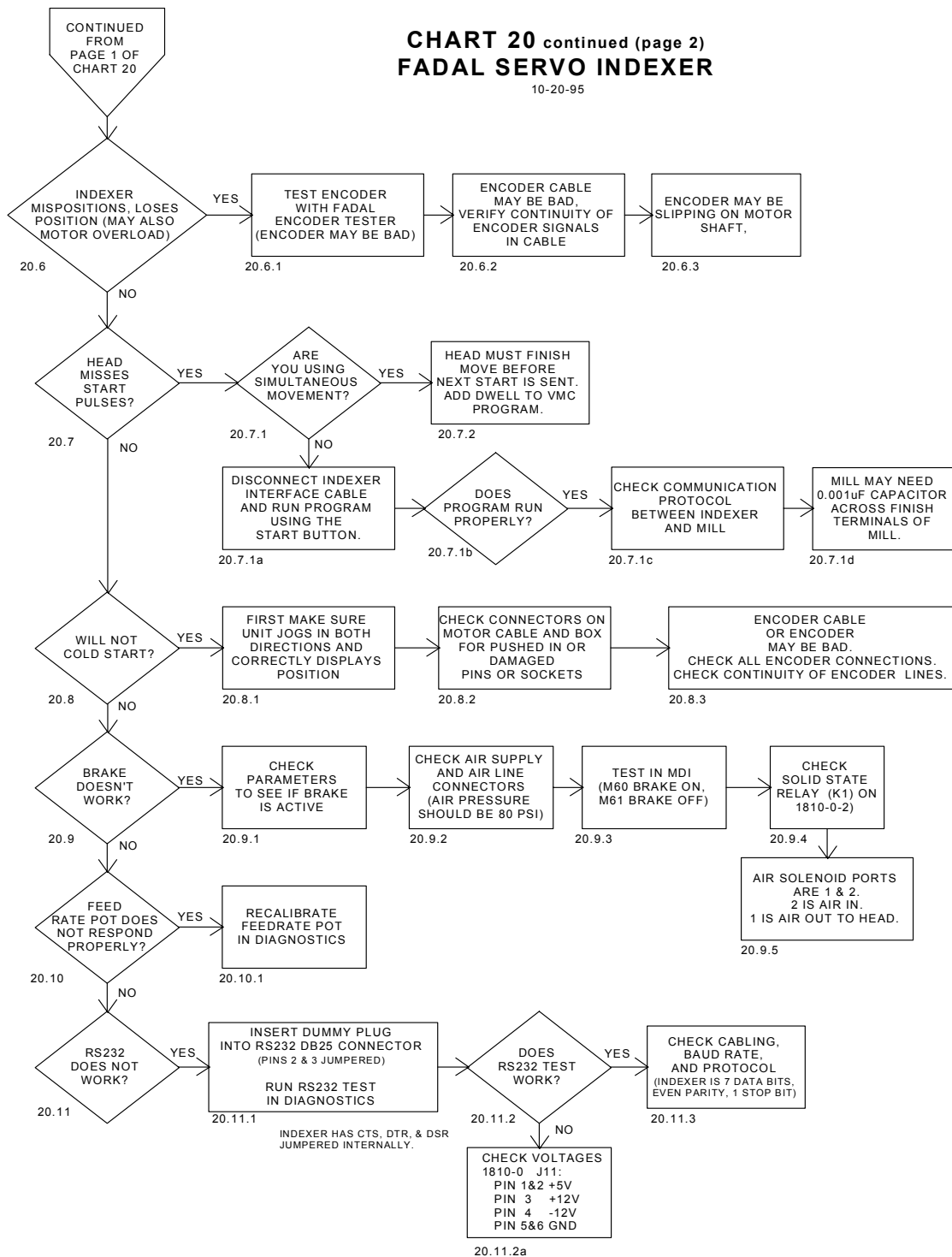


Figure 16-32 Servo Indexer (Continued)

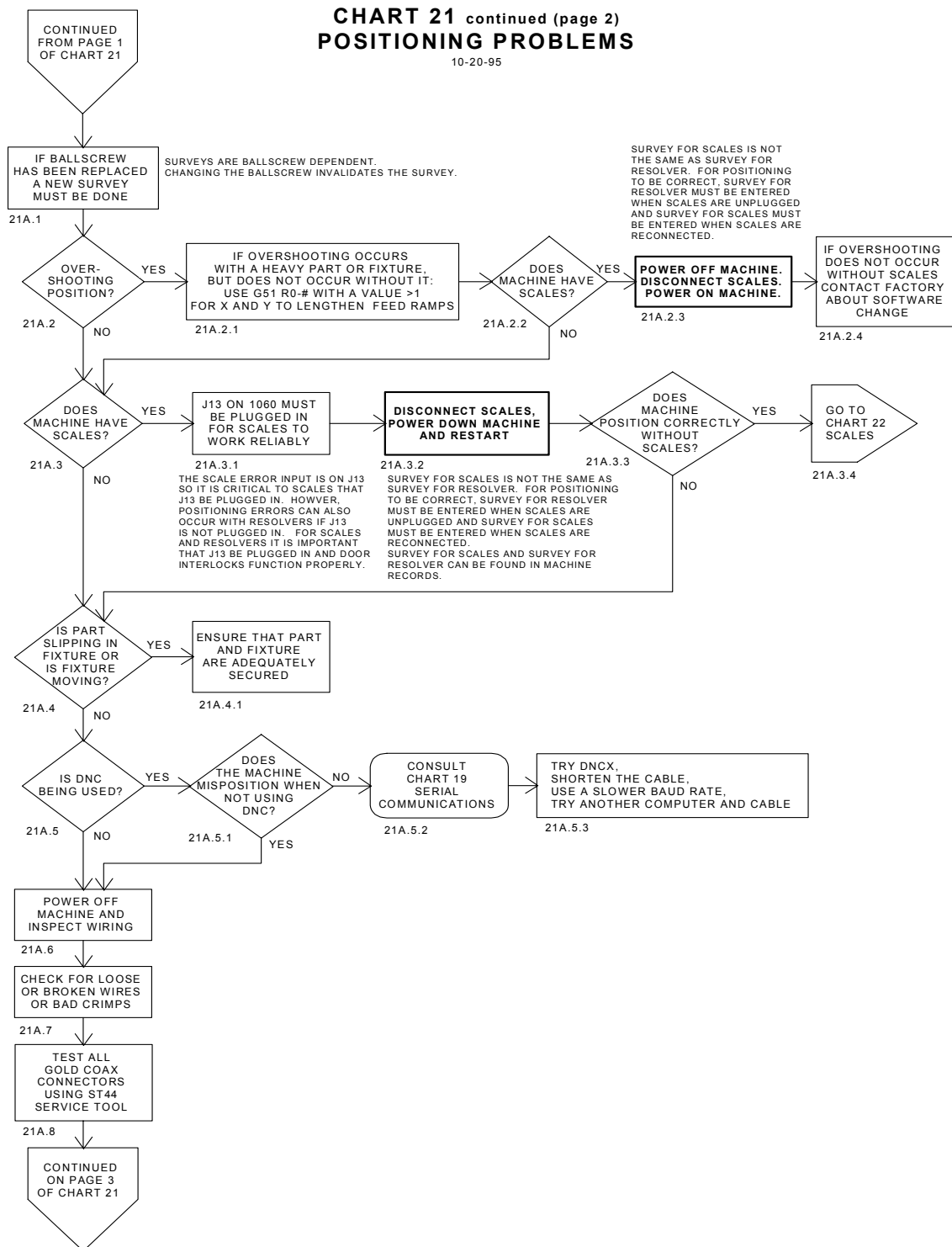
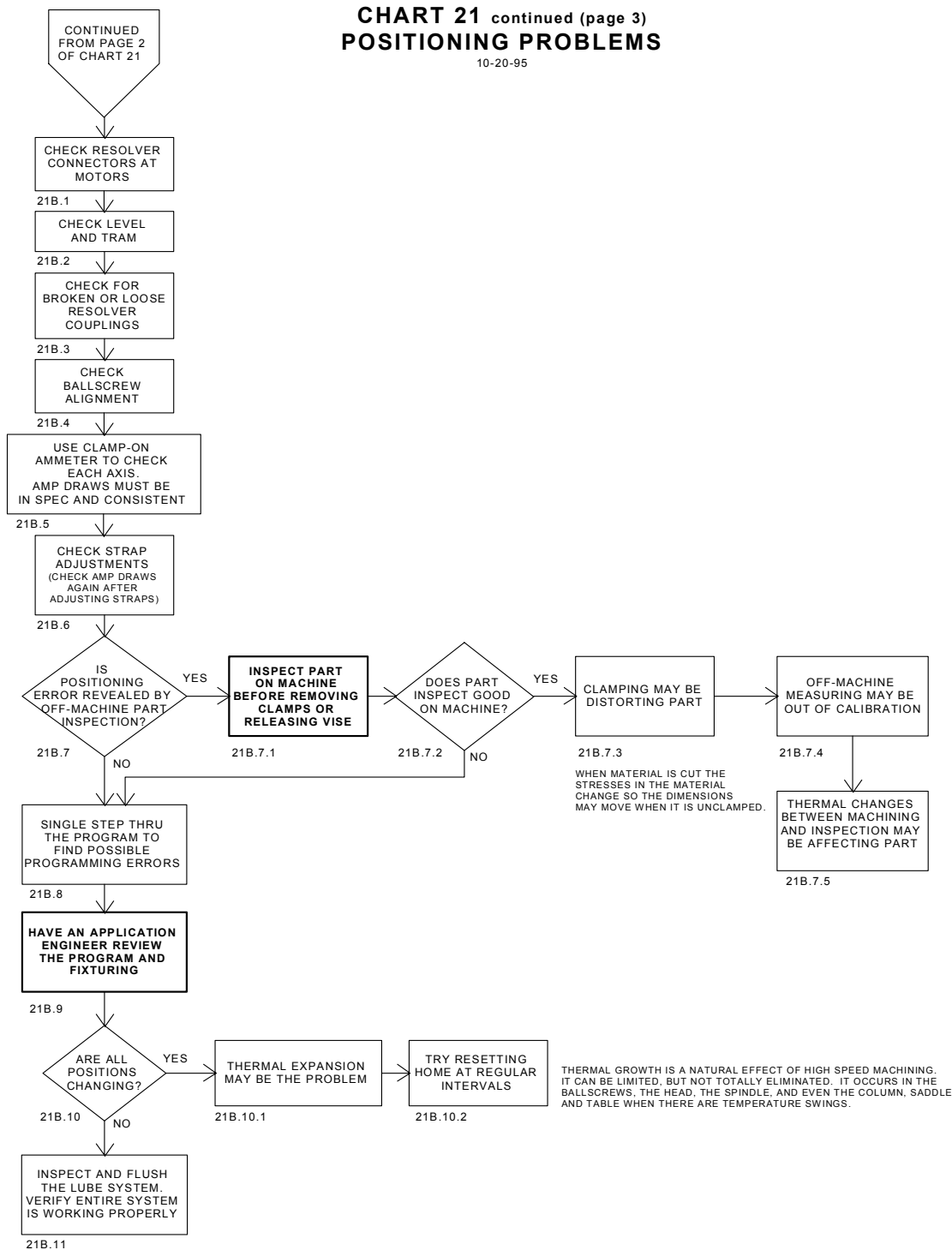


Figure 16-33 Positioning Problems

**CHART 21** continued (page 3)  
**POSITIONING PROBLEMS**  
 10-20-95



*Figure 16-34* Positioning Problems

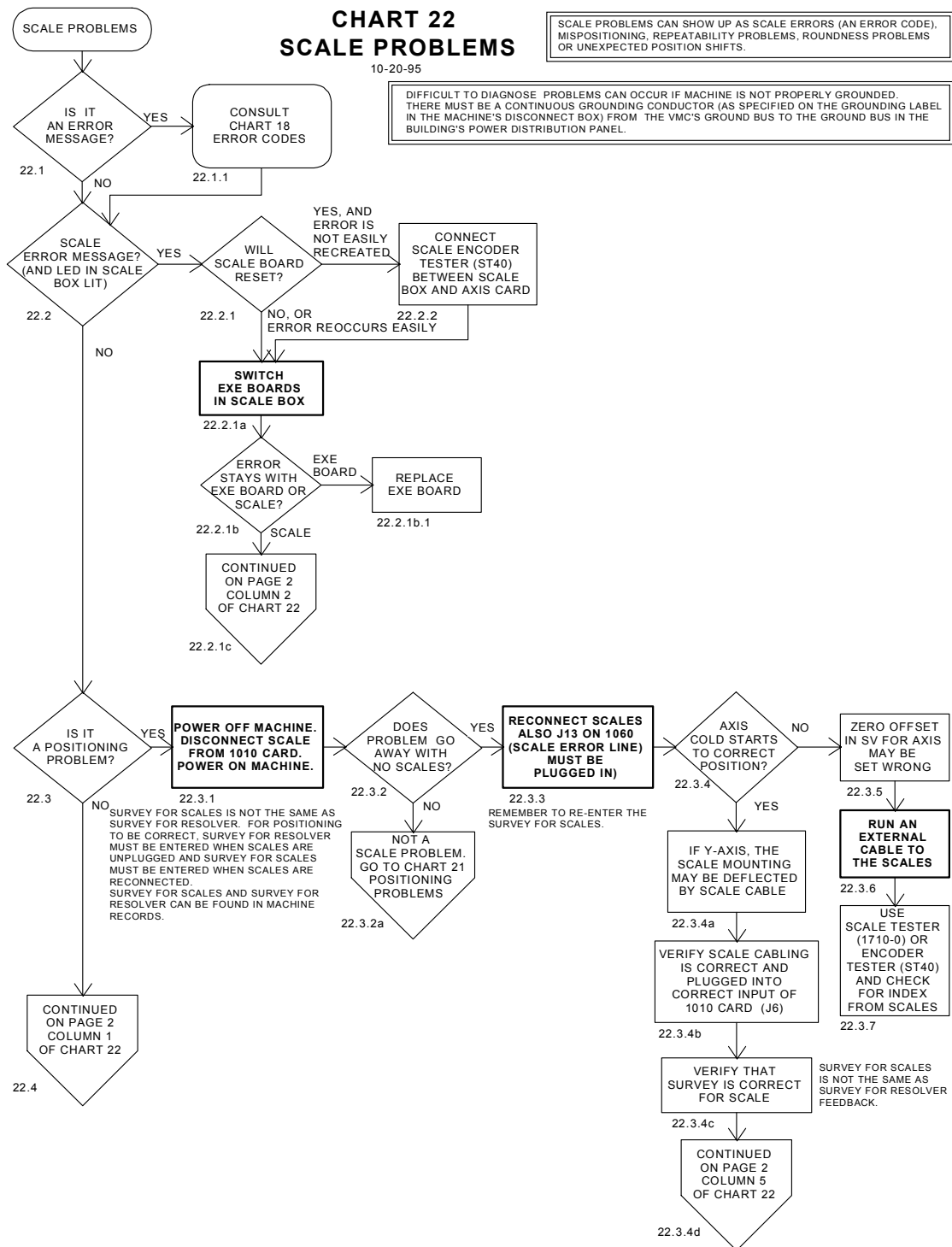


Figure 16-35 Scale Problems

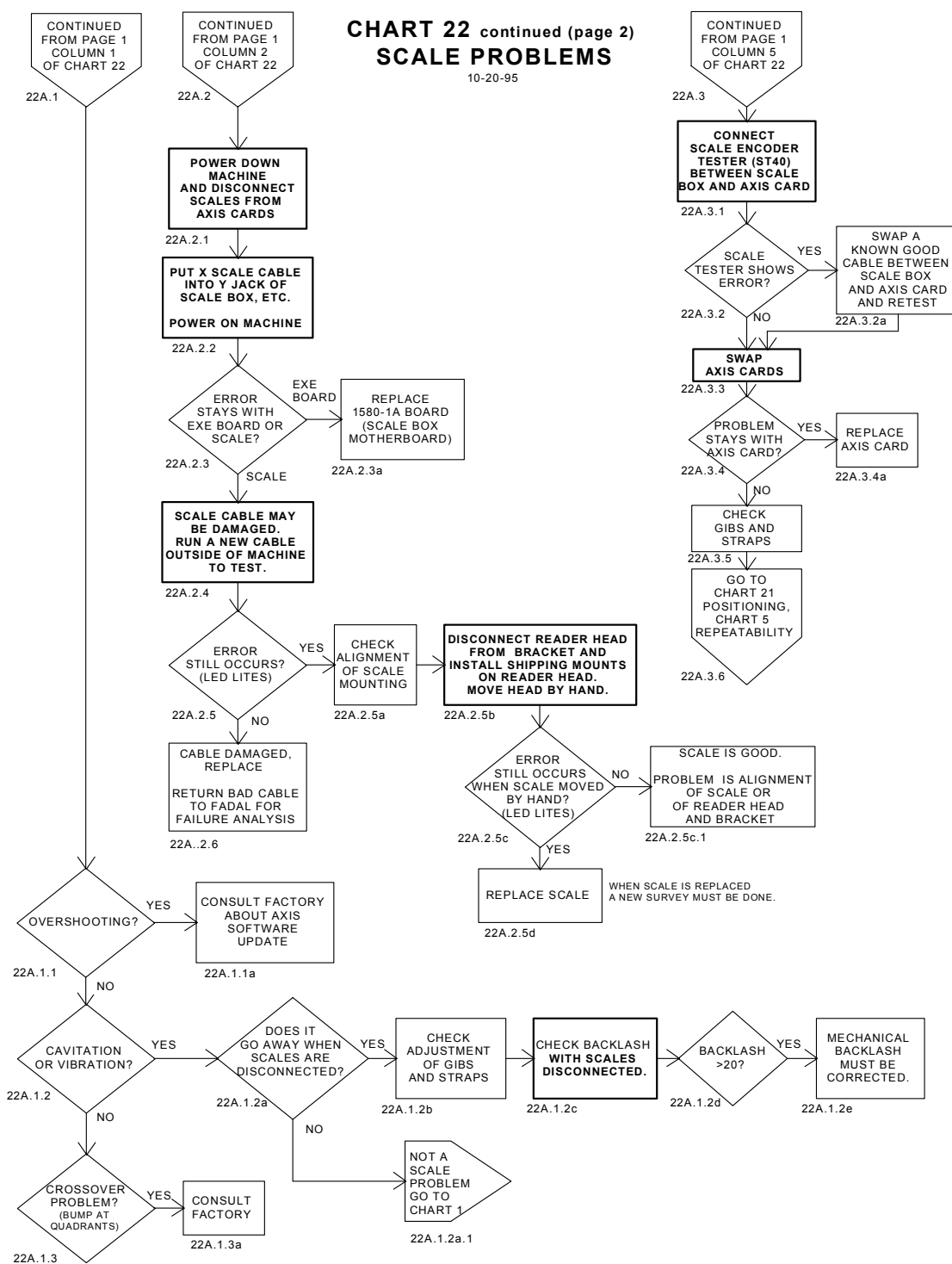


Figure 16-36 Scale Problems (Continued)

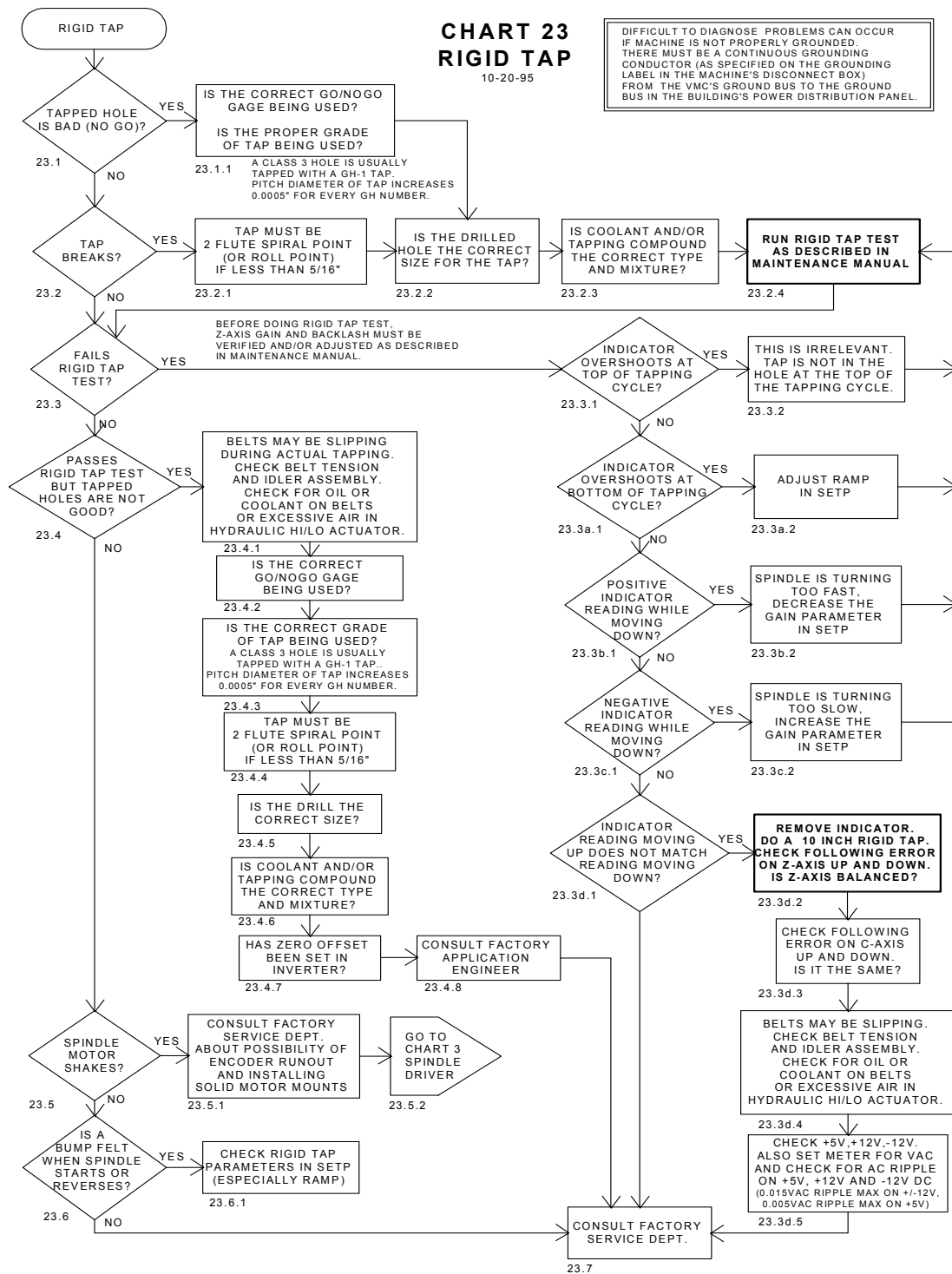


Figure 16-37 Rigid Tap

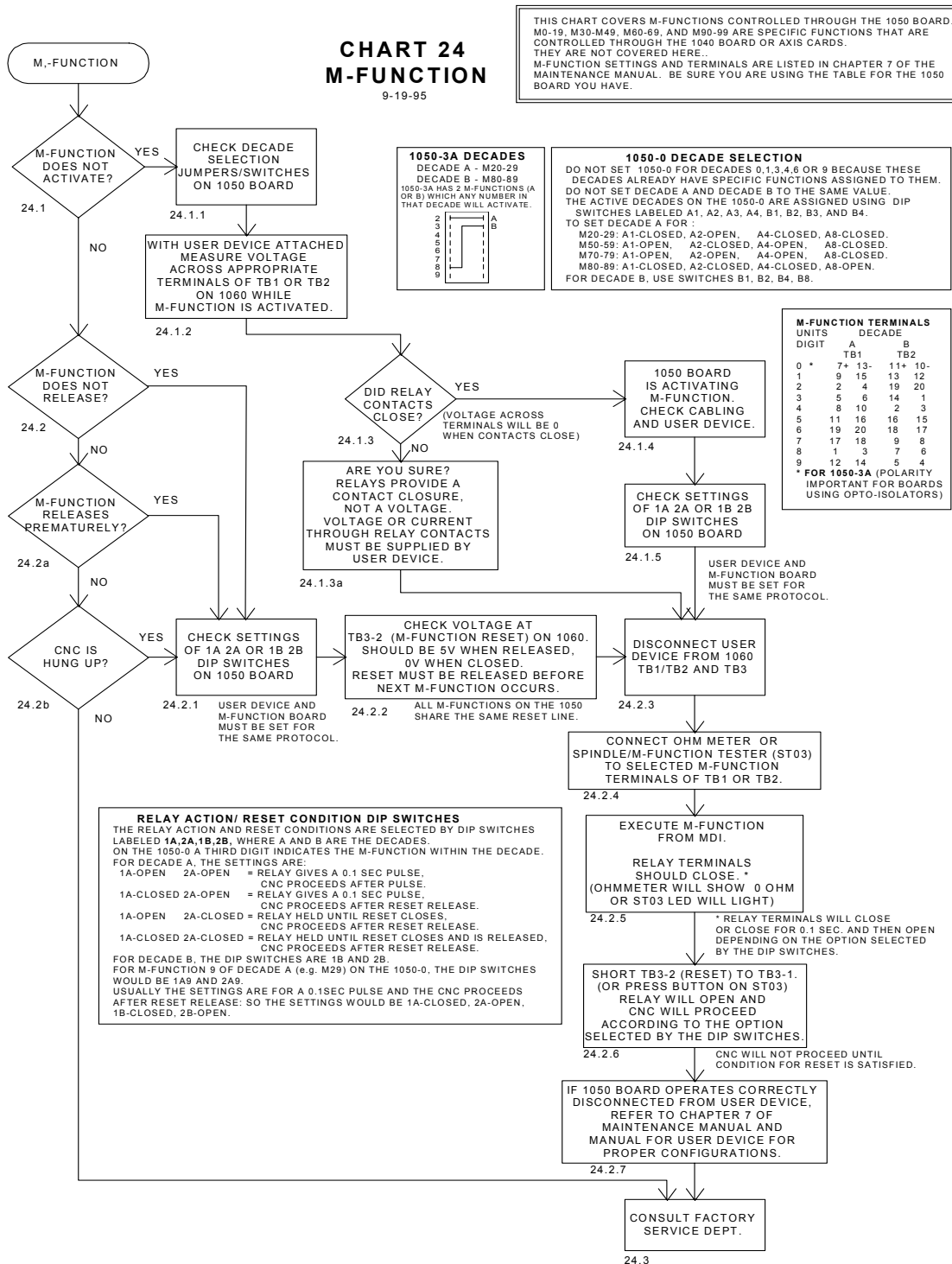


Figure 16-38 M-Function



## INDEXER WIRING DIAGRAM

10-20-95

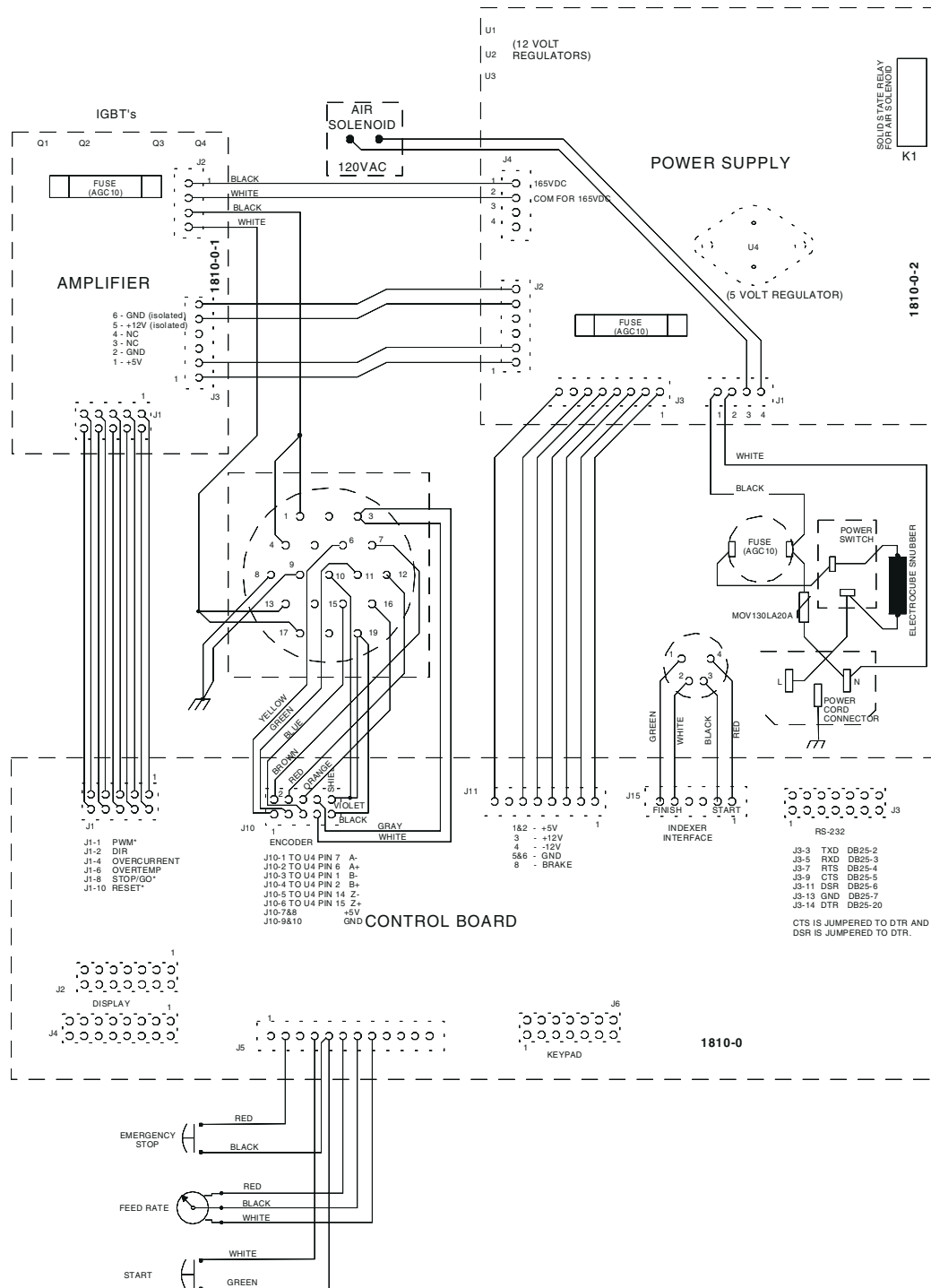
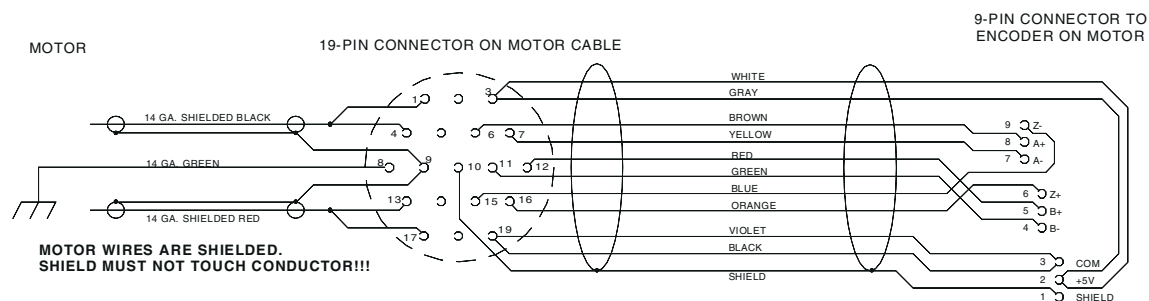
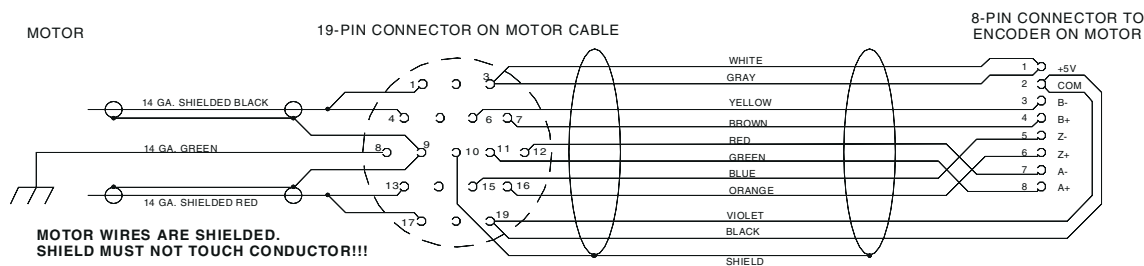


Figure 16-39 Indexer Wiring Diagram



### MOTOR CABLE WIRING FOR VH-5C INDEXER

4-6-95



### MOTOR CABLE WIRING FOR VH-65 INDEXER

4-6-95

### BULKHEAD CONNECTOR WIRING FOR CLOCKWISE POSITIVE MOTION

6-20-95

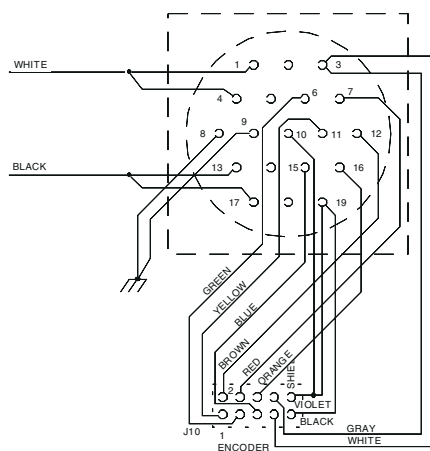
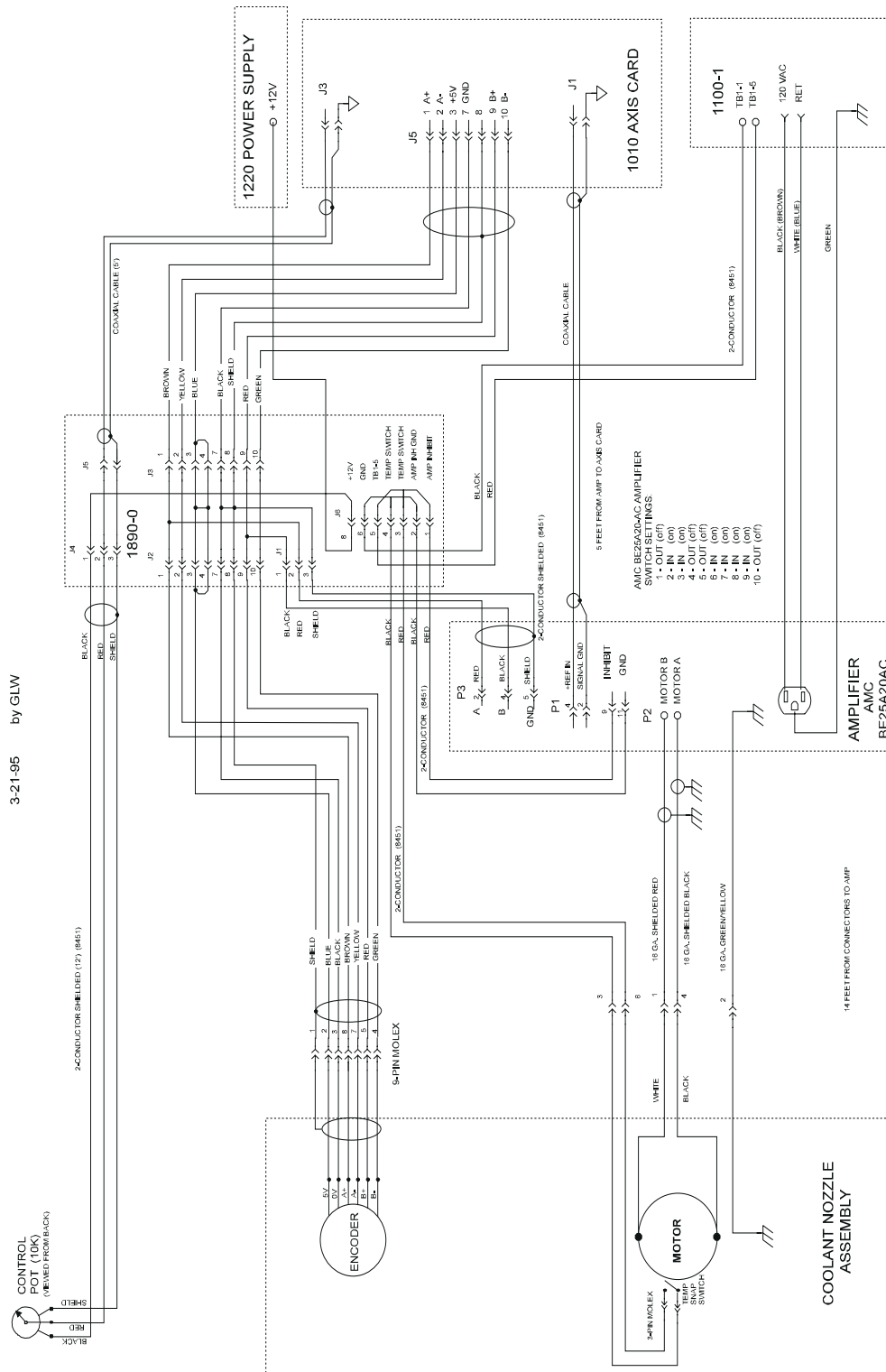


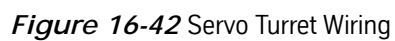
Figure 16-40 Motor Cable Wiring & Bulkhead Connector Wiring

## SERVO COOLANT WIRING

3-21-95 by GLW



**Figure 16-41** Servo Coolant Wiring



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## Section 17: Service Programs

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This section has a listing of all the programs that are used during assembly of the machine. The programs may be helpful when servicing the machine. It is not necessary to type in the programs, as they are stored in EPROM on the main CPU.

To load the programs into memory type the command TA,2 (or TA,5 for program 05827) at the command prompt. If there is already a large program in memory, all the service programs may not fit. It may be necessary to save what is in machine memory and then enter the TA,2 (or TA,5) command again.

---

### Tool Offsets for the Service Programs

TO,1,.5,-1  
TO 11 .5100 0  
TO 12 .5 0  
TO,25,.7,-1.1

---

### TA,2 Programs

**05801-45 Deg Test** N105801(45 DEG TEST  
N2L100  
N3X-4.Y-4.F100.G1  
N4X4.Y4.  
N5M17  
N6M30  
N7(START OF MAIN PROGRAM  
N8L101.1

<b>05802-X Resolver Test</b>	N105802(X RESOLVER TEST N2L100 N3X1.G0 N4X-1. N5G4P1000 N6M17 N7M30 N8G91(START OF THE MAIN PROGRAM N9(THE TABLE WILL MOVE TO THE LEFT IN THE X AXIS N10L130
<b>05803-Y Resolver Test</b>	N105803(Y RESOLVER TEST N2L100 N3Y-1.G0 N4Y1. N5G4P1000 N6M17 N7M30 N8G91(START OF THE MAIN PROGRAM N9(THE TABLE WILL MOVE AWAY FROM YOU IN THE Y AXIS N10L130
<b>05804-Z Resolver Test</b>	N105804(Z RESOLVER TEST N2L100 N3Z1.G0 N4Z-1. N5G4P1000 N6M17 N7M30 N8G91(START OF THE MAIN PROGRAM N9(THE Z AXIS WILL MOVE UP FIRST, THEN DOWN N10L130
<b>05805-Work Toolchanger</b>	N105805(WORK TOOLCHANGER N2L100 N3M3S2000.2 N4X3.Y3.Z-3.F150.G1 N5X-3.Y-3. N6M17 N7L200 N8L101 N9M5M6T5 N10L101 N11M5M6T4 N12L101

N13M5M6T3  
N14L101  
N15M5M6T2  
N16L101  
N17M5M6T10  
N18L101  
N19M5M6T9  
N20L101  
N21M5M6T8  
N22L101  
N23M5M6T7  
N24L101  
N25M5M6T6  
N26L101  
/N27M5M6T21  
/N28L101  
/N29M5M6T20  
/N30L101  
/N31M5M6T19  
/N32L101  
/N33M5M6T18  
/N34L101  
/N35M5M6T17  
/N36L101  
N37M5M6T16  
N38L101  
N39M5M6T15  
N40L101  
N41M5M6T14  
N42L101  
N43M5M6T13  
N44L101  
N45M5M6T12  
N46L101  
N47M5M6T11  
N48M17  
N49M30  
N50G91(START OF THE MAIN PROGRAM  
N51M0(THIS TEST MAKES A TOOL CHANGE AT EVERY TURRET LOCATION  
N52(\*\* SET BLOCK SKIP ON FOR 16 TOOL MACHINES \*\*)  
N53L201.1

**05806-Scrape Z Head** N105806(SCRAPE Z HEAD  
N2L100  
N3X-0.1G0  
N4Y8.2  
N5Z0.1  
N6Y-8.2  
N7Z-0.1  
N8M17  
N9M30  
N10G91(START OF THE MAIN PROGRAM  
N11(  
N12(  
N13(TOOL SHOULD BE POSITIONED TO THE FRONT LEFT  
N14(OF THE SPINDLE DIAMETER  
N15(  
N16(  
N17L178  
N18X7.8

**05807-X Vibration** N105807(X VIBRATION  
N2L100  
N3X6.G0  
N4X-6.  
N5M17  
N6M30  
N7G91(START OF THE MAIN PROGRAM  
N8(  
N9(  
N10(CHECK AND MAKE SURE THE X AXIS MOTOR DOES NOT VIBRATE  
N11(  
N12(  
N13L101.1



**05808-Y Vibration**    N105808(Y VIBRATION  
                              N2L100  
                              N3Y-6.G0  
                              N4Y6.  
                              N5M17  
                              N6M30  
                              N7G91(START OF THE MAIN PROGRAM  
                              N8(  
                              N9(  
                              N10(CHECK THE Y AXIS MOTOR FOR VIBRATION  
                              N11(  
                              N12(  
                              N13L101.1

**05809-Z Vibration**    N105809(Z VIBRATION  
                              N2L100  
                              N3Z-6.G0  
                              N4Z6.  
                              N5M17  
                              N6M30  
                              N7G91(START OF THE MAIN PROGRAM  
                              N8(  
                              N9(  
                              N10(  
                              N11(  
                              N12L101.1

**05810-Orientation** N105810(ORIENTAION  
N2L100  
N3M49  
N4S300  
N5M3  
N6G4P2500  
N7M19  
N8G4P2500  
N9S2501M3  
N10G4P2500  
N11M19  
N12G4P2500  
N13M48  
N14M17  
N15M30  
N16G91(START OF THE MAIN PROGRAM  
N17(  
N18(  
N19(CHECK ORIENTAION IN THE LOW AND HIGH RANGE  
N20(  
N21(  
N22L101.1

**05811-Balance** N105811(BALANCE INCH: 595, METRIC 700IPM: 302  
**Inch: 595, Metric** N2L100  
**700ipm: 302** N3M49  
N4X5.Y5.Z-5.G1F150.  
N5X-5.Y-5.Z5.G1F150.  
N6M17  
N7M30  
N8M91G91(START OF THE MAIN PROGRAM  
N9(  
N10(\*FOR INCH SCREWS:  
N11(BALANCE ALL 3 AXES TO 595 ON THE DISPLAY OR 1.44 VDC  
N12(AT THE COM AND SIG2 LUGS OF THE AXIS AMPLIFIER  
N13(\*FOR METRIC SCREWS:  
N14(BALANCE ALL 3 AXES TO 302 ON THE DISPLAY OR .735 VDC  
N15(AT THE COM AND SIG2 LUGS OF THE AXIS AMPLIFIER  
N16(  
N17(  
N18L101.1

<b>05812-X Balance 680</b>	N105812(X BALANCE 680 N2L100 N3M49 N4X6.G1F100. N5X-6. N6M17 N7M30 N8M91G91(START OF THE MAIN PROGRAM N9( N10( N11(BALANCE THE X TO 680 OR 1.660 VDC N12(AT THE COM AND SIG2 LUGS OF THE AMPLIFIER N13( N14( N15L101.1
<b>05813-Y Balance 680</b>	N105813(Y BALANCE 680 N2L100 N3M49 N4Y6.G1F100. N5Y-6. N6M17 N7M30 N8M91G91(START OF THE MAIN PROGRAM N9( N10( N11(BALANCE THE Y TO 680 OR 1.660 VDC N12(AT THE COM AND SIG2 LUGS OF THE AMPLIFIER N13( N14( N15L101.1

**05814-Z Balance 680** N105814(Z BALANCE 680  
N2L100  
N3M49  
N4Z-6.G1F100.  
N5Z6.  
N6M17  
N7M30  
N8M91G91(START OF THE MAIN PROGRAM  
N9(  
N10(  
N11(BALANCE THE Z TO 680 ON THE CRT OR 1.660 VDC  
N12(AT THE COM AND SIG2 LUGS OF THE AMPLIFIER  
N13(  
N14(  
N15L101.1

**05815-A or B 680 Balance** N105815(A OR B 680 BALANCE  
N2L100  
N3M49  
N4A360.G1F1.(\*\* CHANGE F,A OR B THIS BLOCK \*\*  
N5A-360.  
N6M17  
N7M30  
N8(START OF THE MAIN PROGRAM  
N9M0(\*\*\* BE SURE TO SELECT THE CORRECT FEED \*\*\*  
N10(\*\*\* BESURE THE F-WORD IS WITH THE ROTARY MOVE \*\*\*  
N11(72 TO 1 RATIO = F2500.  
N12(90 TO 1 RATIO = F2000.  
N13(120 TO 1 RATIO = F1500.  
N14(180 TO 1 RATIO = F1000.  
N15(360 TO 1 RATIO = F500.  
N16(  
N17(BALANCE A SINGLE AXIS TO 680 OR 1.660 VDC  
N18(AT THE COM AND SIG2 LUGS OF THE AMPLIFIER  
N19(  
N20L101.1

<b>05817-Spin Fwd Rev</b>	N105817(SPIN FWD REV N2L100 N3M3S1000.2 N4G4P3500 N5M4 N6G4P3500 N7M17 N8M30 N9G91(START OF THE MAIN PROGRAM N10( N11( N12(TEST FOR SPINDLE RUNNING FORWARD AND REVERSE N13( N14( N15L101.1
<b>05818-Workout 2216</b>	N105818(WORKOUT 2216 N2L100 N3(WORK AXIS TO LIMIT WITH Z ALL THE WAY UP N4Z4.G0 N5Y8. N6X-11. N7Y-8. N8Y-8. N9X11. N10X11. N11Y8. N12Y8. N13X-11. N14Y-8. N15Z-4. N16Z-16. N17Y8. N18X-11. N19Y-8. N20Y-8. N21X11. N22X11. N23Y8. N24Y8. N25X-11. N26Y-8. N27Z16. N28M17 N29L200

N30(MOVES BEFORE TOOL CHANGE TEST  
N31M3S1000  
N32X3.Y3.Z-3.G0  
N33X-3.Y-3.Z3.  
N34M17  
N35L300  
N36(TOOL CHANGER TURRET TEST FULL 360 DEGREE ROTATION  
N37L201  
N38M5M6T1  
N39L201  
N40M5M6T11  
N41L201  
N42M5M6T21  
N43L201  
N44M5M6T11  
N45L201  
N46M17  
N47L400  
N48(STEP UP THE RPM AND TEST ORIENTATION  
N49M+R3S1000  
N50G4P1500  
N51M19  
N52M+R3S2500  
N53G4P1500  
N54M19  
N55M+R3S2501  
N56G4P1500  
N57M19  
N58M+R3S5000  
N59G4P1500  
N60M19  
N61M+R3S8000  
N62G4P1500  
N63M19  
N64M+R3S10000  
N65G4P2000  
N66M19  
N67M+R3S300  
N68G4P1000  
N69M19  
N70M+R3  
N71G4P750  
N72M19  
N73M+R3  
N74G4P750

N75M19  
N76M3S10000  
N77G4P2500  
N78M4S10000  
N79G4P2500  
N80M3S10000  
N81G4P2500  
N82M4S10000  
N83G4P2500  
N84M17  
N85L500  
N86L101  
N87L301  
N88L401  
N89M17  
N90M30  
N91G91(START OF THE MAIN PROGRAM  
N92(  
N93(  
N94(\*\*\*\*\*  
N95(\*\*\*\*\* WARNING \*\*\*\*\*  
N96(\*\*\*\*\*  
N97(  
N98(  
N99(NO TOOLS CAN BE IN THE SPINDLE AND NOTHING ON THE TABLE  
N100(  
N101(  
N102M0  
N103L501.1

**O5819-Workout  
4020**

N105819(WORKOUT 4020  
N2L100  
N3(WORK AXIS TO LIMIT WITH Z ALL THE WAY UP  
N4Z4.G0  
N5Y10.  
N6X-20.  
N7Y-10.  
N8Y-10.  
N9X20.  
N10X20.  
N11Y10.  
N12Y10.  
N13X-20.  
N14Y-10.  
N15Z-4.

N16Z-16.  
N17Y10.  
N18X-20.  
N19Y-10.  
N20Y-10.  
N21X20.  
N22X20.  
N23Y10.  
N24Y10.  
N25X-20.  
N26Y-10.  
N27Z16.  
N28M17  
N29L200  
N30(MOVES BEFORE TOOL CHANGE TEST  
N31M3S1000  
N32X3.Y3.Z-3.G0  
N33X-3.Y-3.Z3.  
N34M17  
N35L300  
N36(TOOL CHANGER TURRET TEST FULL 360 DEGREE ROTATION  
N37L201  
N38M5M6T1  
N39L201  
N40M5M6T11  
N41L201  
N42M5M6T21  
N43L201  
N44M5M6T11  
N45L201  
N46M17  
N47L400  
N48(STEP UP THE RPM AND TEST ORIENTATION  
N49M+R3S1000  
N50G4P2500  
N51M19  
N52M+R3S2500  
N53G4P2500  
N54M19  
N55M+R3S2501  
N56G4P2500  
N57M19  
N58M+R3S5000  
N59G4P2500  
N60M19



N61M+R3S8000  
N62G4P3500  
N63M19  
N64M+R3S10000  
N65G4P4000  
N66M19  
N67M+R3S300  
N68G4P2000  
N69M19  
N70M+R3  
N71G4P2000  
N72M19  
N73M+R3  
N74G4P2000  
N75M19  
N76G4P2000  
N77M17  
N78L500  
N79L101  
N80L301  
N81L401R3+0.0003(SPINDLE FORWARE  
N82L401R3+0.0004(SPINDLE REVERSE  
N83M17  
N84M30  
N85(START OF THE MAIN PROGRAM  
N86(  
N87(  
N88(\*\*\*\*\*  
N89(\*\*\*\*\* WARNING \*\*\*\*\*  
N90(\*\*\*\*\*  
N91(  
N92(  
N93(NO TOOLS CAN BE IN THE SPINDLE AND NOTHING ON THE TABLE  
N94(  
N95(  
N96M0  
N97L501.1

**05820-Workout  
6030** N105820(WORKOUT 6030  
N2L100  
N3(WORK AXIS TO LIMIT WITH Z ALL THE WAY UP  
N4Z4.G0  
N5Y10.  
N6X-30.  
N7Y-10.  
N8Y-10.  
N9X30.  
N10X30.  
N11Y10.  
N12Y10.  
N13X-30.  
N14Y-10.  
N15Z-4.  
N16Z-26.  
N17Y10.  
N18X-30.  
N19Y-10.  
N20Y-10.  
N21X30.  
N22X30.  
N23Y10.  
N24Y10.  
N25X-30.  
N26Y-10.  
N27Z26.  
N28M17  
N29L200  
N30(MOVES BEFORE TOOL CHANGE TEST  
N31M3S1000  
N32X3.Y3.Z-3.G0  
N33X-3.Y-3.Z3.  
N34M17  
N35L300  
N36(TOOL CHANGER TURRET TEST FULL 360 DEGREE ROTATION  
N37L201  
N38M5M6T1  
N39L201  
N40M5M6T11  
N41L201  
N42M5M6T21  
N43L201  
N44M5M6T11  
N45L201

N46M17  
N47L400  
N48(STEP UP THE RPM AND TEST ORIENTATION)  
N49M+R3S1000  
N50G4P1500  
N51M19  
N52M+R3S2500  
N53G4P1500  
N54M19  
N55M+R3S2501  
N56G4P1500  
N57M19  
N58M+R3S5000  
N59G4P1500  
N60M19  
N61M+R3S8000  
N62G4P1500  
N63M19  
N64M+R3S10000  
N65G4P2000  
N66M19  
N67M+R3S300  
N68G4P1000  
N69M19  
N70M+R3  
N71G4P750  
N72M19  
N73M+R3  
N74G4P750  
N75M19  
N76M3S10000  
N77G4P2500  
N78M4S10000  
N79G4P2500  
N80M3S10000  
N81G4P2500  
N82M4S10000  
N83G4P2500  
N84M17  
N85L500  
N86L101  
N87L301  
N88L401  
N89M17  
N90M30

```
N91(START OF THE MAIN PROGRAM
N92(
N93(
N94(*****
N95(***** WARNING *****
N96(*****
N97(
N98(
N99(NO TOOLS CAN BE IN THE SPINDLE AND NOTHING ON THE TABLE
N100(
N101(
N102M0
N103L501.1
```

**05821- X Calib 2216**

```
N105821(X CALIB 2216
N2L100
N3Z0.4G1F40.
N4X0.99Z-0.4
N5F2.9X0.01
N6G4P3000
N7M17
N8M30
N9G91(START OF THE MAIN PROGRAM
N10(
N11(
N12(VMC 2216 X AXIS CALIBRATION
N13(
N14(
N15M5M19
N16Z0.4G1F40.
N17X-0.2
N18X0.19Z-0.4
N19F2.9X0.01
N20M0
N21(ZERO INDICATOR DIAL
N22L121
N23F40.Z0.4
N24X-21.2
N25X0.19Z-0.4
N26F2.9X0.01
```

**05822 -Y Calib 2216** N105822(Y CALIB 2216  
N2L100  
N3Z0.4G1F40.  
N4Y0.99Z-0.4  
N5F2.9Y0.01  
N6G4P3000  
N7M17  
N8M30  
N9G91(START OF THE MAIN PROGRAM  
N10(  
N11(  
N12(VMC 2216 Y AXIS CALIBRATION  
N13(  
N14(  
N15M5M19  
N16Z0.4G1F40.  
N17Y-0.2  
N18Y0.19Z-0.4  
N19F2.9Y0.01  
N20M0  
N21(ZERO INDICATOR DIAL  
N22L115  
N23F40.Z0.4  
N24Y-15.2  
N25Y0.19Z-0.4  
N26F2.9Y0.01

**05823-X Calib 4020** N105823(X CALIB 4020  
N2L100  
N3Z0.4G1F40.  
N4X0.99Z-0.4  
N5F2.9X0.01  
N6G4P3000  
N7M17  
N8M30  
N9G91(START OF THE MAIN PROGRAM  
N10(  
N11(  
N12(VMC 4020 X AXIS CALIBRATION  
N13(  
N14(  
N15M5M19  
N16Z0.4G1F40.  
N17X-0.2  
N18X0.19Z-0.4

N19F2.9X0.01  
N20M0  
N21(ZERO INDICATOR DIAL  
N22L139  
N23F40.Z0.4  
N24X-39.2  
N25X0.19Z-0.4  
N26F2.9X0.01

**05824 — Y Calib  
4020**

N105824(Y CALIB 4020  
N2L100  
N3Z0.4G1F40.  
N4Y0.99Z-0.4  
N5F2.9Y0.01  
N6G4P3000  
N7M17  
N8M30  
N9G91(START OF THE MAIN PROGRAM  
N10(  
N11(  
N12(VMC 4020 Y AXIS CALIBRATION  
N13(  
N14(  
N15M5M19  
N16Z0.4G1F40.  
N17Y-0.2  
N18Y0.19Z-0.4  
N19F2.9Y0.01  
N20M0  
N21(ZERO INDICATOR DIAL  
N22L119  
N23F40.Z0.4  
N24Y-19.2  
N25Y0.19Z-0.4  
N26F2.9Y0.01

**05825 — X Calib  
6030**

N105825(X CALIB 6030  
N2L100  
N3F40.Z0.4  
N4X0.99Z-0.4  
N5F2.9X0.01  
N6G4P3000  
N7M17  
N8M30  
N9G91(START OF THE MAIN PROGRAM

N10(  
N11(  
N12(VMC 6030 X AXIS CALIBRATION  
N13(  
N14(  
N15M5M19G1  
N16F40.Z0.4  
N17X-0.2  
N18X0.19Z-0.4  
N19F2.9X0.01  
N20M0  
N21(ZERO THE INDICATOR  
N22L159  
N23F40.Z0.4  
N24X-59.2  
N25X0.19Z-0.4  
N26F2.9X0.01

**05826-Y Calib 6030**

N105826(Y CALIB 6030  
N2L100  
N3F40.Z0.4  
N4Y0.99Z-0.4  
N5F2.9Y0.01  
N6G4P3000  
N7M17  
N8M30  
N9G91(START OF THE MAIN PROGRAM  
N10(  
N11(  
N12(VMC 6030 Y AXIS CALIBRATION  
N13(  
N14(  
N15M5M19G1  
N16F40.Z0.4  
N17Y-0.2  
N18Y0.19Z-0.4  
N19F2.9Y0.01  
N20M0  
N21(ZERO INDICATOR DIAL  
N22L129  
N23F40.Z0.4  
N24Y-29.2  
N25Y0.19Z-0.4  
N26F2.9Y0.01

**05828-Scrape 6030 Table**

N105828(SCRAPE 6030 TABLE  
N2(  
N3(SET Z HOME +.010 ABOVE TABLE  
N4(SET X HOME +30.0  
N5(SET Y HOME -14.7  
N6(  
N7L100  
N8X-0.3Y0.3I-0.3  
N9X-0.3Y-0.3J-0.3  
N10G4P175  
N11L200  
N12X-0.3Y-0.3J-0.3  
N13G4P175  
N14X-0.3Y0.3I-0.3  
N15L300  
N16L199  
N17Z0.01  
N18X59.4G5  
N19Y0.6G5  
N20Z-0.01  
N21L299  
N22Z0.01  
N23X59.4G5  
N24Y0.6G5  
N25Z-0.01  
N26M17  
N27M30  
N28G91M19  
N29M0(CHECK IF TOOL IS ORIENTED WITH LOWEST PART TO THE LEFT  
N30(\*\*\*) TOOL TIP IS .01 ABOVE TABLE \*\*\*  
N31G1F150.  
N32Z-0.01  
N33L324  
N34L199  
N35Z0.01  
N36X59.4G5  
N37Y0.6G5  
N38Z-0.01  
N39L299  
N40Z0.01  
N41M2



**05829 — Mill 6030 Table**

N105829(MILL 6030 TABLE  
N2(  
N3(SET Z HOME +.010 ABOVE TABLE  
N4(SET X HOME +30.  
N5(SET Y HOME -13.75  
N6(  
N7G91M0(CHECK IF TOOL IS .01 ABOVE DESIRED DEPTH OF CUT?  
N8M3S200  
N9G1F0.1Z-0.01  
N10F4.X-60.  
N11Y5.5  
N12X60.  
N13Y5.5  
N14X-60.  
N15Y5.5  
N16X60.  
N17Y5.5  
N18X-60.  
N19Y5.5  
N20X60.  
N21F0.1Z0.01  
N22M5  
N23M2

**05830-Scrape 4020 Table**

N105830(SCRAPE 4020 TABLE  
N2(  
N3(SET Z HOME +.01 ABOVE TABLE  
N4(SET X HOME +20.  
N5(SET Y HOME -9.9  
N6(  
N7L100  
N8X-0.3Y0.3I-0.3  
N9X-0.3Y-0.3J-0.3  
N10G4P175  
N11L200  
N12X-0.3Y-0.3J-0.3  
N13G4P175  
N14X-0.3Y0.3I-0.3  
N15L300  
N16Z-0.01  
N17L166  
N18Z0.01  
N19X39.6G5  
N20Y0.6G5  
N21Z-0.01

N22L266  
N23Z0.01  
N24X39.6G5  
N25L400  
N26Z-0.01F150.G1  
N27L112  
N28Z0.01  
N29X7.2G5  
N30Y0.6G5  
N31Z-0.01  
N32L212  
N33Z0.01  
N34X7.2G5  
N35M17  
N36M30  
N37G91M19  
N38M0(CHECK IF TOOL IS ORIENTED WITH LOWEST PART TO THE LEFT  
N39 (\*\*TOOL TIP IS .01 ABOVE TABLE \*\*)  
N40 (SET LEFT TOOL .01 ABOVE TABLE REMOVE OR RAISE RIGHT TOOL  
N41G91G1F150.  
N42L333  
N43Y-19.8G5  
N44M0 (RAISE LEFT TOOL SET RIGHT TOOL .010 ABOVE TABLE  
N45L433  
N46Y-19.8  
N47M2

**05831-Mill 4020 Table**

N105831(MILL 4020 TABLE  
N2(  
N3 (SET Z HOME +.01  
N4 (SET X HOME +20.  
N5 (SET Y HOME -10.  
N6(  
N7M0(CHECK IF TOOL IS .01 ABOVE DESIRED DEPTH OF CUT  
N8G91M3S150  
N9G0Y9.9  
N10G1F2.Y0.1Z-0.01  
N11F3.X-40.  
N12Y8.25  
N13X40.  
N14Y-16.5  
N15X-40.  
N16Y8.5  
N17Y0.5Z0.01  
N18M5  
N19M2

**05832-Scrape 2216 Table**

N105832(SCRAPE 2216 TABLE  
N2(  
N3 (SET Z HOME +.01 ABOVE TABLE  
N4(SET X HOME 8.25  
N5(SET Y HOME -7.8  
N6(  
N7L100  
N8X-0.3Y0.3I-0.3  
N9X-0.3Y-0.3J-0.3  
N10G4P175  
N11L200  
N12X-0.3Y-0.3J-0.3  
N13G4P175  
N14X-0.3Y0.3I-0.3  
N15L300  
N16Z-0.01  
N17L130  
N18Z0.01  
N19X18.G5  
N20Y0.6G5  
N21Z-0.01  
N22L230  
N23Z0.01  
N24X18.G5  
N25L400

N26Z-0.01F150.G1  
N27L132  
N28Z0.01  
N29X19.2G5  
N30Y0.6G5  
N31Z-0.01  
N32L232  
N33Z0.01  
N34X19.2G5  
N35M17  
N36M30  
N37G91M19  
N38M0 (CHECK IF TOOL IS ORIENTED WITH LOWEST PART TO THE LEFT  
N39(\*\* TOOL TIP IS .01 ABOVE TABLE \*\*\*)  
N40 (SET LEFT TOOL .01 ABOVE TABLE REMOVE OR RAISE RIGHT TOOL  
N41G91G1F150.  
N42L326  
N43Y-15.6G5  
N44M0 (RAISE LEFT TOOL SET RIGHT TOOL .010 ABOVE TABLE  
N45(\*\* MOVE X 2.5 IN. AND SET NEW X HOME \*\*\*)  
N46(\*\*TO START RIGHT TOOL ENTER AU,48,,1  
N47(\*\*  
N48L426  
N49Y-15.6  
N50M2

**05833-Mill VMC  
2216**

N105833(MILL VMC 2216  
N2(  
N3(HOME X+11.  
N4( , Y+.100  
N5( Z+.01 ABOVE TABLE  
N6(  
N7S150M3(USE 4020 FLYCUTTER  
N8Y-0.1Z-0.01F1.G1  
N9X-22.F3.  
N10Y8.  
N11X22.  
N12Y-16.  
N13X-22.  
N14Y8.1  
N15Z0.01  
N16M5  
N17M2

**05834-Scrape 20  
Table**

N105834(SCRAPE 20 TABLE  
N2(  
N3(SET Z HOME +.01 ABOVE TABLE  
N4(SET X HOME 8.25  
N5(SET Y HOME -7.8  
N6(  
N7L100  
N8X-0.3Y0.3I-0.3  
N9X-0.3Y-0.3J-0.3  
N10G4P175  
N11L200  
N12X-0.3Y-0.3J-0.3  
N13G4P175  
N14X-0.3Y0.3I-0.3  
N15L300  
N16Z-0.01  
N17L123  
N18Z0.01  
N19X13.8G5  
N20Y0.6G5  
N21Z-0.01  
N22L223  
N23Z0.01  
N24X13.8G5  
N25L400  
N26Z-0.01F150.G1  
N27L125  
N28Z0.01  
N29X15.G5  
N30Y0.6G5  
N31Z-0.01  
N32L225  
N33Z0.01  
N34X15.G5  
N35M17  
N36M30  
N37G91M19  
N38M0(CHECK IF TOOL IS ORIENTED WITH LOWEST PART TO THE LEFT  
N39(\* SET LEFT TOOL .01 ABOVE TABLE REMOVE, RAISE RIGHT TOOL  
N40G91G1F150.  
N41L326  
N42Y-15.6G5  
N43M0(RAISE LEFT TOOL, SET RIGHT TOOL .010 ABOVE TABLE  
N44(\*\* MOVE X-2.3 IN. AND SET NEW X HOME \*\*\*  
N45(\*\*TO START RIGHT TOOL ENTER AU,48,,1

N46(\*\*  
N47(\*\*  
N48L426  
N49Y-15.6  
N50M2

**05835-Test Scales**

N105835(TEST SCALES  
N2L100(TEST 6030 X-TEST  
N3G0X-30.  
N4G1F50.X60.  
N5G0X-30.  
N6G4P3000M1  
N7L200(TEST 6030 Y-AXIS  
N8G0Y-15.  
N9G1F50.Y30.  
N10G0Y-15.  
N11G4P3000M1  
N12L300(TEST 4020 X-AXIS  
N13G0X-20.  
N14G1F50.X40.  
N15G0X-20.  
N16G4P3000M1  
N17L400(TEST 4020 Y-AXIS  
N18G0Y-10.  
N19G1F50.Y20.  
N20G0Y-10.  
N21G4P3000M1  
N22M17  
N23M30  
N24(\*\*\*\*\*  
N25(START ALL TESTS AT COLDSTART  
N26(\*\*\*\*\*  
N27(TEST 6030 X AXIS  
N28L101.1  
N29(  
N30(TEST 6030 Y AXIS  
N31L201.1  
N32(  
N33(TEST 4020 X AXIS  
N34L301.1  
N35(  
N36(TEST 4020 Y AXIS  
N37L401.1  
N38(

**05836-Test Cut** N105836(TEST CUT  
N2(11-10-92  
N3L100  
N4M6T11(TOOL 11=.500 DIA. ROUGHING ENDMILL  
N5G90S7000M3  
N6X0.75Y4.G0  
N7H11Z-1.7M7  
N8X0F75.G1G41  
N9Y1.G8  
N10X-1.Y0I-1.G2  
N11X-2.9G1  
N12X-3.9Y1.J1.G2  
N13Y2.9G1  
N14X-2.9Y3.9I1.G2  
N15X-1.G1  
N16X0Y2.9J-1.G2  
N17Y-0.5G1  
N18Z-1.25G0G40  
N19X-0.6242Y0.6242F75.G1G41  
N20X-0.6242Y0.6242I-1.3258J1.3258G2  
N21G40  
N22X-3.9Y3.9G1F50.  
N23M5M9  
N24M17  
N25M30  
N26L101  
N27M6T12(TOOL 12=.500 DIA. FINISH ENDMILL  
N28S10000M3  
N29X0.75Y4.G0  
N30H12Z-1.7  
N31X0F50.G1G41  
N32Y1.G8  
N33X-1.Y0I-1.G2  
N34X-2.9G1  
N35X-3.9Y1.J1.G2  
N36Y2.9G1  
N37X-2.9Y3.9I1.G2  
N38X-1.G1  
N39X0Y2.9J-1.G2  
N40X0.1Y1.5G1  
N41Z-1.25G0  
N42X0Y0F50.G1  
N43G40  
N44G8  
N45X-0.6242Y0.6242G1G41

N46X-0.6242Y0.6242I-1.3258J1.3258G2  
N47X0Y0G40  
N48G8  
N49G41Y0.3536G1  
N50X-3.5464Y3.9  
N51X-3.9Y3.5464  
N52X-0.3536Y0  
N53G40X0.5Y0G0  
N54Y2.8  
N55X0.2Y3.1198G41G1F50.  
N56X-1.7Y3.4548  
N57X-1.7Y2.8456  
N58X0.2Y2.5105  
N59X0.2Y3.1248  
N60X-1.7Y3.4598  
N61X-1.7Y2.8406  
N62X0.2Y2.5055  
N63Z0G0  
N64G40X-2.8Y-0.5  
N65Z-1.25  
N66X-2.5105Y-0.2G41G1F50.  
N67X-2.8192Y1.55  
N68X-3.4284Y1.55  
N69X-3.1198Y-0.2  
N70X-2.5055Y-0.2  
N71X-2.8142Y1.55  
N72X-3.4334Y1.55  
N73X-3.1248Y-0.2  
N74Z0G0  
N75X0.75Y4.G40G0  
N76S5000G4P1000  
N77Z-1.375  
N78X-0.025F50.G1G41  
N79Y1.G8  
N80X-1.Y0.025I-0.975G2  
N81X-2.9G1  
N82X-3.875Y0.975J0.975G2  
N83Y2.9G1  
N84X-2.9Y3.875I0.975G2  
N85X-1.G1  
N86X-0.025Y2.9J-0.975G2  
N87X0.01Y1.5G1  
N88Z-1.125G0  
N89X0Y0F50.G1  
N90G40



N91G8  
N92X-0.6492Y0.6492G1G41  
N93X-0.6492Y0.6492I-1.3008J1.3008G2  
N94X0Y0G1  
N95G40  
N96G8  
N97Y0.3889G41  
N98X-3.5111Y3.9G1  
N99X-3.9Y3.5111  
N100X-0.3889Y0  
N101G40X0  
N102M5M9  
N103G28  
N104M2

**05837-Probe Cycle  
Test**

N105837(PROBE CYCLE TEST  
N2L100(FIND TARGET POINT)  
N3M65  
N4G31G1F100.Z-26.  
N5G91  
N6Z-0.05  
N7Z0.075  
N8G90  
N9G31G1F0.5Z-26.P1(FINAL TOUCH (TARGET POINT)  
N10L9101R1+5.(CHANGE P1 TO R1  
N11R9+R1(STORE R1 IN MEMORY AS R9  
N12G91G1F50.Z-0.05  
N13M17  
N14L200  
N15G90  
N16G10L108P+R9(MAKE R8=R9  
N17G10L107P+R9(MAKE R7=R9  
N18G91  
N19G10L108P-0.0011(CHANGE R8 BY -.0011 FOR MAXIMUM RANGE  
N20G10L107P0.0010(CHANGE R7 BY .001 FOR MINIMUM RANGE  
N21G90  
N22G10L12P99R+R9(STORE TARGET POINT AS DIA. #99  
N23G0Z0  
N24M17  
N25L300  
N26G91  
N27G10L12P75R+0.0001(DIA. #75 REPRESENTS COUNTER  
N28D75(DISPLAY COUNTER ON SCREEN  
N29G90G0Z0  
N30M65

N31G31G1F50.Z-26.  
N32G91  
N33Z-0.05  
N34Z0.075  
N35G90  
N36G31G1F0.5Z-26.P1  
N37L9101R1+5.  
N38G10L12P87R+R1(STORE TOUCH POINT IN TOOL TABLE  
N39D87  
N40M17  
N41M30  
N42G90G1G80G40G17M49  
N43G10L12P75R+0(ZERO COUNTER  
N44L101(INITIAL POINT  
N45L201(ADJUST RANGE  
N46L301(FIND TEST TOUCH  
N47L9101Z+R7R1+7.R2+54.R3+49.R4-1.(AT OR PAST R7?  
N48M99P+R2  
N49L9101Z+R8R1+7.R2+53.R3+54.R4-1.(NOT PAST R8?  
/N50G4P2000  
N51M99P+R2  
N52(\*\*\*\*PASSED, CONTINUE PROGRAM\*\*\*\*  
N53M99P57  
N54(\*\*\*\*FAILED\*\*\*\*)  
N55M1  
N56M99P54(LOOP FAILED MESSAGE  
N57G91G1Z-0.05F20.(NEXT TEST  
N58M99P46

**05838-Spindle  
Break In**

N105838(SPINDLE BREAK IN  
N2G90Z0G0  
N3G91M49  
N4M3S1000  
N5Z-1.G1F0.2  
N6S2000  
N7Z1.  
N8S3000  
N9Z-1.  
N10S4000  
N11Z1.  
N12S5000  
N13Z-1.  
N14M5  
N15Z1.  
N16S7000M3

N17Z-0.5  
N18M5  
N19Z-0.5  
N20S10000M3  
N21Z0.1  
N22M5  
N23Z0.1  
N24M3  
N25Z0.8  
N26M2

**O5839-Pallet  
Changer**

N105839(PALLET CHANGER)  
N2(TABLE MODIFICATIONS FOR FADAL PALLET CHANGER)  
N3L100(3/8-16 8PLS)  
N4G90  
N5X-19.625Y1.25  
N6X-19.625Y-1.25  
N7X-16.375Y-1.25  
N8X-16.375Y1.25  
N9X-15.4Y-9.13  
N10X-10.15  
N11X-4.9  
N12X0.35  
N13M17  
N14L200(3/8-16 32 PLS)  
N15G90  
N16X-14.404Y7.5  
N17X-12.091  
N18X-9.779  
N19X-7.468  
N20Y3.75X-7.468  
N21X-9.779  
N22X-12.091  
N23X-14.404  
N24Y-3.75X-14.404  
N25X-12.091  
N26X-9.779  
N27X-7.468  
N28Y-7.5X-7.468  
N29X-9.779  
N30X-12.091  
N31X-14.404  
N32X14.403Y7.5  
N33X12.091  
N34X9.779

N35X7.467  
N36Y3.75X7.467  
N37X9.779  
N38X12.091  
N39X14.403  
N40Y-3.75X14.403  
N41X12.091  
N42X9.779  
N43X7.467  
N44Y-7.5X7.467  
N45X9.779  
N46X12.091  
N47X14.403  
N48M17  
N49L300(.390 DIA HOLES 16 PLS)  
N50G90  
N51X-14.404Y5.22  
N52X-12.091  
N53X-9.779  
N54X-7.468  
N55Y-5.22X-7.468  
N56X-9.779  
N57X-12.091  
N58X-14.404  
N59X7.467  
N60X9.779  
N61X12.091  
N62X14.403  
N63Y5.22X14.403  
N64X12.091  
N65X9.779  
N66X7.467  
N67M17  
N68M30  
N69M6T1(CENTER DRILL)  
N70G90G0S1200M3  
N71H1Z-0.9X-16.8Y5.3  
N72G81G98R-0.9F4.Z-1.225  
N73L301  
N74L101  
N75R-2.Z-2.41  
N76L201  
N77G80  
N78M5M9  
N79G28

N80M6T2(.312 DRILL)  
N81G90G0S1400M3  
N82H2Z-0.9X-16.8Y7.6  
N83G83G98R-0.9Q0.14F6.Z-2.1  
N84L101  
N85R-2.Z-3.285  
N86L201  
N87G80  
N88M5M9  
N89G28  
N90M6T3(3/8-16 TAP EXTENDED)  
N91G90G0S200M3  
N92H3Z-0.9X-19.7Y1.3  
N93G84G98R-0.9Q0.0625F200.Z-1.8  
N94L101  
N95R-2.Z-2.985  
N96L201  
N97G80  
N98M5M9  
N99G28  
N100M6T4(.390 DRILL)  
N101G90G0S1200M3  
N102H4Z-0.9X-16.8Y5.3  
N103G83G98R-0.9Q0.14F6.Z-3.9  
N104L301  
N105G80  
N106M5M9  
N107G28  
N108M0  
N109(INSTALL RAIL SUPPORTS)  
N110M0  
N111M0  
N112G90G0S1500M3  
N113H4Z1.475  
N114G83G98R+1.475Z-1.3  
N115L301  
N116G80  
N117M5M9  
N118G28  
N119M6T5(.1875 DIA END MILL)  
N120G90G0S4000M3  
N121H5Z2.Y5.3X-17.434  
N122Z1.225Y5.22X-17.434  
N123X-5.75G1F15.  
N124X5.75G5

N125X17.434G1  
N126Y-5.22G5  
N127X5.75G1  
N128X-5.75G5  
N129X-17.434G1  
N130M5M9  
N131G28  
N132M6T6(1.5 DIA BALL)  
N133G90G0S3200M3  
N134X-18.37Y5.32H6Z2.  
N135Z1.255Y5.22X-18.37  
N136X-5.75G1F30.  
N137X5.75G5  
N138X18.37G1  
N139Y-5.22G5  
N140X5.75G1  
N141X-5.75G5  
N142X-18.37G1  
N143Y5.32G5  
N144Y5.22G5  
N145Z1.25  
N146X-5.75G1F35.  
N147X5.75G5  
N148X18.37G1  
N149Y-5.22G5  
N150X5.75G1  
N151X-5.75G5  
N152X-18.37G1  
N153M5M9  
N154G28  
N155M6T1  
N156M2

**05840-Mill Pallet  
Table**

N105840(MILL PALLET TABLE  
N2(HOME IS Y=0 X=19.5 Z=0  
N3(SET HERTEL TO 1.0 ABOVE PALLET TABLE  
N4G0G90(5.0 DIA. HERTEL FACEMILL  
N5M3S5000Y2.375  
N6Z-0.75H1  
N7G1Z-0.99F10.M7  
N8Z-1.002G1F2.  
N9G1X-39.F75.  
N10Y7.125  
N11X0  
N12Y-7.125

N13X-39.  
N14Y-2.375  
N15X0  
N16M5M9  
N17G0G49Z0  
N18M2

**05841-Mill Pallet  
Slot .687-.689**

N105841(MILL PALLET SLOT .687-.689  
N2(HOME POSITION X=18.75 Y=0 Z=0  
N3(SET TOOL 1.0 ABOVE PALLET TABLE  
N4(.500 DIA. 2FL ENDMILL  
N5G0G90M3S10000  
N6H1Z-1.375M8  
N7G1G41Y0.344F60.  
N8M92  
N9G8  
N10X-37.5  
N11G3Y-0.344J-0.344  
N12G1X0  
N13G3Y0.344J0.344  
N14G9  
N15M90  
N16G0G40Y0  
N17M5M9  
N18G0G49Z0  
N19M2

**05842-Engrave  
Pallet A**

N105842(ENGRAVE PALLET A  
N2(HOME X= -19.25 Y= -9.15 Z=0  
N3(SET TOOL 1.0 ABOVE PALLET TABLE  
N4(.125 DIA. ENDMILL  
N5G0G90M3S10000  
N6Z-0.98H1  
N7L9201R-0.98R1+0R2+1.R3+0Z-1.01F20.(A  
N8M5M9  
N9G0G49Z0  
N10M2

**05843 — Center  
Bearing Assy.**

N105843(CENTER BEARING ASSY.  
N2(\*\*\*\*\*  
N3(PROCEDURE TO SET UP:  
N4(1. SET HOME:  
N5( Z COLD START  
N6(2. SETX AND SETY  
N7(3. SETY AT Y-3.75

```
N8(*****  
N9(START C. DRILL  
N10G0G90  
N11H1  
N12M3S2000  
N13G81G99Z-1.15R-0.9F15.  
N14X13.25Y3.  
N15Y7.334  
N16Y11.666  
N17Y16.  
N18G80  
N19Z0G0M5  
N20M6T2  
N21(START .390 DRILL  
N22G0G90  
N23H2  
N24M3S1100  
N25G83G99R-0.9Z-2.9F10.Q0.1X13.25Y16.  
N26Y11.666  
N27Y7.334  
N28Y3.  
N29G80  
N30Z0G0M5  
N31M6T3  
N32(START 5/8 END MILL  
N33H3  
N34M3S950  
N35G83G99R-0.9Z-1.44Q0.1F10.X13.25Y3.  
N36Y7.334  
N37Y11.666  
N38Y16.  
N39G80  
N40Z0G0M5  
N41M6T1  
N42G28  
N43M2
```

```
05844-Mill VMC 20 N105844(MILL VMC 20  
N2(  
N3(HOME X+10.  
N4( Y+.100  
N5( Z+.01 ABOVE TABLE  
N6(  
N7S150M3(USE 4020 FLYCUTTER  
N8Y-0.1Z-0.01F1.G1
```



N9X-20.F3.  
N10Y8.  
N11X20.  
N12Y-16.  
N13X-20.  
N14Y8.1  
N15Z0.01  
N16M5  
N17M2

**O5845-Mill VMC 15** N105845(MILL VMC 15  
N2(  
N3(HOME X+10.  
N4( Y+5.5  
N5( Z+.01  
N6(  
N7S150M3(USE VMC15 CUTTER  
N8Z-0.01F1.G1  
N9X-20.F3.  
N10Y11.  
N11X20.  
N12Y-11.  
N13Z0.01  
N14M5  
N15M2

**O6000-Rigid Tap  
Cycle** N106000(RIGID TAP CYCLE  
N2G80  
N3S750  
N4M19  
N5G91  
N6X0.1Y0.1G1F10.  
N7G84.1Z-1.R+0F750.Q0.0714  
N8X-0.1Y-0.1G1F10.  
N9M45  
N10M45  
N11M45  
N12M45  
N13G80  
N14M5  
N15G4P66000  
N16M99P5  
N17(!  
N18(NOTE: O5827 CNC88 TEST WAS MOVED TO TA,5!!!

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**TA,5 Programs**

**05827-Cycle Test** N105827(CYCLE TEST)  
N2L100(BEGIN XY RECIP  
N3G0G90  
N4G53X10.Y-8.  
N5G1  
N6G53X-10.Y8.  
N7M11  
N8M12  
N9M17  
N10L200(Z RECIP)  
N11G0G90  
N12Z0  
N13G1  
N14G53Z4.(MOVE FROM SETZ TO TOP STROKE)  
N15M13  
N16M17  
N17L300(A AXIS RECIP)  
N18G91  
N19G1F2000.A360.  
N20M15  
N21G90  
N22M17  
N23L400(B AXIS RECIP)  
N24G90B5.G0  
N25G91G1F2000.B-100.  
N26M14  
N27G90  
N28L500(RIGID TAP CYCLE)  
N29S+R1M5  
N30L1001  
N31#IF R2 GT 1 THEN R2=1  
N32T-5  
N33G91  
N34G84.1R+0Z-R2Q0.0714F+R1  
N35G0X-0.1  
N36T-4  
N37X-0.1  
N38T-3  
N39X-0.1  
N40T-2  
N41X-0.1  
N42T-1

N43G90X0  
N44G80  
N45M3  
N46G4P3000  
N47M5  
/N48T-5  
/N49G91  
/N50G74.1R+OZ-R2Q0.0714F+R1  
/N51G91X-0.1  
/N52T-4  
/N53X-0.1  
/N54T-3  
/N55X-0.1  
/N56T-2  
/N57X-0.1  
/N58T-1  
/N59G90X0  
/N60G80  
/N61M3  
/N62G4P3000  
/N63M5  
N64L600(CYCLE ORIENTATION AND TURRET)  
N65#V11=V11+1  
N66#IF V11 GT 16 THEN V11=1  
N67#R2=V11  
N68M3  
N69T-R2  
N70G4P3000  
N71M19  
N72G4P1000  
N73M4  
N74G4P3000  
N75M19  
N76G4P1000  
N77L700(GAIN SELECTION TEST)  
N78T-2  
N79M93  
N80G4P1000  
N81M92  
N82T-1  
N83G4P500  
N84M91  
N85G4P500  
N86L800(RAPID AXES WITH SPINDLE ON)  
N87G0M3S+R9

```
N88G53Z4.X-10.Y-8.
N89M19
N90G4P5000
N91X10.Y8.Z0M3(TO Z HOME)
N92M19
N93G4P5000
N94L900(SPINDLE RUN TEST)
N95T-10
N96G4P20000(20 SECONDS)
N97T-1
N98G4P20000
N99L1000(CHECK Z DISTANCE)
N100(THE AZ IS CURRENT DISTANCE FROM Z HOME)
N101(TEST SO Z MOVE DOES NOT GO BELOW Z HOME)
N102G0G90
N103G53Z4.
N104#WAIT
N105#R2=AZ
N106#IF R2=0 THEN R2=.001
N107M17
N108M30
N109(
N110(
N111#V1=-1
N112#V2=-1
N113#V3=-1
N114#V4=-1
N115#V5=10000
N116#V20=0
N117(V1=1 FOR A-AXIS)
N118(V2=1 FOR B-AXIS)
N119(V3=1 FOR RIGID TAP)
N120(V4=1 FOR PALLET TEST)
N121(V5= MAXIMUM RPM)
N122(V10 IS PUBLIC)
N123(V11 IS PUBLIC)
N124(V20 IS CURRENT SPINDLE RUN IN RPM)
N125(V21 IS RPM DIRECTION UP=1,DOWN=-1)
N126(V22 IS RPM INCREMENT)
N127(R9= V20=MAX RPM)
N128(START Z HOME AT THE FURTEST Z- POSITION)
N129#:MAINMENU
N130#PRINT "    CYCLE TEST PROGRAM
N131#PRINT "-----CYCLE TEST PROGRAM-----"
N132#IF V1=1 THEN PRINT "* 1- 4TH AXIS"
```

```
N133#IF V1=-1 THEN PRINT "1- 4TH AXIS"
N134#IF V2=1 THEN PRINT "* 2- 5TH AXIS"
N135#IF V2=-1 THEN PRINT "2- 5TH AXIS"
N136#IF V3=1 THEN PRINT "* 3- RIGID TAP"
N137#IF V3=-1 THEN PRINT "3- RIGID TAP"
N138#IF V4=1 THEN PRINT "* 4- PALLET CHANGER"
N139#IF V4=-1 THEN PRINT "4- PALLET CHANGER"
N140#PRINT "5- MAXIMUM RPM=",V5
N141#PRINT "_____ "
N142#PRINT "SET Z HOME AT MAXIMUM DEPTH"
N143#PRINT "SELECT OPTIONS THEN ENTER 6 TO BEGIN",
N144#INPUT V10
N145#IF V10=1 THEN V1=V1*-1
N146#IF V10=2 THEN V2=V2*-1
N147#IF V10=3 THEN V3=V3*-1
N148#IF V10=4 THEN V4=V4*-1
N149#IF V10 NE 5 THEN:NEXT1
N150#PRINT "ENTER MAXIMUM RPM",
N151#INPUT V5
N152#IF V5=0 THEN V5=10000
N153#:NEXT1
N154#IF V10=6 THEN:STARTING
N155#GOTO:MAINMENU
N156#:STARTING
N157#IF V1=-1 THEN V1=0
N158#IF V2=-1 THEN V2=0
N159#IF V3=-1 THEN V3=0
N160#IF V4=-1 THEN V4=0
N161#R9=V5
N162#V20=0
N163#V21=1
N164#V22=V5/5
N165(
N166(
N167G90
N168G10L12P1R+0(RESET D COUNTER)
N169T1M6
N170#:RUNLOOP
N171G91
N172G10L12P1R+1.(INCREMENT RUN COUNTER IN D-WORD, OFFSET 1)
N173G90M49M3S300D1
N174F150.
N175L101
N176#IF V1=0 THEN:NOARICP
N177L301
```

```
N178#:NOARICP
N179#IF V2=0 THEN:NOBRICP
N180L401
N181#:NOBRICP
N182(AXES RECIPROCATING)
N183(TESTS WITH XY MAYBE A,B)
N184(
N185L1001(MOVE TO Z+4 FROM CS AND SET R2)
N186G91
N187#IF R2 GT 4 THEN R2=4
N188G83R+0Z-R2Q0.5F150.
N189M45
/N190M45
/N191M45
/N192M45
/N193M45
N194G90G80
N195(START Z RICPROCATING)
N196L201
N197(TESTS WITH XYZ AB? RICP)
N198(CYCLE HI/LOW RANGE)
N199M3S1000
N200G4P2000
N201#V10=0
N202#V11=4
N203#:HILOWLOOP
N204S2000.2
N205G4P2000
N206S2000.1
N207G4P2000
N208#V10=V10+V11
N209#IF V10 LT 11 THEN:HILOWLOOP
N210#V10=0
N211#V11=5
N212M5
N213(FAST CHANGE)
N214#:HILOWLOOP1
N215S0.1000
N216S0.2000
N217#V10=V10+V11
N218#IF V10 LT 21 THEN:HILOWLOOP1
N219(RIGID TAP CALIBRATE TEST)
N220#IF V3=0 THEN:NORIGID
N221#V10=100
N222#V11=500
```

```
N223#:CALLOOP
N224#R1=V10
N225S+R1
N226M3
N227G4P2000
N228G84.2
N229G4P4000
/N230M4
/N231G4P2000
/N232G74.2
/N233G4P4000
N234#V10=V10+V11
N235#IF V10 LT 2000 THEN:CALLOOP
N236#:NORIGID
N237(CYCLE ORIENTATION)
N238#V11=0
N239S100
N240L602
N241S500
N242L604
/N243S1000
/N244L606
/N245S3000
/N246L602
/N247S+R9
/N248L601
N249(CYCLE SPINDLE WHILE MOVING AXES)
N250(V21 CONTROLS S-WORD VALUE; S100,S200,S300,S200
S100,S200,S300)
N251(V21 POSITIVE ADDS, NEG SUBTRACTS)
N252#:SETRPM
N253#IF V21=1 THEN V20=V20+V22
N254#IF V21=-1 THEN V20=V20-V22
N255#IF V20 LT V22 THEN V21=V21*-1
N256#IF V20 LT V22 THEN GOTO:SETRPM
N257#IF V20 GT V5 THEN V21=V21*-1
N258#IF V20 GT V5 THEN GOTO:SETRPM
N259#R1=V20
N260S+R1
N261#IF V21=-1 THEN R1=4
N262#IF V21=1 THEN R1=3
N263M+R1
N264L901(40 SECONDS PER CALL)
/N265L906(7*40=4.6 MINUTES)
N266(SECOND PART, NO RECIPLICATION)
```

N267T-1  
N268M10  
N269G4P10000  
N270G0G28  
N271(CYCLE GAIN SELECTION, 3 SEC PER TEST)  
N272#:GAINSEL  
N273L703  
/N274L712  
N275#IF V3=0 THEN:NORIGIDCYCLE  
N276(RIGID TAP CYCLES:G84.1,G74.1)  
N277R1+750.  
N278L501  
N279R1+3000.  
N280L501  
N281#:NORIGIDCYCLE  
N282(RAPID AXIS FULL TRAVEL WITH SPINDLE ON)  
N283G0G90M5  
N284G53X10.Y8.Z4.  
N285L801  
/N286L801  
/N287L801  
/N288L801  
/N289L801  
N290(TEST TOOL CHANGER)  
N291#V10=2  
N292#V11=2  
N293M3S500  
N294#:TCLOOP  
N295#R1=V10  
N296T+R1M6  
N297M3  
N298G4P2500  
N299#V10=V10+V11  
N300#IF V10 LT 17 THEN:TCLOOP  
N301T1M6  
N302(PALLET CYCLE)  
N303(RECIPROCAT Z, A, B)  
N304#IF V4=0 THEN:NOPALLET  
N305#R1=V20  
N306M3S+R1  
N307L201(RECIP Z)  
N308#IF V1=0 THEN:NOARICP1  
N309L301  
N310#:NOARICP1  
N311#IF V2=0 THEN:NOBRICP1



N312L401  
N313#:NOBRICP1  
N314M31(CYCLE PALLET)  
N315G4P2000  
N316M31  
N317G4P2000  
N318M31  
N319G4P2000  
N320M31  
N321G4P2000  
N322M5  
N323M10  
N324G4P10000  
N325G0G28  
N326#:NOPALLET  
N327#GOTO:RUNLOOP

**6001-Ballbar Test** N106001(BALLBAR XY PLANE 5.907 RADIUS  
N2G91  
N3M19  
N4M49  
N5R1+5.907  
N6G1F40.  
N7X-0.06  
N8M0  
N9G1F40.  
N10X0.06  
N11G2I+R1  
N12I+R1  
N13M99P6

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# Section 18: Fuses, Heaters, Parameters

## FUSE LIST FOR FADAL VMC

LBL-0017 Rev. D 3-17-03

TYPE	AMPS	PART#	DESCRIPTION	RELAY	PART#	LOC	BRN	WHT
<b>1100-1</b>								
F9	MDL	5	SPINDLE COOLER PUMP	K15	ELE-0070	TB2	18	17
CB4	ETA	2.5	ELE-0098					
F10	AGC	2	DUAL PROBE INTERFACE - M64 / M65	K16	ELE-0070	TB2	36	RET
F11	AGC	2	A-AXIS BRAKE SOLENOID (OPT.) - M60 / M61	K17	ELE-0937	TB2	40	RET
F14	AGC	2	EMERGENCY STOP	controls K1 & K2	K20	ELE-0937	TB2	26
F16	MDA	10	120 VAC Power Input to 1100-1					
F17	AGC	2	SERVO CHASSIS POWER			TB1	8	9
F18	AGC	2	COOLANT TWO PUMP	K22	ELE-0070	TB2	24	23
F21	-	-	M18 - Air Indexer	K25	-	TB2	14	15
F22	MDL	5	FLOOD COOLANT PUMP	K26	ELE-0070	TB2	28	27
CB7	ETA	2.5	ELE-0098					
CB7	ETA	3.5	ELE-0993					
F23	AGC	1	AXIS AMP FANS			TB2	2	1
F25	MDL	5	120 VAC PENDANT			TB2	4	3
F27	AGC	3	CABINET COOLING FANS			TB2	10	9
F29	AGC	2	MP12 TRANSFORMER			TB2	6	5
CB1	KD1	2.5	ELE-0086					
F30	AGC	2	VALVE COIL, HI RANGE IDLER ARM	K27	ELE-0937	TB2	14	13
F31	-	-	M68 / 69	K28	ELE-0070	TB2	16	RET
F34	AGC	2	VALVE COIL, LO RANGE IDLER ARM	K10	ELE-0937	TB2	34	33
F40	-	-	M66 / 67	K31	ELE-0070	TB2	20	RET
F41	-	-	SPARE-2	K32	-	TB2	22	21
F42	MDL	3	CE DOOR LOCK (Power for 2030 board)			TB2	8	7
F43	-	-	SPARE			TB2	12	11
CB2	KD1	-	-					
F44	AGC	2	B-AXIS BRAKE SOLENOID (OPT.) - M62 / 63	K8	ELE-0937	TB2	38	RET
<b>1100-2</b>								
F1	AGC	1	SPINDLE ON	controls K3	K7	ELE-0937*	TB1	20
F3	AGC	1	SPINDLE REVERSE	controls K4	K9	ELE-0937*	TB1	17
F4	AGC	2	SERVO TURRET		K12	ELE-0937*	TB1	31
CB7	KD1	2.5	ELE-0086					
F5	AGC	1	TURRET MOTOR REVERSE	controls K5	K11	ELE-0937*	TB1	7 & 5
F6	ABC	5	TURRET MOTOR (GENEVA) passes thru K33		K12	ELE-0070	TB1	6
-or-	ABC	5	TURRET MOTOR (SERVO) passes thru K33		K12	ELE-0937*	TB1	6
CB2	KD1	2.5	ELE-0086					
CB2	KD1	3	ELE-0087					
F7	AGC	1	ATC SLIDE MOTOR REVERSE	controls K6	K13	ELE-0937*	TB1	3 & 5
F8	AGC	5	ATC SLIDE MOTOR		K14	ELE-0070	TB1	2
CB1	KD1	2.5	ELE-0086					
CB1	KD1	3	ELE-0087					
F13	AGC	2	WAY LUBRICATOR		K19	ELE-0937	TB1	11
F15	AGC	2	AIR THROUGH SPINDLE		K21	ELE-0937	TB1	15
F19	AGC	2	VALVE COIL, SPINDLE ORIENTATION		K23	ELE-0937	TB1	27
F20	AGC	2	VALVE COIL, DRAWBAR		K24	ELE-0937	TB1	23
F24	MDL	3	SPINDLE MOTOR FAN			TB1	29	30
CB8	KD1	3	ELE-0087					
CB8	KD1	5	ELE-0089					
F26	MDA	10	120 VAC Power Input to 1100-2					
F28	AGC	3	COOLING FAN			TB1	21	22
F32	-	-	Spare-4		K29	-	TB1	9
F33	-	-	Spare-1		K30	-	TB1	13
<b>1100-3 PALLET CHANGER</b>								
F1	AGC	1	HYDRAULIC PUMP STARTER	K1	ELE-0070	J2	1	2
F2	AGC	1	PALLET TO TABLE VALVE	K2	ELE-0937	J2	3	4
F3	AGC	1	PALLET TO STORAGE VALVE	K3	ELE-0937	J2	5	6
F4	AGC	1	OPEN PALLET DOOR SOLENOID	K4	ELE-0937	J2	7	8
F5	AGC	1	UNCLAMP SOLENOID	K5	ELE-0937	J2	9	10
F9	MDA	10	MAIN 120 VAC POWER SUPPLY					
F10	AGC	3	24V DC TO LIGHT CURTAIN					
<b>MISCELLANEOUS</b>								
F1	MDL	7	120 VAC INPUT	K1	ELE-0071			DC POWER SUPPLY
AGC	3		DISK DRIVE POWER				1270	
			AUGER PUMP	K1	ELE-0070		1310	
			AUGER VALVES, CONTACTOR, ETC.	K2-4, K6, K101	ELE-0937		1310	
CB1	ETA	3.5	ELE-0993		K1-K4	ELE-0937	1330	
CB1	KD1	10	ELE-1492				1350-1	
F1	MDA	15	SERVO TURRET POWER SUPPLY (1350-0 uses MDA 6 fuse)				1560	
F1	MDL	5	CHILLER AND PUMP				1790	
F1, F2	AGC	10	HYDROSWEET CONTROL	K1-9	ELE-0070		1810-0-1	
F1	AGC	2	SERVO TURRET AMP				1980	
			AIR/OIL CONTROL					
			BEACON, 32MP POWER SUPPLY	K1, K2	ELE-0070		1990-1 & 1990-2	
			SPINDLE RELAY CONTROL	K1	ELE-0937*		2000 (CE machines)	
			AXIS CONTACTOR CONTROL	K8	ELE-09372030 (CE machines)			
	BLN OR KLK	30	ELE-0837					
	KTK OR KLK	20	ELE-0994					
	T16L250AC							
			SERVO AMP CHASSIS INPUT (AC BRUSHLESS)					
			SERVO AMP CHASSIS OUTPUT (AC BRUSHLESS)					
			SERVO COOLANT AMP					in 120V Inlet or Amp

Solid state relays are:

ELE-0070 (Crouzet GA8-6B02 or Magnecraft 7052-04-B-03-V, rated 3 amps, color black).  
ELE-0937 (Crouzet M-0ACS-315, rated 1 amp, color yellow, or Grayhill 70YY14350, color green) (Grayhill 70YY14303 may be substituted for those marked \*\*\*).  
ELE-0071 (Grayhill, 70YY21084, drops out at 4.7V, color white)

All mechanical relays are ELE-0072 (Omron MY4N-AC110/120 or equivalent).

**THERMAL OVERLOAD HEATERS:** B4.15 Coolant Thru Spindle Pump (3/4 Hp) B4.85 Pallet Changer Hydraulic Pump (1 Hp) B12.8 Wash Down Pump (3 Hp)

VMC with fuses at Main Disconnect ***		INPUT VOLTAGE		AMPERAGE	CLASS
60Hz 3-Phase	2216 / 3016 / 4020	208V / 240V / 480V	60Hz 3-phase	45 / 40 / 20	RK1, 600V
	4020A / 5020A / 6030 / 8030 & HT	208V / 240V / 480V	60Hz 3-phase	50 / 45 / 25	RK1, 600V
	All VHT models	230V	60Hz 3-phase	60	RK5, 600V
Single Phase	All models except VHT	240V	60Hz 1-phase	40 (45 for HT models)	RK5, 600V
50Hz 3-Phase	2216 / 3016 / 4020	380-415V	50Hz 3-phase	25	RK5, 600V
	6030 / 8030 & all HT models	380-415V	50Hz 3-phase	30	RK5, 600V
	All VHT models	230V	50Hz 3-phase	60	RK5, 600V

\*\*\* Machines with slant sheet metal have a circuit breaker in place of fuses at the main power disconnect

## FUSE LIST FOR EMC

Fadal EMC Fuse List LBL-0501 Rev. A 2-4-03

.....TYPE .. AMPS .. PART#.....	DESCRIPTION.....	RELAY .....	PART#.....	LOC .....	BRN.....	WHT
<b>1100-1</b>						
F9 .....MDL.....5 .....	SPINDLE COOLER PUMP .....	K15 .....	ELE-0070 .....	TB2 .....	18 .....	17
CB4 .....ETA.....2.5 .....	ELE-0098 .....					
F10 .....AGC.....2 .....	DUAL PROBE INTERFACE M64 / M65 .....	K16 .....	ELE-0070 .....	TB2 .....	36 .....	RET
F11 .....AGC.....2 .....	A-AXIS BRAKE SOLENOID M60 / M61 .....	K17 .....	ELE-0937 .....	TB2 .....	40 .....	RET
F14 .....AGC.....2 .....	EMERGENCY STOP controls K1 & K2 .....	K20 .....	ELE-0937 .....	TB2 .....	26 .....	-
F16 .....MDA.....10 .....	120 VAC INPUT TO 1100-1 .....					
F17 .....AGC.....2 .....	AXIS AMPLIFIER CHASSIS POWER .....			TB1 .....	8 .....	9
F18 .....AGC.....2 .....	COOLANT TWO PUMP .....	K22 .....	ELE-0070 .....	TB2 .....	24 .....	23
F21 .....MDL.....5 .....	M18 .....	K25 .....	ELE-0070 .....	TB2 .....	14 .....	15
F22 .....MDL.....5 .....	FLOOD COOLANT PUMP .....	K26 .....	ELE-0070 .....	TB2 .....	28 .....	27
CB7 .....ETA.....2.5 .....	for 60HZ, all machines except 2016L and 3016L .....					
CB7 .....ETA.....3.5 .....	for 2016L, 3016L, or 50Hz .....					
F23 .....AGC.....1 .....	AXIS AMP FANS .....			TB2 .....	2 .....	1
F25 .....MDL.....5 .....	120 VAC PENDANT .....			TB2 .....	4 .....	3
F27 .....AGC.....3 .....	CABINET COOLING FANS .....			TB2 .....	10 .....	9
F29 .....AGC.....2 .....	MP12 TRANSFORMER .....			TB2 .....	6 .....	5
CB1 .....KD1.....2.5 .....	ELE-0086 .....					
F30 .....AGC.....2 .....	VALVE COIL, HI RANGE IDLER ARM .....	K27 .....	ELE-0937 .....	TB2 .....	14 .....	13
F31 .....MDL.....5 .....	M68 / 69 .....	K28 .....	ELE-0070 .....	TB2 .....	16 .....	RET
F34 .....AGC.....2 .....	VALVE COIL, LO RANGE IDLER ARM .....	K10 .....	ELE-0937 .....	TB2 .....	34 .....	33
F40 .....MDL.....5 .....	M66 / 67 .....	K31 .....	ELE-0070 .....	TB2 .....	20 .....	RET
F41 .....MDL.....5 .....	SPARE-2 .....	K32 .....	ELE-0070 .....	TB2 .....	22 .....	21
F42 .....MDL.....3 .....	CE DOOR LOCK (2030-0A) .....			TB2 .....	8 .....	7
F43 .....MDL.....3 .....	SPARE .....			TB2 .....	12 .....	11
CB2 .....KD1.....2.5 .....	ELE-0086 .....					
F44 .....AGC.....2 .....	B-AXIS BRAKE SOLENOID M62 / 63 .....	K8 .....	ELE-0937 .....	TB2 .....	38 .....	RET
<b>1100-2</b>						
F1 .....AGC.....1 .....	SPINDLE ON controls K3 .....	K7 .....	ELE-0937 .....	TB1 .....	19 .....	20
F3 .....AGC.....1 .....	SPINDLE REVERSE controls K4 .....	K9 .....	ELE-0937 .....	TB1 .....	17 .....	18
F4 .....AGC.....2 .....	SERVO TURRET .....	K12 .....	ELE-0937 .....	TB1 .....	31 .....	-
CB7 .....KD1.....2.5 .....	ELE-0086 .....					
F5 .....AGC.....1 .....	TURRET MOTOR REVERSE controls K5 .....	K11 .....	ELE-0937 .....	TB1 .....	7 & 5 .....	-
F6 .....ABC.....5 .....	TURRET MOTOR (GENEVA) passes thru K33 .....	K12 .....	ELE-0070 .....	TB1 .....	6 .....	8
-or- .....ABC.....5 .....	TURRET MOTOR (SERVO) passes thru K33 .....	K12 .....	ELE-0937 .....	TB1 .....	6 .....	8
CB2 .....KD1.....2.5 .....	for 60Hz .....					
CB2 .....KD1.....3 .....	for 50Hz .....					
F7 .....AGC.....1 .....	ATC SLIDE MOTOR REVERSE controls K6 .....	K13 .....	ELE-0937 .....	TB1 .....	3 & 5 .....	-
F8 .....AGC.....5 .....	ATC SLIDE MOTOR .....	K14 .....	ELE-0070 .....	TB1 .....	2 .....	4
CB1 .....KD1.....2.5 .....	for 60Hz .....					
CB1 .....KD1.....3 .....	for 50Hz .....					
F13 .....AGC.....2 .....	WAY LUBRICATOR .....	K19 .....	ELE-0937 .....	TB1 .....	11 .....	12
F15 .....AGC.....2 .....	AIR THROUGH SPINDLE .....	K21 .....	ELE-0937 .....	TB1 .....	15 .....	16
F19 .....AGC.....2 .....	VALVE COIL, SPINDLE ORIENTATION .....	K23 .....	ELE-0937 .....	TB1 .....	27 .....	28
F20 .....AGC.....2 .....	VALVE COIL, DRAWBAR .....	K24 .....	ELE-0937 .....	TB1 .....	23 .....	24
F24 .....MDL.....3 .....	SPINDLE MOTOR FAN .....			TB1 .....	29 .....	30
CB8 .....KD1.....3 .....	for 60Hz .....					
CB8 .....KD1.....5 .....	for 50Hz .....					
F26 .....MDA.....10 .....	120 VAC INPUT TO 1100-2 .....					
F28 .....AGC.....3 .....	COOLING FAN .....			TB1 .....	21 .....	22
F32 .....MDL.....5 .....	SPARE-4 .....	K29 .....	-	TB1 .....	9 .....	10
F33 .....MDL.....5 .....	SPARE-1 .....	K30 .....	-	TB1 .....	13 .....	14
<b>MISCELLANEOUS</b>						
.....KTK or KTK20 .....	ELE-0994 ... SERVO AMP X,Y,Z,A POWER INPUT .....					
.....AGC.....3 .....	DISK DRIVE POWER .....				1270-2 .....	
F1 .....TR5 373 ... 1 .....	ELE-1485 ... Z-AXIS BRAKE .....				1290-0 .....	
.....MDL.....7 .....	BEACON, 32MP POWER SUPPLY .....	K1,K2 .....	ELE-00701990-1 & 1990-2 .....			
.....MDL.....7 .....	POWER SUPPLY MAIN 120 VAC .....	K1 .....	ELE-0071DC Power Supply .....			
.....MDL.....7 .....	SPINDLE RELAY CONTROL .....	K1 .....	ELE-0937 .....		2000 (CE machines) .....	
.....MDL.....7 .....	AXIS CONTACTOR CONTROL .....	K8 .....	ELE-0937 .....		2030 (CE machines) .....	

Solid state relays are : ELE-0070 (Crouzet GA8-6B02 or Magnecraft 70S2-04-B-03-V, rated 3 amps, color black),  
ELE-0937 (Crouzet M-0AC5-315, rated 1 amp, color yellow)  
ELE-0071 (Grayhill, 70YY21084, drops out at 4.7V, color white)  
All mechanical relays are ELE-0072 (Omron MY4N-AC110/120 or equivalent).

TOOL ROOM MILL FUSE LIST

Fuse List for Tool Room Mill - LBL-0500 Rev. A 1-29-03

FUSETYPE	AMPS	PART#	DESCRIPTION	RELAY	PART#	PINK
WHITE						
			1100-5			TERMINALS
CB1	KD1	5	ELE-0089.....18 VAC INPUT TO 1100-5			
			.....SPINDLE FWD (controls K3 relay) .....	K7	ELE-1649.....	TB2....19 .....20
			.....SPINDLE REV (controls K4 relay) .....	K9	ELE-1649.....	TB2....17 .....18
F1	TR5 374	2	ELE-1487.....SPARE (jumper selectable) optional .....	K40	ELE-1649.....	TB3.....1 .....2
F2	TR5 374	2	ELE-1487.....SPARE (jumper selectable) optional .....	K41	ELE-1649.....	TB3.....3 .....4
F14	TR5 374	2	ELE-1487.....EMERGENCY STOP (controls K1 & K2 relays) .....	K20	ELE-1649.....	TB2....26 .....--
F15	TR5 374	2	ELE-1487.....AIR THROUGH SPINDLE .....	K21	ELE-1649.....	TB2....15 .....16
F18	TR5 374	2	ELE-1487.....COOLANT TWO PUMP .....	K22	ELE-1649.....	TB2....24a.....23a
F20	TR5 374	2	ELE-1487.....DRAWBAR .....	K24	ELE-1649.....	TB2....23 .....24
F25	TR5 374	2	ELE-1487.....BEACON .....	K6	ELE-1649.....	TB5.....1 .....2
F11	TR5 374	2	ELE-1487.....M60 / M61 .....	K17		TB2 39 & 40
			DC POWER SUPPLY			
CB	KD1	5	.....POWER SUPPLY MAIN 240 VAC			

Tool Room Mill uses 24 VDC solenoids.

All solid state relays except K17 are DC. Use ELE-1649 Crouzet type MODC5, Grayhill type 70M-ODC5, or equivalent. The relay used for K17 is dependent on what M60/M61 controls.

All mechanical relays have 24 VDC coil. Use ELE-1110, Omron MY4N-DC24.

All fuses are Wickman TR5 No. 374 or Littlefuse LT-5 665 series subminiature fuses.

Use an insulated alligator clip to remove fuse. Always power off machine before removing or inserting fuses.

Table 1: Parameter Settings

Options in SETP Mode	Available Formats	Factory Setting	Customer Preference
There are two Program Formats available. Do you want 6MB/10M/11M compatibility (Format 2)?	1&2	2	
Enter the default Baud rate (the rate after power on)	1&2	6	
Should spindle come on automatically after a tool change when the M6 had to turn the spindle off?	1&2	1	
Enter the Axis Configuration	1&2		
Enter X,Y,Z travel	1&2		
Enter the Pendant style	1&2	3	
Enter the default value (G0,G1)	1&2	2	
Enter the A axis ratio	1&2		
Does M60 turn on the A axis brake?	1&2		
Enter the default value (G90,G91)	1&2	1	
Enter the B axis ratio	1&2		
Does M62 turn on the B axis brake?	1&2		
Enter the default value (G17,G18,G19)	1&2	1	
Enter the Tool Changer capacity	1&2		
Should a Fixed Cycle execute immediately?	1		
Enter the Spindle RPM Adjustment factor The factor must be between 0 and 31	1&2		
Enter the Spindle Drive Type and RPM	1&2		
Enter the Spindle Orientation RPM Adjustment factor The factor must be between 0 and 31	1&2		
Enter the default value (Inch, Metric)	1&2	1	
Enter M7, M8 preference	1&2	2	
Is your 3 Phase power more than 5% low?	1&2	2	
Select Punch Output format	1&2	2	
Enter the N Word sequence configuration	2	1	
Will the Tool Compensation Table have the radius or the diameter?	2	1	
Enter the default outside corner movement (M96,M97)	1&2	1	
Select the number of binary buffers for CNC look ahead	1&2	5	
Do you have the High Torque or Rigid Tapping option?	1&2		
Do you want the spindle to turn off when exiting JOG or MANUAL DATA INPUT?	1&2	1	
Enter the Engagement factor for the Tool Turret Geneva Gear The factor must be between 1 and 50 <b>Note:</b> For Servo Turret the factor must ALWAYS be 1	1&2		

Table 1: Parameter Settings

Options in SETP Mode	Available Formats	Factory Setting	Customer Preference
Turn the Command Menus ON or OFF?	1&2	3	
Do you have a Pallet Changer?	1&2		
Enter the Gain factor for Rigid Tapping The factor must be between 0 and 255	1&2		
Enter the Ramp factor for Rigid Tapping The factor must be between 0 and 255	1&2		
Enter the Graphics Aspect Ratio of Y to X	1&2	65	
Select the Automatic Tool Timer mode	1&2	1	
Enter the Motor Overload factor The factor must be between 1 and 8	1&2	2	
Select the Screw Pitch type	1&2		
Select the Maximum Rapid Feed Rate	1&2		
Enter the X, Y, & Z Ramp Length factor The factor must be between 50 and 200	1&2		
Enter the Z Gain during Rigid Tapping	1&2		
Do you have a vector drive (10 RPM min).	1&2		
Display the axis following error or Load?	1&2	1	
Automatically apply the A or B brake during Idle Time?	1&2	2	
Which rotary axis is installed on this pallet	1&2	1	
Do you have the 5th axis programmable head attachment?	1&2	1	
Enter the detail desired for G0 moves between 2 to 250 (241=Off)	1&2	241	
Do you have air valve feedback?	1&2	2	
Wait until spindle is at-speed before next block is executed?	1&2	1	
Enter slide hold ramp factor between 1 to 10 (10 is Standard)?	1&2	10	
Is this a Manual Machine with 1 MPG for each Axis?	1&2		



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**Machine Parameters**

This section covers parameter settings and their purpose.

To enter the parameter setting area of a Fadal VMC, type “**SETP**” at the “**ENTER NEXT COMMAND**” prompt and press the <**ENTER**> key.

To enter the parameters using the menus; enter the “**Function Menu**” then select “**2 Memory**” then “**6 Settings**” and “**2 Parameters**”.

The selected parameter will be stated under the parameters listed for that page with all the possible selections and the current selection with an “\*” sign.

To navigate the parameters, the <**ENTER**> key will move to the next parameter each time it is pressed, the “**D**” key will move to the next line down, the “**U**” key will move to the last line above and the “**P**” will move to the next page of parameters.

To change a parameter, select the parameter and enter the number of the setting to be changed to and press the <**ENTER**> key.

Many of the parameter changes will require machine to be powered off and back on to make the change take effect.

**Note:** Machine factory set parameter settings are located inside the pendant door.

**Note:** The current machine software will have three pages of parameters. Older software revisions may not have all of the parameters listed in this document.

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**Machine Parameters:**  
**Page One**

**FORMAT** DO YOU WANT MAXIMUM 6MB/10M/11M CAPABILITY?

- 1)NO, ORIGINAL FADAL STYLE – FORMAT 1
- 2)YES, FORMAT 2

THERE ARE TWO PROGRAM OPERATION FORMATS AVAILABLE.

This parameter allows the user to select Fanuc 6MB/10M/11M compatibility. The operational difference between the two formats depends upon the coding used.

**BAUD RATE** ENTER DEFAULT BAUD RATE (THE RATE AFTER POWER-ON)

- 1) 110    5) 1200    9) 19200
- 2) 150    6) 2400    10) 38400
- 3) 300    7) 4800    11) 57600
- 4) 600    8) 9600    12) 115200

The operator may select the desired communications baud rate.

**SPINDLE AFTER M6** SHOULD SPINDLE COME ON  
AUTOMATICALLY AFTER A TOOL CHANGE  
WHEN THE M6 HAD TO TURN THE SPINDLE  
OFF?

- 1)NO (FADAL RECOMMENDS THIS RESPONSE)
- 2)YES

IF YES, ALL PERSONNEL MUST BE AWARE OF THE POSSIBILITY  
OF OVER SPEEDING A TOOL BEFORE THE NEW S-WORD IS ENCOUNTERED

When this parameter is selected as YES, the spindle automatically turns on after the tool change. The spindle comes on at the last programmed spindle speed. This may cause an overspeed of the next tool. **It is recommended that this parameter is set to number 1.**

**AXES: X,Y,Z** ENTER THE AXIS CONFIGURATION

- 1)A
- 2)A, B
- 3)X,Y,Z
- 4)X,Y,Z,A
- 5)X,Y,Z,A,B
- 6)X,Y,Z,B
- 7)C only

When selecting the axes, the machine must be powered off. When the power is returned the axes selected will be active. COLD START must be performed. The axes that are not selected will be inactive, the CPU will not look for them or try to move them.

**TRAVEL** ENTER X,Y,Z TRAVEL

- |                |                 |                 |                 |
|----------------|-----------------|-----------------|-----------------|
| 1) X22 Y16 Z20 | 8) X40 Y20 Z28  | 15) X50 Y20 Z20 | 22) X65 Y35 Z34 |
| 2) X20 Y12 Z20 | 9) X60 Y30 Z30  | 16) X50 Y20 Z28 | 23) X85 Y35 Z34 |
| 3) X45 Y25 Z24 | 10) X22 Y16 Z28 | 17) X80 Y30 Z30 | 24) X30 Y14 Z14 |
| 4) X45 Y25 Z32 | 11) X20 Y16 Z20 | 18) X30 Y20 Z24 |                 |
| 5) X22 Y13 Z20 | 12) X20 Y16 Z28 | 19) X30 Y20 Z32 |                 |
| 6) X20 Y13 Z20 | 13) X30 Y16 Z20 | 20) X20 Y20 Z24 |                 |
| 7) X40 Y20 Z20 | 14) X30 Y16 Z28 | 21) X20 Y20 Z32 |                 |

The machine travel limits are selected with this parameter. This parameter will default to selection 7 if parameters are lost.

**DANGER!**

Serious damage to machine may occur if this parameter is set incorrectly.

**PENDANT** ENTER THE PENDANT STYLE

- 1)KEYBOARD BESIDE THE VIDEO TUBE
- 2)KEYBOARD BELOW THE VIDEO TUBE
- 3)SAME AS 2 BUT MOUNTED ON FULL-ENCLOSURE CHIP GUARDS

Select the appropriate pendant location for the machine. When option 2 is selected the table may make a Y axis positive move before a tool change. This occurs only when the Y axis is five inches or more, in the negative direction, from the cold start position.

**DEFAULT: G0** ENTER THE DEFAULT VALUE

- 1)G0
- 2)G1

The code selected is active at power on and when entering the MDI mode. The G0 is rapid travel and the G1 is linear interpolation (travels at a stated feedrate).

**A-AXIS RATIO** ENTER A-AXIS RATIO  
**Note:** Displayed only when  
A axis selected

- 1) 90:1
- 2) 180:1
- 3) 360:1
- 4) 120:1
- 5) 72:1
- 6) COOLANT
- 7) 60:1
- 8) 144:1

Select the appropriate gear ratio for the rotary table being used or select the servo coolant option (see rotary table nameplate for ratio).

**M60/A-AXIS BRAKE** DOES M60 TURN ON THE A-AXIS BRAKE?  
**Note:** Displayed only when  
A axis selected

- 1) YES
- 2) NO

Select the option desired to activate or de-activate the air for the axis brake.

**DEFAULT: G90** ENTER THE DEFAULT VALUE

- 1)G90
- 2)G91

The code selected is active at power on and when entering the MDI mode. The G90 is absolute positioning and the G91 is incremental positioning.

**B-AXIS RATIO** ENTER B-AXIS RATIO  
**Note:** Displayed only when  
B axis selected

- 1) 90:1
- 2) 180:1
- 3) 360:1
- 4) 120:1
- 5) 72:1
- 6) COOLANT
- 7) 60:1
- 8) 144:1

Select the appropriate gear ratio for the rotary table being used or select the servo coolant option (see rotary table nameplate for ratio).

**M62/B-AXIS BRAKE** DOES M62 TURN ON THE B-AXIS BRAKE?  
Note: Displayed only when  
B axis selected

- 1)YES
- 2)NO

Select the option desired to activate or de-activate the air for the axis brake.

**DEFAULT: G17** ENTER THE DEFAULT VALUE

- 1)G17
- 2)G18
- 3)G19

This parameter is used to select the default machine plane. The G17 selects the XY plane, the G18 selects the ZX plane and the G19 selects the YZ plane.

**TOOL CHANGER** ENTER THE TOOL CHANGER CAPACITY  
CAP

- 1) 16 TOOL ATC
- 2) 21 TOOL ATC
- 3) 30 TOOL ATC
- 4) 24 TOOL DATC (Dual Arm Tool Changer)
- 5) 32 TOOL DATC (Dual Arm Tool Changer)
- 6) 62 TOOL DATC (Dual Arm Tool Changer)
- 7) NONE (TRM)

Select the appropriate tool changer capacity

**IMM. FIXED CYCLE** SHOULD A FIXED CYCLE EXECUTE IMMEDIATELY?

**Note:** Displayed only when  
Format 1 is selected.

- 1)YES
- 2)NO, ONLY IF X OR Y DIMENSION WORDS ARE IN THE DEFINITION LINE

A YES response causes a fixed cycle to be executed immediately upon definition at the current axis location. A NO response requires axis motion to activate the fixed cycle.

**RPM FACTOR** ENTER THE SPINDLE RPM ADJUSTMENT  
FACTOR. THE FACTOR MUST BE BETWEEN 0 AND 31.

This parameter adjusts the speed command signal voltage from the spindle controller card to the spindle drive in small increments in order to adjust the spindle RPM. Adjustment procedure: run the spindle at the desired RPM with a M49. Measure the spindle speed with a tach or read the RPM on the spindle vector drive (remember that the drive is motor speed so you must account for the pulley ratio). Change the RPM factor for the closest RPM.

**SPINDLE TYPE** ENTER THE SPINDLE DRIVE TYPE & RPM

- 1)10,000 HI/LOW
- 2)10,000 3 STEP
- 3)15,000 DIRECT
- 4)5,000 HI/LOW
- 5)6,500 HI/LOW
- 6)3750 WYE/DEL.
- 7)7500 WYE/DEL.
- 8)5000 DIRECT
- 9)15K WYE/DEL.

Select the correct spindle type for the machine. If set incorrectly the spindle RPM will most likely be incorrect and performance will be poor. The RPM is the maximum spindle RPM and the type after the RPM is: DIRECT which means one belt selection only, 3 STEP has three belt ranges but must be changed manually, HI/LOW is changed between two range is performed by idler arms or the WYE/DELTA changes motor wiring configuration by using relays.

**ORIENTATION  
FACTOR** ENTER THE SPINDLE RPM ADJUSTMENT  
FACTOR THE FACTOR MUST BE BETWEEN 0 AND 31

This parameter adjusts the speed command signal voltage from the spindle controller card to the spindle drive in small increments in order to adjust the spindle RPM during orientation. Find a factor that works for both high and low range.

To set, observe the orientation of the spindle. If it appears to be too fast with overshooting then lower factor, if it is too slow or does not always go around far enough then increase the factor. Check both ranges before completing selection. Normal setting is around 10 to 12.

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**Machine Parameters:****Page Two**

**DEFAULT: INCH** ENTER THE DEFAULT VALUE

- 1)INCH
- 2)METRIC

The operator selects the mode (inch or metric) for the machine. The G70, G71, G20 and G21 check this setting to verify the operational mode.

**M7-FLOOD M8-MIST** ENTER M7, M8 PREFERENCE

- 1)M7 IS FLOOD COOLANT, M8 IS MIST
- 2)M8 IS FLOOD COOLANT, M7 IS MIST

The operator may select either M7 or M8 as the flood coolant code. This selects the appropriate electrical outlet on the back of the machine.

**3 PHASE NO 5%  
LOW: NO** IS YOUR 3 PHASE POWER MORE THAN 5% LOW?

- 1)YES
- 2)NO

The selection chosen is based upon the building power supply. This lowers the rapid rate by 5% to reduce the fault point when the input power is too low. This may be selected if the input power has a large voltage variance or low input such as 208 VAC.

**PU FORMAT**      SELECT PUNCH OUTPUT FORMAT

- 1)PUNCHED TAPE FORMAT (TELETYPE STYLE)
- 2)COMPUTER FILE FORMAT (NO NULLS)

This parameter is set to file for computer use. The punch tape format is used when a tape reader is used.

**N-WORDS ORDERED**      ENTER THE N-WORD SEQUENCE CONFIGURATION

**Note:** Displayed only when  
Format 2 is selected.

- 1) THE N-WORDS ARE IN ASCENDING NUMERICAL ORDER OR THE PROGRAM WILL BE RENUMBERED AFTER INPUT.
- 2) THE N-WORDS ARE NOT IN ORDER.

The CNC 88 requires each block of NC code to have sequence numbers in numerical order. Since the 6MB/10M/11M controls do not require block numbers in numerical order, select option number 2. Upon tape input the CNC will add sequence numbers for reference. Otherwise, after tape input the program must be renumbered if the sequence numbers are not in numerical order.

**TOOL TABLE**      WILL THE TOOL COMPENSATION TABLE HAVE THE RADIUS OR DIAMETER?

**Note:** Displayed only when  
Format 2 is selected.

- 1)DIAMETER
- 2)RADIUS

The cutter offset specification in the tool compensation table may be defined as a diameter or radius.

**CRC MODE**      ENTER THE DEFAULT OUTSIDE CORNER MOVEMENT

- 1)M96 – ROLL
- 2)M97 – INTERSECTIONAL

This parameter selects the default mode for intersectional cutter radius compensation.



**BINARY BUFFERS:** SELECT THE NUMBER OF BINARY BUFFERS  
**255** LOOKAHEAD.

- 1) 15    3) 50    5) 255
- 2) 30    4) 100

The BINARY BUFFERS parameter can be changed to increase or decrease the control look ahead. The factory sets the buffers at 255. This is the most effective for programs with many small moves that must be executed rapidly. This parameter is used to more efficiently utilize the Run Time Menu. The smaller the buffers the more quickly the Run Time Menu changes will take effect in the program.

**HIGH TORQUE** DO YOU HAVE THE HIGH TORQUE OPTION  
OR RIGID TAP OPTION?

- 1)NO
- 2)YES

This parameter is for machines with the hydraulic Hi/Low system. A yes allows more time for the belt change process required by the hydraulic system.

**SPINDLE OFF** DO YOU WANT THE SPINDLE TO TURN OFF WHEN EXITING JOG OR MANUAL  
DATA INPUT?

- 1)NO
- 2)YES

The Fadal recommended setting is NO.

**TURRET FACTOR** ENTER THE ENGAGEMENT FACTOR FOR THE TOOL TURRET GENEVA GEAR  
THE FACTOR MUST BE BETWEEN 1 AND 50 (1 FOR SERVO TURRET)

This parameter adjusts the position of the Geneva gear with the Geneva wheel. For VMCs equipped with the servo turret, this factor MUST always be 1. This should be adjusted for the pin of the Geneva gear to be opposite the Geneva wheel when at tool position.

**CMD MENU** TURN COMMAND MENUS:

- 1)OFF
- 2)ON
- 3)TOGGLE ON WITH SPACE BAR

The operator may select the command menu display method.

**PALLET** DO YOU HAVE A PALLET CHANGER?

- 1)NO
- 2)YES

Select yes if a Fadal pallet changer is installed.

**GAIN** ENTER THE GAIN FACTOR FOR RIGID TAPPING  
THE FACTOR MUST BE BETWEEN 0 AND 255

This parameter effects the spindle response during rigid tapping. The higher the number the faster the spindle turns in relation to the feed rate. When the speed is too fast the thread may be too loose. See the Rigid Tapping Procedure in the “Spindle Drive and Motors” Section.

**RAMP** ENTER THE RAMP FACTOR FOR RIGID TAPPING  
THE FACTOR MUST BETWEEN 0 AND 255

This parameter sets the speed at which the spindle accelerates during rigid tapping.

See the Rigid Tapping Procedure in the “Spindle Drive and Motors” Section.

**ASPECT** ENTER THE ASPECT RATIO OF Y TO X

THE RATIO MUST BE BETWEEN 25 AND 150

This parameter affects the look of the display. Program a circle and change the aspect to get a round circle on the display.

**TIMERS** SELECT THE AUTOMATIC TOOL TIMER MODE?

- 1)ALL TOOL TIMING OFF
- 2)DO NOT CHECK
- 3)END OF TOOL (AT M6)
- 4)AFTER EACH MOVE
- 5)AT END OF PROGRAM

Select the desired option and set a value in the DTT table for TIME. The USED value will be inserted by the control. See DTT command in Users Manual.

**OVERLOAD** ENTER THE MOTOR OVERLOAD FACTOR  
(2 IS STANDARD)  
THE FACTOR MUST BE BETWEEN 1 AND 8

This parameter determines the allowable following distance the actual axis position can be behind the computer commanded position. Each number is a turn of the ball screw.

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**Machine Parameters:  
Page Three**

**SCREW** SELECT THE SCREW PITCH TYPE

1) INCH PITCH

2) 8/10 MILLIMETER PITCH

This parameter sets the type of ballscrews installed in the machine.

**DANGER!**

Serious damage to machine may occur if this parameter is set incorrectly.

**IPM** SELECT THE MAX RAPID FEED RATE

1) 400 IPM    4) 800 IPM

2) 500 IPM    5) 900 IPM

3) 700 IPM    6) 1000 IPM

This parameter sets the maximum rapid feed rate for the machine. Check machine specifications for proper setting.

**Caution!** Machine damage and excessive faults may occur if this parameter is set too high.

**XYZ RAMP** ENTER THE X, Y, & Z RAMP LENGTH  
FACTOR (160 IS STANDARD)  
THE FACTOR MUST BE BETWEEN 50 AND 200

This parameter sets the speed at which the axes accelerate and decelerate during travel. The typical standard settings are 160 for millimeter and 100 for inch ballscrews. For the 6536, 12 mm pitch screws, use 250. Lower numbers than the typical standard may be used for any machines. A lower number will result in faster accelerations/decelerations. Varying machine environments and parameters (ie rapid travel parameter) will affect the absolute minimum for a particular machine.

**Z TAP GAIN**     SELECT THE Z GAIN DURING RIPID  
TAPPING?

- 1)NORMAL
- 2)MEDIUM
- 3)HIGH

This parameter should be set to Normal for Millimeter and High for Inch ball screws. It determines the gain of the Amplifier.

**VECTOR**     DO YOU HAVE VECTOR DRIVE  
(10 RPM MIN)?

- 1)YES
- 2)NO

If the machine is equipped with a vector drive then this parameter will allow a 10 RPM minimum spindle speed. A closed loop Baldor or AMC drive is required for a yes response. Closed loop vector systems will have the encoder cable coming all the back the axis controller card used.

**AXIS DISPLAY**     DISPLAY THE AXIS FOLLOW ERROR OR  
LOAD?

- 1)LOAD PERCENTAGE
- 2)FOLLOWING ERROR

This option is used to select what the axis display will show on the position display while auto running a program. DC amplifiers can not display the load percentage.

**AUTO BRAKE**     AUTOMATICALLY APPLY THE A OR B  
BRAKE DURING IDLE TIME?

- 1)YES
- 2)NO

Select the option desired to activate or de-activate the air for the axes brake. The brake will apply after 75 seconds of non-activity.

**A-PALLET** WHICH ROTARY AXIS IS INSTALLED ON THIS PALLET?

- 1)NOT APPLICABLE
- 2)A-AXIS
- 3)B-AXIS
- 4)A-AXIS & B-AXIS

Select the appropriate option for the rotary axis being used.

**B-PALLET** WHICH ROTARY AXIS IS INSTALLED ON THIS PALLET?

- 5)NOT APPLICABLE
- 6)A-AXIS
- 7)B-AXIS
- 8)A-AXIS & B-AXIS

Select the appropriate option for the rotary axis being used.

**5TH AXIS HEAD** DO YOU HAVE THE 5TH AXIS PROGRAMMABLE HEAD ATTACHMENT?  
HEAD

- 1)NO
- 2)YES

Answer YES if a 4th or 5th axis rotary head attachment is installed in the spindle. This will turn on the vectoring jog when the axis selector is set to C.

**GO DETAIL** ENTER THE DETAIL DESIRED FOR G0 MOVES  
BETWEEN 2 TO 240 TENTHS (241=OFF)

This command is a parameter that adjusts the tolerance of positioning in G0 Rapid moves. The smaller the number, the closer the machine is held to the commanded position before moving to the next position. Holding the rapid travel moves to a tight tolerance in the majority of cases is not needed. This parameter just allows flexibility for the rapid travel move. VMC's are shipped with this parameter set at 241, which is the OFF setting. Setting the value too low will slow the machine down considerably.

**AIR VALVE  
FEEDBACK**

DO YOU HAVE AIR VALVE FEEDBACK?

- 1)NO
- 2)YES

Answer NO only for machines built previous to having feedback on the drawbar.

**AT SPEED**

WAIT UNTIL SPINDLE IS AT-SPEED BEFORE  
NEXT BLOCK IS EXECUTED?

- 1)NO
- 2)YES

This will inhibit any axis motion until 80% of the commanded RPM is achieved.

ENTER SLIDE HOLD RAMP FACTOR  
BETWEEN 1 TO 10 (10 IS STANDARD)?

This parameter will change the amount of time permitted to bring the machine to a Slide Hold condition. The typical setting is 10, this is about 250 milliseconds. Lower values may be used, but the higher the feed rate of the machine the more deceleration time will be needed to avoid amplifier faults.

IS THIS A MANUAL MACHINE WITH 1 MPG FOR EACH AXIS?

This will enable the manually operated machines (i.e. TRM, Tool Room Mill). Setting this parameter incorrectly will cause the JOG mode to malfunction.

**SLIDE HOLD**

ENTER SLIDE HOLD RAMP FACTOR  
BETWEEN 1 TO 10 (10 IS STANDARD)?

This parameter controls the ramp after pressing Slide Hold. Depending on the size of the machine and customer preference, this parameter can be made smaller to generate sharper stops after pressing slide hold. The default value is 10. If the number is too small the machine could generate Amplifier Fault #18. Choose a number that best fits desired results without causing faults.

**MANUAL**

IS THIS A MANUAL MACHINE WITH 1 MPG FOR EACH AXIS?

This parameter enables the “Manual” feature of some machines. Manual machines are those that are outfitted with separate MPG handwheels on each axis, as on the Tool Room Mill machine. Set the parameter to YES if it has these MPG on each axis. If the machine does not have separate MPG handwheels on each axis the parameter must be set to NO.

## Typical TRM Parameters

The following parameters in red are the typical settings for the Tool Room Mill machine:

PAGE 1 OF 3

*FORMAT: 1	BAUD RATE: 2400	SPINDLE AFTER M6: NO
AXES: X,Y,Z	TRAVEL: X30 Y14 Z14	PENDANT: MOUNTED
DEFAULT: G1		
DEFAULT: G91		
DEFAULT: G17	TOOL CHANGER CAP: 0	IMM. FIXED CYCLE: NO
RPM FACTOR: 5	SPINDLE TYPE: 4,000	ORIENTATION FACTR: 10

PAGE 2 OF 3

*DEFAULT: INCH	_M8=FLOOD M7=MIST	3 PHASE > 5% LOW: NO
PU FORMAT: FILE		
CRC MODE: M96	BINARY BUFFERS: 255	HI TORQUE/RIGID: NO
SPINDLE OFF: NO	TURRET FACTOR: 1	CMD MENU: SPACE
PALLET: NO	GAIN: 100	RAMP: 100
ASPECT: 65	TIMERS: OFF	OVERLOAD: 2

PAGE 3 OF 3

*SCREW: #1	IPM: 200	XYZ RAMP: 100
Z TAP GAIN: HI	VECTOR: NO	AXIS DISPLAY: LOAD
AUTO BRAKE: YES	A-PALLET: A-AXIS	B-PALLET: B-AXIS
5 AXIS HEAD: NO	GO DETAIL: 241	FEEDBACK: NO
AT-SPEED: NO	SLIDE HOLD: 10	MANUAL: NO

## 15" (SHARP) LCD display

Here are the settings for the 15" LCD Display unit used with the Fadal Control:

Clock: 127  
 Phase: 0  
 H Pos: 12  
 V Pos: 34  
 640x480V:60Hz      H:31.4 KHz

Black Level: 68  
 Contrast: 29

400 Lines    640    720  
 Expand: ON1    ON2  
 Scaling: 3  
 Bright: Auto    Low    Med    High    if Auto selected set to 31.

