HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

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- This content is for illustrative purposes.
- Historic machine Service Manuals are posted here to provide information for Haas machine owners.
- Publications are intended for use only with machines built at the time of original publication.
- As machine designs change the content of these publications can become obsolete.
- You should not do mechanical or electrical machine repairs or service procedures unless you are qualified and knowledgeable about the processes.
- Only authorized personnel with the proper training and certification should do many repair procedures.

**WARNING: Some mechanical and electrical service procedures can be extremely dangerous or life-threatening.
Know your skill level and abilities.**

All information herein is provided as a courtesy for Haas machine owners for reference and illustrative purposes only. Haas Automation cannot be held responsible for repairs you perform. Only those services and repairs that are provided by authorized Haas Factory Outlet distributors are guaranteed.

Only an authorized Haas Factory Outlet distributor should service or repair a Haas machine that is protected by the original factory warranty. Servicing by any other party automatically voids the factory warranty.

COMMON ABBREVIATIONS

AC	Alternating Current
AMP	Ampere
APC	Automatic Pallet Changer
APL	Automatic Parts Loader
ASCII	American Standard Code for Information Interchange
ATC	Automatic Tool Changer
ATC FWD	Automatic Tool Changer Forward
ATC REV	Automatic Tool Changer Reverse
AWG	American Wire Gauge
BHCS	Button Head Cap Screw
BT	British Tooling (Common usage)
CAD	Computer Assisted Design
CAM	Computer Assisted Manufacturing (Assisted Machining)
CAT-5	Category 5 Cable
CB	Circuit Breaker
CC	Cubic Centimeter
CCW	Counter Clock Wise
CFM	Cubic Feet per Minute
CNC	Computerized Numeric Control
CNCR SPINDLE	Concurrent Spindle with axis motion
CRC	Cyclic Redundancy Check digit
CRT	Cathode Ray Tube
CT	Caterpillar Tooling
CTS	Clear To Send
CW	Clock Wise
DB	Draw Bar
DC	Direct Current
DGNOS	Diagnostic
DHCP	Dynamic Host Configuration Protocol
DIR	Directory
DNC	Direct Numerical Control
DOS	Disk Operating System
DTE	Data Terminal Equipment
ENA CNVR	Enable Conveyor
EOB	End Of Block
EOF	End Of File
EPROM	Erasable Programmable Read Only Memory
E-STOP	Emergency Stop
FHCS	Flat Head Cap Screw
FT	Foot
FU	Fuse
FWD	Forward
GA	Gauge
HHB	Hex Head Bolts
HP	Horse Power
HS	Horizontal Series of Machining Centers
ID	Inside Diameter
IGBT	Isolated Gate Bipolar Transistor
IN	Inch
IOPCB	Input Output Printed Circuit Board
LAN	Local Area Network
LB	Pound
LED	Light Emitting Diode

LO CLNT	Low Coolant
LOW AIR PR	Low Air Pressure
LVPS	Low Voltage Power Supply
MB	Megabyte (1 million)
MCD RLY BRD	M -Code Relay Board
MDI	Manual Data Input
MEM	Memory
M-FIN	M -code Finished
MM	MilliMeter
MOCON	Motor Control
MOTIF	Motor Interface
MSG	Message
MSHCP	Metric Socket Head Cap Screw
NC	Numerical Control
NC	Normally Closed
NO	Normally Open
OD	Outside Diameter
OPER	Operator
P	Pocket
PARAM	Parameter
PCB	Printed Circuit Board
PGM	Program
POR	Power On Reset
POSIT	Positions
PROG	Program
PSI	Pounds per Square Inch
PST	Pallet Schedule Table
PWM	Pulse Width Modulation
RAM	Random Access Memory
RET	Return
REV CNVR	Reverse Conveyor
RJH	Remote Jog Handle
RPDBDN	Rotary Pallet Draw Bar Down
RPDBUP	Rotary Pallet Draw Bar Up
RPM	Revolutions Per Minute
RTS	Request To Send
RXD	Receive Data
S	Spindle Speed
SDIST	Servo Distribution PCB
SFM	Surface Feet per Minute
SHCS	Socket Head Cap Screw
SIO	Serial Input/Output
SKBIF	Serial Key Board Inter Face PCB
SMTC	Side Mount Tool Changer
SP	Spindle
T	Tool Number
TC	Tool Changer
TIR	Total Indicated Runout
TNC	Tool Nose Compensation
TRP	Tool Release Piston
TS	Tail Stock
TSC	Thru the Spindle Coolant
TXD	Transmit Data
VDI	Verein Deutscher Ingenieure
VMC	Vertical Machining Center
WAN	Wide Area Network

1. TROUBLESHOOTING

This section is intended for use in determining the solution to a known problem. Solutions given are intended to give the individual servicing the CNC a pattern to follow in, first, determining the problem's source and, second, solving the problem.

The troubleshooting tips are organized in this section according to the area of the CNC that may be giving sign of a problem. (Ex.: Out-of round circles in drilling will be found under the heading General Machine Operation - Accuracy).

If the problem you are experiencing cannot be found under the heading you expect, please try several other possible headings. If the problem is still not found, contact Haas Automation for further details.

BEFORE YOU BEGIN:

USE COMMON SENSE

Many problems are easily overcome by correctly evaluating the situation. All machine operations are composed of a program, tools, and tooling. You must look at all three before blaming one as the fault area. If a bored hole is chattering because of an overextended boring bar, don't expect the machine to correct the fault. Don't suspect machine accuracy if the vise bends the part. Don't claim hole mis-positioning if you don't first center-drill the hole.

FIND THE PROBLEM FIRST

Many mechanics tear into things before they understand the problem, hoping that it will appear as they go. We know this from the fact that more than half of all warranty returned parts are in good working order. If the spindle doesn't turn, remember that the spindle is connected to the gear box, which is connected to the spindle motor, which is driven by the spindle drive, which is connected to the I/O BOARD, which is driven by the MOCON, which is driven by the processor. The moral here is don't replace the spindle drive if the belt is broken. Find the problem first; don't just replace the easiest part to get to.

DON'T TINKER WITH THE MACHINE

There are hundreds of parameters, wires, switches, etc., that you can change in this machine. Don't start randomly changing parts and parameters. Remember, there is a good chance that if you change something, you will incorrectly install it or break something else in the process. Consider for a moment changing the processor's board. First, you have to download all parameters, remove a dozen connectors, replace the board, reconnect and reload, and if you make one mistake or bend one tiny pin it WON'T WORK. You always need to consider the risk of accidentally damaging the machine anytime you work on it. It is cheap insurance to double-check a suspect part before physically changing it. The less work you do on the machine the better.

1.1 General Machine Operation

Machine Not Running

Machine cannot be powered on.

- Check input voltage to machine (see "Electrical Service").
- Check main circuit breaker at top right of electrical cabinet; switch must be at the on position.
- Check overvoltage fuses (see "Electrical Service").
- Check wiring to POWER OFF button on front control panel.
- Check wiring to AUTO OFF relay to IOPCB.
- Check connection between 24V transformer and K1 contactor
- Check IOPCB (see "Electrical Service").
- Check POWER PCB (see "Electrical Service").

Machine can be powered on, but turns off by itself.

- Check settings #1 and #2 for Auto Off Timer or Off at M30.
- Check alarm history for OVERVOLTAGE or OVERHEAT shutdown.
- Check AC power supply lines for intermittent supply.
- Check wiring to POWER OFF button on front control panel.
- Check connection between 24V transformer and K1 contactor.
- Check IOPCB (see "Electrical Service").
- Check Parameter 57 for Power Off at E-STOP.
- Check MOTIF or MOCON PCB (see "Electrical Service").

Machine turns on, keyboard beeps, but no CRT display.

- Check for power connections to CRT from IOPCB. Check for green POWER LED at front of CRT.
- Close doors and Zero Return machine (possible bad monitor).
- Check video cable (760) from VIDEO PCB to CRT.
- Check for lights on the processor.

Machine turns on, CRT works, but no keyboard keys work.

- Check keyboard cable (700B) from VIDEO to KBIF PCB.
- Check keypad (see "Electrical Service").
- Check KBIF PCB (see "Electrical Service").

Constant E-Stop Condition (will not reset)

- Check Hydraulic counterbalance pressure, low pressure switches and cabling.

VIBRATION

Vibration is a subjective evaluation with perceptions varying among individuals, making it difficult to determine in mild cases if there is an actual problem. Because the VF Series uses a gear head, it will be noisier than a direct drive or belt system. In obvious cases, it is a matter of determining the source - which is not easy, since all parts rotate together and sound can be transferred readily. Vibrations also need to be distinguished from noise such as a bad bearing. We will assume that vibrations would be something that could be felt by putting your hand on the spindle covers. One crude method of measurement would be to take an indicator on a magnetic base extended 10 inches between the table and spindle housing and observe the reading of the indicator. A reading of more than .001 would indicate excessive vibration. The two common sources of noise are the spindle and axis drives. Most complaints about vibration, accuracy, and finish can be attributed to incorrect machining practices such as poor quality or damaged tooling, incorrect speeds or feeds, or poor fixturing. Before concluding that the machine is not working properly, ensure that good machining practices are being observed. These symptoms will not occur individually (Ex. A machine with backlash may vibrate heavily, yielding a bad finish.). Put all of the symptoms together to arrive at an accurate picture of the problem.

Machine vibrates while jogging the axis with the hand wheel.

- The HAAS control uses very high gain accelerations curves. This vibration as you jog is simply the servos quickly trying to follow the handle divisions. If this is a problem, try using a smaller division on the handle. You will notice the vibration more at individual clicks than when you are turning the handle faster. This is normal.

The machine vibrates excessively in a cut.

- This is a tough one to call because machining practices come into play. Generally speaking, the least rigid element of a cut is the tool because it is the smallest part. Any cutter will vibrate if pushed beyond its tensile strength. In order to eliminate the machine as the source of the problem, you need to check the spindle and the backlash of the axes as described in the following sections. Once machining practices have been eliminated as the source of vibration, observe the machine in both operation and "cutting air." Move the axes (individually) without the spindle turning and then turn the spindle without moving the axes. Isolate whether the vibration comes from the spindle head or from an axis. Isolate the source of vibration per "Spindle", "Servo Motors/Ballscrews", and "Gearbox and Spindle Motor" sections.

ACCURACY

Before you complain of an accuracy problem, please make sure you follow these simple do's and don'ts:

- Ensure that the machine has been sufficiently warmed up before cutting parts. This will eliminate mispositioning errors caused by thermal growth of the ballscrews (see "Thermal Growth" section).
- **Do not** use a wiggler test indicator for linear dimensions. They measure in an arc and have sine/cosine errors over larger distances.
- **Do not** use magnetic bases as accurate test stops. The high accel/decel of the axis can cause them to move.
- **Do not** attach magnetic base to the sheet metal of the spindle head or table.
- **Do not** mount the magnetic base on the spindle dogs.
- **Do not** check for accuracy/repeatability using an indicator with a long extension.
- Ensure that test indicators and stops are absolutely rigid and mounted to machined casting surfaces (e.g. spindle head casting, spindle nose, or the table).
- **Do not** rapid to position when checking accuracy. The indicator may get bumped and give an inaccurate reading. For best results, feed to position at 5-10 inches per minute.
- Check a suspected error with another indicator or method for verification.
- Ensure that the indicator is parallel to the axis being checked to avoid tangential reading errors.
- Center drill holes before using jobber length drills if accuracy is questioned.
- Once machining practices have been eliminated as the source of the problem, determine specifically what the machine is doing wrong.

Machine will not interpolate a round hole.

- Check that the machine is level (see "Installation" section).
- Check for backlash ("Servo Motors/Ballscrews" section).

Bored holes do not go straight through the workpiece.

- Check that the machine is level (see "Installation" section).
- Check for squareness in the Z axis.

Machine bores holes out-of-round.

- Check that the machine is level (see "Installation" section).
- Check the sweep of the machine (see "Spindle Sweep Adjustment" section).

Bored holes are out of round or out of position.

- Check for thermal growth of the ballscrew (see "Thermal Growth" section).
- The spindle is not parallel to the Z axis. Check the spindle sweep to the table and the squareness of the Z axis with a cylinder square. If available use a spindle master bar and indicate the spindle to the Z axis.

Machine mis-positions holes.

- Check for thermal growth of the ballscrew (see "Thermal Growth" section).
- Check that the machine is level (see "Installation" section).
- Check for backlash (see "Servo Motors/Ballscrews" section).
- Check the squareness of the X axis to the Y axis.

Machine leaves large steps when using a shell mill.

- Check that the machine is level (see "Installation" section).
- Check the sweep of the machine (see "Spindle Sweep Adjustment" section).
- Cutter diameter too large for depth of cut.

Boring depth inaccurate

- Check for thermal growth of the ballscrew (see "Thermal Growth" section).
- Check the hydraulic counterbalance system. Check for:
  - abnormal noises from counterbalance system,
  - oil leaks (esp. at fittings and at filter at top of cylinder),
  - bound cylinder.

FINISH

Machining yields a poor finish.

- Check for gearbox vibration.
- Check for backlash ("Accuracy/Backlash" section)
- Check the condition of the tooling and the spindle.
- Check spindle
- Check the condition of the servo motors.
- Check that the is machine level.

THERMAL GROWTH

A possible source of accuracy and positioning errors is thermal growth of the ballscrew. As the machine warms up, the ballscrews expand in all three linear axes, causing accuracy and positioning errors, or inaccurate boring depths. This is especially critical in jobs that require high accuracy, machining multiple parts in one setup, or machining one part with multiple setups.

NOTE: On machines equipped with ***linear scales***, thermal growth will not affect machine positioning or accuracy. However, it is still recommended that the machine be warmed up before cutting parts.

NOTE: The ballscrew will always expand ***away*** from the motor end.

VERIFY THERMAL GROWTH

There are a number of ways to verify the problem. The following procedure will verify thermal growth of the X-axis ballscrew in a machine that has not been warmed up:

1. Home the machine. In MDI mode, press POSIT and PAGE DOWN to the OPER page.

2. Jog to an offset location on the table (example: X-15.0" Y-8.0"). Select the X axis and press the ORIGIN key to zero it. Select the Y axis and zero it.

3. Press the OFSET key, then scroll down to G110 (or any unused offset). Cursor to X and press PART ZERO SET twice. This will set X0, Y0 at this position.

4. Enter the following program. It will start at the new zero position, rapid 10 inches in the X direction, feed the final .25 inches at 10 inches/min., and then repeat the X movement.

```
G00 G90 G110 X0 Y0;
X10.0;
G01 X10.25 F10. ;
M99;
```

5. In order to set up the indicator, run the program in SINGLE BLOCK mode, and stop it when X is at 10.25". Set the magnetic base on the table, with the indicator tip touching the spindle housing in the X-axis, and zero it.

6. Exit SINGLE BLOCK mode, and run the program for a few minutes. Enter SINGLE BLOCK mode again, stop the program when X is at 10.25", and take a final reading on the indicator. If the problem is thermal growth, the indicator will show a difference in the X position.

NOTE: Ensure the indicator setup is correct as described in "Accuracy" section. Errors in setup are common, and often incorrectly appear to be thermal growth.

7. A similar program can be written to test for thermal growth in the Y and Z axes, if necessary.

SOLUTIONS

Since there are many variables that affect thermal growth, such as the ambient temperature of the shop and program feed rates, it is difficult to give one solution for all problems.

Thermal growth problems can generally be eliminated by running a warm-up program for approximately 20 minutes before machining parts. The most effective warm-up is to run the current program, at an offset Z position above the part or table, with the spindle "cutting air". This will allow the ballscrews to warm up to the correct temperature and stabilize. Once the machine is at temperature, the ballscrews won't expand any further, unless they're allowed to cool down. A warm-up program should be run after each time the machine is left idle.

COMPENSATION FOR THERMAL GROWTH

During normal operation, small inaccuracies in the work pieces may develop due to thermal expansion of the ball screws. Ball screws are made of steel which expands at the rate of 11 millionths of an inch per degree C. The Haas Control contains built-in features to electronically correct for ball screw growth. This compensation works by estimating the heating of the screw based on the amount of travel over the length of the screw and is measured from the motor. On a mill, the X-axis motor is on the left, the Y-axis motor is at the back, and the Z-axis motor is at the top. Adjustments can be made to the settings as needed. The user can fine-tune this compensation up to plus or minus 30% with the use of settings 158, 159 and 160. If the part size is too big decrease the amount of compensation for the appropriate axis For example, increasing the value in Setting 158 “X Screw Thermal Comp%” can increase the amount of thermal compensation.

1.2 Spindle

Not Turning

Spindle not turning.

- If there are any alarms, refer to "Alarms" section.
- Check that the spindle turns freely when machine is off.
- If motor turns but spindle does not, see "Belt Assembly" and "Spindle Motor & Transmission" sections.
- Command spindle to turn at 1800 RPM and check spindle drive display. If display blinks “bb”, check spindle orientation switch ("Spindle Orientation" section). If spindle drive does not light the RUN LED, check forward/reverse commands from IOPCB ("Electrical Service").
- Check the wiring of analog speed command from MOTIF PCB to spindle drive (cable 720).
- If spindle is still not turning, replace MOCON PCB ("Electrical Service").
- If spindle is still not turning, replace spindle drive ("Electrical Service").
- Check for rotation of the gearbox (if applicable) or the motor. If the motor or gearbox operates, check the drive belt ("Belt Assembly" section).
- Disconnect the drive belt. If the spindle will not turn, it is seized and must be replaced ("Spindle Assembly" section).

NOTE: Before using the replacement spindle, the cause of the previous failure must be determined.

Noise

Most noises attributed to the spindle actually lie in the motor/gearbox or drive belt of the machine. Isolate the sources of noise as follows:

Excessive noise coming from the spindle head area.

On VF-1 through 6 models, first determine if the noise is related to the RPM of the motor or the RPM of the spindle. For example: If the noise appears at 2000 RPM in high gear, listen for a similar noise at 500 RPM in low gear. If the same noise persists, the problem lies with the gearbox. If the noise disappears, the problem could be either the gearbox or the spindle, and further testing is necessary.

NOTE: The gear ratio is 1:1.25 in high gear, and 3.2:1 in low gear.

- Remove the head covers and check the machine’s drive belt tension ("Tension Adjustment" section).
  - If the noise persists, turn the drive belt over on the pulleys. If the noise is significantly different, the belt is at fault. Replace the belt ("Belt Assembly" section).
  - If the noise does not change, remove the belt and go on to the next step.

- Check the pulleys for excessive runout (more than 0.003" axial or radial).

- Run the motor or the gearbox with the drive belt disconnected. If the noise persists, the problem lies with the gearbox/motor. If it disappears, go on to the next step.

- Check for the correct amount of lubrication to the spindle bearings (0.5-1.0 cc every two hours) in an air mist-lubricated spindle.
    - If the spindle is not getting lubrication, correct the problem per the lube and air diagram at the back of this manual and replace the spindle ("Spindle Assembly" section).
    - If the spindle is getting lubrication, replace the spindle ("Spindle Assembly" section).

Note: Haas Automation does not honor warranty requests for gearbox or spindles without vibration analyzer signatures.

OVERHEATING

When investigating complaints of overheating, a temperature probe must be used to accurately check the temperature at the top of the spindle taper. The temperature displayed in Diagnostics is not relevant. A machine that runs at high RPM continuously will have a much warmer spindle than a machine that runs at a lower RPM. New spindles tend to run much warmer than spindles that have already been run-in. In order to run a valid test on a new spindle, ensure that it is properly run-in.

To run-in a spindle, run the following program (it will take approximately 6 hours):

```
N100 S300 M03
G04 P900.
M05
G04 P900.
N200 S1000 M03
G04 P900.
M05
G04 P900.
N300 S2000 M03
G04 P900.
M05
G04 P900.
G04 P900.
N400 S3000 M03
G04 P900.
M05
G04 P900.
G04 P900.
N500 S4000 M03
G04 P900.
M05
G04 P900.
G04 P900.
N600 S5000 M03
G04 P900.
M05
G04 P900.
G04 P900.
N700 S6000 M03
G04 P900.
M05
G04 P900.
G04 P900.
N800 S7500 M03
G04 P900.
M05
G04 P900.
G04 P900.
M99
```

NOTE: This program will step the spindle speed from 300 RPM up to 7500 RPM at regular intervals of time, stop the spindle and allow it to cool to room temperature, then restart it so the temperature can be monitored.

Alternate Spindle Run-in Program

Run program #O02021 with the air pressure to the spindle set to 30 psi. (for all spindles). Program time is approximately 2 hours. If possible run the program overnight by changing M30 to M99 so it can repeat. Adjust spindle speed override depending on maximum spindle speed of machine: Set override 50% for 5,000 RPM machines; Set at 100% for 7,500 and 10,000 RPM machines; Set at 150% for 15,000 RPM machines.

```
N100
S750M3
G04 P600.;
S2500M3;
G04 P600.;
S5000M3;
G04 P900.;
N200
M97 P1000 L15
M97 P2000 L15
M30;
N1000
S7500M3;
G04 P30.;
S500 M3;
G04 P150.;
M99;

N2000
S10000M3;
G04 P30.;
S500M3;
G04 P150.;
M99;
%
```

- If at any time during this procedure the spindle temperature rises above 150 degrees (120 degrees for 50 Taper), start the procedure over from the beginning and follow the steps below.

NOTE: Once run-in program is complete **reset** the air pressure back to **17psi. (20psi.** for 15K spindles or **25psi.** for Mini-Mills regardless of spindle speed) prior to checking spindle temperature.

If the spindle fails this test for any reason, check the following:

- Check for correct amount of lubrication.

NOTE: Over lubrication is a common source of overheating. Check the oil flow carefully.

- Check the drive belt tension. Belts that are too tight will cause heating of the top bearing in the spindle housing.

- Ensure that the correct oil is being used (refer to "Maintenance Schedule").

Stalling / Low Torque

Generally, complaints of stalling or low torque relate to incorrect tooling or machining practices. A spindle that is tending to seize will yield a poor finish machining, run very hot and very loud. Investigate machining problems before concluding the problem exists with the spindle or spindle drive.

Spindle Drive

Low line voltage may prevent the spindle from accelerating properly. If the spindle takes a long time to accelerate, slows down or stays at a speed below the commanded speed with the load meter at full load, the spindle drive and motor are overloaded. High load, low voltage, or too fast accel/decel can cause this problem.

If the spindle is accelerated and decelerated frequently, the regenerative load resistor on top of the control may heat up. If this resistor heats beyond 100^{0}C, a thermostat will generate an “overheat” alarm.

If the regen load resistors are not connected or open, this could then result in an overvoltage alarm. The overvoltage occurs because the regenerative energy being absorbed from the motor while decelerating is turned into voltage by the spindle drive. If this problem occurs, the possible fixes are to slow the decel rate or reduce the frequency of spindle speed changes.

Vector Drive

To properly troubleshoot the Vector Drive, use the following questions as a guide:

- What alarms are generated?
- When does the alarm occur?
- Is the Vector Drive top fault light on?
- Is there a fault light on any of the servo amplifiers?
- Does the alarm reset?
- Does the spindle motor turn at all?
- Does the spindle turn freely by hand?
- Have the C-axis parameters been confirmed?
- What is the input voltage to the vector drive unit?
- What does the DC Bus voltage measure? (320 VDC to 345 VDC)
- Does the DC Bus voltage displayed on the diagnostic page match the measured DC Bus voltage?

All of the questions above must be answered. The DC Bus voltage should be between 320 VDC to 345 VDC with the machine powered up but not running. If the voltage is not in this range, adjust the taps on the main line transformer until this voltage range is achieved. There is a possibility the drive is faulty, but low Bus voltage can also be caused by a shorted REGEN load or a shorted amplifier.

If the DC Bus voltage is below 50 VDC and never goes any higher, perform Steps 1-6.

1. With the machine powered up, is the green “POWER-ON” L.E.D. lit? If not, replace the Vector Drive unit.

2. Power down the machine. Disconnect the REGEN load (terminals 1 and 2 on the Vector Drive unit) and measure the resistance from each wire-to-chassis ground (open) and between the wire leads. The resistance should be 8.6 ohms for machines with 20/15 Vector drives and HT10K mills equipped with 40/30 drives. All other machines with 40/30 drives should measure 6 ohms. If not, replace the REGEN load or cabling.

3. Disconnect cable 490 at terminals 2 and 3 of the Vector Drive and from the servo amplifiers. With a multimeter in the diode mode, place the red meter lead to the +HV terminal and the black meter lead to the -HV terminal of each amplifier. The meter should read open.

4. Reverse the leads: Place the red meter lead on the -HV terminal and the black lead on the +HV terminal. The meter should read .7 ohms in both instances. If not, replace the faulty amplifier.

5. Measure the resistance between terminals 1 and 3 of the Vector Drive. The meter should read greater than 100K ohms. If not, the Vector Drive is faulty.

6. If the green “POWER-ON” L.E.D. was lit (from Step 2), leave both 490 cables (2 and 3) disconnected from the drive and power up the machine.
   a. Does the DC Bus voltage come up? If not, the Vector Drive is faulty.
   b. Measure the voltage between terminals 1 and 3. The voltage should be 300 VDC or more. If not, the Vector Drive is faulty.

   If both ‘a’ and ‘b’ check out okay, there is a problem with either the amplifiers or the REGEN load.

If the fault occurs upon acceleration -or- the spindle accelerates slowly -or- the spindle makes noise, do the following:

7. Disconnect the output cables to the spindle motor. Turn on the machine and press <**RESET**>. Do not command the spindle to turn. With a volt meter, measure the DC voltage between each output phase (terminals 9, 10, and 11) to the 320V RTN (terminal 3). The meter should read 165 VDC in each case, else one phase is faulty.

8. Measure the resistance across the motor wires from phase to phase and from each phase to chassis. The meter should read .1 ohms phase-to-phase and open phase-to-chassis.

If the fault occurs upon deceleration or acceleration just as the spindle reaches its specified speed, or if an overvoltage alarm (119) occurred, do the following:

9. Disconnect the REGEN load resistors (terminals 1 and 2) and measure the resistance from each wire lead-to-chassis ground and between the wire leads. The meter should read open lead-to-ground, and 6 ohms between the leads for machines with 40/30 Vector drives and 8.6 ohms between the leads on machines with 20/15 Vector drives and HT10K mills.

10. Measure the resistance from terminal 1 to terminal 3. If the resistance is less than 100K, the drive is faulty.

11. With the REGEN load left disconnected, power-up the machine and command a spindle speed of 700 RPM (300 RPM for lathes in high gear). Press <**RESET**> while monitoring the DC voltage between terminal 1 and terminal 3. The voltage should read 330 VDC and then drop to less than 50 VDC momentarily. If not, that drive is faulty. If the voltage at RESET was okay and the alarm was resettable, the REGEN load should be replaced even if the resistance appears to be okay.

Orientation

Spindle loses correct orientation.

Non Vector Drive

- Check the orientation ring for tightness. Ensure the shaft on which the ring mounts is clean and is free of grease and oil.
- Check the orientation ring for cracks near the bolt holes or near the balancing holes.
  - If there are cracks, replace the ring.
- Check the shot pin on the gearbox for binding, damage, and proper operation. Replace it if it is damaged.

Vector Drive

- Check alarm history. Look for Spindle Z Fault, or Spindle Reference Missing alarms. If these alarms exist, there may be a defective spindle encoder, or a broken ground or shield connection.
- Check parameters.
- Check for a mechanical slip at the contact points of all components between the spindle and the spindle encoder.

Tools Sticking In Taper

Tool sticking in the taper causes ATC to be pulled up; accompanied by a popping noise as the tool holder pops out of the spindle taper.

NOTE: This problem may occur after loading a cold tool into a hot spindle (a result of thermal expansion of the tool holder inside the spindle taper). It may also occur due to heavy milling, milling with long tooling, or cuts with heavy vibration. This also is the result of thermal expansion.

If sticking only occurs during these situations, check your application to ensure proper machining techniques are being used; check the feeds and speeds for the tools and material being used. If a tool is pulled out of the extractors due to a tool stuck in the taper then the unclamp switch is not adjusted correctly or the switch could be bad.

NOTE: In a proper working system the spindle will pop slightly during a tool change. This popping does not create flex in the carousel or the need to remove the tool with a mallet.

- Check the condition of the tooling, verifying the taper on the tooling is ground and not turned. Look for damage to the taper caused by chips in the taper or rough handling. If the tooling is suspected, try to duplicate the symptoms with known-to-be-good tooling.
- Check the condition of the spindle taper. Look for damage caused by chips or damaged tooling. Also, look for damage such as deep gouges in the spindle taper caused by tool crashing.
- Duplicate the cutting conditions under which the deflection occurs, but do not execute an automatic tool change. Try instead to release the tool using the tool release button on the front of the spindle head. If sticking is observed, the deflection is not caused by improper ATC adjustment, but is a problem in the spindle head on the machine.
- Ensure the spindle is not running too hot (140° or above).

- Check air supply. Max air pressure drop of 10psi. during a tool change is allowed.
- Check drawbar height adjustment.
- Does the tool tip to the spindle gauge line exceed 3.5”?
- Are the correct pull studs being used?

Tool Holder / Spindle Fretting

Is fretting present on the tool holder or spindle?

Fretting is the result of sideways movement of a tool holder in the spindle. Fretting can leave a wave pattern on the mating surfaces and will affect the fit and finish of both the tool holder and the spindle.

- If light fretting is present, check the application to ensure proper machining techniques are being used; check the feeds and speeds for the tools and material being used.
- Light fretting and rust may be cleaned from the tool holder with a fine scotchbrite hand pad and solvent. If scotchbrite is used, clean the tool holder and spindle taper thoroughly after use with an alcohol pad. Apply a thin coat of light oil to the taper of the tool holder. Grease the pull stud.

Checking Spindle Oil Flow

Disconnect the air/oil line to the spindle at the lube-air panel (30K 30 Taper and 15K GR-Series are disconnected at the check valve). Install a short piece of hose into the port on the regulator and place the other end into a graduated cylinder. Lower spindle air pressure regulator to 0psi. Program a repetitive machine axis movement (DO NOT run the spindle) and note the amount of oil collected. The program should be allowed to run for four hours. Be sure to reset the spindle air pressure regulator to proper pressure.

Note: Use 5% or 25% rapid for axis movement. Moving the axes faster will not change the results.

The following gives the range for each type of spindle:
40 Taper (7.5K and 10K) 1.5 to 2.5 cc every four hours
15K 40 Taper 1.1 to 1.4 cc every four hours* For GR-Series machines see the notes below.
50 Taper 1.7 to 2.1 cc every 4 hours
30K 30 Taper*

*Airmatic Pumps (These pumps are identified by the addition of a solenoid on top of the pump) The 30 K 30 taper and the GR series 15K or higher spindle use this type of pump.

30K 30 Taper

Disconnect the air/oil line at the check valve. Manually energize the solenoid 30 times holding it for 2 seconds each time.

Each pulse from the pump will deliver .01cc; after 30 pulses, .3cc should have been collected **per injector**, the 30K spindle has two injectors.

GR-Series 15K

Disconnect the air/oil line at the check valve. Manually energize the solenoid 30 times holding it for 2 seconds each time.

Each pulse from the pump will deliver .2cc; after 30 pulses, 6cc should have been collected.

1.3 Servo Motors / Ballscrews

Not Operating

All problems that are caused by servo motor failures should also register an alarm. Check the alarm history to determine the problem's cause before any action is taken.

Servo motor is not functioning.

- Check the power cable from rear electrical cabinet to ensure connection is tight.
- Encoder is faulty or contaminated (Alarms 139-142, 153-156, 165-168, 182-185). Replace motor assembly on brushless machines, replace the encoder on brush machines.
- Open circuit in motor (Alarms 139-142, 153-156, 182-185). Replace motor assembly ("Axis Motor Removal / Installation").
- Motor has overheated, resulting in damage to the interior components (Alarms 135-138, 176). Replace motor assembly ("Axis Motor Removal/Installation").
- Wiring is broken, shorted, or missing shield (Alarms 153-156, 175, 182-185).
- Dust in the motor from brushes has shorted out the motor (VF-E only) (Alarms 153-156, 175, 182-185). Replace motor assembly ("Axis Motor Removal/Installation").
- Motor has overheated; no damage to the interior components. OVERHEAT alarm has been triggered. After thorough check of motor (DO NOT DISASSEMBLE!), take necessary steps to eliminate the problem and alarm to resume operation. If motor is still inoperable, replace motor assembly ("Axis Motor Removal/Installation").
- Check for broken or loose coupling between the servo motor and the ball screw. Replace or repair the coupling ("Axis Motor Removal/Installation")
- Check for a damaged ball screw, and replace if necessary ("Ball Screw Removal and Installation" section).

NOTE: If a ball screw fails, it is most often due to a failed bearing sleeve. When replacing the ball screw in an older machine, always replace the bearing sleeve with the current angular contact bearing sleeve ("Bearing Sleeve Removal and Installation" section).

Noise

Ball screw noise is usually caused by a lack of lubrication and is usually accompanied by heating. Other causes are misalignment, bearing sleeve damage, or ball nut damage. Check the alarm history of the machine and look for axis overcurrent and following error alarms.

NOTE: Do not replace ball screws or bearing sleeves without due consideration; they are extremely durable and reliable. Verify that customer complaints are not due to tooling, programming, or fixturing problems.

Servo motor noise.

- Disconnect the servo motor from the ball screw and rotate by hand. If the noise persists, replace the motor assembly ("Axis Motor Removal/Installation" section).
- Noise is caused by motor brushes (VF-E only). Remove and inspect brushes. Blow out brush dust and inspect the armature.

Ball screw noise.

- Ensure oil is getting to the ball screw through the lubrication system (See Air and Oil Diagrams). Look for a plugged metering valve.
- Check for damage to the bearing sleeve.

NOTE: The current angular contact design sleeve has a fixed pre-load; it cannot be adjusted.

- Run the axis back and forth. The motor will get very hot if the bearing sleeve is damaged. If so, turn the axis by hand and feel for roughness in the ball screw. Loosen the clamp nuts at both ends of the ball screw. If the symptom disappears, replace the bearing sleeve. Be certain to check for damage to the ball screw shaft where the bearing sleeve is mounted.
  - If the noise persists, the ball screw is damaged and must be replaced. When replacing the ball screw in an older machine, always replace the bearing sleeve with the current angular contact design bearing sleeve.
- Misalignment in the ball screw itself will tend to cause the ball screw to tighten up and make excessive noise at both ends of the travel. The ballnut may get hot. Misalignment radially at the yoke where the ball screw ball nut mounts is indicated by heating up of the ball nut on the ball screw, and noise and tightness through out the travel of the ball screw. Misalignment at the yoke where the ball nut mounts is indicated by noise and tightness at both ends of the travel of the ball screw. The ball nut may get hot.

NOTE: Customer complaints of Ball Screw noise may not indicate a bad screw. Screws from different manufacturers produce varying levels of noise. Often machines are built with two or more different brands of screws in the same machine. If complaints are generated about one axis screw in comparison to another, it is possible that the screws are simply sourced from different manufacturers.

Accuracy / Backlash

Accuracy complaints are usually related to tooling, programming, or fixturing problems. Eliminate these possibilities before working on the machine.

Poor mill table-positioning accuracy.

- Check for backlash in the ball screw as outlined below:
- Check parameters for that axis
- Check for a loose encoder on the servo motor. Also, ensure the key in the motor or the ball screw is in place and the coupling is tight (Brush machines only).

INITIAL PREPARATION -

Turn the VMC ON. ZERO RET the machine and move the mill table to the approximate center of its travel in the X and Y directions. Move the spindle head to approximate center of the Z-axis travel, also.

CHECKING X-AXIS:

1. Set up a dial indicator and base on the mill table as shown in Fig. 1-1.

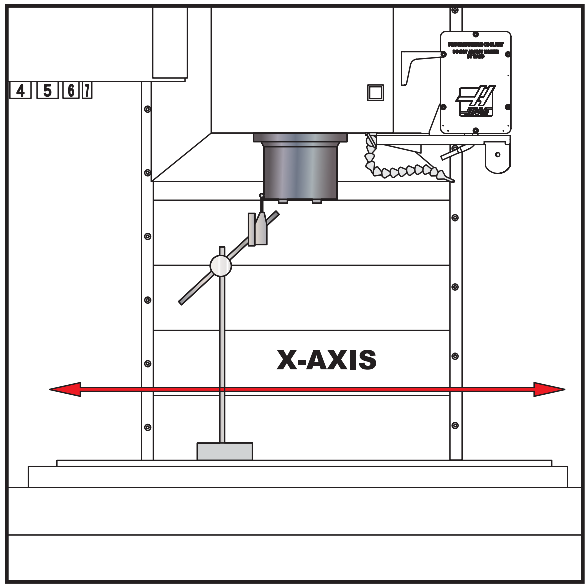


Figure 1-1. Dial indicator in position to check X-axis.

2. Set dial indicator and the “Distance to go” display in the HANDLE JOG mode to zero as follows:
   - •Zero the dial indicator.
   - •Press the MDI button on the control panel.
   - •Press the HANDLE JOG button on the control panel.

   The “Distance to go” display on the lower right hand corner should read: X=0 Y=0 Z=0

3. Set the rate of travel to .001 on the control panel and jog the machine .010 in the positive (+) X direction. Jog back to zero (0) on the display. The dial indicator should read zero (0) ± .0001.

4. Repeat Step 3 in the negative (-) direction.

TOTAL DEVIATION BETWEEN THE DIAL INDICATOR AND THE CONTROL PANEL DISPLAY SHOULD NOT EXCEED .0002.

An alternate method for checking backlash is to place the dial indicator as shown in Fig. 1-1 and manually push on the mill table in both directions. The dial indicator should return to zero after releasing the table.

NOTE: The servos must be on to check backlash by this method.

CHECKING Y-AXIS:

1. Set up a dial indicator and base on the mill table as shown in Fig. 1-2.

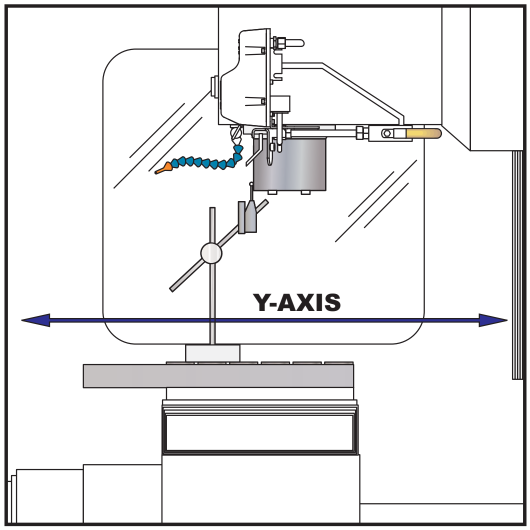


Figure 1-2. Dial indicator in position to check Y-axis.

2. Set dial indicator and the “Distance to go” display in the HANDLE JOG mode to zero as follows:
   •Zero the dial indicator.
   •Press the MDI button on the control panel.
   •Press the HANDLE JOG button on the control panel.
   The “Distance to go” display on the lower right hand corner should read: X=0 Y=0 Z=0.

3. Set the rate of travel to .001 on the control panel and jog the machine .010 in the positive (+) Y direction. Jog back to zero (0) on the display. The dial indicator should read zero (0) ± .0001.

4. Repeat Step 3 in the negative (-) direction.

TOTAL DEVIATION BETWEEN THE DIAL INDICATOR AND THE CONTROL PANEL DISPLAY SHOULD NOT EXCEED .0002.

An alternate method for checking backlash is to place the dial indicator as shown in Fig. 1-2 and manually push on the mill table in both directions. The dial indicator should return to zero after releasing the table.

NOTE: The servos must be on to check backlash by this method.

CHECKING Z-AXIS:

1. Set up a dial indicator and base on the mill table as shown in Fig. 1-3.

2. Manually push up and down on the spindle head while listening for a ‘clunk’. Also, watch for any rapid change in the dial indicator. Either of these indicate possible backlash.

NOTE: Servos must be on to check for backlash in the Z-axis.

NOTE: Do not mistake deflection for backlash in the system.

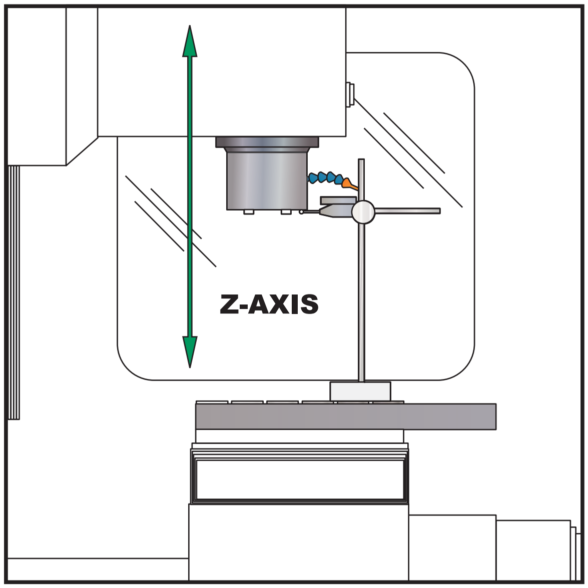


Figure 1-3 Dial indicator in position to check Z-axis.

If backlash is found in the system, check for the following possible causes:

- Loose SHCS attaching the ball nut to the nut housing. Tighten the SHCS as described in Mechanical Service.
- Loose SHCS attaching the nut housing to the mill table, spindle head, or saddle, depending on the axis. Tighten the SHCS as described in Mechanical Service.
- Loose clamp nut on the bearing sleeve. Tighten the SHCS on the clamp nut.
- Loose motor coupling. Tighten as described in Mechanical Service.
- Broken or loose flex plates on the motor coupling.

NOTE: The coupling cannot be serviced in the field and must be replaced as a unit if it is found to be defective.

- Loose SHCS attaching the bearing sleeve to the motor housing. Tighten as described in "Ball Screw Removal and Installation".
- Defective thrust bearings in the bearing sleeve. Replace the bearing sleeve as outlined in "Bearing Sleeve Removal and Installation".
- Loose SHCS attaching the axis motor to the motor housing. If the SHCS are found to be loose, inspect the motor for damage and if none is found, tighten as described in "Axis Motor Removal/ Installation". If damage is found, replace the motor.
- Incorrect backlash compensation number in the parameter in the machine. Check Parameters 13, 27, and 41.
- Worn ball screw.

Vibration

Excessive servo motor vibration.

- Swap the suspected bad servo motor with a known good driver and check to see if there is a driver problem. If needed, replace the DRIVER PCB ("Electrical Service" section).
- Check all Parameters of the suspected axis against the Parameters as shipped with the machine. If there are any differences, correct those and determine how the Parameters were changed.
- A bad motor can cause vibration if there is an open or short in the motor. A short would normally cause a GROUND FAULT or OVERCURRENT alarm; check the ALARMS. An ohmmeter applied to the motor leads should show between 1 and 3 ohms between leads, and over 1 megohm from leads to chassis. If the motor is open or shorted, replace.

Overheating

Servo motor overheating.

- If a motor OVERHEAT alarm occurs (ALARMS 135-138), check the Parameters for an incorrect setting. Axis flags in Parameters 1, 15, or 29 can invert the overheat switch (OVER TEMP NC).
- If the motor is actually getting hot to the touch, there is excessive load on the motor. Check the user's application for excessive load or high duty cycle. Check the ball screw for binding ("Accuracy/ Backlash" section). If the motor is binding by itself, replace in accordance with "Axis Motor Removal/ Installation".

Following Errors

FOLLOWING ERROR (Brush Machines only) or SERVO ERROR TOO LARGE alarms 103-106, 187 occur on one or more axes sporadically.

- Check DC bus voltage on diagnostics page #2 (brush machines only). Verify this voltage on the drive cards in the control panel. If it is at the low side of the recommended voltages, change the transformer tap to the next lower voltage group as explained in the Installation Manual.
- Check motor wiring for a short.
- Check driver card ("Electrical Service").
- Check servo motor ("Axis Motor Removal/Installation").
- Check encoder (brush machines only)

Drive Fault / Overcurrent

Z-axis motor overcurrent.

- Alarm not cleared
- Low counterbalance pressure
- Check Z axis parameters
- Check the ball screw for binding
- Check motor and cable for shorts
- Check amplifier (drive card on a VF-E)

VF-6 with Z axis brake only

- Brake power fuse blown
- Brake power transformer blown
- Brake power rectifier blown
- Cabling pinched
- Brake failed

BALL SCREWS - VISUAL INSPECTION

The three main causes of Ball Screw failure are:
Loss of Lubrication
Contamination
Machine Crash

Wear of the Nut balls and the screw threads is generally a non-issue under proper operating conditions.

Each type of suspect cause will leave telltale signs on the Ball Screw itself.

Loss of Lubrication:

The lubrication system of the machine provides a layer of oil for the Ball Screw components to operate on, eliminating metal-to-metal contact. Should a problem with the lubrication system develop, that failure will accelerate all wear issues.

1. Dry metal-to-metal contact following lube breakdown will create intense heat at the contact points. The Nut balls will weld to the Nut races due to the heat and pressure of the preload. When movement of the Ball Screw continues, the welds will be broken, ripping off particles of both the balls and the races. This loss of diameter will reduce the preload, reducing machine accuracy.
Ball Screws with this type of wear, but no screw surface marring, can be repaired by the factory.

2. A second cause of wear of the Ball Screws is material fatigue. Material fatigue typically occurs at the end of the Ball Screw service life. Signs of material fatigue include black, contaminated coolant, pitting of the screw surface, loss of preload, and metal flakes on the Ball Screw.
Ball Screws suffering from material fatigue are not repairable and are considered scrap.

Contamination:

Contamination of the lubrication and/or coolant systems of the machine will produce problems with the Ball Screws.

Check the condition of the lube on the Ball Screw threads.

1. If the lube is wet and clean, this indicates a properly functioning lube system.

2. If the lube is thick and dark, but free of metal chips, the lube itself is old and must be changed out. The entire system should be cleaned of the old lube.

3. If the lube is wet and black, the lube system has been contaminated by metal particles. Inspect the Ball Screws for wear.

Contamination of the lube and/or coolant systems can be caused by a wearing Ball Screw, or by metal chips entering the systems through open or loose way covers. Check all way covers and seals for excessive clearances.

Machine Crash:

A hard machine crash can cause a Ball Screw to lock up. The static overload created during a machine crash can break apart the Nut balls, denting the thread surfaces. Turning the Nut by hand will result in an obvious grinding feeling and/or sound.

1. Check the screw for straightness.
2. Look for ball dents at the ends of the screw length. These indents will be a sure sign of a hard machine crash. The inertia of the table is transferred, due to the sudden stop, directly to the balls inside the Nut, creating impressions on the screw surface.

Cleaning

In most cases, a thorough cleaning of the suspect Ball Screw will resolve "bad screw" issues, including noise complaints.

1. Manually jog the Nut to one end of the screw.
2. Visually inspect the screw threads. Look for metal flakes, dark or thick lube, or contaminated coolant: See **Visual Inspection - Contamination** above.
3. Use alcohol, or other approved cleaning agents, to wash the screw.

CAUTION! Do not use detergents, degreasers, or solvents to clean Ball Screws or their components. Do not use water-based cleaners to avoid rust.

4. Jog the Nut to the other end of its travel. If metal flakes are now present on the screw threads, you may have wear issues.
5. Re-lubricate screw threads before returning the machine to service.

1.4 Automatic Tool Changer

Deflection

Deflection is usually caused by ATC misalignment, and sometimes caused by damaged or poor quality tooling, a damaged spindle taper, or a damaged drawbar or poor air supply. Before beginning any troubleshooting, observe the direction of the ATC deflection.

During a tool change, ATC appears to be pushed down.

- Check to see if pull studs on the tool holder are correct and tight.
- Check the adjustment of the “Z” offset ("Setting Parameter 64").

NOTE: If the offset is incorrect a tool changer crash can occur and a thorough inspection of the ATC will be necessary.

- Check the adjustment of the “Z” offset. Check parameters 71, 72, and 143 against the values that are in the documentation sent with the machine.
- Ensure the tool holders are held firmly in place by the extractor forks.
- Ensure the balls on the drawbar move freely in the holes in the drawbar when the tool release button is pressed. If they do not move freely, the ATC will be pushed down about 1/4" before the tool holder is seated in the taper, resulting in damage to the roller bolts on the ATC shuttle. Replace the drawbar.
- Check Drawbar height adjustment.
- If TSC, check for excessive coolant tip wear.

Tool holder sticking in the spindle taper causes the ATC to be pulled up as the spindle head is travelling the distance specified in parameter 71; accompanied by a popping noise as the tool holder pops out of the spindle taper.

NOTE: This problem may occur after loading a cold tool into a hot spindle (a result of thermal expansion of the tool holder inside the spindle taper. It may also occur in cuts with heavy vibration. This also is the result of thermal expansion. If sticking only occurs during these situations, check your application to ensure proper machining techniques are being used. If tool is pulled out of extractors due to a tool being stuck in the taper then the unclamp switch is not adjusted correctly or the switch could be bad.

- Check the condition of the customer’s tooling, verifying the taper on the tool holder is ground and not turned. Look for damage to the taper caused by chips in the taper or rough handling. If the tooling is suspected, try to duplicate the symptoms with different tooling.
- Check the condition of the spindle taper. Look for damage caused by chips or damaged tooling. Also, look for damage such as deep gouges in the spindle taper caused by tool crashing. See "Spindle Assembly" section for spindle cartridge replacement.

- Duplicate the cutting conditions under which the deflection occurs, but do not execute an automatic tool change. Try instead to release the tool using the tool release button on the front of the spindle head. If sticking is observed, the deflection is not caused by improper ATC adjustment, but is a problem in the spindle or tool release piston. See the "Spindle Assembly" section in Mechanical Service for spindle cartridge replacement.
- Check air supply pressure it should be 85 psi (min). An air pressure drop of no more than 10 psi during tool release is acceptable. An air pressure drop greater than 10 psi is caused by a supply line restriction or an undersize supply line. Use of quick couplers ($^1/_4$") can cause restriction. Directly connecting the air hose to a barb fitting can help.

During a tool change, ATC appears to be pulled up; no popping noises.

- Check the adjustment of the “Z” offset ("Setting Parameter 64" section).

NOTE: If the offset is incorrect, a tool changer crash can occurred, and a thorough inspection of the ATC will be necessary.

- Ensure the roller bolts on the shuttle of the ATC are tight against the V-guides on the ATC holding arm. If the lower right roller bolt is loose against the V-guide, the upper right bolt is probably bent. See the following section ("ATC Crashing") or "Roller Bolt Replacement", for roller bolt replacement.

NOTE: Bent roller bolts are a symptom of another problem with the ATC. Repair the bent roller bolt and then isolate the ATC problem.

- Check Parameter 71 against the values that are in the documentation sent with the machine.
- Ensure the balls on the drawbar move freely in the holes in the drawbar when the tool release button is pressed. If they do not move freely, the ATC will be pushed down about ¼” before the tool holder is seated in the taper, resulting in damage to the roller bolts on the ATC shuttle. Replace drawbar.

Tool holders twist against extractor fork during a tool change.

- Check the alignment of the ATC in the X and Y axes ("Automatic Tool Changer Alignment" section).

Tool holders spin at all pockets of the ATC when the ATC shuttle retracts.

- ATC is misaligned in the “Y” axis. Realign ATC ("Automatic Tool Changer Alignment" section).

NOTE: Observe the direction the tool holder rotates, as this will be the direction in which the “Y” axis of the ATC needs to be moved.

Tool holders spin only at certain pockets of the ATC when the ATC shuttle retracts.

- Check all the extractor forks to ensure they are centered in the pocket of the ATC. Also, see above. See "Extractor Fork Replacement" section, if necessary.

NOTE: If the ATC shows the problem as described here, each extractor fork must be checked and centered to eliminate the possibility of the ATC being aligned against an incorrectly-centered fork.

Crashing

The most common ATC crashes are outlined as follows:

Shuttle crashes into spindle when a tool change is commanded (tool holder is in the pocket facing the spindle head).

- Rotate the carousel to an empty pocket. Refer to the Programming and Operation manual for correct operation.

NOTE: This crash is fairly common and is a result of operator error. If the ATC is stopped in the middle of tool change cycle, the operator must command the ATC to an empty pocket before the machine will operate correctly. Repeated crashes of this type can damage the I/O board, the slip clutch, and the shuttle motor in the ATC.

During a tool change spindle crashes into top of the tool holder after a turret rotation.

When the spindle head moves down over the top of the tool holder during a tool change, the pull stud will bind inside the drawbar bore of the spindle, forcing the ATC down, breaking the carousel. Bending the upper right roller bolt on the ATC shuttle or completely breaking it off is also possible. Tool holder is not held correctly in the extractor fork, possibly held only in one side of the extractor and at an odd angle.

- Check all of the extractor forks on the ATC.

During a tool change spindle crashes into top of the tool holder after a turret rotation.

The balls in the drawbar do not move freely, causing the ATC to be forced down far enough to break the carousel. Bending the upper right roller bolt on the ATC shuttle or completely breaking it off is also possible.

- Ensure the balls on the drawbar move freely in the holes in the drawbar when the tool release button is pressed. If this failure occurs, check all of the extractor forks on the ATC for damage and repair the spindle drawbar.
- Check drawbar height and set according to the appropriate section, if necessary.

ATC properly deposits a tool holder in the spindle, but the tools are dropped onto the machine table when the shuttle retracts.

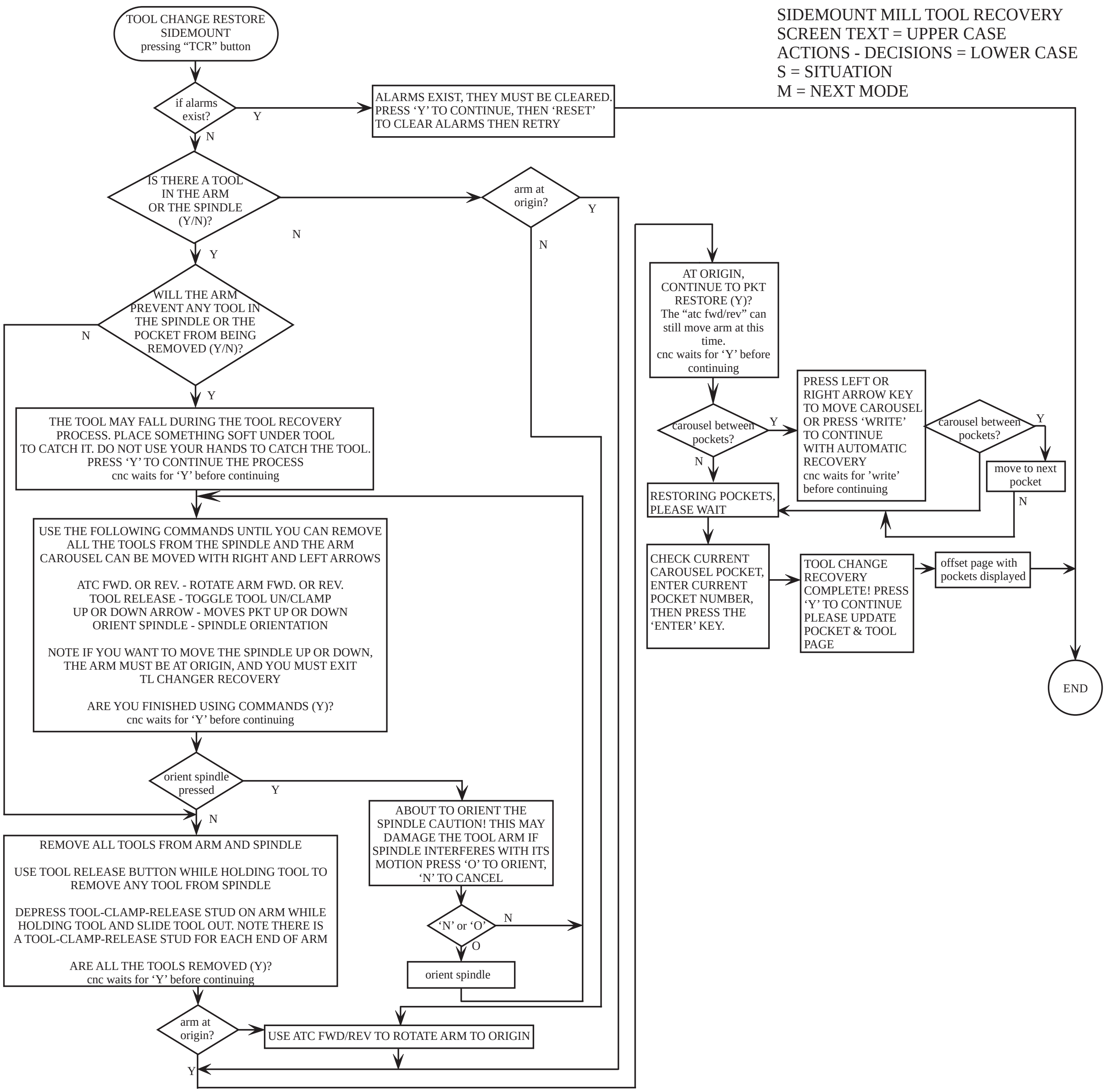
- Inspect the balls and the Belleville springs in the drawbar. See appropriate section and replace drawbar.

The part or fixture on the mill table crashes into long tooling or into the ATC itself when machining.

- Either reposition the tools to remove the interference, or program the carousel to rotate long tooling out of the way of the part (USE THIS ONLY AS A LAST RESORT). CAUTION! If the carousel has to be programmed to rotate long tools clear of the part, the correct carousel position must be programmed back in before a tool change can be executed.

NOTE: If these crashes occur, thoroughly inspect the ATC for damage. Pay close attention to the extractor forks, the sliding covers on the ATC carousel, and the roller bolts on the ATC shuttle. See appropriate section for extractor fork replacement.

Side Mount Tool Changer Recovery Flow Chart



Breakage

Breakage of the ATC is caused by either very hard and repeated crashes or excessive TSC coolant tip wear.

ATC shuttle is broken off of the holding plate.

- Carefully inspect the bosses on the shuttle casting (where the roller bolts mount) for damage to the threads or cracks. If any of the bosses are cracked, replace the casting. Realign the tool changer after repairing the machine.

ATC extractor forks are damaged after breakage.

- Check the condition of the mounting holes in the carousel. If the threads are damaged, they must be repaired or the carousel replaced. See appropriate section for extractor fork replacement.

Noisy Operation

To isolate noise(s) in the ATC, carefully observe the ATC in operation and look for the following:

ATC makes noise as the shuttle moves.

- Check the adjustment of the roller bolts on the ATC ("Roller Bolt Replacement" section). Loose roller bolts can cause the ATC to make a clunking noise when the shuttle is commanded to move. Tight roller bolts can cause the shuttle motor to labor excessively, possibly damaging the motor or the I/O board. In this case, the shuttle may also move too slowly.
- Check for damage to the trap door on the ATC cover. See appropriate section for trap door replacement.
- Check for missing plastic riders on the ATC shutter. See "ATC Trap Door Replacement" for shutter replacement.
- Ensure the guide pin mounted to the holding plate is not bent and does not scrape the ATC cover during movement. See "ATC Trap Door Replacement" for guide pin replacement.
- Listen for damage to the gear train in the shuttle motor. If the motor is found to be the source of the noise, replace the motor ("Shuttle Motor Removal" section). DO NOT try to repair the motor or to further isolate the noise in the motor.
- Check to ensure the Geneva driver on the turret motor is tight and properly adjusted ("Shuttle Motor Removal" section). If the Geneva driver is found to be loose, check for damage to the Geneva star. Any roughness in the slots will require that it be replaced ("Geneva Star Replace ment" section).
- Check the adjustment of the Geneva driver in relation to the Geneva star ("Geneva Star Replace ment" section). If the adjustment is too loose, the carousel will vibrate heavily and make a loud clanking noise during carousel rotation. If the adjustment is too tight, the turret motor will labor excessively and the carousel may appear to move erratically.

NOTE: If the turret motor adjustment is tight for extended periods, the turret motor, Geneva star, and the I/O board may be damaged. If the adjustment of the Geneva star appears tight at some pockets and loose at others, the problem lies with the Geneva star. Check the concentricity of the star relative to the bearing housing on the carousel assembly. If the concentricity of the star is proven to within specification and the problem still persists, the Geneva star must be replaced ("Geneva Star Replacement" section).

- Ensure the screws holding the turret motor to the mounting plate are tight ("Turret Motor Removal" section).
- Ensure the screws attaching the motor mounting plate to the shuttle casting are tight.
- Check for excessive noise in the gear train of the turret motor. See appropriate section for turret motor replacement.

NOTE: If the motor is found to be the source of noise, replace the motor assembly (motor, mounting plate, and Geneva driver). **DO NOT** attempt to repair the motor or to further isolate the problem in the motor.

Spindle Orientation

When commanded to orient the spindle, the spindle will rotate to the position determined by parameter 257 (spindle orient offset).

ATC out of orientation with the spindle. Incorrect spindle orientation will cause the ATC to crash as the shuttle moves. Alarm 113 will be generated.

- Check the orientation of the spindle.

ATC will not run.

- In all cases where the tool changer will not run, an alarm is generated to indicate either a shuttle in/out problem or a turret rotation problem. These alarms will occur either on an attempt to change tools (ATC FWD) or ZERO RETURN the machine (AUTO ALL AXES). Use the appropriate alarm to select one of the following problems:

ATC shuttle will not move; shuttle is getting power (Command a tool change and check for power being applied to the shuttle motor).

- Disconnect the slip clutch arm from the ATC shuttle and ensure the shuttle can move freely. If not, appropriate section for shuttle adjustment.

- Command a tool change with the shuttle disconnected.
  • If the shuttle cycles, check the slip clutch on the ATC. See "Shuttle Installation" section for slip clutch replacement.

NOTE: The slip clutch should move the shuttle with a fair amount of force, but not so much that the shuttle cannot be made to slip when holding it back by hand. If the slip clutch is frozen, replace it. It cannot be rebuilt in the field.

• If the ATC shuttle does not cycle, the motor has failed and must be replaced. Turn the motor by hand and feel for binding in the gear train in the motor.

NOTE: The motor uses a large amount of gear reduction and should be hard to turn by hand.

ATC shuttle will not move; shuttle is not getting power.

- Command a tool change check for power being applied to the shuttle motor.
- Check that the TC IN/TC OUT LED on the I/O PCB is illuminated when a tool change takes place.
  • If the LED lights, check the fuse FU5 on the POWER PCB or FU1 on the I/O PCB. Otherwise, check the I/O PCB ("Electrical Service").
  • If the LED does not light, check cables I/O-P65-510 and I/O-P64-520.
- Check ATC shuttle relay

ATC turret will not rotate; turret motor is getting power.

- Command a tool change check for power being applied to the turret motor.
- If power is applied but the output shaft on the motor does not turn, check for binding between the turret motor assembly and the Geneva star ("Automatic Tool Changer" section). Check for damage to the Geneva star or the Geneva driver. Check for a broken turret motor ("Turret Motor Removal" section).

NOTE: Do not attempt to repair the motor or to further isolate the problem in the motor.

ATC turret will not rotate; turret motor is not getting power.

- Command a tool change check for power being applied to the turret motor.
- Check that the TC CW/ TC CCW LED on the I/O PCB is illuminated when a tool change takes place.
  •If the LED lights, check the fuse FU5 on the POWER PCB or FU1 on the I/O PCB. Otherwise, replace the I/O PCB (Electrical Service).
  •If the LED does not light, check cables I/O-P65-510 and I/O-P64-520.
- Check ATC turret relay.

1.5 Gearbox and Spindle Motor

The gearbox cannot be serviced in the field and must be replaced as a unit. **NEVER** remove a motor from a VF-Series mill that has a gearbox, as this will damage the gearbox and void the warranty.

Noise

When investigating complaints of gearbox noise, also refer to "Spindle" troubleshooting section. Gearboxes can be damaged by, gearshift cylinders, or bearings, resulting in noisy operation. While gearbox vibration can cause a poor finish on a workpiece, noisy gearbox operation may not.

Excessive or unusual noise coming from the gearbox and/or spindle motor.

Operate the machine in both high and low gears. Monitor the gearbox for noise in both gear positions and if the pitch of the noise varies with the motor or the output shaft speed.

- If the noise only occurs in one gear throughout the entire RPM range of that gear position, the problem lies with the gearbox, and it must be replaced ("Spindle Motor & Transmission" section).
- If the noise occurs in both gear positions, disconnect the drive belt and repeat the previous step. If the noise persists, the gearbox is damaged and must be replaced, ("Spindle Motor & Transmission" section).
- With the drive belt disconnected, run the machine at 1000 RPM in high gear. Command a change of direction and listen for a banging noise in the gearbox as the machine slows to zero RPM and speeds back up to 1000 RPM in reverse. If the noise occurs, the motor has failed and the gearbox must be replaced.

Gears Will Not Change

Machine will not execute a gear change.

NOTE: Whenever a gear change problem occurs, an alarm will also occur. Refer ALARMS section to diagnose each problem before working on the machine.

When a gear change is performed, the following sequence of events occurs:

1. If the spindle is turning, it is commanded to stop,
2. Pause until spindle is stopped,
3. Gear change spindle speed is commanded forward,
4. Pause until spindle is at speed,
5. Command high or low gear solenoid active,
6. Pause until in new gear or reversal time,
7. Alarm and stop if max. gear change time elapsed,
8. If not in new gear, reverse spindle direction,
9. Turn off high and low gear solenoids.

- Check air supply pressure. If pressure is too low, the gears will not change.
- Check the air solenoid assembly on the solenoid bracket (rear of gearbox). If the solenoid operates properly and the limit switches on the gearbox operate properly, the problem lies with the gear change piston. Replace the gearbox ("Spindle Motor & Transmission" section).
- Check contactor CB4.

Low Pressure Alarm

Alarm 179 (Low Pressure Transmission Oil) has been triggered.

- Check for low oil supply in reservoir.
- Check to see that pump motor is running.
- Check for an air leak in the suction side of the pump.
- Check for a bad pressure sensor.
- Check for a broken or damaged cable.
- Check for a worn pump head.

1.6 Through The Spindle Coolant

Coolant Overflow

Check the alarm history to determine the cause of the problem before any action is taken.

Coolant pouring out of spindle head covers.

- Check the customer's tooling for through holes in the pull stud, holder and tool.
- Check the TSC coolant union. If failure is found, replace the coolant union.
- Check that the TSC drain and purge lines are intact. If necessary, replace with 5/32" O.D. nylon tubing.
- Check for coolant flowing from a failed fitting or check valve.
- Check precharge pressure in accordance with TSC "Pressure Regulator Adjustment' section and reset if necessary. Low precharge pressure can cause coolant to dump into the spindle head.
- Check the coolant pump pressure (should be 300 psi. for high pressure TSC , and 140 psi. for old system), with a standard (non-TSC) tool holder in spindle. If pump pressure is above 310 psi. (above 140 psi for old system), reset the pump relief valve in accordance with the "Setting TSC Pump Relief Valve" section.

Excessive coolant flow out of drain line.
Pulsating flow through tool and drain line.

- Check precharge pressure in accordance with TSC "Pressure Regulator Adjustment" section. Reset precharge pressure if necessary. Low precharge pressure will cause heavy or pulsating flow from the drain line.
- Ensure the coolant pump relief valve has not been tampered with (yellow paint band is intact). Check the coolant pump pressure (should be 300psi. for high pressure TSC, and 140 psi. for old system), with a standard (non-TSC) tool holder in spindle. If pump pressure is above 310 psi (above 140 psi. for old system), reset pump relief valve in accordance with "Setting Pump Relief Valve" section.

Low Coolant

Alarm 151, "Low Thru Spindle Coolant"

- Check coolant tank level.
- Check for slow coolant drainage from machine enclosure.
- Read the filter gauges and check the intake strainer to ensure there is no clogging. Read gauges with TSC running with no tool in spindle. Check coolant lines for any clogging or kinking. Clean or replace as needed.
- If received at start-up, check that the breaker hasn't tripped and that the pump is turning. Check the electrical continuity of cables.
- Check for overheating TSC motor. Three phase TSC motors have a thermal circuit that interrupts power to the relay coil.
- For old TSC system, if the drawbar was replaced, check that the hole through the drawbar is 0.156 dia. not 0.190 dia. Replace if it is 0.190.
- Check for pressure switch failure (refer to "Testing the Coolant Pressure Switch" section), and replace if necessary. Check "LO CLNT" bit in the diagnostics display (0 = pressure on, 1= pres sure off). Leaking pressure switches can also give intermittent alarms.
- Check the pump pressure with TSC running and no tool in the spindle. Normal pressure is 75-95 PSI. Replace the pump if pressure is 60 psi or less.
- Another alarm generated during TSC operation can cause this alarm.

Pre-Charge Failure

Alarm 198, "Precharge Failure"

NOTE: This alarm only applies to the TSC system. This alarm does not apply to 50 taper spindle machines. If this alarm is received on a 50 taper TSC machine, check that parameter 235 is set to zero. A non-zero value will cause the control to act as a 40 taper TSC.

- Check for broken or disconnected precharge air line, and replace if necessary.
- Check if the "Tool Clamped" limit switch is sticking, and replace if necessary.
- Check the "Tool Clamped" limit switch adjustment (refer to "Tool Clamp/Unclamp Switch Adjust ment").
- Check for low precharge pressure (refer to "Pressure Regulator Adjustment" section).
- Check precharge solenoid for proper operation.
- May be generated if another alarm occurs during TSC operation.

1.7 Chip Conveyor

Chip conveyor does not turn

- Check that Parameter 209 bit switch ENA CNVR is enabled.
- Check that the front enclosure door is completely closed and door switches function properly.
- Check that hub is connected to auger with bolt.
- Check that all conveyor fuses are intact. [Single phase motor uses 2 fuses (VF-1/2 ; Three phase motor uses 3 fuse (VF-3,4,6,8)]
- Check thermal reset button on conveyor motor body.

NOTE: Thermal reset indicates further problems: Ensure conveyor is not jammed, all necessary fuses are intact, check motor connector and I/O Board conveyor relays

Chip conveyor is moving in the wrong direction

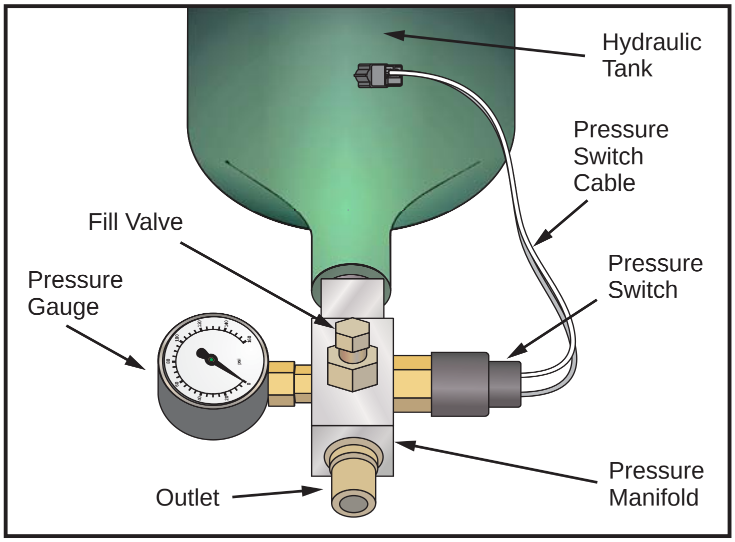
- Toggle Parameter 209 bit switch REV CNVR to reverse direction of conveyor.
- Check I/O Board conveyor relays.

Chip conveyor reverses, then shuts down

- Check that the conveyor is free of obstruction.
- Check that Parameters are at Default settings.
- Check that Discrete Input **CNVYR** (conveyor overload) cycles from 0 **-** 1 or 1 **-** 0 (0 means overload condition).

NOTE: If it does cycle check the motor for burnout or binding. If it does not cycle check the I/O board.

1.8 Hydraulic Counterbalance



Hydraulic Tank Assembly

Top of Travel Pressure

A reference table is listed below indicating top of travel pressure and switch setting pressure for each machine.

Machine	Top of Travel Pressure (PSI)	Switch Setting Pressure (PSI)
VF-1,2	750	600
VF-3, 4	1150	900
VF-5/40	875	750
VF-5/50	1100	1000
VF-6/40 – 11/40	750	600
VF-6/50, 7/50, 10/50	1150	900
VF-8/50, 9/50, 11/50	1550	1400
VR-11	1100	1000
VB-1	1550	1400
HS-1, 15AXT, 1R, 1RP	600	450
HS-3, 3R	1150	1000

The table below lists observable machine conditions and their probable cause. Find the appropriate corrective action step to fix the observed faults.

Machine Condition	Possible Problem(s)	Corrective Action
Machine alarms, pressure reading low.	-Cylinder leaks -Fitting leaks	1 2
Machine alarms, pressure reading ok, alarm does not reset.	-I/O board failure -Bad cable or dirty contacts -Switch setting too high and/or system is under-pressurized due to inaccurate gauge.	5 4 3
No alarm, pressure reading low (at or below switch setting).	-Cylinder leaks -Fitting leaks -Shorted cable -Switch setting too log and/or system has an inaccurate gauge.	1 2 6 7
Spindle head drifts up.	-Over-pressurized due to inaccurate gauge.	8
Spindle head drifts down, no alarm.	-Cylinder leaks -Fitting leaks -Switch setting too low and/or system under-presurized due to inaccurate gauge.	1 2 2

Corrective Action

Tools Required

Hand tools.
Charge/Discharge Kit P/N 35-4050A
Hydraulic Hand Pump Kit P/N 93-0206

1. Check for sufficient oil in system: Block spindle head at top of travel. Attach charge/discharge kit to schrader valve, slowly turn t-handle clockwise to begin releasing pressure and make one of the following observations:

   a) If oil is immediately present stop discharging, there is sufficient oil in the system. There are two courses of action at this point; add nitrogen to system to obtain top of travel pressure specification. This step may last indefinitely depending on the severity of the leak, or what caused it. The second course of action is to proceed to Corrective Action 2 if it is felt that the leak is substantial.

   b) If nitrogen gas is immediately present stop discharging and proceed to Corrective Action 2. There is not enough oil in the system.

2. Block spindle head at bottom of travel (if the cylinder is to be replaced block the head in the lowest position that will permit access to the rod attachment).

   a) Carefully drain remaining gas and oil.

b) Replace faulty component(s). (SAE straight thread o-ring fittings are to be lubricated with a film of hydraulic oil prior to install) Note that machines built after August, 1999 use straight thread fittings with o-rings, and sealed connectors on the switch wires. Earlier machines have pipe thread connections. Replacing older style components with newer style requires that all components of the counter balance system be changed as well as the cable back to the control.

c) Pump new Mobil DTE-25 oil (see chart for qty.) into system using Hydraulic Hand Pump Kit. (see “Hydraulic Hand Pump Instructions” below).

Machine	Quarts of Mobile DTE-25	# of Pump Strokes
VF-1-11, VR-11, HS-1	2 per tank	93
VB-1, HS-3	3 per tank	0140

d) Pressurize with nitrogen using charge/discharge kit to spec. at top of travel.

3. Add 50 psi of nitrogen to the system at top of travel.

   Does the alarm clear?

   Yes: Now check if the head drifts up more than 1” upon E-stop at the bottom of travel. If it does then replace the switch as described in corrective action 2.

   No: Add another 50 psi to the system at top of travel. If the alarm still does not clear replace the switch as described in corrective action 2. If the alarm clears check if the head drifts up more than 1” upon E-stop at the bottom-of-travel. If it does then replace the switch as described in corrective action 2.

4. Place a dial indicator on top of the column and verify that the movement of the Z axis travel from side to side does not exceed .015 inches. If the side to side movment exceedes .015 inches then adjust the cylinder bracket unitl the cylinder is lined up and the measurements are correct.

5. Once the

4. If the counter balance system pressure is ok and there is an E-stop alarm that won’t reset check the cable for dirty contacts. Loose connections or broken wire can be tested by disconnecting the cable at the switch and adding a jumper across the connector pins of the cable and clear the alarm. If the alarm does not clear the cable is defective. Repair or replace the cable if necessary.

5. Check I/O board and replace if necessary.

6. Test for short in cable. Repair or replace if necessary.

7. Does spindle head drift down from top of travel upon E-stop?

   Yes: Replace switch as described in corrective action 2.
   No: Replace pressure gauge as described in corrective action 2.

8. Invert tank to bleed about 50 psi of nitrogen gas. Re-evaluate machine condition.

Leak Failures

Leaks can occur at any fitting connection, at the hydraulic cylinder's rod seal (where the rod enters the cylinder), at the cylinder's piston seal, or through hose failures. Inspections for leaks are visual although rod seal leaks may be inconclusive because of way oil spatter. Piston seal leaks, if advanced, exit the top end of the cylinder and oil can be seen at the vent area. Early piston leaks accumulate over time on top of the piston to about ¾" high before they are pushed out the cylinder at top of travel. Leaks are normally very slow and machines can operate until the pressure switch sends an E-stop alarm.

Mechanical Diagnosis

Important! Hydraulic counterbalance oil contains red dye for easier recognition.

Noise in the system

- Slight moan or creaking at slow speeds is normal for rubber seals.
- While Z-axis is in motion a whistle sound at tank location is normal fluid flow.
- Verify cylinder is seated correctly in counterbore. If not then reseat the cylinder.
- Bumping or grinding noise indicates a mechanical cylinder failure. Replace cylinder assembly.
- Look for galling and wear on cylinder shaft. If so replace the cylinder assembly.

System is not holding pressure and/or has an E-STOP (Alarm 107) that cannot be reset.

Check for accurate pressure readings. If low then the following items need to be checked:

- Check for leaks at all cylinder fittings. If leaking then replace cylinder assembly.
- Collapse the lower Z-axis waycover and look for any red oil pooled at the bottom of the base. If so, then fittings or seals could be damaged. Replace cylinder assembly.
- Remove cylinder vent fitting. If there is red oil inside the vent cavity then the cylinder assembly needs replacement.
- Check for leaks at all hydraulic tank fittings. If leaking then tank assembly needs replacement.

Over Current alarms

- Pressure is set too high.
- Pressure is set too low.
- Too much oil has been added. (Insufficient gas volume causes large pressure rise)
- Hydraulic cylinder is binding or is misaligned. Replace cylinder assembly.
- Length of replacement cylinder incorrect.

1.9 Linear Scales

If any linear scale faults (alarms 279-290) are detected, contact the Haas service Department.

The following information is needed in order to properly diagnose the machine:
List of the faults and the dates
Any pertinent information on the conditions and circumstances surrounding the fault
All machine parameters
Software version
Machine serial number

Do not attempt to adjust or inspect the scale without notifying the service department.

1.10 Automatic Pallet Changer

Checking pallet repeatability on to the receiver.

- Maximum tolerance is .+/-0005.
- Pallets are not considered repeatable from one to the other. Pallets should use separate offsets.
- If pallet is out of tolerance check the alignment pins on the receiver base and bushings on the bottom side of the clamp rails for damage.
- Check the height of the alignment pins on the receiver base, the top of the pin should be .450 to .490 above the receiver base.
- If the alignment pins are out of the receiver body, check the depth of the hole. Depth should be .510 to .550.

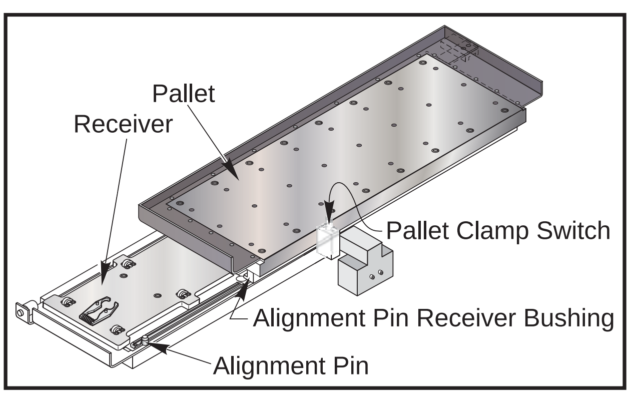
Sticking Pallet.

- Check for chips around the alignment pins or pallet clamp rail bushings.
- Check the torque on the bolts that fasten the clamp rails to the pallet. If the bolts are loose realign the pallet according to the instructions in the APC section of Mechanical Service.

APC not responding to controller commands.

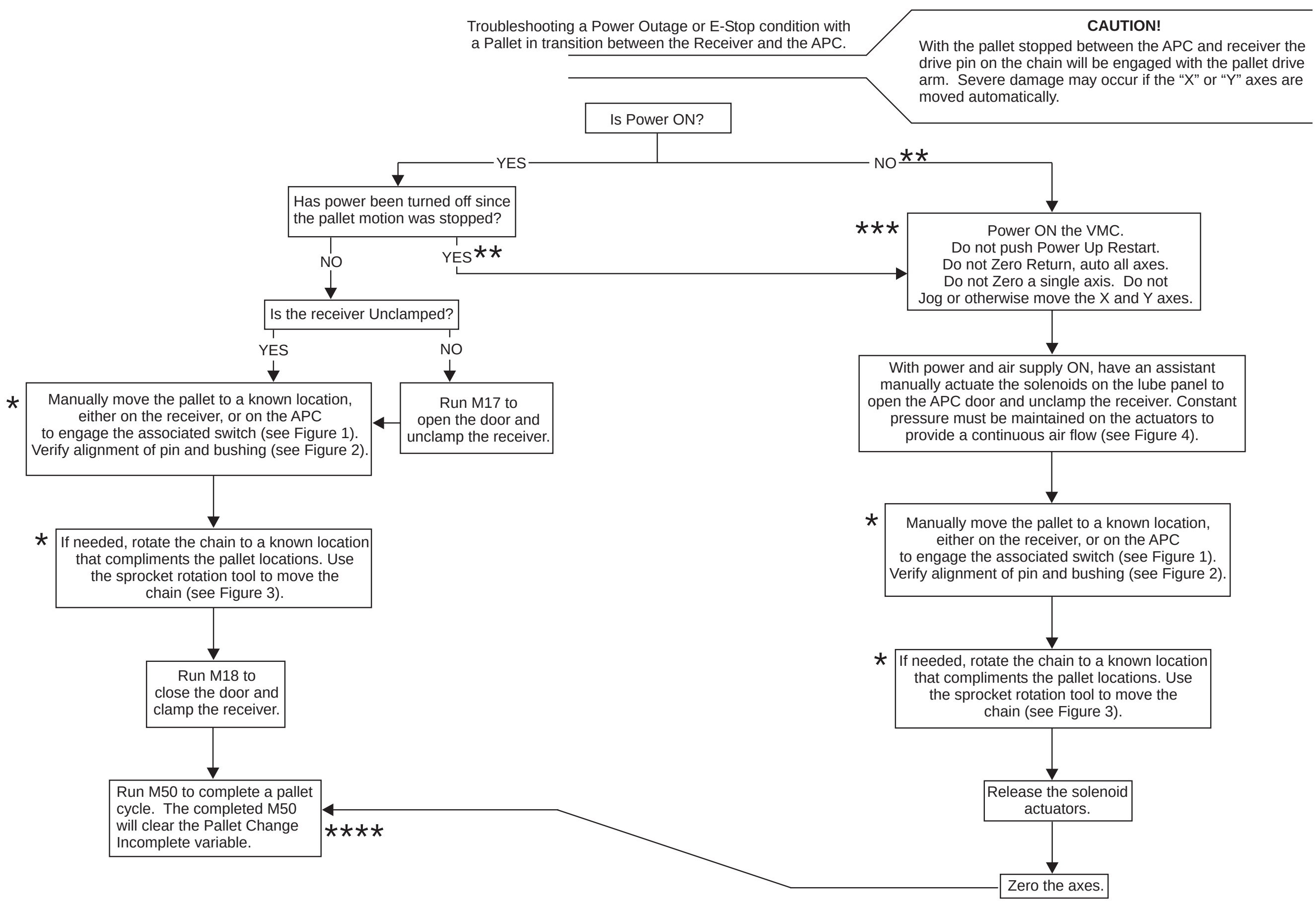
- If the APC does not run but the mill does, check the APC control cable.
- Make sure the E-Stop jumper is removed and that the APC control cable is plugged into the 5th axis port tightly.

The receiver is on the APC and engaging the Pallet Home Switch under the control panel. **Note:** the alignment Pin and Receiver Bushing alignment must be verified when manually positioning a pallet on the receiver.



Recovery from an initiated E-Stop or power outage during a pallet change

Not used for MDC Pallet Changer.



* There are 5 switches involved in the location of the pallets and chain.
1 pallet switch on the receiver (Pallet Clamp Switch).
2 pallet switches on the APC (Pallet Home Switches).
2 chain switches on the APC (Pin Clear Switches).

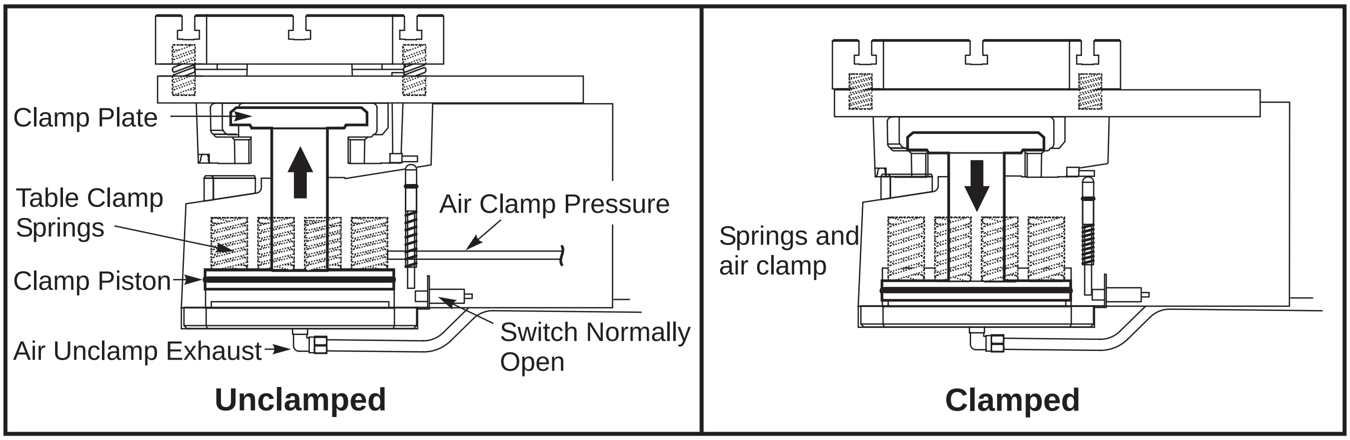
** If the power to the VMC has been shut down either intentionally or by power outage, damage may occur to the APC pallet, the receiver, or the drive chain if the X or Y axes are moved in the VMC at power ON.

*** At power ON the VMC will investigate the pallet and chain location and alarm if either an unknown chain location or unknown pallet location are detected.

**** At the beginning of the APC M50, a Pallet Change Incomplete variable is set to 1 and reset to 0 at the end. The VMC will not operate properly if a pallet change (M50) has not been completed.

Pallet Changer (Mill Dill Center - MDC)

Introduction



Operation

Note: Pallet is pulled down by clamp plate.

The table trips the clamp switch, not the clamp plate

1. Table Indexes into position based on servo control parameters.
•Clamp plate is in un-clamp position; it is held there by air pressure compressing the springs.
•Clamp status switch plunger is away from the Normally Open (NO) proximity switch.

2. When table is in position, the solenoid valve actuates to pressurize the clamp side of the piston. A combination of air pressure and spring force combine to clamp the table (approximately 10,000 pounds of clamp force depending on air pressure.
•The table lowers and contacts the clamp status switch plunger. The plunger is pushed down and trips the normally open (NO) status switch to close contacts.

3. To unclamp, the solenoid switch shuttles to exhaust the clamp side and pressurize the unclamp side of the piston. The unclamp air pressure must compress the clamp springs to raise the clamp plate. For the first portion of the travel the springs between the table and the H-frame aid in raising the clamp plate.
• At the top of piston travel the clamp status switch plunger raises (it is pushed up by a spring) and comes clear of the proximity switch. The NO switch is now open and the table is ready to index.

Table Clamp Status Under Different Conditions

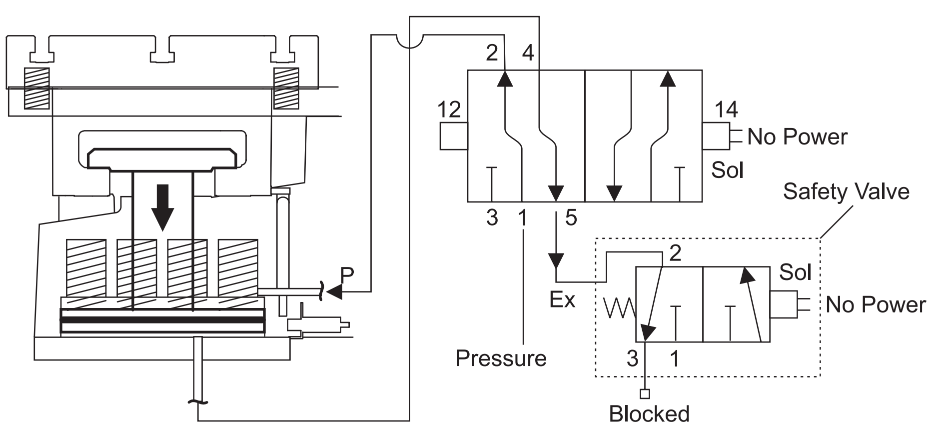
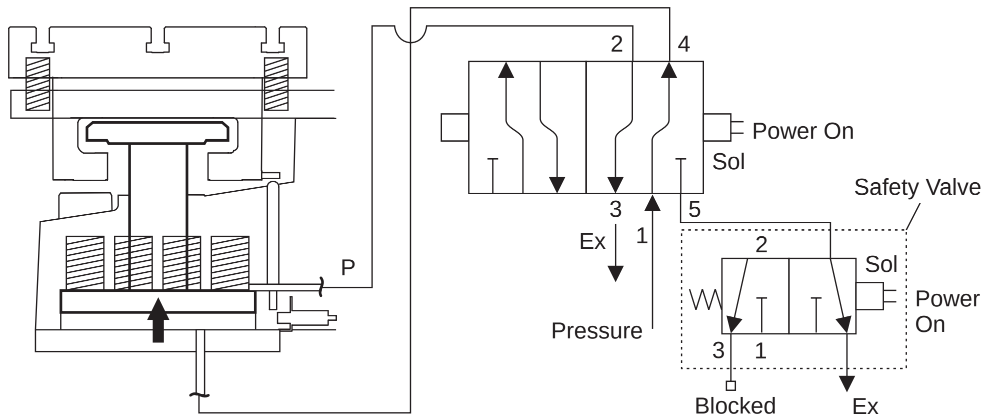


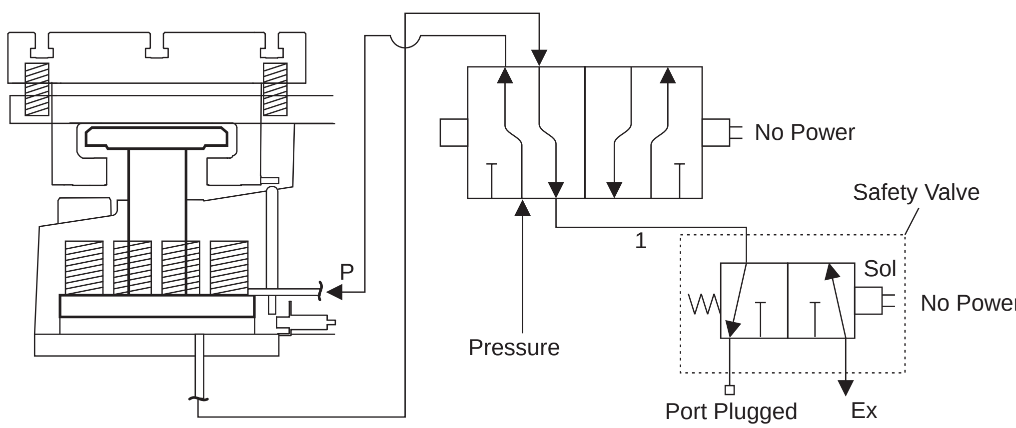
Table Clamp

A. Condition is clamped when machine is normally powered off or when first powered on or when table index is completed.



B. Condition when machine is unclamped

• Note: Same condition applies if table is unclamped and the machine is emergency stopped in the middle of a table index. The table remains unclamped.



C. Condition when the table is unclamped and then power is lost.

• Main valve shuttles to clamp the table but the safety valve also loses power and blocks the exhaust port on the clamp side of the piston. This prevents the clamp plate from clamping immediately. The clamp plate will slowly move to its clamp position.

Troubleshooting

1. Failure - Clamp switch wires cut

Result   The control see the switch as open at all times. The table can index into position and clamp. The control will not see the switch close therefore it assumes that the pallet is not clamped; an alarm will generate.

Comment This is a safe condition; there is no threat of injury or machine damage. However, the machine will not function until the switch is replaced.

2. Failure - The clamp status plunger rod is stuck in clamp position (broken rod, broken switch, stuck rod). The same scenario if an errant piece of metal keeps the switch tripped closed.

Result The clamp plate unclamps, raising the pallet. The machine is ready to rotate the pallet, but the control does not receive a signal that the table has raised. Without the signal the control thinks the pallet is clamped. After a period of time an alarm will be generated.

Comment - This is a safe condition; there is no threat of injury or machine damage. However the machine will not function until the plunger problem is corrected.

3. Failure Table index (pallet change) starts and then is E-stopped in the middle of indexing

Result the clamp plate remains in the unclamp position.

Comment This is a safe condition. To resume machining, clear the alarms and Zero Return all axes. The machine will automatically home all axes and the clamp plate will clamp the table.

4. Failure - Table Indexer (pallet change) starts and then the machine is E-stopped and powered off.

Result The clamp plate remains unclamped because the exhaust port on the unclamp side of the piston is blocked (closed). In other words the clamp plate is being pressurized in order to clamp, but as the exhaust port is blocked this prevents the pallet from being clamped.

Comment This is initially a safe condition, however, due to leakage on the exhaust side of the piston the clamp plate will eventually move to its fully clamped position. It is not safe to leave the table partially over the table locator teeth. It should be rotated fully off of the clamp plate. This can be done by manually rotating the pallet changer.

5. Clamp valve solenoid loses power or burns up while machine is running and table is clamped.

Result Table remains clamped upon attempting to unclamp the clamp plate will not rise and the clamp status switch will show the table as “clamped”. The machine will generate an alarm.

Comment This is a safe condition. The table will remain clamped. Machine will not function until solenoid is replaced.

6. Failure The solenoid on the safety valve burns out or loses power when the table is clamped and the machine is operating.

Result The machine will continue to function normally. It will clamp and unclamp without incident. In the event the machine is E-Stopped in the middle of a table index, the clamp plate remains unclamped. If power is lost or the machine is powered off during a table index the clamp plate will clamp.

Comment A failed safety circuit valve is not detectable. This is an unsafe condition as it is found only when the machine has already crashed.

7. Failure Table clamped and machine loses air pressure

Result The low air-pressure alarm will reach its time limit and alarm-out the machine. If air is lost while the machine is cutting, the table will remain clamped via the clamp springs.

Comment The clamp springs are adequate to prevent the table from moving grossly off of the locating fingers.

8. Failure Table unclamped and the machine loses air during a pallet change.

Result The low air pressure alarm will not alarm out the machine until it has reached its time limit. At the time of air loss the clamp plate will lower to the clamped position via the clamp springs.

Comment This is a dangerous condition. If the table is partially on or partially off of the clamp plate; potential damage to the indexer can result. If the table is heading towards the clamp plate and the clamp plate lowers due to loss of air, a crash will result.

1.11 Electrical Troubleshooting

CAUTION! Before working on any electrical components, power off the machine and wait approximately 10 minutes. This will allow the high voltage power on the brushless amplifiers to be discharged.

Electrical Alarms

Axis Drive Fault Alarm

- Blown amplifier - indicated by a light at bottom of amplifier when power is on. Replace amplifier.
- Amplifier or MOCON is noise sensitive. If this is the case, the alarm can be cleared and the axis will run normally for a while.
  To check an amplifier, switch the motor leads and control cables between the amplifier and the one next to it. If the same problem occurs with the other axis, the amplifier must be replaced. If the problem stays on the same axis, either the MOCON or control cable. The problem could also be the axis motor itself, with leads either shorted to each other or to ground, which is very rare.
- Amplifier faulting out for valid reason, such as overtemp, overvoltage, or +/-12 volt undervoltage condition. This usually results from running a servo intensive program, or unadjusted 12 volt power supply. Replace amplifier.
  Overvoltage could occur if regen load is not coming on, but this does not usually happen. The problem could also be the axis motor itself, with leads either shorted to each other or to ground, which is very rare.

Axis Overload

- The fuse function built into the MOCON has been overloaded, due to a lot of motor accel/decels, or hitting a hard stop with the axis. This safety function protects the amplifier and motor, so find the cause and correct it. If the current program is the cause, change the program. If the axis hits a hard stop, the travel limits may be set wrong.

Phasing Error

- The MOCON did not receive the proper phasing information from the motors. DO NOT RESET the machine if this alarm occurs. Power the machine down and back up. If the problem persists, it is probably a broken wire or faulty MOCON connectors. This problem could also be related to the Low Voltage Power Supply. Check to see if the LVPS is functioning properly.

Servo Error Too Large

- This alarms occurs when the difference between the commanded axis position and the actual position becomes larger than the maximum that is set in the parameter.
  This condition occurs when the amplifier is blown, is not receiving the commands, or the 320 volt power source is dead. If the MOCON is not sending the correct commands to the amplifier, it is probably due to a broken wire, or a PHASING ERROR that was generated.

Axis Z Fault or Z Channel Missing

- During a self-test, the number of encoder counts was found to be incorrect. This is usually caused by a noisy environment, and not a bad encoder. Check all shields and grounds on the encoder cables and the motor leads that come into the amplifiers. An alarm for one axis can be caused by a bad grounding on the motor leads of another axis.

Axis Cable Fault

- During a self-test, the encoder cable signals were found to be invalid. This alarm is usually caused by a bad cable, or a bad connection on the motor encoder connectors. Check the cable for any breaks, and the encoder connectors at the motor controller board. Machine noise can also cause this alarm, although it is less common.

Alarm 101, "MOCON Comm. Failure"

- During a self-test of communications between the MOCON and main processor, the main processor does not respond, and is suspected to be dead. This alarm is generated and the servos are stopped. Check all ribbon cable connections, and all grounding. Machine noise can also cause this alarm, although it is less common.

Alarm 157, "MOCON Watchdog Fault"

- The self-test of the MOCON has failed. Replace the MOCON.

Alarm 222, “C Phasing Error”

- If this alarm occurs on a VB-1, it is probably because parameter 176 bit 3 (SP AXIS DISABLED) is set to 0. It should be set to 1.

Rotary CRC Error Alarm 261

- This alarm is normally the result of an incomplete software installation. To correct this error, Change Setting 30 to any selection but OFF (note the original selection). Then go to parameter 43 and change one of the bits from 1 to 0 or vice versa and press WRITE (The bit must be changed from its original value to its alternate value). Simply changing the Setting and Parameter bit from one value to another and then back again corrects the fault, and will clear any further occurrences of the alarm. Change the bit and Setting 30 back to their original values. Press Reset to clear the alarms or cycle power to the machine.

KEYBOARD DIAGNOSTIC

NOTE: Refer to the "Cable Locations" section of this manual for a drawing of the Keyboard Interface PCB.

	1	2	3	4	5	6	7	8	9	10	11
12	OFSET	SETNG GRAPH		↑		↓	B	H	N	T	Z
13	POSIT	PARAM DGNOS		HOME	←	END	A	G	M	S	Y
14	PRGRM CONVRS	ALARM MESGS		*CLNT UP*	*CLNT DOWN*	*AUX CLNT*	*SHIFT*	F	L	R	X
15	POWER DOWN	F4	PART ZERO SET	-Y	-X	-A					*100% RAPID*
16	POWER UP RESTART	F3	TOOL RELEASE	+Z	JOG LOCK	-Z		+10	+10	CCW	50% RAPID
17	RESET	F2	NEXT TOOL	+B +A	<+X	+Y		100%	100%	STOP	25% RAPID
18		F1	TOOL OFSET MESUR	*CHIP FWD*	*CHIP STOP*	*CHIP REV*		-10	-10	CW	5% RAPID
19	CURNT COMDS	HELP	PAGE UP		→	PAGE DOWN	C	I	O	U	EOB
20	EDIT	MEM	MDI DNC	HANDLE JOG	ZERO RET	LIST PROG	D	J	P	V	[(
21	INSERT	SINGLE BLOCK	COOLNT	.0001 .1	AUTO ALL AXES	SELECT PROG	E	K	Q	W	])
22	ALTER	DRY RUN	ORIENT SPNDLE	.0001 1.	ORIGIN	SEND RS232	& 7	% 4	* 1	+ -	CANCEL
23	DELETE	OPT STOP	ATC FWD	.01 10.	ZERO SINGL AXES	RECV RS232	@ 8	$ 5	, 2	= 0	SPACE
24	UNDO	BLOCK DELETE	ATC REV	.01 100.	HOME G28	ERASE PROG	: 9	! 6	? 3	# PERIOD .	WRITE

KEYBOARD GRID

NOTE: This Keyboard Grid is for machines with a Keyboard Interface only. This Keyboard Grid is not for machines with a Serial Keyboard Interface.

The following is an example of how to troubleshoot the keypad:

NOTE: Keypad Diodes 1-24 correspond to chart numbers 1-24.

Example

1. Pressing the **RESET** button will cause diodes 1 and 17 to conduct.
   - With the POWER OFF read across diode 1.
   - A typical reading is between .400-.700 ohms, note your reading.

2. Press and hold the **RESET** button. If the diode is conducting, the reading should drop about .03 ohms.
   - (If your reading was .486 and it dropped to .460, for a difference of .026; the diode is good).
   - The same will hold true for diode 17 in this example. If the reading stays the same or there is no change, the diode is not conducting. Pull P2 and read between pins 1 and 17.
   - Press and hold <**RESET**>. The meter should read a short (0 ohms) if not the keypad is bad.

CRT Test Pattern

This is current commands page displays a grid of 6 x 9 blocks which allows technicians to align the display on the CRT and make sure the display is centered and 'square'. The page is accessed by entering DEBUG mode from the alarms screen, pressing CURNT COMDS, and then pressing PAGE UP.

Saving the Machine Information

To review a machine's set-up save the parameters, settings, offsets, variables and G-code programs and alarm history to a floppy disk. To do this, insert a blank diskette, press LISTPROG, POSIT, enter the machine's serial number and press F2. The new file suffix will be ".HIS".

2. ALARMS

Any time an alarm is present, the lower right hand corner of the screen will have a blinking "ALARM". Push the ALARM display key to view the current alarm. All alarms are displayed with a reference number and a complete description. If the RESET key is pressed, one alarm will be removed from the list of alarms. If there are more than 18 alarms, only the last 18 are displayed and the RESET must be used to see the rest. The presence of any alarm will prevent the operator from starting a program.

The **ALARMS DISPLAY** can be selected at any time by pressing the ALARM MESGS button. When there are no alarms, the display will show NO ALARM. If there are any alarms, they will be listed with the most recent alarm at the bottom of the list. The CURSOR and PAGE UP and PAGE DOWN buttons can be used to move through a large number of alarms. The CURSOR **right** and **left** buttons can be used to turn on and off the ALARM history display.

Note that tool changer alarms can be easily corrected by first correcting any mechanical problem, pressing RESET until the alarms are clear, selecting ZERO RET mode, and selecting AUTO ALL AXES. Some messages are displayed while editing to tell the operator what is wrong but these are not alarms. See the editing topic for those errors.

The following alarm list shows the alarm numbers, the text displayed along with the alarm, and a detailed description of the alarm, what can cause it, when it can happen, and how to correct it.

101 COMM. FAILURE WITH MOCON/MOCON MEMORY FAULT During a self-test of communications between the MOCON and main processor the main processor does not respond, and one of them is possibly bad. Check cable connections and boards. This alarm could also be caused by a memory fault, which was detected on the MOCON.

102 SERVOS OFF Indicates that the servo motors are off, the tool changer is disabled, the coolant pump is off, and the spindle motor is stopped. Caused by EMERGENCY STOP, motor fault, or power failure.

103 X SERVO ERROR TOO LARGE Too much load or speed on X-axis motor. The difference between the motor position and the commanded position has exceeded Parameter 9 X-axis Max Error. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops.

104 Y SERVO ERROR TOO LARGE Too much load or speed on Y-axis motor. The difference between the motor position and the commanded position has exceeded Parameter 23. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops.

105 Z SERVO ERROR TOO LARGE Too much load or speed on Z-axis motor. The difference between the motor position and the commanded position has exceeded Parameter 37. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops.

106 A SERVO ERROR TOO LARGE Too much load or speed on A-axis motor. The difference between the motor position and the commanded position has exceeded Parameter 51. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops.

107 EMERGENCY OFF EMERGENCY STOP button was pressed. Servos are also turned off. After the E-STOP is released, the RESET button must be pressed at least twice to correct this; once to clear the E-STOP alarm and once to clear the Servo Off alarm. This alarm will also be generated if there is a low-pressure condition in the hydraulic counterbalance system. In this case, the alarm will not reset until the condition has been corrected.

108 X SERVO OVERLOAD Excessive load on X-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops. It can also be caused by anything that causes a very high load on the motors.

109 Y SERVO OVERLOAD Excessive load on Y-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops. It can also be caused by anything that causes a very high load on the motors.

110 Z SERVO OVERLOAD Excessive load on Z-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops. It can also be caused by anything that causes a very high load on the motors.

111 A SERVO OVERLOAD Excessive load on A-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops. It can also be caused by anything that causes a very high load on the motors.

112 NO INTERRUPT Electronics fault. Call your dealer.

1**13 SHUTTLE IN FAULT** Tool changer is not completely to the right. During a tool changer operation the tool in/out shuttle failed to get to the in position. Parameters 62 and 63 can adjust the time-out times. This alarm can be caused by anything that jams the motion of the slide or by the presence of a tool in the pocket facing the spindle. A loss of power to the tool changer can also cause this. Check relays K9-K12 and fuse F1 on IOPCB.

114 SHUTTLE OUT FAULT Tool changer is not completely to the left. During a tool changer operation the tool in/out shuttle failed to get to the in position. Parameters 62 and 63 can adjust the time-out times. This alarm can be caused by anything that jams the motion of the slide or by the presence of a tool in the pocket facing the spindle. A loss of power to the tool changer can also cause this. Check relays K9-K12 and fuse F1 on IOPCB.

115 TURRET ROTATE FAULT Tool carousel motor not in position. During a tool changer operation the tool turret failed to start moving or failed to stop at the right position. Parameters 60 and 61 can adjust the time-out times. This alarm can be caused by anything that jams the rotation of the turret. A loss of power to the tool changer can also cause this. Check relays K9-K12 and fuse F1 on IOPCB.

116 SPINDLE ORIENTATION FAULT Spindle did not orient correctly. During a spindle orientation function, the spindle rotated but never achieved proper orientation. This can be caused by failure of encoder, cables, belts, MOCON or vector drive.

117 SPINDLE HIGH GEAR FAULT Gearbox did not shift into high gear. During a change to high gear, the spindle is rotated slowly while air pressure is used to move the gears but the high gear sensor was not detected in time. Parameters 67, 70 and 75 can adjust the time-out times. Check the air pressure, the circuit breaker CB4 for the solenoids, and the spindle drive.

118 SPINDLE LOW GEAR FAULT Gearbox did not shift into low gear. During a change to low gear, the spindle is rotated slowly while air pressure is used to move the gears but the low gear sensor was not detected in time. Parameters 67, 70 and 75 can adjust the time-out times. Check the air pressure, the circuit breaker CB4 for the solenoids, and the spindle drive.

119 OVERVOLTAGE Incoming line voltage is above maximum. The servos will be turned off and the spindle, tool changer, and coolant pump will stop. If this condition persists, an automatic shutdown will begin after the interval specified by parameter 296.

120 LOW AIR PRESSURE Air pressure dropped below 80 PSI for a period defined by Parameter 76. The LOW AIR PR alarm will appear on the screen as soon as the pressure gets low, and this alarm appears after some time has elapsed. Check your incoming air pressure for at least 100 PSI and ensure that the regulator is set at 85 PSI.

121 LOW LUBE OR LOW PRESSURE Way lube is low or empty or there is no lube pressure or too high a pressure. Check tank at rear of mill and below control cabinet. Also check connector on the side of the control cabinet. Check that the lube lines are not blocked.

122 REGEN OVERHEAT The regenerative load temperature is above a safe limit. This alarm will turn off the servos, spindle drive, coolant pump, and tool changer. One common cause of this overheat condition is an input line voltage too high. If this condition persists, an automatic shutdown will begin after the interval specified by parameter 297. It can also be caused by a high start/stop duty cycle of spindle.

123 SPINDLE DRIVE FAULT Failure of spindle drive, motor or regen load. This can be caused by a shorted motor, overvoltage, overcurrent, under-voltage, failure of drive or shorted or open regen load. Under-voltage and overvoltage of DC bus are also reported as alarms 160 and 119, respectively.

124 LOW BATTERY Memory batteries need replacing within 30 days. This alarm is only generated at power on and indicates that the 3.3 volt Lithium battery is below 2.5 volts. If this is not corrected within about 30 days, you may lose your stored programs, parameters, offsets, and settings.

125 SHUTTLE FAULT Tool shuttle not initialized at power on, CYCLE START or spindle motion command. This means that the tool shuttle was not fully retracted to the Out position.

126 GEAR FAULT Gearshifter is out of position when a command is given to start a program or rotate the spindle. This means that the two speed gear box is not in either high or low gear but is somewhere in between. Check the air pressure, the circuit breaker CB4 for the solenoids, and the spindle drive. Use the POWER UP/RESTART button to correct the problem.

127 NO TURRET MARK Tool carousel motor not in position. The AUTO ALL AXES button will correct this but be sure that the pocket facing the spindle afterwards does not contain a tool.

128 SUPER TRAVEL ENABLED ON MULTIPLE AXES Two or more axes are enabled for super travel. Only one axis is allowed to have super travel capability. Super travel is enabled when a tool change offset parameter, is greater than or less than normal travel limits. Check the Max Travel and Tool Change Offset parameter values for the X and Y axes.

129 M FIN FAULT M-Fin was active at power on. Check the wiring to your M code interfaces. This test is only performed at power-on.

130 TOOL UNCLAMPED The tool appeared to be unclamped during spindle orientation, a gear change, a speed change, or TSC start-up. The alarm will also be generated if the tool release piston is energized during Power Up. This can be caused by a fault in the air solenoids, the relays on the I/O assembly, the drawbar assembly, or the wiring.

131 TOOL NOT CLAMPED When clamping or powering up the machine, the Tool Release Piston is not Home. There is a possible fault in the air solenoids, relays on the I/O Assembly, the drawbar assembly, or wiring.

132 POWER DOWN FAILURE Machine did not turn off when an automatic power-down was commanded. Check wiring to the Power Interface (POWIF) card on power supply assembly, relays on the I/O assembly, and the main contactor K1.

133 SPINDLE INOPERATIVE Spindle does not respond when spindle motion is commanded. This can be caused by failure of encoder, cables, belts, MOCON or vector drive.

134 TOOL CLAMP FAULT While UNCLAMPING, the tool did not release from spindle when commanded. Check air pressure and solenoid circuit breaker CB4. This fault can also be caused by maladjustment of the drawbar assembly.

135 X-AXIS MOTOR OVERHEAT Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F (65 deg. C). This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.

136 Y-AXIS MOTOR OVERHEAT Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F (65 deg. C). This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.

137 Z-AXIS MOTOR OVERHEAT Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F (65 deg. C). This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.

138 A-AXIS MOTOR OVERHEAT Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F (65 deg. C). This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.

139 X MOTOR Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

140 Y MOTOR Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

141 Z MOTOR Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

142 A MOTOR Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

143 SPINDLE ORIENTATION LOST Spindle orientation lost during a tool change operation. This can be caused by failure of encoder, cables, belts, MOCON or vector drive.

144 TIMEOUT - CALL YOUR DEALER Time allocated for use prior to payment exceeded. Call your dealer.

145 X LIMIT SWITCH Axis hit limit switch or switch disconnected. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter 125 Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.

146 Y LIMIT SWITCH Axis hit limit switch or switch disconnected. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter 126 Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.

147 Z LIMIT SWITCH Axis hit limit switch or switch disconnected. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter 127 Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.

148 A LIMIT SWITCH Normally disabled for rotary axis.

149 SPINDLE TURNING A signal from spindle drive indicating that the spindle drive is stopped is not present while a tool change operation is going on.

150 Z AND TOOL INTERLOCKED Tool changer not at home and either the Z or A or B axis (or any combination) is not Interlocked at zero. If RESET, E-STOP, or POWER OFF occurs during tool change, Z-axis motion and tool changer motion may not be safe. Check the position of the tool changer and remove the tool if possible. Re-initialize with the AUTO ALL AXES button but be sure that the pocket facing the spindle afterwards does not contain a tool.

151 LOW THRU SPINDLE COOLANT For machines with Through the Spindle Coolant only. This alarm will shut off the coolant spigot, feed, and pump all at once. It will turn on purge, wait for the amount of time specified in parameter 237 for the coolant to purge, and then turn off the purge. Check for low coolant tank level, any filter or intake strainer clogging, or for any kinked or clogged coolant lines. Verify proper pump and machine phasing. If no problems are found with any of these, and none of the coolant lines are clogged or kinked, call your dealer.

152 SELF TEST FAIL Control has detected an electronics fault. All motors and solenoids are shut down. This is most likely caused by a fault of the processor board stack. Call your dealer.

153 X AXIS Z CH MISSING Z Reference signal from encoder was not received as expected. Can be caused by loose connections, encoder contamination, or parameter error.

154 Y AXIS Z CH MISSING Z Reference signal from encoder was not received as expected. Can be caused by loose connections, encoder contamination, or parameter error.

155 Z AXIS Z CH MISSING Z Reference signal from encoder was not received as expected. Can be caused by loose connections, encoder contamination, or parameter error.

156 A AXIS Z CH MISSING Z Reference signal from encoder was not received as expected. Can be caused by loose connections, encoder contamination, or parameter error.

157 MOCON WATCHDOG FAULT The self-test of the MOCON has failed. Call your dealer.

158 VIDEO/KEYBOARD PCB FAILURE During power-on tests, the control has detected a problem in either the keyboard or the video memory. Call your dealer.

159 KEYBOARD FAILURE Keyboard shorted or button pressed at power on. A power-on test of the membrane keypad has found a shorted button. It can also be caused by a short in the cable from the main cabinet or by holding a switch down during power-on.

160 LOW VOLTAGE The line voltage to control is too low. This alarm occurs when the AC line voltage drops more than 10% below nominal.

161 X AXIS DRIVE FAULT Current in X servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. This can be caused by running the axis into a mechanical stop. A short in the motor or a short of one motor lead to ground can also cause it.

162 Y AXIS DRIVE FAULT Current in Y servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. This can be caused by running the axis into a mechanical stop. A short in the motor or a short of one motor lead to ground can also cause it.

163 Z AXIS DRIVE FAULT Current in Z servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. This can be caused by running the axis into a mechanical stop. A short in the motor or a short of one motor lead to ground can also cause it.

164 A AXIS DRIVE FAULT Current in A servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. This can be caused by running the axis into a mechanical stop. A short in the motor or a short of one motor lead to ground can also cause it.

165 X ZERO RET MARGIN TOO SMALL This alarm will occur if the home/limit switches move or are mis-adjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return operation.

166 Y ZERO RET MARGIN TOO SMALL This alarm will occur if the home/limit switches move or are mis-adjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return operation.

167 Z ZERO RET MARGIN TOO SMALL This alarm will occur if the home/limit switches move or are mis-adjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return operation.

168 A ZERO RET MARGIN TOO SMALL This alarm will occur if the home/limit switches move or are mis-adjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return operation.

169 SPINDLE DIRECTION FAULT Problem with rigid tapping hardware. The spindle started turning in the wrong direction.

171 APC-PALLET CLAMP TIMEOUT The pallet in the mill did not clamp in the time allowed. Check for foreign objects under the pallet and between the pallet and the clamp plate. Verify there is an adequate supply of air pressure and air volume. Check air solenoids for sticking and air release ports for clogging. Check the pallet position switch for correct operation, the switch and wiring for damage, and pallet alignment. Check the pallet clamp mechanism for correct operation. After determining the cause and correcting the problem, run M50 P1 in MDI to recover the pallet changer and then continue operation. Parameter 320 specifies the pallet clamp timeout period.

172 APC-PALLET UNCLAMP TIMEOUT The pallet in the mill did not unclamp in the time allowed. Check for foreign objects between the pallet and the clamp plate. Verify there is an adequate supply of air pressure and air volume. Check air solenoids for sticking and air release ports for clogging. Check the pallet position switch for correct operation, the switch and wiring for damage and pallet alignment. Check the pallet clamp plate for damage. After determining the cause and correcting the problem, run M50 P1 in MDI to recover the pallet changer and then continue operation. Parameter 321 specifies the unclamp timeout period.

173 SPINDLE ENCODER Z CH MISSING The Z channel pulse from the spindle encoder is missing for hard tapping synchronization.

174 TOOL LOAD EXCEEDED The tool load limit is set and the load limit for a tool was exceeded in a feed.

175 GROUND FAULT DETECTED A ground fault condition was detected in the 115V AC supply. This can be caused by a short to ground in any of the servo motors, the tool change motors, the fans, or the oil pump.

176 OVERHEAT SHUTDOWN An overheat condition persisted longer than the interval specified by parameter 297 and caused an automatic shutdown.

177 OVERVOLTAGE SHUTDOWN An overvoltage condition persisted longer than the interval specified by parameter 296 and caused an automatic shutdown.

178 DIVIDE BY ZERO! There are some parameters that are used as a divisor and therefore must never be set to zero. If the problem cannot be corrected by parameters, cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

179 LOW PRESSURE TRANS OIL Transmission oil is low or low pressure condition in oil lines.

180 PALLET/FIXTURE NOT CLAMPED The Pallet/Fixture clamped input indicates that the pallet or fixture is not clamped and it is unsafe to run the spindle, jog an axis, or start a part program by pressing CYCLE START. This could also indicate that a previous pallet change was incomplete and the pallet changer needs to be recovered.

182 X CABLE FAULT Cable from X-axis encoder does not have valid differential signals.

183 Y CABLE FAULT Cable from Y-axis encoder does not have valid differential signals.

184 Z CABLE FAULT Cable from Z-axis encoder does not have valid differential signals.

185 A CABLE FAULT Cable from A-axis encoder does not have valid differential signals.

186 SPINDLE NOT TURNING Status from spindle drive indicates it is not at speed when expected.

187 B SERVO ERROR TOO LARGE Too much load or speed on B axis motor. The difference between the motor position and the commanded position has exceeded Parameter 159. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops. On machines with servo based tool changer chains the chain was unable to move. On Machines with servo based tool changer arms the arm was unable to move possibly due to a stuck tool.

188 B SERVO OVERLOAD Excessive load on B-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops. It can also be caused by anything that causes a very high load on the motors.

189 B-AXIS MOTOR OVERHEAT Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F. This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.

190 B MOTOR Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

191 B LIMIT SWITCH Normally disabled for rotary axis.

192 B AXIS Z CH MISSING Z reference signal from encoder was not received as expected. Can be caused by loose connections, encoder contamination, or parameter error.

193 B AXIS DRIVE FAULT Current in B servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. This can be caused by running the axis into a mechanical stop. A short in the motor or a short of one motor lead to ground can also cause it.

194 B ZERO RET MARGIN TOO SMALL This alarm will occur if the home/limit switches move or are mis-adjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return operation.

195 B CABLE FAULT Cable from B-axis encoder does not have valid differential signals.

196 COOLANT SPIGOT FAILURE Spigot failed to achieve commanded location after two (2) attempts.

197 MISC. SOFTWARE ERROR This alarm indicates an error in the control software. Call your dealer.

198 PRECHARGE FAILURE During TSC operation, the precharge failed for greater than 0.1 seconds. It will shut off the feed, spindle and pump all at once. Check all airlines and the air supply pressure. Also, check 3-phase power phasing.

199 NEGATIVE RPM A negative spindle RPM was sensed.

201 PARAMETER CRC ERROR Parameters lost maybe by low battery. Check for a low battery and low battery alarm.

202 SETTING CRC ERROR Settings lost maybe by low battery. Check for a low battery and low battery alarm.

203 LEAD SCREW CRC ERROR Lead screw compensation tables lost maybe by low battery. Check for low battery and low battery alarm.

204 OFFSET CRC ERROR Offsets lost maybe by low battery. Check for a low battery and low battery alarm.

205 PROGRAMS CRC ERROR Users program lost maybe by low battery. Check for a low battery and low battery alarm.

206 INTERNAL PROG ERROR Possible corrupted program. Save all programs to disk, delete all, then reload. Check for a low battery and low battery alarm.

207 QUEUE ADVANCE ERROR Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

208 QUEUE ALLOCATION ERROR Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

209 QUEUE CUTTER COMP ERROR Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

210 INSUFFICIENT MEMORY Not enough memory to store users program. Check the space available in the LIST PROG mode and possibly delete some programs.

211 ODD PROG BLOCK Possible corrupted program. Save all programs to disk, delete all, then reload.

212 PROG INTEGRITY ERROR Possible corrupted program. Save all programs to disk, delete all, then reload. Check for a low battery and low battery alarm.

213 PROGRAM RAM CRC ERROR Electronics fault; possibly with main processor.

214 NO. OF PROGRAMS CHANGED Indicates that the number of programs disagrees with the internal variable that keeps count of the loaded programs. Possible processor board problem.

215 FREE MEMORY PTR CHANGED Indicates that the amount of memory used by the programs counted in the system disagrees with the variable that points to free memory. Possible processor board problem

216 EPROM SPEED FAILURE Possible processor board problem

217 X PHASING ERROR Error occurred in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.

218 Y PHASING ERROR Error occurred in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.

219 Z PHASING ERROR Error occurred in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.

220 A PHASING ERROR Error occurred in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.

221 B PHASING ERROR Error occurred in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.

222 C PHASING ERROR Error occurred in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.

223 DOOR LOCK FAILURE In machines equipped with safety interlocks, this alarm occurs when the control senses the door is open but it is locked. Check the door lock circuit.

224 X TRANSITION FAULT Illegal transition of encoder count pulses in X axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF printed circuit board.

225 Y TRANSITION FAULT Illegal transition of encoder count pulses in Y axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF printed circuit board.

226 Z TRANSITION FAULT Illegal transition of encoder count pulses in Z axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF printed circuit board.

227 A TRANSITION FAULT Illegal transition of encoder count pulses in A axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF printed circuit board.

228 B TRANSITION FAULT Illegal transition of count pulses in B axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF printed circuit board.

229 C TRANSITION FAULT Illegal transition of count pulses in C axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF printed circuit board.

231 JOG HANDLE TRANSITION FAULT Illegal transition of count pulses in jog handle encoder. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors.

232 SPINDLE TRANSITION FAULT Illegal transition of count pulses in spindle encoder. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON.

233 JOG HANDLE CABLE FAULT Cable from jog handle encoder does not have valid differential signals.

234 SPINDLE CABLE FAULT Cable from spindle encoder does not have valid differential signals.

235 SPINDLE Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

236 SPINDLE MOTOR OVERLOAD The spindle motor is overloaded.

237 SPINDLE FOLLOWING ERROR The error between the commanded spindle speed and the actual speed has exceeded the maximum allowable (as set in Parameter 184).

238 AUTOMATIC DOOR FAULT The automatic door was commanded to operate, but did not complete the operation. The door was: 1) Commanded to close but failed to contact the closed switch in the time allowed, 2) Commanded to open but failed to contact the opened switch (not all doors have an opened switch) in the time allowed, or 3) Commanded to open but did not begin moving in the time allowed. Check the door switch, the door for mechanical binding, and that the door motor and clutch are functioning correctly.

239 UNKNOWN MOCON1 ALARM Mocon has reported an alarm to the current software. The current version of software was unable to identify the alarm.

240 EMPTY PROG OR NO EOB DNC program not found, or no end of program found.

241 INVALID CODE RS-232 load bad. Data was stored as comment. Check the program being received.

242 NUMBER FORMAT ERROR-OR TOO LONG Check input file for an improperly formatted number. Number may have too many digits or multiple decimal points. The erroneous data will be placed on the MESSAGES page as a comment with trailing question mark.

243 BAD NUMBER Data entered is not a number.

244 MISSING (...) Comment must end with a ")". This alarm can also occur if a comment is greater than 80 characters long.

245 UNKNOWN CODE Check input line or data from RS-232. This alarm can occur while editing data into a program or loading from RS-232. See MESSAGE PAGE for input line.

246 STRING TOO LONG Input line is too long. The data entry line must be shortened.

247 CURSOR DATA BASE ERROR Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

248 NUMBER RANGE ERROR Number entry is out of range.

249 PROG DATA BEGINS ODD Possible corrupted program. Save all programs to disk, delete all, then reload.

250 PROG DATA ERROR Possible corrupted program. Save all programs to disk, delete all, then reload.

251 PROG DATA STRUCT ERROR Possible corrupted program. Save all programs to disk, delete all, then reload.

252 MEMORY OVERFLOW Possible corrupted program. Save all programs to disk, delete all, then reload.

253 ELECTRONICS OVERHEAT The control box temperature has exceeded 135 degrees F (60 deg. C). This can be caused by an electronics problem, high room temperature, or clogged air filter.

254 SPINDLE MOTOR OVERHEAT Motor driving spindle is too hot. The spindle motor temperature sensor sensed a high temperature for greater than 1.5 seconds.

255 NO TOOL IN SPINDLE There is an invalid tool number in the spindle entry of the POCKET-TOOL table. The spindle entry cannot be 0 and must be listed in the body of the table. If there is no tool in the spindle, enter the number for an empty pocket into the spindle entry. If there is a tool number in the spindle entry, make sure that it is in the body of the table and that the pocket is empty.

256 CURRENT TOOL UNKNOWN Current tool information has been lost. This is most likely due to re-initialization. It is likely that the next commanded tool change will result in a collision between the spindle and a tool in a pocket. To eliminate the possibility of a crash, perform Tool Changer Restore. Do not use Power Up/Restart as this will cause the machine to try to return a tool to the carousel.

257 PROG DATA ERROR Possible corrupted program. Save all programs to disk, delete all, then reload.

258 INVALID DPRNT FORMAT Macro DPRNT statement not structured properly.

259 LANGUAGE VERSION Problem with language files. Please reload foreign language files.

260 LANGUAGE CRC Indicates FLASH memory has been corrupted or damaged.

261 ROTARY CRC ERROR Rotary table saved parameters (used by Settings 30, 78) have a CRC error.

262 PARAMETER CRC MISSING RS-232 or disk read of parameter had no CRC when loading from disk or RS-232.

263 LEAD SCREW CRC MISSING Lead screw compensation tables have no CRC when loading from disk or RS-232.

264 ROTARY CRC MISSING Rotary table parameters have no CRC when loading from disk or RS-232.

265 MACRO VARIABLE FILE CRC ERROR Macro variable file has a CRC error. Possible corrupted file

266 TOOL CHANGER FAULT Run Tool Changer recovery.

267 TOOL DOOR OUT OF POSITION This alarm will be generated on a horizontal mill during a tool change when parameter 278 TL DR SWITCH is set to 1, and the tool carousel air door switch indicates that the door is open after it was commanded closed, or closed after it was commanded open. This alarm will most likely be caused by a stuck or broken switch.

268 DOOR OPEN @ M95 START Generated whenever an M95 (Sleep Mode) is encountered and the door is open. The door must be closed in order to start sleep mode.

269 TOOL ARM FAULT The tool changer arm is not in position. Run tool changer recovery.

270 C SERVO ERROR TOO LARGE Too much load or speed on C-axis motor. The difference between the motor position and the commanded position has exceeded Parameter 506. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor.

271 C SERVO OVERLOAD Excessive load on C-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This alarm can be caused by anything that causes a very high load on the motors.

272 C-AXIS MOTOR OVERHEAT Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F. This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.

273 C MOTOR Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

274 C LIMIT SWITCH Axis hit limit switch or switch disconnected. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.

275 C AXIS Z CH MISSING Z Reference signal from encoder was not received as expected. Can be caused by loose connections, encoder contamination, or parameter error.

276 C AXIS DRIVE FAULT Current in C servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. It can also be caused by a short in the motor or a short of one of the motor leads to ground.

277 C ZERO RET MARGIN TOO SMALL This alarm will occur if the home/limit switches move or are misadjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return operation.

278 C CABLE FAULT Cable from C-axis encoder does not have valid differential signals.

279 X AXIS LINEAR SCALE Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the Z Fault encoder has been damaged and encoder position data is unreliable. This can also be caused by loose scale connectors.

280 Y AXIS LINEAR SCALE Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the Z Fault encoder has been damaged and encoder position data is unreliable. This can also be caused by loose scale connectors.

281 Z AXIS LINEAR SCALE Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the Z Fault encoder has been damaged and encoder position data is unreliable. This can also be caused by loose scale connectors.

282 A AXIS LINEAR SCALE Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the Z Fault encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

283 X AXIS LINEAR SCALE Z CH MISSING Broken wires or encoder contamination. All servos are turned off. This Z Channel Missing can also be caused by loose scale connectors.

284 Y AXIS LINEAR SCALE Z CH MISSING Broken wires or encoder contamination. All servos are turned off. This Z Channel Missing can also be caused by loose encoder connectors.

285 Z AXIS LINEAR SCALE Z CH MISSING Broken wires or encoder contamination. All servos are turned off. This Z Channel Missing can also be caused by loose encoder connectors.

286 A AXIS LINEAR SCALE Z CH MISSING Broken wires or encoder contamination. All servos are turned off. This Z Channel Missing can also be caused by loose encoder connectors.

287 X AXIS LINEAR SCALE CABLE FAULT Cable from X-axis scale does not have valid differential signals.

288 Y AXIS LINEAR SCALE CABLE FAULT Cable from Y-axis scale does not have valid differential signals.

289 Z AXIS LINEAR SCALE CABLE FAULT Cable from Z-axis scale does not have valid differential signals.

290 A AXIS LINEAR SCALE CABLE FAULT Cable from A-axis scale does not have valid differential signals.

291 LOW AIR VOLUME/PRESSURE DURING ATC An Automatic Tool Change was not completed due to insufficient volume or pressure of compressed air. Check air supply line.

292 320V POWER SUPPLY FAULT Power to the servos will be turned off when this alarm occurs. Note that error code 5 on the mini power supply may occur under this condition.

293 INVALID CHAMFER OR CORNER ROUNDING DISTANCE IN G01 Check your geometry.

294 NO END MOVE FOR G01 CHAMFER CORNER ROUNDING A chamfer or corner rounding move was requested in a G01 command, but no end move was commanded.

295 MOVE ANGLE TOO SMALL IN G01 CORNER ROUNDING Tangent of half angle is zero. Move Angle must be greater than 1 deg.

296 INVALID PLANE SELECTION IN G01 CHAMFER OR CORNER ROUNDING Chamfer or corner rounding move and end move must be in the same plane as the beginning move.

297 ATC SHUTTLE OVERSHOOT The ATC shuttle has failed to stop within the allowable standby position window during a tool change. Check for a loose drive belt, damaged or overheated motor, sticking or damaged shuttle standby switch or shuttle mark switch, or burned gear motor control board relay contacts. Use Tool Changer Restore to recover the ATC, then resume normal operation.

298 ATC DOUBLE ARM OUT OF POSITION The ATC double arm mark switch, CW position switch or CCW position switch is in an incorrect state. Check for sticking, misaligned or damaged switches, mechanism binding, damaged motor, or debris build up. Use Tool Changer Restore to recover the ATC, then resume normal operation.

299 ATC SHUTTLE OUT OF POSITION The ATC shuttle mark switch is in an incorrect state. Check for a sticking, misaligned, or damaged switch, mechanism binding, damaged motor, or debris build up. Use Tool Changer Restore to recover the ATC, then resume normal operation.

302 INVALID R IN G02 OR G03 Check your geometry. R must be greater than or equal to half the distance from start to end with an accuracy of 0.0010 inches (0.010 mm.).

303 INVALID X, Y OR Z IN G02 OR G03 Check your geometry.

304 INVALID I, J OR K IN G02 OR G03 Check your geometry. Radius at start must match radius at end of arc within 0.001 inches (0.01 mm.).

305 INVALID Q IN CANNED CYCLE Q in a canned cycle must be greater than zero.

306 INVALID I, J, K, OR Q IN CANNED CYCL I, J, K, and Q in a canned cycle must be greater than zero.

307 SUBROUTINE NESTING TOO DEEP Subprogram nesting is limited to nine levels. Simplify your program.

309 EXCEEDED MAX FEEDRATE Use a lower feed rate.

310 INVALID G CODE G code not defined and is not a macro call.

311 UNKNOWN CODE Program contained a line or code that is not understood.

312 PROGRAM END End of subroutine reached before M99. Need an M99 to return from subroutine.

313 NO P CODE IN M98, M97, M96, G47 OR G65 In M96, M97, M98 or G65 must put subprogram number in P code. G47 must have P0 for text engraving or P1 for sequential serial number.

314 SUBPROGRAM NOT IN MEMORY Check that a subroutine is in memory or that a macro is defined.

315 INVALID P CODE IN M97, M98, G47, M99 The P code must be the name of a program stored in memory without a decimal point for M98 and must be a valid N number for M99. If G47 command, then P must be a 0 for text engraving, 1 for sequential serial numbers or ASCII value between 32 and 126.

316 X OVER TRAVEL RANGE Commanded X-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user's program or improper offsets.

317 Y OVER TRAVEL RANGE Commanded Y-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user's program or improper offsets.

318 Z OVER TRAVEL RANGE Commanded Z-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user's program or improper offsets.

319 A OVER TRAVEL RANGE Commanded A-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user's program or improper offsets.

320 NO FEED RATE Must have a valid F code for interpolation functions.

321 AUTO OFF ALARM Occurs in debug mode only.

322 SUB PROG WITHOUT M99 Add an M99 code to the end of program called as a subroutine.

323 ATM CRC ERROR Advanced Tool Management (ATM) variables lost maybe by low battery. Check for a low battery and low battery alarm.

324 DELAY TIME RANGE ERROR P code in G04 is greater than or equal to 1000 seconds (over 999999 milliseconds). This alarm can also be generated by entering an invalid M95 time format.

325 QUEUE FULL Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

326 G04 WITHOUT P CODE Put a Pn.n for seconds or a Pn for milliseconds.

327 NO LOOP FOR M CODE EXCEPT M97, 98 L code not used here. Remove L Code.

328 INVALID TOOL NUMBER Tool number must be between 1 and the value in Parameter 65.

329 UNDEFINED M CODE That M code is not defined and is not a macro call.

330 UNDEFINED MACRO CALL Macro name O90nn not in memory. A macro call definition is in parameters and was accessed by user program but that macro was not loaded into memory.

331 RANGE ERROR Number too large.

332 H AND T NOT MATCHED This alarm is generated when Setting 15 is turned ON and an H code number in a running program does not match the tool number in the spindle. Correct the Hn codes, select the right tool, or turn off Setting 15.

333 X AXIS DISABLED Parameter has disabled this axis.

334 Y AXIS DISABLED Parameter has disabled this axis.

335 Z AXIS DISABLED Parameter has disabled this axis.

336 A AXIS DISABLED An attempt was made to program the A-axis while it was disabled (DISABLED bit in Parameter 43 set to 1), or invisible (INVIS AXIS bit in Parameter 43 set to 1), or a program commanded the A-axis while it was the outside rotary table (ROTARY INDEX button feature, MAP 4TH AXIS bit in Parameter 315 set to 1).

337 GOTO OR P LINE NOT FOUND Subprogram is not in memory, or P code is incorrect. P Not Found.

338 INVALID IJK AND XYZ IN G02 OR G03 There is a problem with circle definition; check your geometry.

339 MULTIPLE CODES Only one M, X, Y, Z, A, Q etc. allowed in any block, only one G codes in the same group.

340 CUTTER COMP BEGIN WITH G02 OR G03 Select cutter compensation earlier. Cutter compensation must begin on a linear move.

341 CUTTER COMP END WITH G02 OR G03 Disable cutter compensation later.

342 CUTTER COMP PATH TOO SMALL Geometry not possible. Check your geometry.

343 DISPLAY QUEUE RECORD FULL Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

344 CUTTER COMP WITH G18 & G19 Cutter compensation only allowed in XY plane (G17).

346 M CODE DISABLED A There was an M80 or M81 commanded. These commands are not allowed if Setting 51 DOOR HOLD OVERRIDE is OFF, the SAFETY CIRCUIT ENABLED, or the Parameter 251 is set zero. Also check Setting 131 for Auto Door and Parameter 57 for DOOR STOP SP. B. There was an M17 or M18 commanded in program restart. These commands are illegal in program restart.

347 INVALID OR MISSING E CODE All 5-axis canned cycles require the depth to be specified using a positive E code.

348 MOTION NOT ALLOWED IN G93 MODE This alarm is generated if the mill is in Inverse Time Feed mode, and a G12, G13, G70, G71, G72, G150, or any Group 9 motion command is issued.

349 PROG STOP WITHOUT CANCELING CUTTER COMP An X/Y cutter compensation exit move is required before a program stop.

350 CUTTER COMP LOOK AHEAD ERROR There are too many non-movement blocks between motions when cutter compensation is being used. Remove some intervening blocks.

351 INVALID P CODE In a block with G103 (Block Lookahead Limit), a value between 0 and 15 must be used for the P code.

352 AUX AXIS POWER OFF Aux C, U, V, or W axis indicate servo off. Check auxiliary axes. Status from control was OFF.

353 AUX AXIS NO HOME A ZERO RET has not been done yet on the aux axes. Check auxiliary axes.

354 AUX AXIS DISCONNECTED Aux axes not responding. Check auxiliary axes and RS-232 connections.

355 AUX AXIS POSITION MISMATCH Mismatch between machine and aux axes position. Check aux axes and interfaces. Make sure no manual inputs occur to aux axes.

356 AUX AXIS TRAVEL LIMIT Aux axes are attempting to travel past their limits.

357 AUX AXIS DISABLED Aux axes are disabled.

358 MULTIPLE AUX AXIS Can only move one auxiliary axis at a time.

359 INVALID I, J OR K IN G12 OR G13 Check your geometry.

360 TOOL CHANGER DISABLED Check Parameter 57.

361 GEAR CHANGER DISABLED Check Parameter 57.

362 TOOL USAGE ALARM Tool life limit was reached. To continue, hi-light the Usage count in the Current Commands Tool Life display and press ORIGIN. Then press RESET.

363 COOLANT LOCKED OFF Override is off and program tried to turn on coolant.

364 NO CIRC INTERP AUX AXIS Only rapid or feed is allowed with aux axes.

365 P DEFINITION ERROR P value not defined, or P value out of range. An M59 or M69 must have a P value between the range of 1100 and 1155. If using G154 command, then P value must be between 1 and 99.

366 MISSING I, K OR L IN G70, G71 OR G72 Check for missing values.

367 CUTTER COMP INTERFERENCE G01 cannot be done with tool size.

368 GROOVE TOO SMALL Tool too big to enter cut.

369 TOOL TOO BIG Use a smaller tool for cut.

370 POCKET DEFINITION ERROR Check geometry for G150.

371 INVALID I, J, K OR Q Check G150.

372 TOOL CHANGE IN CANNED CYCLE Tool change not allowed while canned cycle is active.

373 INVALID CODE IN DNC A code found in a DNC program could not be interpreted because of DNC restrictions.

374 MISSING XYZA IN G31 OR G36 G31 skip function requires an X, Y, Z, or A move.

375 MISSING Z OR H IN G37 G37 automatic tool length measurement function requires H code, Z value, and tool offset enabled. X, Y, and A values not allowed.

376 NO CUTTER COMP IN SKIP Skip G31 and G37 functions cannot be used with cutter compensation.

377 NO SKIP IN GRAPH/SIM Graphics mode cannot simulate skip function.

378 SKIP SIGNAL FOUND Skip signal check code was included but skip was found when it was not expected.

379 SKIP SIGNAL NOT FOUND Skip signal check code was included but skip was not found when it was expected.

380 X, Y, A OR G49 NOT ALLOWED IN G37 G37 may only specify Z-axis and must have tool offset defined.

381 G43, G44 NOT ALLOWED IN G36 OR G136 Auto work offset probing must be done without tool offset.

382 D CODE REQUIRED IN G35 A Dnn code is required in G35 in order to store the measured tool diameter.

383 INCH IS NOT SELECTED G20 was specified but settings have selected metric input.

384 METRIC IS NOT SELECTED G21 was specified but settings have selected inches.

385 INVALID L, P, OR R CODE IN G10 G10 was used to changes offsets but L, P, or R code is missing or invalid.

386 INVALID ADDRESS FORMAT An address A...Z was used improperly.

387 CUTTER COMP NOT ALLOWED WITH G103 If block buffering has been limited, Cutter Compensation cannot be used.

388 CUTTER COMP NOT ALLOWED WITH G10 Coordinates cannot be altered while Cutter Comp is active. Move the G10 outside of Cutter Comp enablement.

389 G17, G18, G19 ILLEGAL IN G68 Planes of rotation cannot be changed while rotation is enabled.

390 NO SPINDLE SPEED S code has not been encountered. Add an S code.

391 FEATURE DISABLED An attempt was made to use a control feature not enabled by a parameter bit. Set the parameter bit to 1.

392 B AXIS DISABLED An attempt was made to program the B-axis while it was disabled (DISABLED bit in Parameter 151 set to 1) or invisible (INVIS AXIS bit in Parameter 151 set to 1), or a program commanded the B-axis while it was the outside rotary table (ROTARY INDEX button feature, MAP 4TH AXIS bit in Parameter 315 set to 1).

393 INVALID MOTION IN G74 OR G84 Rigid Tapping can only be in the Z minus G74 or G84 direction. Make sure that the distance from the initial position to the commanded Z depth is in the minus direction.

394 B OVER TRAVEL RANGE B-axis will exceed stored stroke limits. This is a parameter in negative direction and is machine zero in the positive direction. This will only occur during the operation of a user's program.

395 NO G107 ROTARY AXIS SPECIFIED A rotary axis must be specified in order to perform cylindrical mapping.

396 INVALID G107 ROTARY AXIS SPECIFIED The rotary axis specified is not a valid axis, or has been disabled.

397 AUX AXIS IN G93 BLOCK This alarm is generated if a G-code block specifies any form of interpolated motion that involves BOTH one or more of the regular axes (X, Y, Z, A, B, etc...) AND one or more of the auxiliary axes (C, U, V, W).

398 AUX AXIS SERVO OFF Aux. axis servo shut off due to a fault.

400 SKIP SIGNAL DURING RESTART A skip signal G-code (G31, G35, G36, G37, G136) was found during program restart.

401 INVALID TANGENT IN GROUP 1 CORNER ROUNDING OR CHAMFERING The point or angle calculated has yielded invalid results in automatic chamfering or corner rounding. This can be for one of the following reasons: 1) Tangent of angle was too close to zero. 2) Cosine of angle was invalid. 3) Hypotenuse of calculated right triangle was shorter than side. 4) Calculated point did not line on arc or line. Check your geometry.

402 POSSIBLE CORRUPTED FILE The parameters being loaded do not match the expected number of parameters. This can be due to the loading of an older or newer parameter file than the system binary, or the file is corrupted.

403 TOO MANY PROGS Cannot have more than 500 programs in memory.

404 RS-232 NO PROG NAME Need name in programs when receiving ALL; otherwise has no way to store them.

405 RS-232 ILLEGAL PROG NAME Check files being loaded. Program name must be Onnnn and must be at beginning of a block.

406 RS-232 MISSING CODE Bad data was received. Check your program. The program will be stored but the bad data is turned into a comment.

407 RS-232 INVALID CODE Check your program. The program will be stored but the bad data is turned into a comment.

408 RS-232 NUMBER RANGE ERROR Check your program. The program will be stored but the bad data is turned into a comment.

409 FILE INVALID N CODE Bad parameter or setting number. Positive number must exist after the 'N' character, and cannot be longer than 5 digits.

410 FILE INVALID V CODE Bad parameter or setting value. Positive or negative number must exist after the 'V' character, and cannot be longer than 10 digits.

411 RS-232 EMPTY PROG Check your program. Between % and % there was no program found.

412 RS-232 UNEXPECTED END OF INPUT Check Your Program. An ASCII EOF code was found in the input data before program receive was complete. This is a decimal code 26.

413 RS-232 LOAD INSUFFICIENT MEMORY Program received does not fit. Check the space available in the LIST PROG mode and possibly delete some programs.

414 RS-232 BUFFER OVERFLOW Data sent too fast to CNC. Computer sending data may not respond to X-OFF.

415 RS-232 OVERRUN Data sent too fast to CNC.

416 RS-232 PARITY ERROR Data received by CNC has bad parity. Check parity settings, number of data bits and speed. Also check your cables.

417 RS-232 FRAMING ERROR Data received was garbled and proper framing bits were not found. One or more characters of the data will be lost. Check parity settings, number of data bits and speed.

418 RS-232 BREAK Break condition while receiving. The sending device set the line to a break condition. This might also be caused by a simple break in the cable.

419 INVALID FUNCTION FOR DNC A code found on input of a DNC program could not be interpreted.

420 PROGRAM NUMBER MISMATCH The O code in the program being loaded did not match the O code entered at the keyboard. Warning only.

421 NO VALID POCKETS Pocket Table is full of dashes.

422 POCKET TABLE ERROR If the machine has a 50 taper spindle, there must be 2 dashes between L's. L's must be surrounded by dashes.

423 X SCALE/SCREW MISMATCH Scale induced correction exceeds one motor revolution.

424 Y SCALE/SCREW MISMATCH Scale induced correction exceeds one motor revolution.

425 Z SCALE/SCREW MISMATCH Scale induced correction exceeds one motor revolution.

426 A SCALE/SCREW MISMATCH Scale induced correction exceeds one motor revolution.

427 INTERRUPT OVERRUN The control detected an interrupt overrun condition. An interrupt occurred before the previous interrupt was completed. Call your dealer.

429 DISK DIR INSUFFICIENT MEMORY CNC memory was almost full when an attempt was made to read the directory.

430 FILE UNEXPECTED END OF INPUT Ending % sign not found. Check your program. An ASCII EOF code was found in the input data before program receive was complete. This is a decimal code 26.

431 FILE NO PROG NAME Need name in programs when receiving ALL; otherwise has no way to store them.

432 FILE ILLEGAL PROG NAME Check files being loaded. Program must be Onnnn and must be at the beginning of a block.

433 FILE EMPTY PROG Check your program. Between % and % there was no program found.

434 FILE LOAD INSUFFICIENT MEMORY Program received does not fit. Check the space available in the LIST PROG mode and possibly delete some programs.

435 DISK ABORT Could not read disk. Possible corrupted or unformatted disk. Try a known good disk. Also caused by dirty drive heads. Use an appropriate cleaning kit.

436 DISK FILE NOT FOUND Could not find file. Possible corrupted or unformatted disk. Try a known good disk. Also caused by dirty drive heads. Use an appropriate cleaning kit.

457 AUX AXIS IS ENABLED One or more auxiliary axes are enabled. For the macro variables 750 and 751 to work the auxiliary axes must be disabled. Make sure Setting 38 is 0.

471 OUT OF TOOLS The life of all tools in the Advanced Tool Management group has expired.

472 ATM FAULT Indicates an error related to the Advanced Tool Management feature. ATM software encountered a group which does not exist. Usually it can be fixed by adding the corresponding group.

501 TOO MANY ASSIGNMENTS IN ONE BLOCK Only one assignment macro assignment is allowed per block. Divide block into multiple blocks.

502 [OR = NOT FIRST TERM IN EXPRESSN An expression element was found where it was not preceded by [or =, that start expressions.

503 ILLEGAL MACRO VARIABLE REFERENCE A macro variable number was used that is not supported by this control, use another variable.

504 UNBALANCED BRACKETS IN EXPRESSION Unbalanced brackets, [or], were found in an expression. Add or delete a bracket.

505 VALUE STACK ERROR The macro expression value stack pointer is in error. Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

506 OPERAND STACK ERROR The macro expression operand stack pointer is in error. Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

507 TOO FEW OPERANDS ON STACK An expression operand found too few operands on the expression stack. Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

508 DIVISION BY ZERO A division in a macro expression attempted to divide by zero. Re-configure expression.

509 ILLEGAL MACRO VARIABLE USE See MACROS section for valid variables.

510 ILLEGAL OPERATOR OR FUNCTION USE See MACROS section for valid operators.

511 UNBALANCED RIGHT BRACKETS Number of right brackets not equal to the number of left brackets.

512 ILLEGAL ASSIGNMENT USE Attempted to write to a read-only macro variable.

513 VARIABLE REFERENCE NOT ALLOWED WITH N OR O Alphabetic addresses N and O cannot be combined with macro variables. Do not declare N#1, etc.

514 ILLEGAL MACRO ADDRESS REFERENCE Alphabetic addresses N and O cannot be combined with macro variables. Do not declare N#1, etc.

515 TOO MANY CONDITIONALS IN A BLOCK Only one conditional expression is allowed in any WHILE or IF-THEN block.

516 ILLEGAL CONDITIONAL OR NO THEN A conditional expression was found outside of an IF-THEN, WHILE, or M99 block.

517 EXPRSN. NOT ALLOWED WITH N OR O A macro expression cannot be used with N or O. Do not declare O[#1], etc.

518 ILLEGAL MACRO EXPRSN REFERENCE A macro expression cannot be used with N or O. Do not declare O[#1], etc.

519 TERM EXPECTED In the evaluation of a macro expression an operand was expected but not found.

520 OPERATOR EXPECTED In the evaluation of a macro expression an operator was expected but not found.

521 ILLEGAL FUNCTIONAL PARAMETER An illegal value was passed to a function, such as SQRT[or ASIN[.

522 ILLEGAL ASSIGNMENT VAR OR VALUE A variable was referenced for writing. The variable referenced is read only.

523 CONDITIONAL REQUIRED PRIOR TO THEN A THEN was encountered and a conditional statement was not processed in the same block.

524 END FOUND WITH NO MATCHING DO An END was encountered without encountering a previous matching DO. DO-END numbers must agree.

525 VAR. REF. ILLEGAL DURING MOVEMENT Variable cannot be read during axis movement.

526 COMMAND FOUND ON DO/END LINE A G-code command was found on a WHILE-DO or END macro block. Move the G-code to a separate block.

527 = NOT EXPECTED OR THEN REQUIRED Only one assignment is allowed per block, or a THEN statement is missing.

528 PARAMETER PRECEDES G65 On G65 lines, all parameters must follow the G65 G-code. Place parameters after G65.

529 ILLEGAL G65 PARAMETER The addresses G, L, N, O, and P cannot be used to pass parameters.

530 TOO MANY I, J, or K'S IN G65 Only 10 occurrences of I, J, or K can occur in a G65 subroutine call. Reduce the I, J, or K count.

531 MACRO NESTING TOO DEEP Only four levels of macro nesting can occur. Reduce the number of nested G65 calls.

532 UNKNOWN CODE IN POCKET PATTERN Macro syntax is not allowed in a pocket pattern subroutine.

533 MACRO VARIABLE UNDEFINED A conditional expression evaluated to an UNDEFINED value, i.e. #0. Return True or False.

534 DO OR END ALREADY IN USE Multiple use of a DO that has not been closed by an END in the same subroutine. Use another DO number.

535 ILLEGAL DPRNT STATEMENT A DPRNT statement has been formatted improperly, or DPRNT does not begin block.

536 COMMAND FOUND ON DPRNT LINE A G-code was included on a DPRNT block. Make two separate blocks.

537 RS-232 ABORT ON DPRNT While a DPRNT statement was executing, the RS-232 communications failed.

538 MATCHING END NOT FOUND A WHILE-DO statement does not contain a matching END statement. Add the proper END statement.

539 ILLEGAL GOTO Expression after GOTO not valid.

540 MACRO SYNTAX NOT ALLOWED A section of code was interpreted by the control where macro statement syntax is not permitted.

541 MACRO ALARM This alarm was generated by a macro command in a program.

542 OPERATION NOT AVAILABLE This operation is not compatible with FNC mode.

600 U OVER TRAVEL RANGE Commanded U-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user's program or improper offsets.

601 V OVER TRAVEL RANGE Commanded V-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user's program or improper offsets.

602 W OVER TRAVEL RANGE Commanded W-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user's program or improper offsets.

603 U LIMIT SWITCH Axis hit limit switch or switch disconnected. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter 373 Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.

604 V LIMIT SWITCH Axis hit limit switch or switch disconnected. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter 409 Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.

605 W LIMIT SWITCH Axis hit limit switch or switch disconnected. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter 445 Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.

608 INVALID Q CODE A Q address code used a numeric value that was incorrect in the context used. In M96 Q can reference only bits 0 to 63. Use an appropriate value for Q.

609 U SERVO ERROR TOO LARGE Too much load or speed on U-axis motor. The difference between the motor position and the commanded position has exceeded Parameter 362. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops.

610 V SERVO ERROR TOO LARGE Too much load or speed on V-axis motor. The difference between the motor position and the commanded position has exceeded Parameter 398. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops.

611 W SERVO ERROR TOO LARGE Too much load or speed on W-axis motor. The difference between the motor position and the commanded position has exceeded Parameter 434. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops.

612 U SERVO OVERLOAD Excessive load on U-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops. It can also be caused by anything that causes a very high load on the motors.

613 COMMAND NOT ALLOWED IN CUTTER COMP At least one command in the highlighted block cannot be executed while cutter compensation is active. Block Delete characters ('/') and M codes such as M06, M46, M50 and M96 are not allowed. Your program must have a G40 and a cutter compensation exit move before these can be commanded.

614 V SERVO OVERLOAD Excessive load on V-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops. It can also be caused by anything that causes a very high load on the motors.

615 W SERVO OVERLOAD Excessive load on W-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops. It can also be caused by anything that causes a very high load on the motors.

616 U-AXIS MOTOR OVERHEAT Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F (65 deg. C). This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.

617 V-AXIS MOTOR OVERHEAT Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F (65 deg. C). This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.

618 W-AXIS MOTOR OVERHEAT Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F (65 deg. C). This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.

620 C AXIS DISABLED Parameters have disabled this axis

621 C OVER TRAVEL RANGE C-axis will exceed stored stroke limits. This is a parameter in negative direction and is machine zero in the positive direction. This will only occur during the operation of a user's program.

622 TOOL ARM FAULT This alarm is generated by the tool changer if the arm is not at the Origin position or the arm motor is already running when a tool change process is started.

625 CAROUSEL POSITIONING ERROR This alarm is generated by the tool changer if the conditions are not correct when:
• The carousel or tool arm was started and illegal conditions are present, for example: The carousel or arm motor already running. The arm is not at the Origin. The tool carousel is not at TC mark, or the tool pocket is not locked.
• The tool carousel was in motion and the Tool One Mark was detected but the current pocket facing the spindle was not at pocket one. Or the current pocket is at pocket one but Tool One Mark is not detected.

626 TOOL POCKET SLIDE ERROR This alarm is generated by the tool changer. It is generated if the tool pocket has not moved to its commanded position (and settled) within the total time allowed by parameters 306 and 62.

627 ATC ARM MOTION This alarm is generated by the sidemount disk type tool changer. It is generated if the tool arm failed to move within the time specified by Parameter 309 ARM START TIMEOUT or if the tool arm failed to move to the designated position, such as origin, clamp or unclamp within the time specified by Parameter 308 ARM ROTATE TIME, or if the tool pocket failed to move up or down within the time specified by Parameter 306 POCKET UP/DN DELAY.

628 ATC ARM POSITIONING ERROR This alarm is generated by the tool changer if:
• The arm was being moved from the ORIGIN position to the CLAMP position and it coasted past the MOTOR STOP point, or could not get to the CLAMP point.
• The arm was being moved from the CLAMP position to the UNCLAMP position and it coasted past the MOTOR STOP point or could not get to the UNCLAMP point (same physical point as CLAMP).
• The arm was being moved back to the ORIGIN position and it coasted past the MOTOR STOP point or could not get to the ORIGIN point.

629 APC-PIN CLEAR/HOME SWITCH FAULT A pin clear switch was contacted when all pallets were at their home positions. The most likely cause is debris on a switch. Check for accumulation of debris on the pin clear switches and the pallet home switches. Check switches and their electrical wiring for damage. After correcting the condition run an M50 (with P code for the pallet to be loaded) to continue machining.

630 APC-DOOR SW FAULT-SWITCH NOT EQUAL TO SOLENOID The APC Door Switch indicates the door is open but the solenoid shows the door has been commanded to close. Either the door failed to close and is stuck or the switch itself is broken or stuck. Also, the door switch wiring may have a fault. Check switch then cable. After correcting the condition, run an M50 to continue machining.

631 PALLET NOT CLAMPED Vertical Mills: APC-Pallet not clamped or home. Do not attempt to move X or Y axes of the mill until the APC is in a safe condition. One pallet is at home but the other pallet is neither clamped nor at home. Locate the unclamped pallet and return to home if possible. If drive pin is engaged or pallet is partially clamped, go to the lube/air panel at rear of mill and continuously press both white buttons in center of solenoid air valves while assistant pulls the pallet off the receiver. After correcting the condition, run an M50 to continue machining.

Horizontal Mills: RP-Pallet is not clamped. The RP pallet change was not completed or the pallet was not clamped properly when a spindle command was given. After correcting the condition, run an M50 to continue machining.

632 APC-UNCLAMP ERROR The pallet did not unclamp in the amount of time allowed. This can be caused by a bad air solenoid, a blocked or kinked airline, or a mechanical problem. After correcting the condition, run an M50 to continue machining.

633 APC-CLAMP ERROR The pallet did not clamp in the amount of time allowed by parameter 316. This alarm is most likely caused by the mill table not being in the correct position. This can be adjusted using the setting for the X position (#121, #125) as described in the 'Installation' section. If the pallet is in the correct position but not clamped, push the pallet against the hard stop and run M18. If the pallet is clamped, but not correctly, run an M17 to unclamp, push the pallet to the correct position, and run an M18 to clamp the pallet. Less common causes could be that the slip clutch is slipping, the motor is at fault, or an airline is blocked or kinked. After correcting the condition, run an M50 to continue machining.

634 APC-MISLOCATED PALLET A pallet is not in the proper place on the APC. The pallet must be pushed back against the hard stop by hand. After correcting the condition, run an M50 to continue machining.

635 APC-PAL NUM CONFLICT REC & CH Pallet Number Conflict Receiver and Pallet Changer: The pallet number in memory does not agree with the actual pallet in use. Run an M50 to reset this variable.

636 APC UNLOAD-SWITCH MISSED PAL 1 Pallet #1 did not return from the receiver to the APC in the allowable amount of time. This can be caused by the chain switch block missing the limit switch, or from another mechanical problem, such as clutch slippage. After correcting the condition, run an M50 to continue machining.

637 APC UNLOAD-SWITCH MISSED PAL 2 Pallet #2 did not return from the receiver to the APC in the allowable amount of time. This can be caused by the chain switch block missing the limit switch, or from another mechanical problem, such as clutch slippage. After correcting the condition, run an M50 to continue machining.

638 APC-DOOR NOT OPEN The automatic door did not open (in the allowable time), or may have fallen during an APC function. This can be caused by a bad air solenoid, a blocked or kinked airline, or a mechanical problem. After correcting the condition, run an M50 to continue machining.

639 APC-DOOR NOT CLOSED The automatic door did not close (in the allowable time), when necessary after an APC function has been performed. This can be caused by a bad air solenoid, a blocked or kinked airline, or a mechanical problem. After correcting the condition, run an M50 to continue machining.

640 APC-MISSING PALLET @ REC Pallet change sequence was halted because receiver switch was not activated. Pallet is either unclamped or not on the receiver. Ensure the pallet is correctly located on receiver (against hard stop) then run M18 to clamp the pallet. After correcting the condition, run an M50 to continue machining.

641 APC-UNKNOWN CHAIN LOCATION Neither chain location switch is tripped, so the control cannot locate the chain position. This can occur if a pallet change is interrupted for any reason, such as an alarm or an E-STOP. To correct this problem, the pallets and chain must be moved back into a recognized position, such as both pallets home or one pallet home and one on the receiver. The chain position adjustment tool must be used to rotate the chain into position. The pallets must be pushed into place by hand. After correcting the condition, run an M50 to continue machining.

642 642 APC-PIN CLEAR SWITCH FAULT – One of the pallet changer pin clear switches was contacted unexpectedly. The most likely cause is debris on a switch. Also check the pin clear switches for damage and their electrical wiring for damage. After correcting the condition run an M50 to continue machining.

643 LOW BRAKE OIL A-AXIS The oil level in the air/oil booster, supplying hydraulic pressure to the A-axis brake, is low. The booster is located on the front of the machine's table. Access the booster fill fitting and add Mobile DTE 24 oil to bring the oil level to the high oil level line marked on the booster. If the alarm reoccurs within 90 days contact your Haas Dealer for service.

644 APC-LOW AIR PRESSURE A low air pressure condition was detected during pallet changer operation. Check that the air supply is 100 PSI, minimum. Check that the air supply line is the correct diameter. Check that the mill pressure regulator is set to 85 PSI. If this alarm continues to occur, check the entire pressurized air system for any abnormal air leakage.

645 RP-PALLET JAMMED, CHECK FOR OBSTRUCTION The pallet changer has not rotated away from its original position (CW/CCW) in a reasonable time, or has not achieved its final position (CW/CCW) in a reasonable time, or has not been permitted to lower to the fully down position. After correcting the condition, run an M50 to continue machining.

646 RP-CW/CCW SWITCH ILLEGAL CONDITION Both of the switches that sense the rotational position of the pallet changer are indicating the impossible condition that the pallet changer is rotated CW and CCW at the same time. Only one switch should be tripped at a time. Check the function of the rotational sense switches, their connectors, and their wiring. After correcting the condition, run an M50 to continue machining.

647 RP-UP/DOWN SWITCH ILLEGAL CONDITION, LIFT CYLINDER The switches that sense the lifted and lowered position of the pallet changer are indicating the impossible condition that the pallet changer is both lifted and lowered at the same time. Check the function of the lift and lower sense switches, check the adjustment of the top switch, check both switch electrical connections and their wiring. After correcting the condition, run an M50 to continue machining.

648 RP-MAIN DRAWBAR LOCKED IN PALLET CLAMPED POSITION The drawbar has not tripped the unclamp sense switch in a reasonable amount of time. Check to see that the motor is plugged in at the connector panel in the rear of the machine and at the motor through the access panel; check the function of the main drawbar motor (does it turn or try to turn); check the condition of the drive belt, check power supply to the motor; check the relays that supply power to the motor, check the condition of the current limiting resistors. After correcting the condition, run an M50 to continue machining.

649 RP-MAIN DRAWBAR LOCKED IN PALLET UNCLAMPED POSITION The drawbar has not come off the unclamp sense switch in a reasonable amount of time. Check to see that the motor is plugged in at the connector panel in the rear of the machine and at the motor through the access panel; check the function of the main drawbar motor (does it turn or try to turn); check the condition of the drive belt, check power supply to the motor; check the relays that supply power to the motor, check the condition of the current limiting resistors. After correcting the condition, run an M50 to continue machining.

650 RP-PALLET NOT ENGAGING RP MAIN DRAWBAR This alarm occurs when the Pull Stud cannot properly engage the Ball Pull Collet. If this happens, the Ball Pull Collet has been pushed down into the Collet Housing and pallet clamping is not possible. Check alignment of the 'H'-frame with the adjustable Hard Stops. Check the Pallet Pull Studs and the RP-Main Drawbar Ball Collet for damage or obstruction. Remove any debris that may have entered the Collet. Check that the six balls in the collet float within the holes. If lift to the H-frame has been lost following a collet jammed condition, orientation of the pallet is not guarantied. Check orientation of the pallet as well. Zeroing of the A Axis is not safe if lift has been lost. It may be necessary to remove workpiece from the pallet. After correcting the condition, run an M50 to continue machining.

651 Z AXIS IS NOT ZEROED The Z axis has not been zeroed. In order to continue Tool Change Recovery the Z axis must be zeroed. Once the Z axis has been zeroed, continue with Tool Change Recovery.

652 U ZERO RET MARGIN TOO SMALL This alarm will occur if the home/limit switches move or are misadjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return operation.

653 V ZERO RET MARGIN TOO SMALL This alarm will occur if the home/limit switches move or are misadjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return operation.

654 W ZERO RET MARGIN TOO SMALL This alarm will occur if the home/limit switches move or are misadjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return operation.

655 U CABLE FAULT Cable from U-axis encoder does not have valid differential signals.

656 V CABLE FAULT Cable from V-axis encoder does not have valid differential signals.

657 W CABLE FAULT Cable from W-axis encoder does not have valid differential signals.

658 U PHASING ERROR Error occurred in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.

659 V PHASING ERROR Error occurred in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.

660 W PHASING ERROR Error occurred in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.

661 U TRANSITION FAULT Illegal transition of count pulses in U axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF printed circuit board.

662 V TRANSITION FAULT Illegal transition of count pulses in V axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF printed circuit board.

663 W TRANSITION FAULT Illegal transition of count pulses in W axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF printed circuit board.

664 U AXIS DISABLED Parameter has disabled this axis.

665 V AXIS DISABLED Parameter has disabled this axis.

666 W AXIS DISABLED Parameter has disabled this axis.

667 U AXIS LINEAR SCALE Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the Z Fault encoder has been damaged and encoder position data is unreliable. This can also be caused by loose scale connectors.

668 V AXIS LINEAR SCALE Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the Z Fault encoder has been damaged and encoder position data is unreliable. This can also be caused by loose scale connectors.

669 W AXIS LINEAR SCALE Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the Z Fault encoder has been damaged and encoder position data is unreliable. This can also be caused by loose scale connectors.

670 TT or B OVER TRAVEL RANGE Commanded TT or B-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user's program or improper offsets.

671 TT or B LIMIT SWITCH Axis hit limit switch or switch disconnected. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter 481 Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.

673 TT or B SERVO ERROR TOO LARGE Too much load or speed on TT or B-axis motor. The difference between the motor position and the commanded position has exceeded Parameter 470. The motor may also be stalled, disconnected, or the driver failed. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops.

674 TT or B SERVO OVERLOAD Excessive load on TT or B-axis motor. This can occur if the load on the motor over a period of several seconds or even minutes is large enough to exceed the continuous rating of the motor. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops or by a very high load on the motors. If this alarm occurs on a machine with a VF-SS-type tool changer, the most likely cause is a tool over 3 pounds not identified as 'heavy' in the tool table.

675 TT or B-AXIS MOTOR OVERHEAT Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F. This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.

676 TT or B MOTOR Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

677 TT or B AXIS Z CH MISSING Z Reference signal from encoder was not received as expected. Can be caused by loose connections, encoder contamination, or parameter error.

678 TT or B AXIS DRIVE FAULT Current in TT or B servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. This can be caused by running the axis into a mechanical stop. A short in the motor or a short of one motor lead to ground can also cause it.

679 TT or B ZERO RET MARGIN TOO SMALL This alarm will occur if the home/limit switches move or are misadjusted. This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder Z channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return operation.

680 TT or B CABLE FAULT Cable from TT or B-axis encoder does not have valid differential signals.

681 TT or B PHASING ERROR Error occurred in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.

682 TT or B TRANSITION FAULT Illegal transition of count pulses in B axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF.

683 TT or B AXIS DISABLED Parameter has disabled this axis.

684 TT or B AXIS LINEAR SCALE Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the Z Fault encoder has been damaged and encoder position data is unreliable. This can also be caused by loose scale connectors.

685 V MOTOR Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

686 W MOTOR Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

687 U MOTOR Z FAULT Encoder marker pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose encoder connectors.

688 U AXIS Z CH MISSING Z Reference signal from encoder was not received as expected. Can be caused by loose connections, encoder contamination, or parameter error.

689 V AXIS Z CH MISSING Z Reference signal from encoder was not received as expected. Can be caused by loose connections, encoder contamination, or parameter error.

690 W AXIS Z CH MISSING Z Reference signal from encoder was not received as expected. Can be caused by loose connections, encoder contamination, or parameter error.

691 U AXIS DRIVE FAULT Current in U servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. This can be caused by running the axis into a mechanical stop. A short in the motor or a short of one motor lead to ground can also cause it.

692 V AXIS DRIVE FAULT Current in V servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. This can be caused by running the axis into a mechanical stop. A short in the motor or a short of one motor lead to ground can also cause it.

693 W AXIS DRIVE FAULT Current in W servo motor beyond limit. Possibly caused by a stalled or overloaded motor. The servos are turned off. This can be caused by running the axis into a mechanical stop. A short in the motor or a short of one motor lead to ground can also cause it.

694 ATC SWITCH FAULT Conflicting switch states detected, such as shuttle at spindle and shuttle at chain simultaneously or tool pocket up and down simultaneously. Check for damaged or sticking switches, damaged wiring, or debris build up. Use Tool Changer Restore to recover the ATC, then resume normal operation.

695 ATC DOUBLE-ARM CYLINDER TIME OUT The ATC double arm did not complete extending or retracting within the time allowed by Parameter 61. Check for proper spindle orientation, correct alignment of the double arm with the chain or spindle, adequate air supply, mechanism binding, air leakage, excessive tool weight, debris build up, adequate chain tension, correct chain guide strip adjustment, and interference between the tool holder set screw and the chain or tool gripper. Use Tool Changer Restore to recover the ATC, then resume normal operation.

696 ATC MOTOR TIME OUT The ATC shuttle motor or double arm motor failed to complete the commanded movement within the time allowed by Parameter 60. Check for mechanism binding, correct motor and switch operation, damaged gear motor control board relays, damaged electrical wiring, or blown fuses on the gear motor control board. Use Tool Changer Restore to recover the ATC, then resume normal operation.

697 ATC MOTOR FAULT The ATC shuttle motor or double arm motor was on unexpectedly. Use Tool Changer Restore to recover the ATC, then resume normal operation.

698 ATC PARAMETER ERROR The ATC type cannot be determined. Check Parameter 278, bit 10, HS3 HYD TC, or Parameter 209, bit 2, CHAIN TC, as appropriate for the installed tool changer. Use Tool Changer Restore to recover the ATC, then resume normal operation.

791 COMM. FAILURE WITH MOCON2 During a self-test of communications between the MOCON2 and main processor the main processor does not respond. Check cable connections and boards. This alarm could also be caused by a memory fault, which was detected on the MOCON2.

792 MOCON2 WATCHDOG FAULT The self-test of the MOCON2 has failed. Call your dealer.

799 UNKNOWN MOCON2 ERROR Mocon2 has reported an alarm to the current software. The current version of software was unable to identify the alarm.

900 A PARAMETER HAS BEEN CHANGED When the operator alters the value of a parameter, alarm 900 will be added to the alarm history. When the alarm history is displayed, the operator will be able to see the parameter number and the old value along with the date and time the change was made. Note that this is not a resetable alarm; it is for information purposes only.

901 PARAMETERS HAVE BEEN LOADED BY DISK When a parameter file has been loaded from disk, alarm 901 will be added to the alarm history along with the date and time. Note that this is not a resetable alarm; it is for information purposes only.

902 PARAMETERS HAVE BEEN LOADED BY RS232 When a parameter file has been loaded from RS-232, alarm 902 will be added to the alarm history along with the date and time. Note that this is not a resetable alarm; it is for information purposes only.

903 CNC MACHINE POWERED UP When the machine is powered up, alarm 903 will be added to the alarm history along with the date and time. Note that this is not a resetable alarm; it is for information purposes only.

904 ATC AXIS VISIBLE The tool changer axis must be invisible for tool change operations with the HS tool changers. Set Parameter 462, bit 18, INVIS AXIS to 1. This will make the tool changer axis invisible and tool changes will be allowed.

905 NO P CODE IN M14, M15, M36 In M14, M15, M36 must put pallet number in a P code.

906 INVALID P CODE IN M14, M15, M36 OR M50 The P code must be the pallet number of a valid pallet without a decimal point, and must be a valid integer number.

907 APC UNLOAD-SWITCH MISSED PAL 3 Pallet #3 did not return from the receiver to the APC in the allowable amount of time. This can be caused by the chain switch block missing the limit switch, or from another mechanical problem, such as clutch slippage.

908 APC UNLOAD-SWITCH MISSED PAL 4 Pallet #4 did not return from the receiver to the APC in the allowable amount of time. This can be caused by the chain switch block missing the limit switch, or from another mechanical problem, such as clutch slippage.

909 APC-PROGRAM NOT LISTED There is no program name in the Pallet Schedule Table for the loaded pallet. To run a program for the loaded pallet, enter the program name into the Program Name column of the Pallet Schedule Table, for the pallet you want to operate on, or remove the M48 from the subprogram you want to use. Verify that the program and the pallet are compatible.

910 APC-PROGRAM CONFLICT The subprogram you are trying to run is not assigned to the loaded pallet. Another program is assigned to this pallet in the Pallet Schedule Table. Either enter the program name that you want to run into the Program Name column of the Pallet Status Table or, remove the M48 from the subprogram you want to use. Verify that the subprogram and the pallet are compatible.

911 APC-PAL LOAD/UNLOAD AT ZERO One or more of the pallets on the Automatic Pallet Changer has a load or unload position set to zero. This indicates that the APC set up procedure was incomplete. Establish the correct load and unload positions for all pallets and enter the positions in the appropriate settings. See operator's manual for the APC model and its correct setting numbers.

912 APC-NO P CODE OR Q CODE FOR M46 M46 must have a P code and a Q code. The P code must be a line number in the current program. The Q code is the number of the pallet, if loaded, that will cause a jump to the program line number.

913 APC-NO P CODE OR Q CODE FOR M49 M49 must have a Q code. The P code is the pallet number. The Q code is the status to give the pallet.

914 APC-INVALID P CODE The P code must be the name of a program stored in memory. The program name must not have a decimal point. Remove any decimal points from the program name.

915 APC-ILLEGAL NESTING G188 or M48 G188 is only legal in main program. M48 is only legal in a program listed in the Pallet Schedule Table or a first level subprogram.

916 APC-NEGATIVE PAL PRIORITY INDEX Software Error; Call your dealer.

917 APC-NUMBER OF PALLETS IS ZERO Parameter 606 must have a value if parameter 605 is not zero. Set parameter 606 to the number of pallets in your FMS system.

918 APC LOAD-SWITCH MISSED PAL 1 Pallet #1 did not complete its move from the APC to the receiver in the allowable time. Pallet change sequence was halted because receiver switch was not activated. Pallet is either unclamped or not on the receiver. Ensure the pallet is correctly located on receiver (against hard stop) then run M18 to clamp the pallet. After correcting the condition, run an M50 to continue machining.

919 APC LOAD-SWITCH MISSED PAL 2 Pallet #2 did not complete its move from the APC to the receiver in the allowable time. Pallet change sequence was halted because receiver switch was not activated. Pallet is either unclamped or not on the receiver. Ensure the pallet is correctly located on receiver (against hard stop) then run M18 to clamp the pallet. After correcting the condition, run an M50 to continue machining.

920 APC LOAD-SWITCH MISSED PAL 3 Pallet #3 did not complete its move from the APC to the receiver in the allowable time. Pallet change sequence was halted because receiver switch was not activated. Pallet is either unclamped or not on the receiver. Ensure the pallet is correctly located on receiver (against hard stop) then run M18 to clamp the pallet. After correcting the condition, run an M50 to continue machining.

921 APC LOAD-SWITCH MISSED PAL 4 Pallet #4 did not complete its move from the APC to the receiver in the allowable time. Pallet change sequence was halted because receiver switch was not activated. Pallet is either unclamped or not on the receiver. Ensure the pallet is correctly located on receiver (against hard stop) then run M18 to clamp the pallet. After correcting the condition, run an M50 to continue machining.

922 APC-TABLE NOT DECLARED Software calling invalid tables. Software Error; Call your dealer.

923 A INDEXER IS NOT AT THE PROPER INCREMENTAL POSITION The indexer has moved to a position that cannot be seated.

924 B INDEXER IS NOT AT THE PROPER INCREMENTAL POSITION The indexer has moved to a position that cannot be seated.

925 A INDEXER IS NOT FULLY IN THE UP POSITION The indexer is still seated. It is not completely in the up position and cannot be rotated. Reset then rezero the indexer.

926 B INDEXER IS NOT FULLY IN THE UP POSITION The indexer is still seated. It is not completely in the up position and cannot be rotated. Reset then rezero the indexer.

927 ILLEGAL G1 CODE FOR ROTARY INDEXER The rotary indexer only does rapid G0 motion. Feed G1 motion is not allowed.

937 INPUT LINE POWER FAULT This alarm works with the Power Failure Detection Module. This alarm will be generated whenever incoming power to the machine falls below reference voltage value in parameter 730 and duration of time in parameter 731. Cycle the power to continue.

938 LANGUAGES LOADED Foreign languages were recently loaded into the control.

939 LANGUAGES FAILED TO LOAD Foreign languages fails to be loaded into the control. Languages either exceeded total flash memory, or not enough flash memory available. Try deleting a language from disk.

940 SIDE MOUNT CAROUSEL ERROR This alarm is generated by the tool changer if the carousel motor is still running when the tool pocket is unlocked and lowered prior to a tool change. If the carousel does not start to rotate after the allowed time specified by parameter 60 TURRET START DELAY or does not stop rotating after the allowed time specified by parameter 61 TURRET STOP DELAY.

941 POCKET-TOOL TABLE ERROR This alarm is generated by the tool changer if the tool specified by the program is not found in the POCKET-TOOL table, or the searched pocket is out of range.

942 CAROUSEL POSITION TIMEOUT This alarm is generated by the tool changer if the tool carousel has not moved after the allowed time or has not stopped after the allowed time specified by parameter 60 TURRET START DELAY and parameter 61 TURRET STOP DELAY, respectively.

943 UNPROCESSED QUEUE CELL IN TOOL CHANGE There is an unknown command generated in the Tool change. Please save your current program to disk and notify your dealer.

944 INDEXER OUT OF POSITION The A axis indexer is out of position. Jog the A axis to within 1 degree of a clamping position before you run a program.

945 APC-LIFT FRAME DOWN TIMEOUT The pallet changer was commanded to lower but the down position switch was not contacted before the timeout period. Check for foreign objects under the lift frame. Verify there is an adequate supply of air pressure and air volume. Verify that parameter 320 is correct. Check air solenoids for sticking and air release ports for clogging. Check pallet down position switch and wiring for damage, switch connections for positive electrical contact, and the lifting mechanism for proper operation. After determining the cause and correcting the problem, press TOOL CHANGER RESTORE to enter pallet changer recovery, recover the pallet changer, and then continue operation.

946 APC-PALLET CLAMP TIMEOUT The pallet in the mill did not clamp in the time allowed. Check for foreign objects under the pallet and between the pallet and the clamp plate. Verify there is an adequate supply of air pressure and air volume. Check air solenoids for sticking and air release ports for clogging. Check the pallet clamped position switch for correct operation, the switch and wiring for damage, and pallet alignment. Check the pallet clamp mechanism for correct operation. After determining the cause and correcting the problem, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation. Parameter 317 specifies the pallet clamp timeout period.

947 APC-PALLET UNCLAMP TIMEOUT The pallet in the mill did not unclamp in the time allowed. Check for foreign objects between the pallet and the clamp plate. Verify there is an adequate supply of air pressure and air volume. Check air solenoids for sticking and air release ports for clogging. Check the pallet clamped position switch for correct operation, the switch and wiring for damage and pallet alignment. Check the pallet clamp plate for damage. After determining the cause and correcting the problem, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and continue operation. Parameter 316 specifies the unclamp timeout period.

948 APC-SOFTWARE ERROR Fault in pallet changer software. Note the actions that caused this alarm. Also, record the following information: On the control panel, press PARAM DGNOS key to get the DGNOS screen. Then press PAGE UP to the PC INPUTS page. Record the values of PC STATE, ALARM ST and ALARM. If this alarm recurs regularly call your dealer.

949 APC-AXIS VISIBLE The pallet changer axis must be invisible for the pallet changer to operate. Set the parameter bit INVIS AXIS to one for the axis that the pallet changer is installed on.

950 APC-ILLEGAL SWITCH CONDITION, LIFT FRAME The pallet changer lift frame switches indicate that the pallet changer lift frame is up and down at the same time. Verify there is an adequate supply of air pressure and air volume. Check the adjustment of the lift frame position switches and for debris on the switches. Check switch electrical connections and wiring. This may be a false alarm if the pallet changer was out of position by 90 degrees (+/- 20) when a pallet change was in progress. After correcting the cause, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

951 APC-ILLEGAL SWITCH CONDITION, PALLET CLAMP The pallet changer clamp switches indicate that the pallet changer is clamped and unclamped at the same time. Check the adjustment of the pallet clamp switches and for debris on the switches. Check switch electrical connections and wiring. After correcting the cause, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

952 APC-MISLOCATED LIFT FRAME The pallet changer lift frame is not in the expected position. The lift frame was either down when expected to be up, or up when expected to be down. For example, the lift frame must be up while rotating. The lift frame must be down when a pallet change starts, before clamping the pallet, before the A axis or Z axis can be jogged, or before starting a program with CYCLE START. If the pallet began to lower during rotation, check the lift mechanism for proper operation. If this alarm occurred at start of pallet change or when clamping the pallet, check for foreign objects or misalignment that prevent the frame from lowering all the way. Verify there is an adequate supply of air pressure and air volume. After correcting the cause, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

953 APC-MISLOCATED PALLET CLAMP The pallet changer clamp plate is not in the expected position. The clamp plate must be unclamped while the pallet changer is rotating or before the pallet is lifted. Verify there is an adequate supply of air pressure and air volume. Check operation of the clamp mechanism air solenoids. Check the pallet clamped position switch for correct operation, the switch and wiring for damage and pallet alignment. Check the pallet clamp plate for damage. After correcting the cause, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

954 APC-INCOMPLETE PALLET CHANGE The last pallet change did not complete successfully or the mill has been initialized. Press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

955 APC-INVALID PALLET CHANGER TYPE Parameter 605 has an invalid pallet changer type.

956 APC-LIFT FRAME UP TIMEOUT The pallet changer was commanded to lift but the up position switch was not contacted before the timeout period. The primary cause of this alarm is insufficient air pressure or air volume. Also, verify the pallet is unclamped and there are no obstructing objects. Check pallet up switch and wiring for damage, switch connections for positive electrical contact, and the lifting mechanism for proper operation. Verify parameter 321 is correct. After determining and correcting the problem, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

957 APC-SWITCH FAULT An illegal switch condition was detected. The pallet clamp switch did not function correctly. Use M17 and M18 commands to verify the input switch (input relay 26) changes state when the pallet clamps and unclamps. Check switch adjustment and check wiring for damage or unplugged connectors. The polarity of the clamp switch may be wrong. Parameter 734 is used to invert input switch polarity.

958 TOOL OFS WEAR HAS BEEN CHANGED When tool offsets have been changed, alarm 958 will be added to the alarm history along with the date and time. Note that this is not a resetable alarm; it is for information purposes only.

959 NON-INDEXER POSITION The position commanded for the A axis incremental indexer is a non-indexer position. The indexer positions are multiples of parameter 647. Parameter 647 is in thousandths of a degree. For example, a value of 2500 represents 2.5 degrees.

960 INDEXER SWITCH NOT FOUND IN TIME The A axis indexer down switch was not found within the allowed time specified by parameter 659.

961 FLOPPY OFFSET NOT FOUND This alarm is generated because FNC has lost the offset place mark it needs to correctly advance program. Try to reload program.

962 UNABLE TO RETRIEVE FILE INFORMATION File functions are taking too long to process. Try loading again.

963 UNABLE TO FNC FROM THIS DEVICE This device may not function from FNC. Please change setting 134 connection type to an appropriate FNC device, from the operator’s manual.

968 DOOR HOLD OVERRIDE ENGAGED Whenever setting 51 is changed to ON, alarm 968 will be added to the alarm history along with the date and time the change was made. Note that this is not a resetable alarm; it is for information purposes only.

NOTE: Alarms 1000-1999 are user defined by macro programs.

The following alarms only apply to HS Series mills with a pallet changer

1001 Index St Unlocked The index station is not in the correct orientation for a pallet change.

1002 Pallet Locked Down The pallet did not begin to lift within two seconds of command, or did not complete lifting within six seconds.

1003 Pallets Jammed The lift cylinder has not moved from the clockwise position within three seconds, or has not reached the counter clockwise position within twelve seconds.

1004 CW/CCW Switch Illegal Condition One or both of the switches that sense the rotational position of the pallet changer has failed its self-test.

1007 Up/Down Switch Illegal Condition One or both of the switches that sense the lifted/lowered position of the pallet changer has failed its self-test.

1008 Main Drawbar Locked In Up Position The main drawbar will not disengage from the pallet nut.

1009 Main Drawbar Locked In Down Position The main drawbar will not move upward to the pallet nut.

1010 Main Drawbar Switch Illegal Condition One or both of the switches that sense the up/down position of the main drawbar has failed its self-test.

1011 Main Drawbar Unclamp Timeout The main drawbar has disengaged from the pallet nut, but did not reach the main drawbar down switch.

1012 Main Drawbar Clamp Timeout The main drawbar has begun to travel upward, but did not reach the fully raised position within 15 seconds.

3. MECHANICAL SERVICE

RECOMMENDED TORQUE VALUES FOR MACHINE FASTENERS

The following chart should be used as a reference guide for torquing machine fasteners where specified.

DIAMETER	TORQUE
8-32	30 in. lb.
1/4 - 20	15 ft. lb.
5/16 - 18	30 ft. lb.
3/8 - 16	50 ft. lb.*
M10 - 100	50 ft. lb.
M12 - 65	100 ft. lb.
1/2 - 13	80 ft. lb.
3/4 - 10	275 ft. lb.
1 - 8	450 ft. lb.

* 3/8-16 SHCS used on tool release piston torqued to 35 ft. lb.

3.1 Head Covers Removal / Installation

Please read this section in its entirety before attempting to remove or replace covers.

REMOVAL -

NOTE: This procedure is for the VF-3/4. However, the procedure varies only slightly for other models.

50 Taper machines: Before removing the head cover, remove the fan assembly and disconnect the tool release and fan electrical connectors.

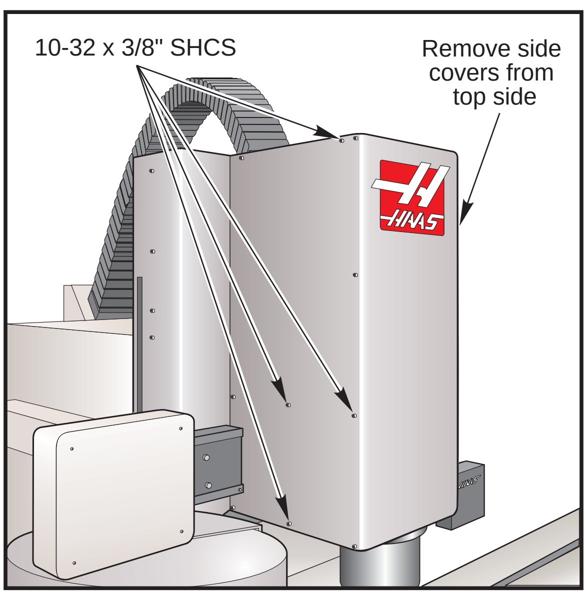


Figure 3.1-1 View of VF-3/4 head covers.

1. Zero return (ZERO RET) all axes, then HANDLE JOG to center X- and Y-axes under spindle. Protect table surface with a piece of cardboard.

2. Remove the top and rear covers.

3. Pull front cover from the bottom until you can disconnect the tool release cable (quick disconnect), then remove cover .

4. Remove the side covers. Jog Z-axis as necessary to make screw removal easier.

INSTALLATION -

1. Protect table surface with a piece of cardboard.

2. Replace each side cover from the top. Jog Z-axis as necessary to make access to screws easier.

3. Reconnect tool release cable, if equipped, then replace front cover from the bottom.

4. Replace rear cover and top cover.

3.2 Tool Release Piston (TRP) Assembly

Please read this section in its entirety before attempting to replace tool release piston assembly.

Overview

The Tool Release Piston is actuated by air. It forces the Tool Draw Bar down against the spring stack, releasing the old tool and permitting the new tool to be inserted. Normally the piston is in the upper, retracted position. During a tool change cycle the piston is forced down by air pressure, pushing the draw bar down until the pull stud on the top of the tool is released.

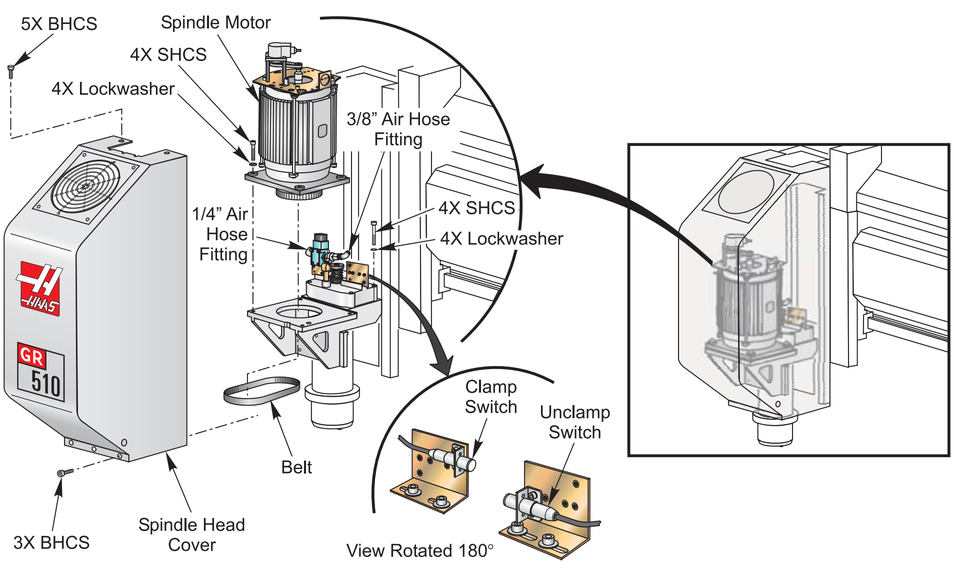
As the piston finishes its downward stroke a hole in the side of the Tool Release Shaft comes clear of the Cylinder Housing and is exposed to the compressed air within the cylinder. The air flows down through the Shaft to the Tool Release Nut at the lower end of the shaft. This nut presses on the end of the Tool Draw Bar and the air flows through a central hole drilled through both the Tool Release Nut and the Tool Drawbar to blow any chips out of the tapered area of the Spindle Shaft.

The Spring Retainer captures the compression spring that returns the Tool Change Piston and Shaft to the normal position when the air is released from the cylinder. The Upper and Lower Limit Switches are actuated by the Spring Retainer. The position of these switches is monitored by the computer control system during the tool change cycle.

There are different tool release pistons for 40 and 50 taper spindles. In addition The tool change pistons have different subassemblies that will need to be adjusted, or may need replacing. **The section(s) that follow the installation instructions must be completed as well or serious damage to the machine could result.**

40 Taper Spindle TRP Removal

Note: GR-series machines must have the spindle motor removed first in order to remove the Tool Release Piston assembly. Refer to the Spindle Motor Removal section of this manual.



GR-Series Spindle Head Assembly

1. If machine is equipped with Through the Spindle Coolant (TSC), place a tool holder in the spindle.
2. Remove cover panels from the headstock area.
3. Remove the four 3/8-16 x 1¾" SHCS holding the tool release piston assembly to the head casting.
4. Disconnect the air line at the lube/air panel.
5. Disconnect the clamp/unclamp cables (quick disconnect) and the assembly's solenoid wiring located on the solenoid bracket.
6. Remove the tool release air hose and precharge hose at the fitting shown in Fig. 3.2-1 If machine is equipped with TSC, also remove the coolant hose.
7. Remove entire tool release piston assembly.

NOTE: Steps 8 and 9 apply only to machines with TSC.

8. Remove the drain and purge lines from the seal housing.
9. Remove the seal housing from the TRP.

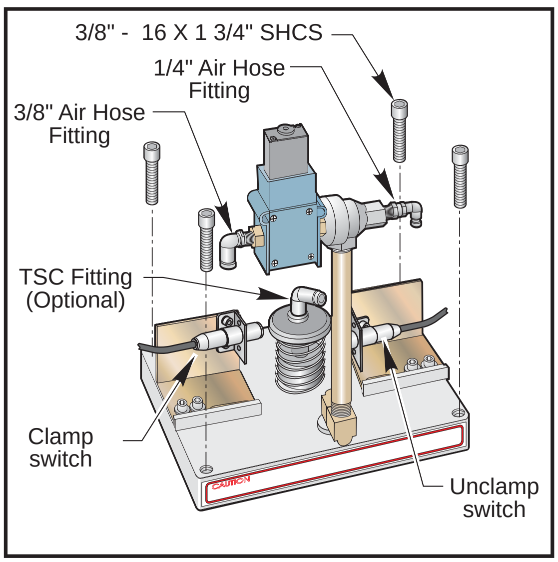


Figure 3.2-1 Tool Release Piston with Optional TSC fitting.

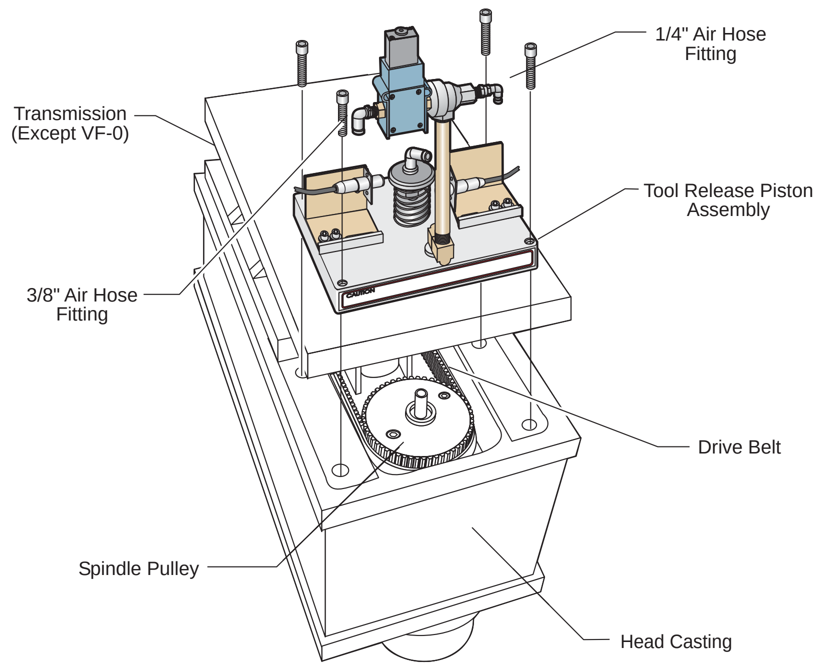


Figure 3.3-2 Mounting location for tool release piston assembly

40 Taper Spindle TRP Installation

The following sections must be completed after installation:

- Set Pre-Charge
- Adjust the Tool Clamp/Unclamp Switches
- Set the Drawbar Height

1. Ensure drive belt has been properly replaced as described in "Belt Assembly" section.
2. Verify spindle sweep adjustment is correct (as shown in "Spindle Assembly" section) before proceeding. If not correct, re-shim as necessary.
3. Reinstall tool release piston assembly loosely if the machine is equipped with TSC. Otherwise tighten the four mounting bolts securely.
4. Reconnect the air hoses at the applicable fittings on the tool release piston assembly.
5. Reconnect the clamp/unclamp cables and solenoid wire to the sides of the solenoid bracket.
6. Connect the 5/32" drain line and 5/32" purge line to the seal housing and install the seal housing on the TRP (use Loctite on the screws). The drain line connector should point toward the rear of the machine.

NOTE: The drain line must run straight through the cable clamp guide on the transmission, and must not interfere with the pulley or belts.

NOTE: Steps 6, 7 and 8 apply only to machines with TSC.

7. Apply precharge pressure several times to allow the seal to center itself with the drawbar. While holding down precharge, tighten the bolts.

8. Install the coolant hose. A wrench must be used, tighten snug. **Do not overtighten!!**

9. Adjust the clamp/unclamp switches in accordance with the appropriate section.

Setting Pre-Charge

Do not perform this procedure on machines equipped with Through the Spindle Coolant (TSC). It will damage the machine. Refer to the "Precharge Regulator Adjustment" section and perform those adjustments.

NOTE: Set the air pressure regulator to 30psi on Super Speed machines with an in-line drive.

1. Turn the air pressure regulator down to zero (0). The knob must be pulled out to unlock before adjusting. **In-Line drive machines -** Disconnect the air hose from the precharge regulator. Install a test gauge between the regulator and the solenoid. Command the precharge (Macro #1120-1), the precharge pressure should be 30 psi.

NOTE: At "0" pressure on the precharge regulator, the adjustment knob is out as far as it will turn.

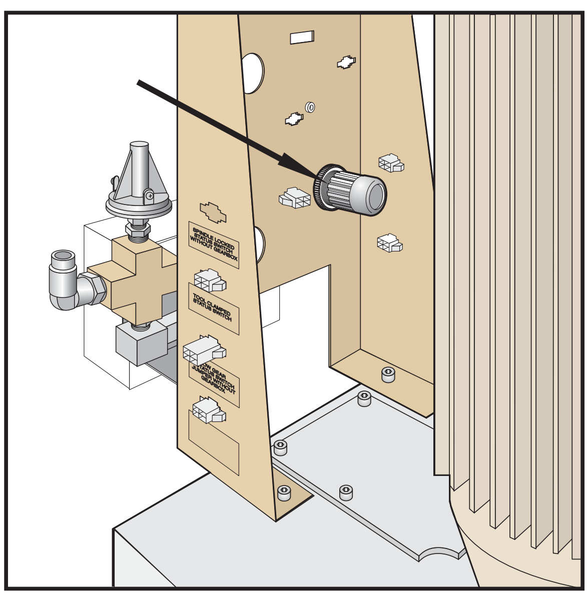


Figure 3.2-3. Air pressure regulator adjustment knob.

2. Ensure Parameter 149, Precharge DELAY, is set to 300. If not, set it at this time.

3. Execute a tool change. A banging noise will be heard as the tool release piston contacts the drawbar.

4. Turn the air pressure regulator ½ turn in. Execute a tool change and listen for the noise described previously. If it is heard, repeat this step until no noise is heard. There should be no noise with or without a tool in the spindle.

CAUTION! Only increase the pressure to the point where tool changes become obviously quiet. Any further pressure increases are not beneficial. Excessive pressure to the precharge system will cause damage to the tool changer and tooling in the machine.

5. Replace the head covers.

Tool Clamp/Unclamp Switch Adjustment - Initial Preparation

Please read this section in its entirety before adjusting clamp/unclamp switches or setting drawbar height.

TOOLS REQUIRED

- Machined aluminum block (2" x 4" x 4")
- 6" flexible ruler or .020" shim
- 1" diameter pipe (approx. 1' long)

1. Remove cover panels, as described in "Head Covers Removal".

2. Place a sheet of paper under the spindle for table protection, then place a machined block of aluminum (approximately 2" x 4" x 4") on the paper.

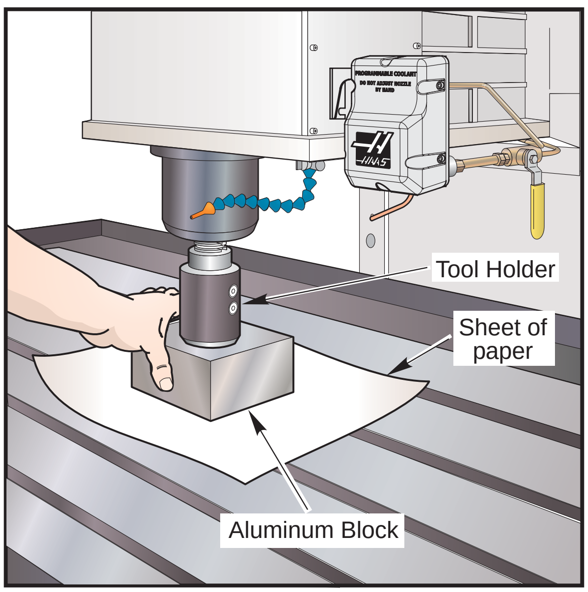


Figure 3.2-4 Placement of aluminum block under spindle.

3. Power on the VMC.

4. Insert a tool holder WITHOUT ANY TYPE OF CUTTER into the spindle taper.

5. Go to the HANDLE JOG mode. Choose Z-axis and set jog increments to .01. If the mill has an In-line spindle, plug the spindle taper air blast.

6. Jog Z-axis in the negative (-) direction until the tool holder is approximately .03 from the block.

7. Jog the Z-axis down until the tool holder is about .030" above the aluminum block. Switch the jog increments to .001" and jog the Z-axis down one increment at a time until the tool holder just presses the block firmly against the table surface. This is the zero point.

CAUTION! Do not jog too far in the negative (-) direction or else it will cause an overload of the Z-axis.

Setting TRP Height

1. Press MDI and turn hand wheel to zero (0).

2. Press HANDLE JOG button and set increments to .01. Jog the Z-axis in the positive (+) direction 0.100".

3. Press and hold the TOOL RELEASE button, grasp the block and try to move it. The block should be tight at .100 and loose at .110. If block moves at .100, jog the Z-axis in the negative (-) direction one increment at a time. Press the TOOL RELEASE button and check for movement between increments until block is tight.

NOTE: The increments jogged in the Z negative (-) direction are the amount of shim washers that must be added to the tool release bolt (or coolant tip for TSC). Refer to the "Shim Washers" section.

4. If the block is tight at .110, move the Z-axis in the positive (+) direction one increment at a time. Press the TOOL RELEASE button and check movement between increments until block is loose.

The increments jogged in the Z positive (+) direction are the amount of shim washers that must be removed. (Refer to the "Shim Washers" section).

Shim Washers

1. To add or subtract shim washers, remove tool release piston assembly ("Tool Release Piston" section) from head casting.

2. Check the condition of the tool release bolt and the draw bar. Repair or replace these items before setting the drawbar height.

NOTE: Shims may need to be added or removed when spindle cartridge, tool release piston assembly, or drawbar is replaced. If none have been replaced, skip this section.

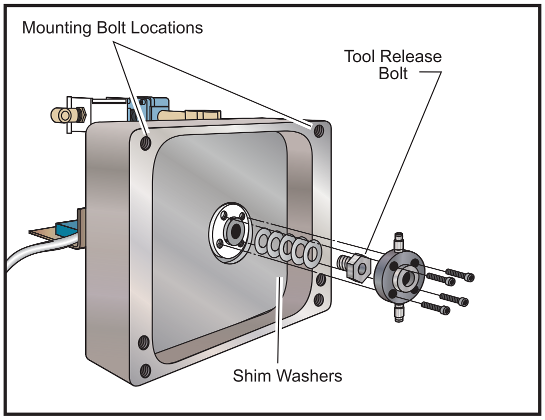


Figure 3.2-5 Tool release piston assembly (TSC shown).

3. Remove tool release bolt. Note that it has a left hand thread. If the machine is equipped with TSC, loosen the three set screws and remove the TSC coolant tip.

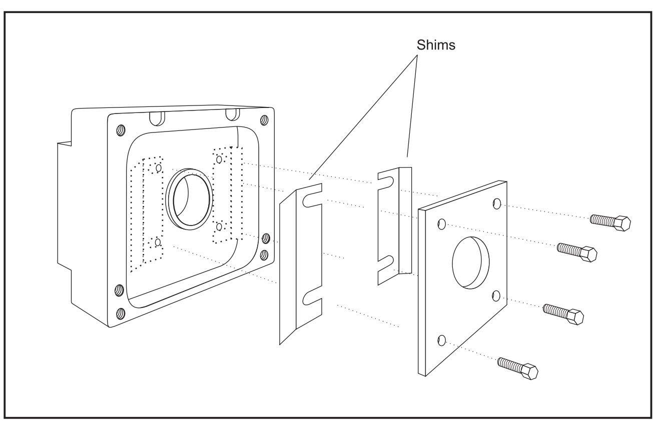
4. Add or subtract required shim washers (See previous section for correct amount to add or remove).

5. Before installing tool release bolt, put a drop of serviceable (blue) Loctite® on the threads and install. If replacing TSC coolant tip, put a drop of Loctite® on the threads of the three set screws before installing.

6. Install tool release piston assembly in accordance with the "Tool Release Piston - Installation" section and recheck settings. If within specifications, continue; if not, readjust.

In-Line Drive Spindle Drawbar height

The drawbar height is set the same way as the belt driven spindle. However the shim washers are set up differently (see the following figures). The drawbar uses a 1-piece shim which can be added or removed without having to remove the TRP assembly. Once the shims have been adjusted the TRP is re-installed and the final torque on the bolts is 35 ft-lb.



40 Taper TRP Switch Adjustment

LOWER (UNCLAMP) SWITCH -

1. Drawbar height must be set properly before adjusting switches. Add or subtract shim washers to the tool release piston until proper height is achieved. In-line drive machines must have the precharge pressure verified. See the previous, "Setting Pre-Charge" section.

2. Push the PARAM/DGNOS twice to enter the diagnostic mode and confirm that DB OPN =0 and DB CLS =1.

3. Using the same set-up for setting the drawbar height, jog the Z-axis to 0.06" away from where the tool holder was touching the aluminum block.

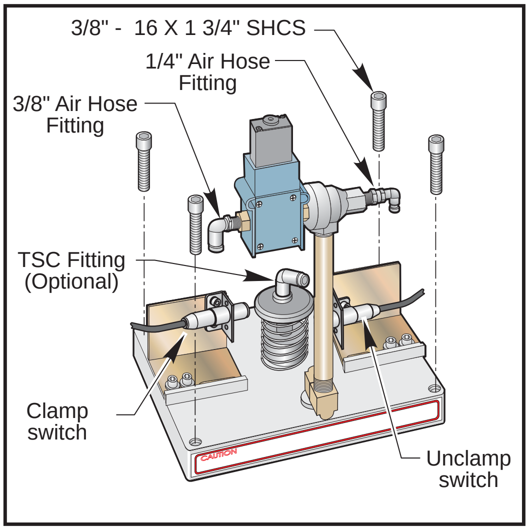


Figure 3.2-6a Tool Release Piston Assembly.

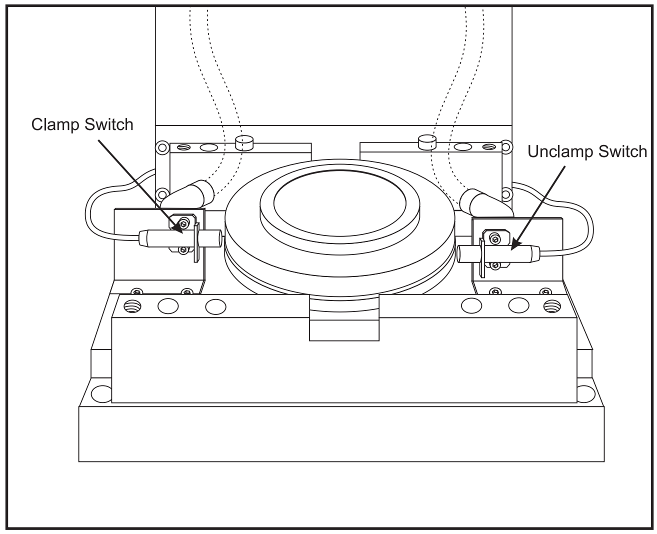
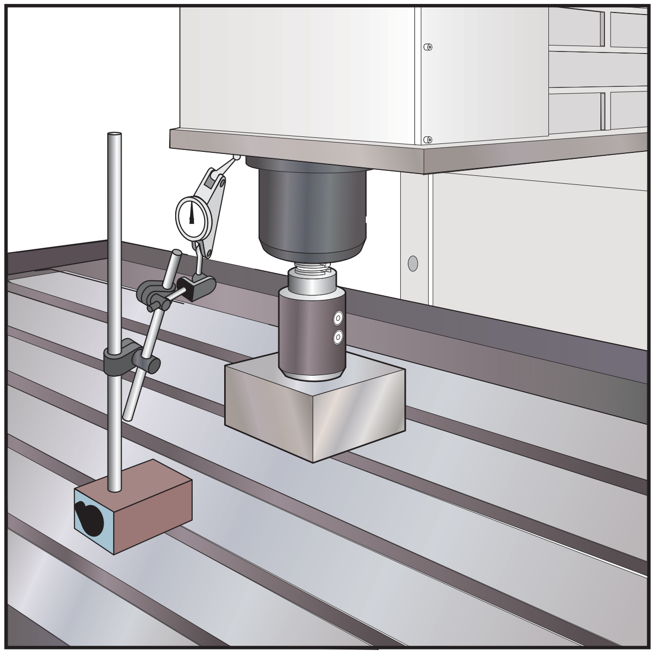


Figure 3.2-6b In-LIne Drive Tool Release Piston Assembly.

4. Change Parameter 76 "Low air Delay" to 45000 to eliminate a low air pressure alarm.

5. In order to limit the spindle head deflection during this next part of the procedure the air pressure will need to be reduced to lower the output force of the TRP. For the Mini-Mill and Toolroom Mill, lower the air pressure to 75psi. (be sure to back the regulator down past 75psi then adjust back up to 75psi) and proceed to the next step. For all other 40 taper mills, change parameter 76 "Low Air Delay" to 45,000 to eliminate a Low Air alarm. Reduce the air regulator to about 60 psi. Place a 0.0005" test indicator between the table and bottom, front face of spindle head to measure axial deflection when the tool release piston is energized. Press and hold the tool release button and check that the block is tight and the head deflection is between 0.002 and 0.004". If the head deflection is too high, reduce the air pressure. If the head deflection is too low, or no deflection, increase the air pressure. Once the head deflection is between .002" and 0.004" proceed to the next step.



6. Press the tool release button and hold it in. Adjust the switch in or out until the switch just trips (DB OPN =1). Cycle the tool release several times and confirm the switch is tripping.

7. Check the adjustment. Jog the Z-axis down until the tool is .050 above the block and confirm that DB OPN=0 when the tool release button is pressed. The switch must trip (DB OPN =1) at 0.06" above the block and not trip (DB OPN =0) at 0.05" above the block.

8. Re-adjust and repeat steps 1-6 if necessary.

9. Set the pressure regulator back to 85PSI.

10. Set parameter 76 back to the original setting.

UPPER (CLAMP) SWITCH -

1. If the machine is equipped with TSC, remove the seal housing before continuing. This step does not apply to In-line drives with TSC.

2. Remove the tool holder from the spindle.

3. Delete everything in MDI mode and write “#1120=1”.

4. Start with the upper switch all the way in. Place a 0.02” shim between the tool release piston adjustment bolt and the drawbar.

5. Push the PARAM/DGNOS button twice to enter the diagnostics mode.

6. Press CYCLE START.

7. If DB CLS=0 (tool Unclamp) you are done (do not check with 0.04” shim).
If not, adjust the upper switch out until the switch is just un-tripped (DB CLS=0).

8. Press RESET. Replace the 0.02” shim with a 0.04” shim. Press CYCLE START. See that DB CLS=1. Readjust and repeat steps 2-8 if necessary. This step is not necessary for In-Line Drive machines

Checking with the 0.04” shim assures that the switch is not backed off too far. If switch is all the way in, this check is not needed.

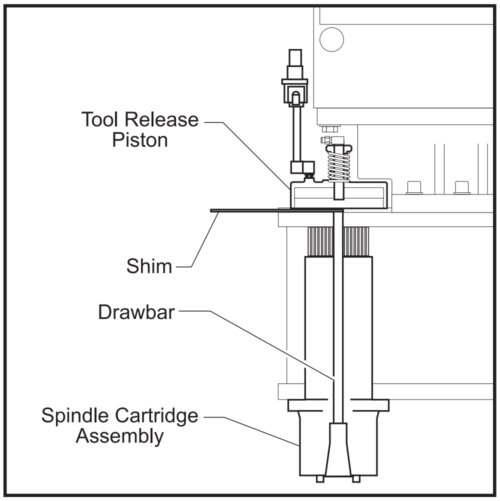


Figure 3.2-7 Placement of shim before checking switch adjustment.

50 Taper Spindle TRP Removal

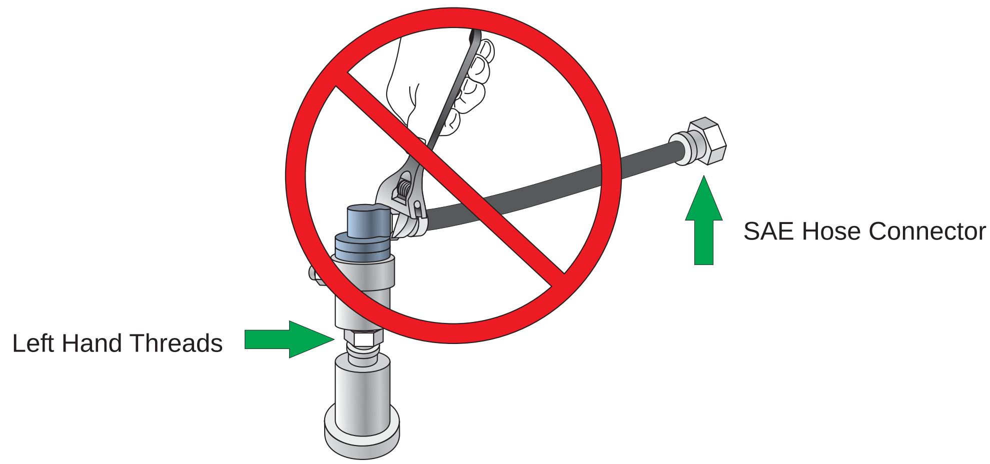
1. For TSC equipped machines, place a tool holder in the spindle.

2. Remove cover panels from the headstock area in accordance with "Head Covers Removal and Installation".

3. For TSC equipped machines the coolant union and extension tube must be removed before proceeding. **They both have left handed threads.**

CAUTION: Do not remove pipe connectors from the coolant union!! Removing any pipe connector from the union will void your warranty on the union.

Use wrenches only on the SAE hose connector and the bottom nut of the Coolant Union. See arrows below:



a. Loosen the SAE hose connector at the Check Valve Assembly with a wrench (right arrow in diagram). Do not use a wrench on the pipe connector attached to the Coolant Union; the Union will be damaged and the Warranty voided.

b. Carefully cut off the clear plastic Drain Hose at the side of the Coolant Union. It is safest to use scissors or snips. Cut it close to the connector, since the hose will be re-used on the replacement union. Do not cut the Black coolant hose. (Note: If you are not replacing the Union, leave the Drain Hose attached to the union.)

c.Remove the coolant union from the Extension Tube (bottom arrow in diagram) using two wrenches (7/8 and 15/16). THIS IS A LEFT HAND THREAD.

d.Return the Coolant Union with all pipe thread connectors and black coolant hose intact to Haas Automation for warranty. Removal of any of the pipe connectors from the union will void any claims for warranty.

4. Disconnect the air line at the lube/air panel.
5. Disconnect the clamp/unclamp cables (quick disconnect) and the assembly's solenoid wiring located on the solenoid bracket.
6. Remove the three tool release air hoses.
7. Remove the four shoulder screws holding the tool release piston assembly to the head casting. Make sure to keep all the washers and shims.
8. Remove entire tool release piston assembly, by sliding it forward then lifting it upward. The assembly is heavy so use great care when removing it.

TRP Disassembly

1. Loosen the shaft clamp and remove. It may be necessary to use a punch and mallet to break the clamp loose.
2. Remove the switch trip and compression spring.
3. Remove the 50T upper spacer.
4. Push the TRP shaft down.
5. Remove the 8 bolts holding the TRP assembly together.

6. Separate and remove the upper half of the housing.
7. Remove the upper TRP piston.
8. Remove the lower half of the TRP housing.
9. Remove the TRP lower spacer.
10. Remove the lower TRP 50T piston.
11. Remove the TRP sub plate.

O' Ring Replacement

1. Remove and replace the 4 O'rings (57-0027) on the TRP 50T shaft
2. Remove and replace the 2 O'rings (57-0092) on the TRP 50T piston, 1 O'ring per piston.
3. Remove and replace the 3 O'rings (57-0095). 2 in the center of the TRP 50T housings and 1 in the center of the TRP 50T sub plate.

TRP Assembly

1. Place the TRP sub plate over the TRP shaft.
2. Place the lower TRP piston, grooved side up, over the TRP shaft.
3. Place the TRP lower spacer over the TRP shaft.
4. Place the lower TRP housing over the TRP shaft.
5. Place the upper TRP piston, grooved side up, over the TRP shaft.
6. Place upper TRP housing over the TRP shaft.
7. Replace the 8 bolts holding the TRP assembly together. Pattern torque to 50 ft. lbs.
8. Place the TRP upper spacer over the TRP shaft.
9. Push the TRP shaft up from the bottom, using the mallet handle. The shaft will bottom out with approximately 1/4" of the shaft still showing.
10. Place the switch trip and compression spring over the TRP shaft.
11. Tighten the shaft clamp on the TRP shaft, then the shaft clamp locking bolt.

The following sections must be completed after installation:

- Tool Push-Out Adjustment
- Setting TRP Switches
- Extension Tube Installation (if equipped with TSC)

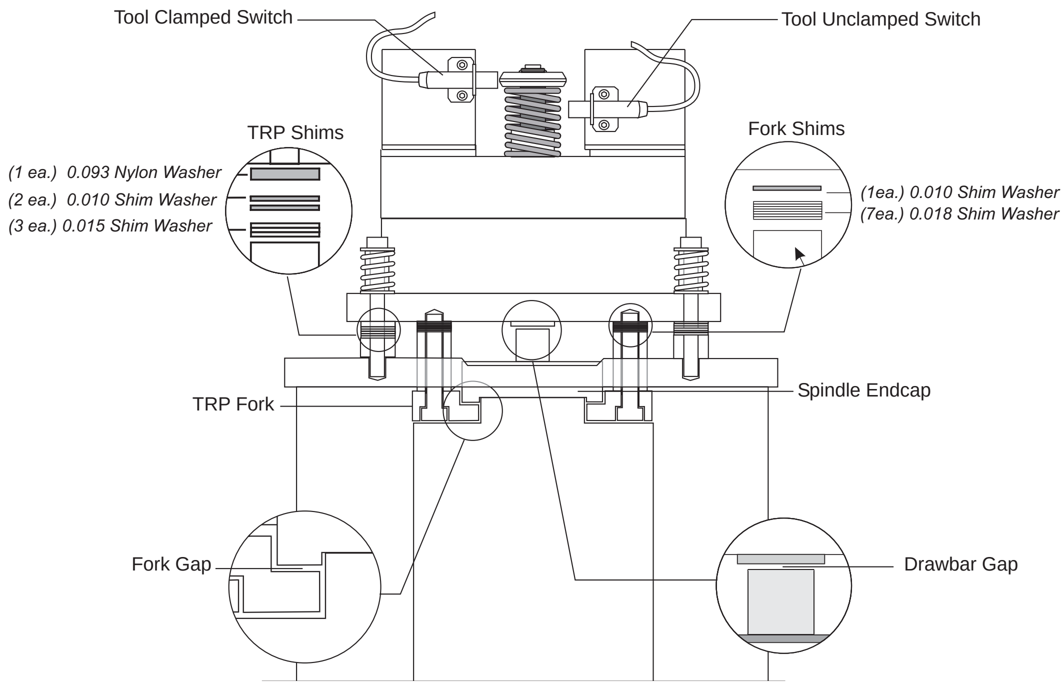


Figure 3-10. Shim and spacer location diagram.

1. Place the TRP on the machine. The TRP will rest on the spindle lift fork. **Caution:** Be careful of the spindle lift fork. Place the assembly toward the front of the machine before lowering it. The assembly is heavy so use great care when replacing it.

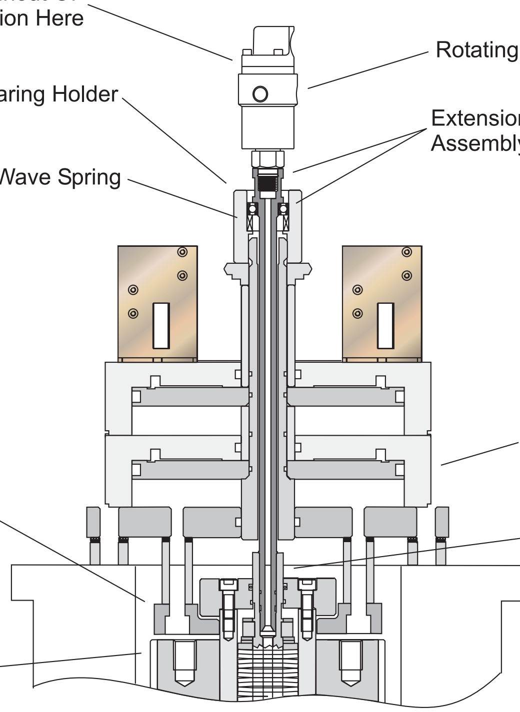
2. Install the 4 bolts, with the shim stock and spacers under the TRP.

	Part No.	Description	30-0013A (NEW)	30-0013 (OLD STYLE)
Fork:	(45-0014)	0.010 Shim Washer	1 ea.	None
	(45-0015)	0.018 Shim Washer	7 ea.	5 ea.
TRP Spacers:	(45-0019)	0.093 Nylon Washer	1 ea.	1 ea.
	(45-0017)	0.010 Shim Washer	2 ea.	2 ea.
	(45-0018)	0.015 Shim Washer	3 ea.	2 ea.

(**NOTE:** TRP Spacers: the nylon washer goes on top of the shims.)

3. If the machine is equipped with TSC, re-install the Extension Tube and Rotating Union in the following manner. Otherwise, skip this step.

NOTE: If the Spindle, Drawbar or Extension Tube has been replaced the Extension Tube Runout must be adjusted.



a) Place a Tool Holder in the Spindle.

b) Insert a 5/8 Allen wrench into the lower end of the piston shaft. Loosen the 1/4-20 screw in the clamp collar on top of the piston shaft. Insert a large flat blade screwdriver into the slot in the clamp collar, and twist the collar off.

c) Screw the Bearing Holder (20-7655) onto the piston shaft, and tighten using a large wrench or pliers.

d) Wipe clean the hole in the end of the Drawbar.

e) Replace the Tool Release Piston.

f) Apply a light layer of Molybdenum Grease to the inside of the Bearing Holder. Insert the Wave Spring (59-0176) into the Bearing Holder.

g) Lightly grease the O-Ring on the end of the Extension Tube Assy (30-1242). Apply blue Loctite to the thread on the end. Insert the Extension Tube down into the Drawbar. Tighten by hand as far as possible **(It has left hand threads).**

h) Block Spindle rotation with a bolt, bar or socket inserted into one of the Pulley holes. It will stop against the TRP Fork.

i) Tighten the Extension Tube to 15-20 ft-lbs. Remove the bolt from the Spindle Pulley.

j) Install the Rotating Union. Lightly grease the O-ring. DO NOT put Loctite on the threads.

i. Thread the Coolant Union onto the end of the Extension Tube (it has left hand threads). DO NOT USE LOCTITE. Tighten the threads snugly using two wrenches.

ii. Attach the clear plastic Drain Hose to the barb connector on the side of the union. Use a hose clamp if one is available. The hose must travel downward (below the union) to drain off collected coolant. The union will be damaged if coolant collects inside the union.

iii. Thread the black coolant hose onto the connector on the check valve assembly. Tighten with a wrench. Do not over-tighten!

k) Measure the runout at the top of the rotating union with a dial indicator. Record the measurement on the Service Report.

l) Check the Tool Clamp and Unclamp switches. They should not have moved.

m) Test run the TSC system to check for leaks before putting the head covers back on.

4. Plug the 3 air hoses in the TRP.

5. Plug in the clamp and unclamp switches.

6. Set the main air regulator to 85 psi.

NOTE: Tool Push Out Adjustment and Setting TRP Switches **must be** completed.

Tool Push Out Adjustment

1. Put tool holder in spindle.

2. Plug the spindle taper air blast.

3. Place machined aluminum block onto machine table. Place a clean sheet of paper under the block to protect the table.

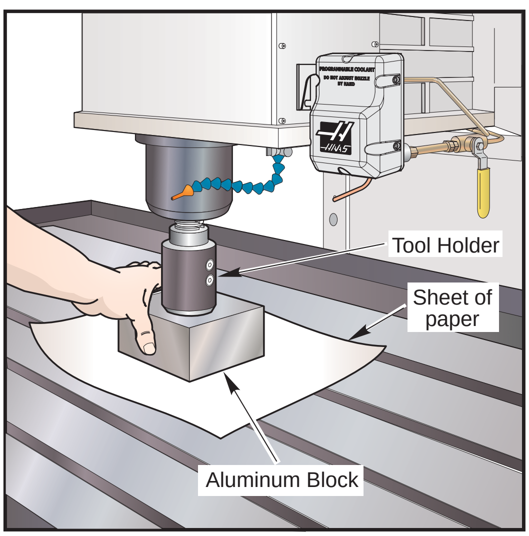


Figure 3.2-9 Pushout Adjustment.

4. Jog the Z-axis down until the tool holder is about .030” above the aluminum block. Switch the jog increments to .001” and jog the Z-axis down one increment at a time until the tool holder just presses the block firmly against the table surface. This is the zero point.

5. Plug the spindle taper air blast.

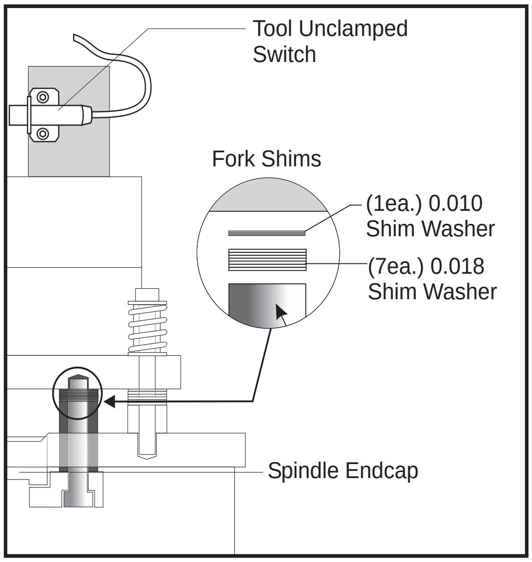


Figure 3.2-10 Fork shim location.

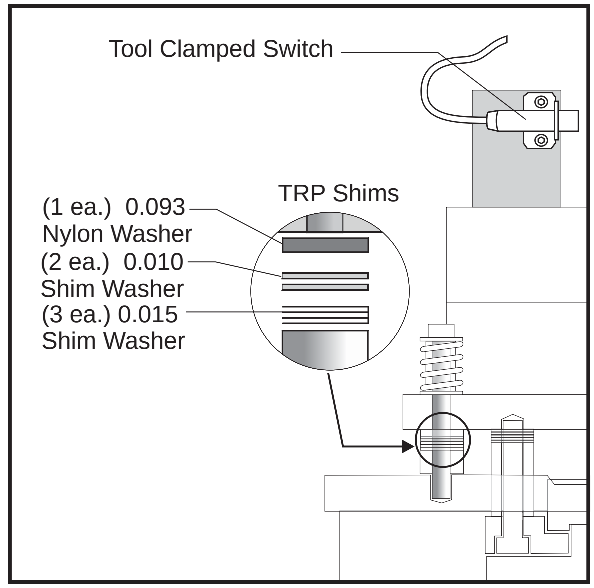


Figure 3.2-11 TRP shim location

6. The Tool Push-out adjustment is 0.060 +/-0.010. Add or remove shims from the tool release fork to make adjustments. The shims come in 0.010 and 0.018 thicknesses.
   Jog upward 0.060. Press and hold the tool release button, and feel for movement in the aluminum block.
   - If the block is tight when the button is pressed, shims may have to be ADDED to the tool release fork.
   - If the block is loose when the button is pressed, shims may have to be REMOVED from the tool release fork.
   (This is the opposite of 40 taper adjustment.)
   - If the aluminum block is tight at 0.060, release the button and jog the Z-Axis up 0.001 and press the tool release button again. Feel for movement in the aluminum block. Repeat this until movement is felt. Note the last position where the block was tight. If the position is 0.070 or more, add shims to the tool release fork.
   - If the aluminum block is loose at 0.060, jog the Z-Axis downward 0.001 at a time and check for movement in the aluminum block. If the position where the block becomes tight is 0.050 or less, remove shims from the tool release fork.

7. If shims were added to the TRP fork, add half that amount to the TRP spacers supporting the TRP. This will keep the two clearance gaps between the TRP and the rotating Spindle equal (approximately 0.095 each). If shims were removed from the TRP fork, remove half that number of shims from the TRP spacers.

8. Apply red grease to the shoulder bolts used to mount the TRP when the shim adjustments are complete. Use blue Loctite on the threads.

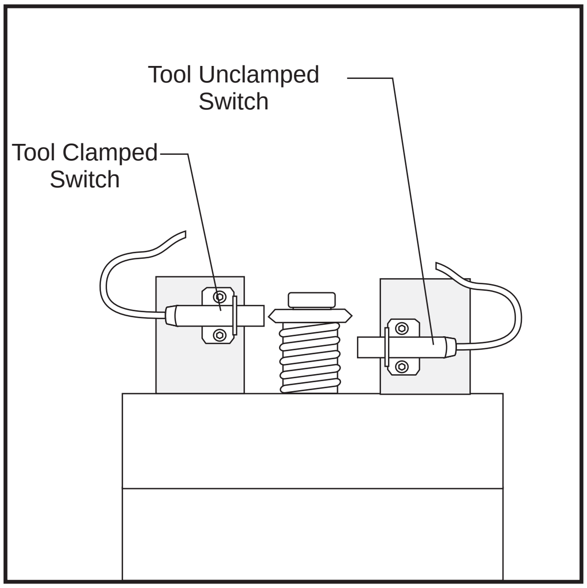


Figure 3.2-12 Tool Clamp / Unclamp Switches.

1. Setting the upper switch (Tool Clamped). Push the switch in slowly until it trips, then push it a little farther. Lock down the screws. Double-Check the switch by turning on the TRP a few times. The bit in the Diagnostics Page should always turn on (1) when the TRP is completely retracted.

2. Setting the lower switch (Tool Unclamped). Use the air pressure regulator on the back of the machine or an extra regulator placed in line.
   a) Jog the Z-Axis to 0.030 above the aluminum block.
   b) Put a jumper across the air switch to prevent a low pressure alarm.
   c) Back off the air pressure to around 65 psi (75 psi for old style TRP's).
   d) Press the tool release and check for movement in the aluminum block. Adjust the air pressure until the block is loose at 0.030 +/-0.005.
   e) While holding the Tool Release Button push the switch in until it just trips (the bit on the Diagnostics Page should change to "1"). Lock down the screws. Double-check the switch by turning the TRP on and off a few times.
   f) Back off the air pressure until the block is loose at 0.020 +/-0.005. Press the tool release button, the Tool Unclamped bit in Diagnostics should remain "0". If not, repeat the above steps.

3. Restore air pressure to 85 psi and remove jumper.

3.3 Belt Assembly

Please read this section in its entirety before attempting to replace the drive belt.

Belt Removal

NOTE: For easier removal, place transmission in high gear before beginning.

1. Remove cover panels from headstock area in accordance with "Head Covers Removal and Installation".

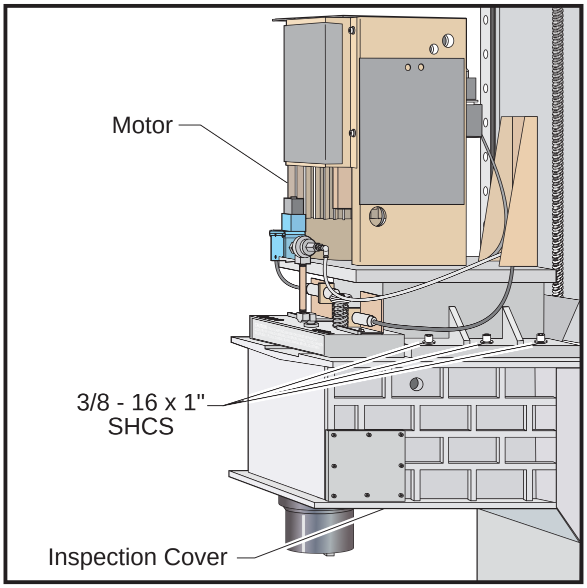


Figure 3.3-1 Spindle head casting disconnect points.

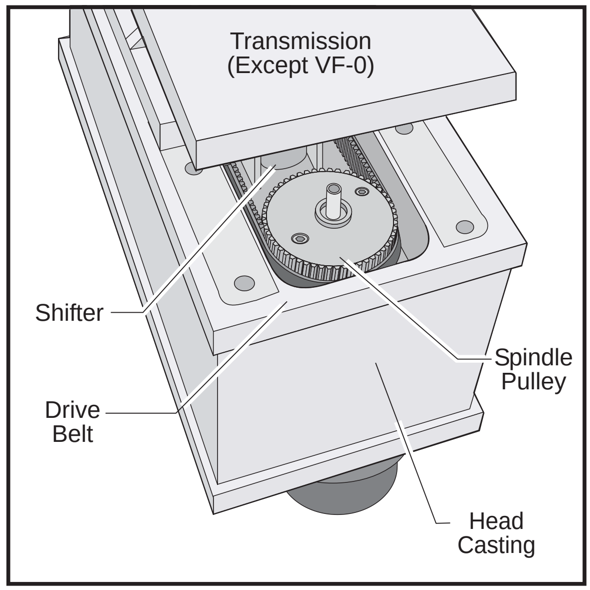


Figure 3.3-2 Head casting area showing belt location.

2. Remove tool release piston assembly in accordance with "Tool Release Piston Assembly Removal".

3. Remove the six SHCS holding the transmission to the head casting and pull the transmission forward enough (½" to ¾" max.) to allow the drive belt to be pulled upward over the spindle pulley.

Note: On direct drive machines, remove the four SHCS holding the mounting plate to the spindle head casting. Slide the assembly forward enough to allow the drive belt to be pulled up over the spindle pulley.

4. Remove the inspection cover from the bottom of the spindle head casting and carefully slide the drive belt between the sump tank and the web in the casting.

5. First, pull the belt up over the spindle pulley, then push the other end down to clear the shifter and pull out.

NOTE: DO NOT bend or kink the belt in any way; damage to the fibers in the belt may result, and the belt will fail soon after installation.

Belt Installation

1. Slide the replacement belt(s) under the sump tank and onto the pulley.

NOTE: DO NOT wrap the belts over the pulley. The pulley can be rather sharp, and may cut the belts. DO NOT bend or kink the belt in any way; damage to the fibers in the belt may result, and the belt will fail soon after installation.

2. Ensuring the belt is properly seated, push the transmission back, tightening the belt. Pull belt forward from rear of head casting. Pull belt over spindle pulley.
3. Tighten the drive belt in accordance with the following section.
4. Set the spindle orientation in accordance with appropriate section.

NOTE: The following step is necessary only if the spindle or transmission was exchanged prior to belt replacement.

5. Double-check the spindle sweep to assure that nothing has moved during the previous steps. If sweep is within tolerance, continue; if not, sweep must be readjusted.

NOTE: Drive belt tension must be adjusted after every installation.

Tension Adjustment

NOTE: The drive belt tension should be adjusted after every service on the transmission or spindle of the machine.

1. Turn the machine ON. Jog the spindle head down to a level that will allow you to work on the drive belt comfortably.
2. Remove the cover panels from the head stock area as shown in "Head Covers Removal" section.
3. Remove the tool release piston assembly in accordance with appropriate section.

FOR THE VF-1 THROUGH 9

4. Loosen the six SHCS holding the transmission to the spindle head casting.

NOTE: Ensure the transmission is broken free by moving it slightly by hand.

5. Set the belt tension tool in place as shown in Figure 3.3-3. Mount it to the head casting by inserting the two SHCS into the two front TRP mounting holes. Tighten the SHCS finger tight.
6. Turn the handle until the tool is flat against the transmission casting.

NOTE: Ensure the transmission is straight, and not cocked, before tensioning belt.

7. Turn the handle until the edge of the tool's plunger and the outer tube are flush. This will set the belt at the proper tension.

NOTE: A belt that is correctly tensioned will whine slightly, and requires approximately 12 hours of break-in time.

8. Check if the belt is too loose or too tight. If the belt is set too tight, the belt will whine excessively when the assembly is at speed; and if it is set too loose, it will vibrate during accelerations and decelerations.

9. With the tool still in place, tighten the six SHCS holding the transmission to the spindle head casting.

10. Loosen the two SHCS and remove the belt tension tool.

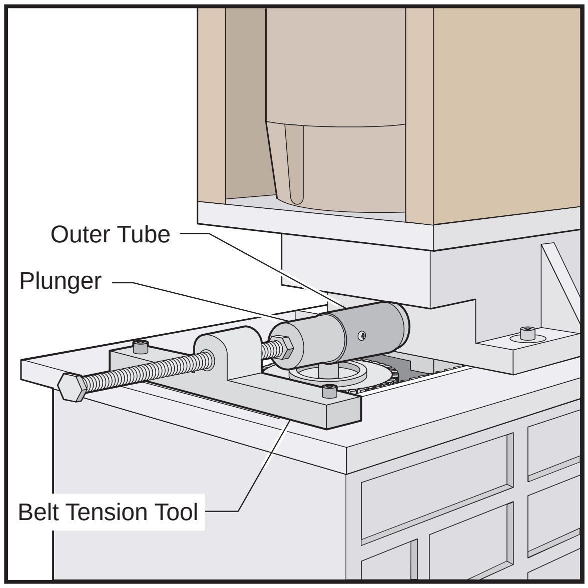


Figure 3.3-3 Belt tension tool.

FOR DIRECT DRIVE MACHINES:

1. Loosen the four SHCS holding the motor mounting plate to the head casting.

NOTE: Ensure the motor is broken free by moving it slightly by hand.

2. Set the belt tension tool in place as shown in Figure 3.3-3. Mount it to the head casting by inserting the two SHCS into the two front TRP mounting holes. Tighten the SHCS finger tight.

3. Turn the handle until the tool is flat against the motor mounting plate.

NOTE: Ensure the motor is straight, and not cocked, before tensioning belt.

4. Turn the handle until the edge of the tool's plunger and the outer tube are flush, and then 1/2 turn more. This will set the belt at the proper tension.

NOTE: A belt that is correctly tensioned will whine slightly, and requires approximately 12 hours of break-in time.

5. Check if the belt is too loose or too tight. If the belt is set too tight, the belt will whine excessively when the assembly is at speed; and if it is set too loose, it will vibrate during accelerations and decelerations.

6. With the tool still in place, tighten the four SHCS holding the mounting plate to the head casting.

7. Loosen the two SHCS and remove the belt tension tool.

30K SPINDLE

There are two types of belts (3 rib and 4 rib) used on the 30K Spindle Drive. To ensure maximum performance, the Spindle Drive belt should be checked for proper tension every 1000 hours of operation or 6 months. The tension is measured using a Gates Sonic Tension Meter, model number 505C or 507C. The table below displays the proper lbf./Hz tension readings.

Belt	New Belt		Used Belt	
Number of Ribs	Minimum	Maximum	Minimum	Maximum
3 Rib	53.7 lbf 174Hz	57.6 lbf 180 Hz	46.2 lbf 161 Hz	50.1 lbf 167 Hz
4 Rib	60.8 lbf 159Hz	64.8 lbf 165 Hz	52.0 lbf 148 Hz	56.4lbf 154 Hz

Note: Specific settings must be entered into the tension meter to obtain a correct tension reading, these are listed below. The Gates Sonic Tension Meter is capable of retaining 10 to 20 separate combinations of settings depending upon model. Be sure that you are on the correct belt drive storage register before taking a reading.

Setting for 3 rib belt: Weight 13.1, Width 3, Span 225
Setting for 4 rib belt: Weight 13.1, Width 4, Span 225

3.4 Spindle Assembly

Please read this section in its entirety before attempting to replace spindle.

WARNING!

The current pulley is shrink-fitted onto the spindle and is not field-serviceable. It is identified by many holes on top of the spindle pulley. Should any attempt to remove the pulley damage the spindle or its components, the service warranty will be voided.

NOTE: The drive belt's tension should be adjusted after every transmission or spindle service.

Spindle Cartridge Removal

NOTE: VMCs equipped with a 15K Spindle must remove the spindle and drawbar as a unit. Do not remove the drawbar separately.

1. Ensure the VMC is ON. You will need to raise and lower the head stock to remove the spindle. Place the cardboard on the mill table to protect the surface.

2. Put the tool into the spindle.

3. Remove cover panels from head stock area as described in "Head Covers Removal" section.

4. Remove the tool release piston assembly in accordance with appropriate section.

5. Remove the spindle drive belt from the spindle pulley as shown in previous section. It is not possible to completely remove the belt at this time.

6. Drawbars are held in the spindle shaft by a spiral ring (newer assemblies). Remove the spiral ring with a small screwdriver. Wedge the tip of the screwdriver to take out one end of the ring from the shaft groove. Force the ring end to stay open and simultaneously rotate the screwdriver all the way around so the entire ring comes out of the groove.

7. Put the tool release piston on and remove the tool.

8. First disconnect the oil line from the fitting at the oil injection cover, then remove the brass fitting.

NOTE: When replacing a new design spindle in any vertical machine, it is important to note that the cavity between the housing and the spindle cartridge will be filled with either oil or grease. An oil filled spindle is identified by the oil fill hole to the left side of the spindle head near the spindle bore as viewed from the top.

9. Ensure oil plug is inserted into oil injection port of spindle before removing spindle or oil may spill into the spindle cartridge.

10. With the 5/16" hex wrench, loosen approximately two turns the six SHCS holding the spindle to the underside of the head casting.

11. Place the block of wood (minimum 6" thick) on the table directly under the spindle.

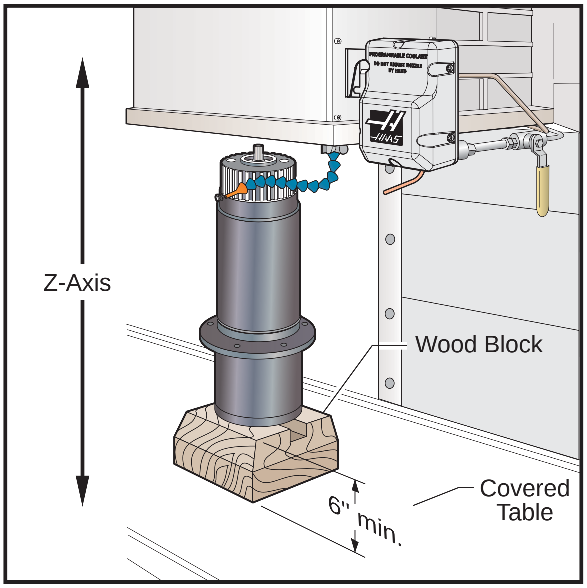


Figure 3.4-1. Position wood block under spindle.

12. At the panel, go to the JOG mode and choose Z-axis. Slowly jog in the negative (-) direction until the spindle rests on the block, then remove the screws that were previously loosened (step 7).

13. Jog Z-axis in the positive (+) direction until spindle is half way out of the head casting.

14. Grasp spindle with one hand and continue to jog in Z in the positive (+) direction until it is completely free of the casting.

Spindle Cartridge Installation

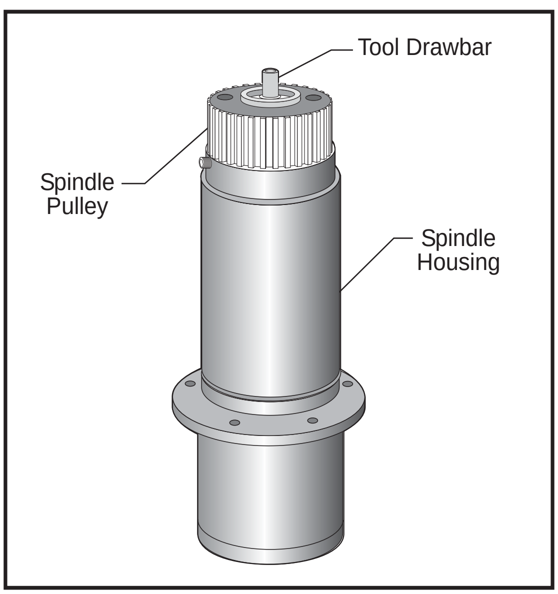


Figure 3.4-2. Spindle cartridge.

1. Thoroughly clean all mating surfaces of both the cartridge and the head casting, lightly stone if necessary to remove burrs or high spots.

2. Place spindle on wood block making sure both spindle dogs contact the block. Align the two 10-32 holes located on the spindle lock so they are approximately 90 degrees from the front of the spindle on the right side.

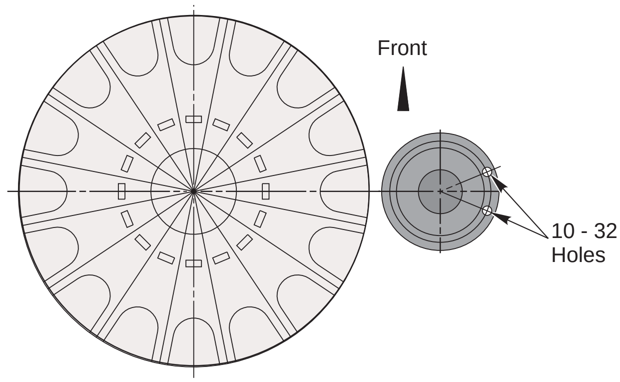


Figure 3.4-3 Underside view of spindle cartridge.

3. Slowly jog the Z-axis in the negative (-) direction until the top portion of spindle is inside of head casting. At this point, align spindle to spindle bore. While performing this operation, you must make sure the spindle cartridge is straight to the spindle bore.

4. If the spindle moves to one side, use a rubber mallet and/or jog in the X or Y directions to straighten it. The spindle must go in easy. If it does not, check your alignment. **Do not force it!**

5. Install and torque the six SHCS.

6. Reattach the brass fitting to the oil injection cover and connect the oil line to the fitting.

CAUTION! Do not overtighten the fittings when replacing on the oil injection cover. Overtightening may result in damage to the spindle cartridge.

NOTE: If replacing copper tubing to spindle, thoroughly clean out with filtered air.

7. Fill the cavity between the housing and the spindle cartridge with Mobil Vactra 2 oil. The oil fill hole is to the left side of the spindle head near the spindle bore, as viewed from the top.

WARNING!

Never pour oil into the spindle housing.

8. Reinstall the drive belt and adjust the tension as needed.

9. Reinstall the tool release piston assembly.

10. Remove the tool release piston. Carefully install the spiral ring on the spindle shaft. Feed one end of the spiral ring into the shaft groove. Rotate the ring until the entire ring is in the groove.

11. Check the spindle sweep, as described later in this section. Check the clamp/unclamp switch adjustment.

12 Check for the correct amount of lubrication to the spindle bearings (0.5-1.0 cc every two hours) in an air mist-lubricated spindle.
•If the spindle is not getting lubrication, correct the problem per the lube and air diagram at the back of this manual and replace the spindle ("Spindle Assembly" section).
•If the spindle is getting lubrication, replace the spindle ("Spindle Assembly" section).

NOTE: Refer to the appropriate sections and check the spindle orientation and ATC alignment.

30K Spindle Cartridge Removal

1. Ensure the VMC is ON. You will need to raise and lower the head stock to remove the spindle. Place the cardboard on the mill table to protect the surface.

2. Remove cover panels from head stock area as described in “Head Covers Removal” section of the VF service manual.

3. Remove the tool release piston assembly in accordance with the instructions in the Service manual. **Note:** The drawbar is not serviceable.

4. Remove the spindle drive belt from the spindle pulley.

5. Disconnect the oil lines from the fittings at the oil injection cover, then both quick disconnect fittings.

6. Ensure the oil plugs are inserted into oil injection ports of spindle before removing spindle or oil may spill into the spindle cartridge.

7. With the 5/16" hex wrench, loosen approximately two turns the six SHCS holding the spindle to the underside of the head casting.

8. Place the block of wood (minimum 6" thick) on the table directly under the spindle.

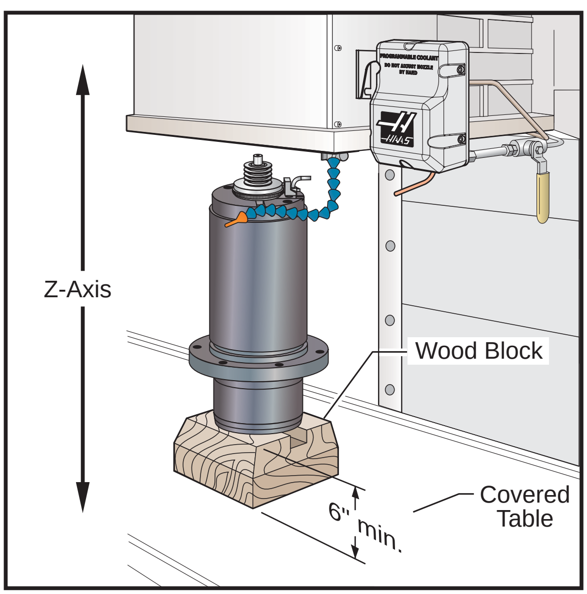


Figure 3.4-1. Position wood block under spindle.

9. At the panel, go to the JOG mode and choose Z-axis. Slowly jog in the negative (-) direction until the spindle rests on the block, then remove the screws that were previously loosened (step 10). Try to protect the spindle from oil. If necessary wrap a shop rag around the top of the spindle to stop oil from going inside the spindle.

10. Jog Z-axis in the positive (+) direction until spindle is half way out of the head casting.

11. Grasp spindle with one hand and continue to jog in Z in the positive (+) direction until it is completely free of the casting.

Spindle Cartridge Installation

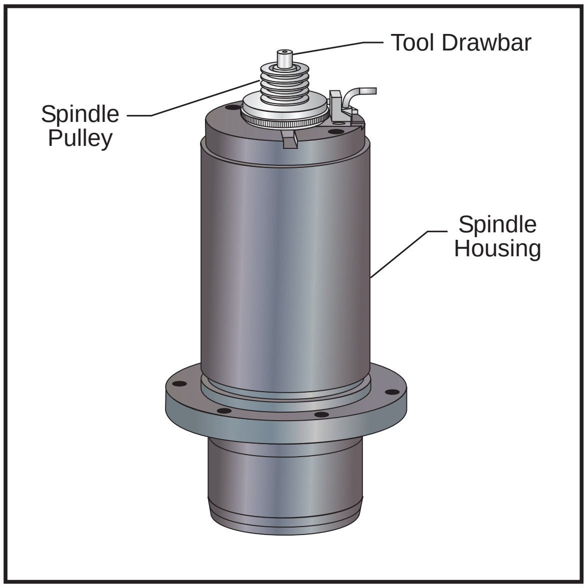


Figure 3.4-2. Spindle cartridge.

1. Thoroughly clean all mating surfaces of both the cartridge and the head casting, lightly stone if necessary to remove burrs or high spots.

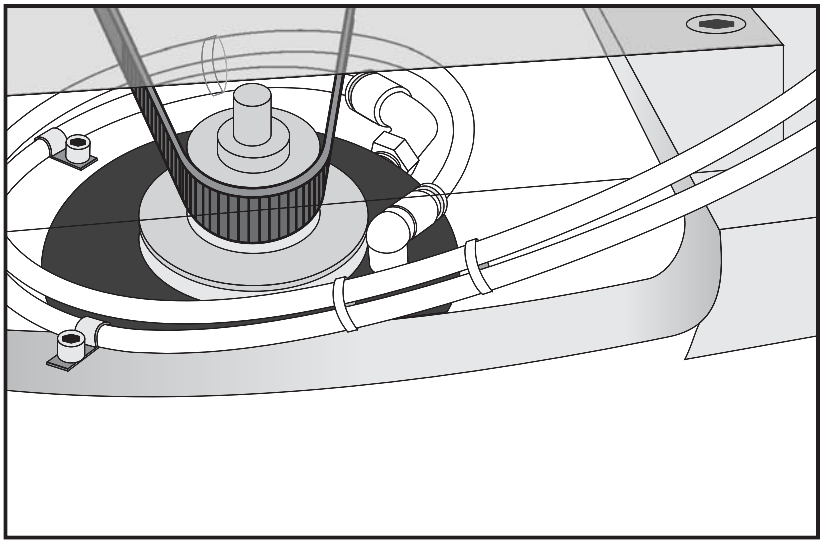
2. Place spindle on wood block.

3. Slowly jog the Z-axis in the negative (-) direction until the top portion of spindle is inside of head casting. At this point, align spindle to spindle bore. While performing this operation, you must make sure the spindle cartridge is straight to the spindle bore.

4. If the spindle moves to one side, use a rubber mallet and/or jog in the X or Y directions to straighten it. The spindle must go in easily. If it does not, check your alignment. Do not force it! Damage to the spindle bearings will occur.

5. Install and torque the six SHCS.

6. Reattach the quick disconnect fittings to the oil injection cover and connect the air/oil lines to the fittings.



CAUTION! Do not overtighten the fittings when replacing on the oil injection cover. Overtightening may result in damage to the spindle cartridge.

7. Fill the cavity between the housing and the spindle cartridge with oil. The oil fill hole is to the left side of the spindle head near the spindle bore, as viewed from the top.

WARNING!

Never pour oil into the spindle housing.

8. Reinstall the drive belt, use the top three grooves of the motor pulley. Adjust the tension as needed. Check the tension by running the spindle through the spindle RPM range and check for belt whipping. If belt whips while at speed, readjust the tension.

9. Reinstall the tool release piston assembly.

10. Check the spindle sweep, as described in the Service manual. Check the clamp/unclamp switch adjustment.

NOTE: Refer to the appropriate sections and check ATC alignment.

Setting the Draw Bar Height

Power on the mill

Set the TRP air pressure regulator to 40psi.

Place a sheet of paper on the mill table under the spindle for protection and then place an aluminum block (approx. 4”x4”x4”) on the paper.

Insert an empty tool holder in to the spindle.

Jog the spindle down so that the tool holder is approximately .03” above the block.

Set the clearance from the block to the tool holder to zero. Do this by pressing “Tool Release” and jogging the Z-axis down with the jog speed set to .001.

Move the axis then press “Tool Release” while feeling for movement on the tool holder. Feel between the tool holder and the spindle. Repeat this process until no movement is felt.

Change the jog speed to .01 and jog the Z-axis to .060 above the block.

Press and hold the “Tool Release” button. Try to move the block. The block should be tight at .050 and loose at .060. If the block can be moved at .050, jog the Z-axis down one increment at a time until the block is tight. If the block is tight at .060, jog the Z-axis up one increment at a time until the block is loose.

The number of increments jogged up or down are the number of shims to add or remove. If the block was tight at .060, remove shim washers. If the block was loose at .050, add shim washers.

Lower TRP Unclamp Switch

With an empty tool holder in the spindle, and the jog speed set to .001”, jog the Z-axis down until the aluminum block is pinched against the table. Jog back up .030”.

The bolts that hold the lower switch should be loose so that the switch can slide in and out for proper adjustment.

Go to the Discrete Inputs page on the control and find “Draw Bar Open”.

Press and hold the “Tool Release” button. Slide the switch towards the piston until the switch trips, This is verified on the control and “Draw Bar Open” should read “1”. Tighten the screws that secure the switch.

Release the “Tool Release Button” and verify that the switch trips (Draw Bar Open =1) at .030 above the block and not tripped (Draw Bar Open=0) at .020 above the block.

Upper Clamp Switch

Push the switch in slowly until it trips (Draw Bar Closed=1). Tighten the bolts to secure the switch.

Final Checks

TRP Air Pressure
Set TPR air pressure regulator to 50 psi.

Perform the Spindle Run-in Program
Run program O02023. As the spindle is running check for proper oil flow. Periodically check the temperature of the spindle. Stop the program if the spindle begins to overheat.

Caution: Never run the spindle without a tool holder in the spindle. Running the spindle without a tool holder will damage the spindle.

Belt Tension

The belt may whip during acceleration and deceleration but should not when a constant speed has been reached. Check the behavior of the belt at different speeds, throughout the RPM range. If the belt whips while at a constant RPM adjust the belt tension.

Drawbar Replacement - 40 Taper

REMOVAL -

NOTE: VMCs equipped with a 15K Spindle must remove the spindle and drawbar as a unit. Do not remove the drawbar separately.

1. Place a tool holder with no cutter in the spindle.
2. Remove head cover panels as shown in "Head Covers Removal'.
3. Remove the tool release piston in accordance with appropriate section.
4. Remove the snap ring from the top of the spindle shaft.
5. Reinstall the tool release piston.
6. Remove the tool holder from the spindle.
7. Remove bolts from the transmission and use 2”x4” blocks of wood, placed underneath the front of the housing, to keep it from falling forward.
8. Angle the transmission back and remove the drawbar from the spindle.

NOTE: Direct drive machines do not require movement of the drive assembly to access/remove the drawbar.

INSTALLATION -

9. Thoroughly coat the replacement drawbar with grease, including the end of the shaft where the four holding balls are located.

CAUTION! Excess grease may cause the drawbar to hydraulic lock preventing the full stroke of the drawbar.

10. If machine is equipped with Through the Spindle Coolant option, grease the O-rings.
11. Insert four new balls in the replacement drawbar and insert into the spindle shaft. Be sure that as the shaft is installed, the balls do not fall out of the bores in the drawbar.

CAUTION! Insert the drawbar gently so the O-rings are not damaged. DO NOT use a hammer to force it.

NOTE: Carefully inspect the spindle shaft for galling or burrs inside the spindle shaft where the end of the drawbar rides. If it is damaged, the spindle must be replaced.

12. The tool release piston will have to be reinstalled at this time.
13. Install a tool holder with no cutter into the spindle taper.
14. Remove the tool release piston.

15. Install the spiral ring on the spindle shaft.
16. Reinstall the tool release piston.
17. Set the drawbar height, and clamp and unclamp switches as described in the following section.
18. Reinstall the head covers.
19. Test-run the machine and perform the necessary ATC adjustments in the "Automatic Tool Changer" section.

Drawbar Replacement - In-Line Drive

The drawbar is only replaceable on the 8K spindle. The 12K spindle has a non-serviceable drawbar.

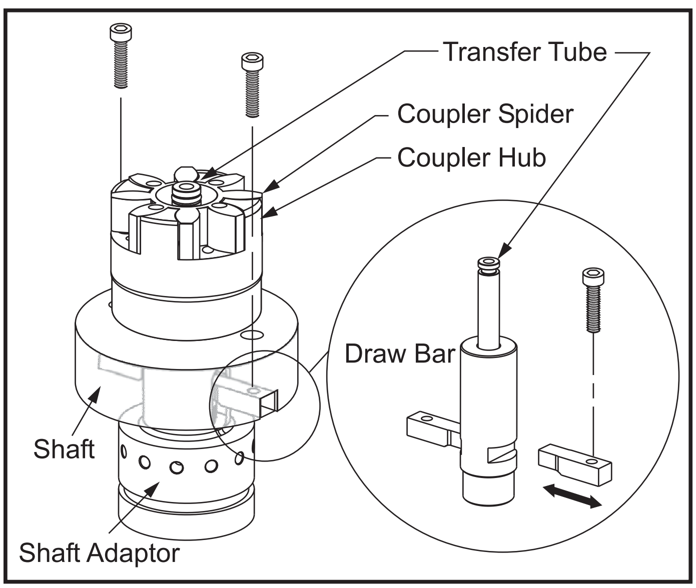
Note: Should a spindle fail, both the spindle and drawbar are to be replaced as a unit. If the drawbar fails, it is not necessary to replace the spindle.

Removal

Remove motor. Unbolt the TRP and remove the assembly. Remove the keys from the drawbar, and remove the drawbar from the spindle.

Installation

Clean and grease guide release and shaft. Install the drawbar unit. Install the two keys, flat side up. Use a “C” clamp to press the keys together to seat them against the drawbar. Torque the 5/16-18 retaining bolts to 30 ft-lb.



Verify the operation of the spindle by running it. If there is excessive vibration, loosen the bolts to the spindle cartridge and spindle head. Run the spindle at 1000 rpm and snug the bolts. Stop the spindle and tighten the bolts.

DRAWBAR REPLACEMENT - 50 TAPER

1. Remove the head covers. Refer to the "Head Covers Removal / Installation" section.
2. Remove the tool release piston. Refer to the "50 Taper Spindle TRP Removal" section.
3. Remove the TSC extension tube if the machine is equipped with Through the Spindle Coolant option. Refer to the TSC section.
4. Remove the six bolts holding the spindle cap to the machine.
5. Remove the drawbar.
6. Thoroughly coat the replacement drawbar with grease, including the end of the shaft where the four holding balls are located.

CAUTION! Excess grease may cause the drawbar to hydraulic lock preventing the full stroke of the drawbar.

7. If machine is equipped with Through the Spindle Coolant option, grease the O-rings.
8. Insert six new balls in the replacement drawbar and insert into the spindle shaft. Be sure that as the shaft is installed, the balls do not fall out of the bores in the drawbar.

CAUTION! Insert the drawbar gently so the O-rings are not damaged. DO NOT use a hammer to force it.

NOTE: Carefully inspect the spindle shaft for galling or burrs inside the spindle shaft where the end of the drawbar rides. If it is damaged, the spindle must be replaced.

9. Install the drawbar.
10. Reinstall the tool release piston.

SPINDLE SWEEP ADJUSTMENT

NOTE: The machine must be properly leveled for the spindle sweep adjustment to be accurate.

1. To check spindle sweep, place a .0005 indicator on a suitable holder, place on spindle nose and jog the Z-axis in the negative (-) direction enough so that you can adjust the indicator to sweep a 5" radius from the center of X and Y axes' travels. Slowly jog Z-axis in the negative (-) direction to zero out indicator.
2. Establish reference zero at rear of the table. Sweep the three remaining points (left, front, and right) and record the reading.

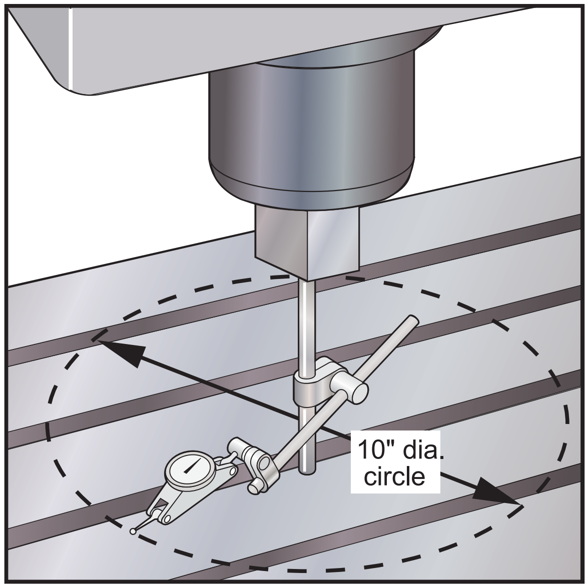


Figure 3.4-4 Spindle sweep area

3. Shim the spindle if necessary to correct the spindle sweep to specifications.

4. Recheck sweep. It must be within .0005 in both X/Z and Y/Z planes, as stated in the inspection report supplied with the VMC.

5. Replace the Tool Release Piston Assembly in accordance with the "Tool Release Piston Assembly Installation" and "Setting Pre-Charge" sections.

3.5 Spindle Orientation

Please read this section in its entirety before attempting to orient the spindle.

Orientation of the spindle is automatically performed for tool changes and can be programmed with M19.

1. Place the machine in low gear.

2. Adjust Parameter 257, "SPINDL ORIENT OFSET", until the spindle dogs are parallel to the X-axis. Ensure that the dogs are within 0.030" using a dial indicator.

   For 50 taper mills with an offset tool changer, add 5 degrees of offset (111 encoder steps) to Parameter 257 to match the tool changer arm offset.

3.6 Setting Parameter 64 (Tool Change Offset)

Please read this section in its entirety before attempting to set Parameter 64.

NOTE: Setting 7 must be "unlocked" before setting Parameter 64.

1. WITHOUT a tool in the spindle taper, initiate a tool change and stop the tool changer using the EMERGENCY STOP button (when the Z-axis moves above the carousel, but before the carousel rotates). Insert a tool holder into the pocket facing the spindle.

2. Using a .0005 indicator and suitable 18" mag base, zero off of bottom left edge “A” of tool holder (looking directly into pocket). Move indicator to bottom right edge “B” of tool holder. Any difference between these edges should be equally divided. For example: if a difference of .002 from left side to right side edge, adjust indicator dial so that indicator reads .001 when it is on either edge. This gives you the tool offset reference.

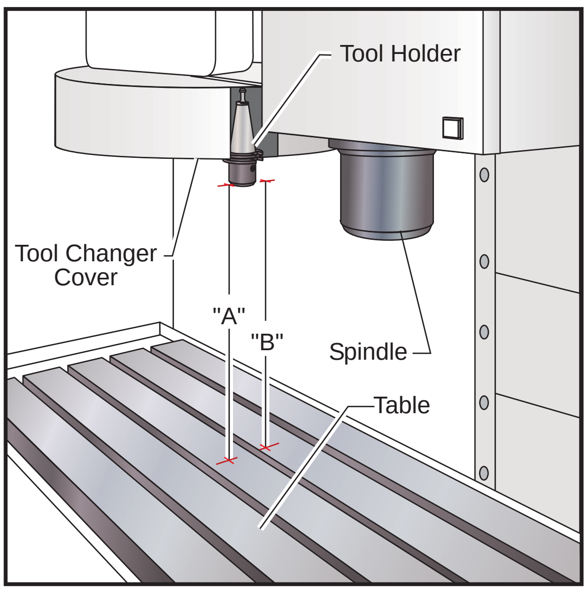


Figure 3.6-1 Checking tool offset reference.

3. Carefully (so as not to disturb relative position) move the indicator to one side. Remove tool from the tool changer and place it in the spindle.

4. Press Z SIGL AXIS to zero return the Z-axis only.

5. Carefully (so as not to disturb relative position) place indicator under spindle and indicate on bottom left edge of the tool holder.

If spindle head is too far in the negative (-) or the positive (+) direction, go to JOG mode and choose Z-axis. Jog Z-axis in the necessary direction until it reads zero (0).

6. Push the help button twice. This will put the machine in the calculator mode.

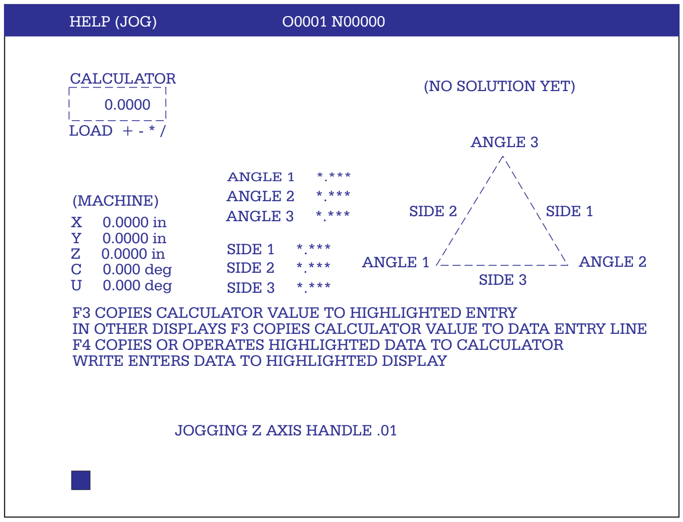


Figure 3.6-2 Screen showing calculator.

7. Take the number in the Z-axis machine display (center left of page) and multiply it by Parameter 33, which is Z RATIO (STEPS/UNIT).

If Z-axis work display is negative (-), add the number to the number that you calculated to Parameter 64. If the number is positive (+), subtract it from Parameter 64.

8. To insert the calculated new number, place the cursor at Parameter 64, type in new number and push WRITE key. ZERO RET Z-axis to initialize the new Parameter 64.

9. Recheck the offset with the indicator (Steps 1-5).

10. Insert tool holder in spindle taper and initiate a tool change.

When the Parameter 64 is changed, the tool offsets must be reset.

3.7 Spindle Motor & Transmission

Please read this section in its entirety before attempting to remove or replace transmission.

NOTE: The drive belt tension should be adjusted after every service on the transmission or spindle.

Motor Removal

1. Ensure the VMC is ON. You will need to raise and lower the head stock to remove the transmission. At this time, raise the Z-axis to the full up position.
2. Remove the cover panels from head stock area ("Head Stock Removal" section).
3. Remove the tool release piston assembly ("Tool Release Piston Assembly" section).
4. Press the POWER OFF button on the control panel and turn the main breaker off. If there is an external breaker box, turn it off and lock it out.
5. Disconnect the air supply from the back panel of the machine.
6. Disconnect all of the electrical and pneumatic lines from the solenoid bracket on top of the spindle motor assembly. Mark any connections that have not been previously labeled for reassembly.
7. Remove the two SHCS holding the cable carrier to the solenoid bracket and position the cable carrier so as to not interfere with removal of the motor. It may be necessary to tie the cable carrier back to the Z-axis motor to keep it in place.
8. If machine is equipped with Through the Spindle Coolant option, remove the pressure regulator and bracket from the old transmission and install them on the new transmission.

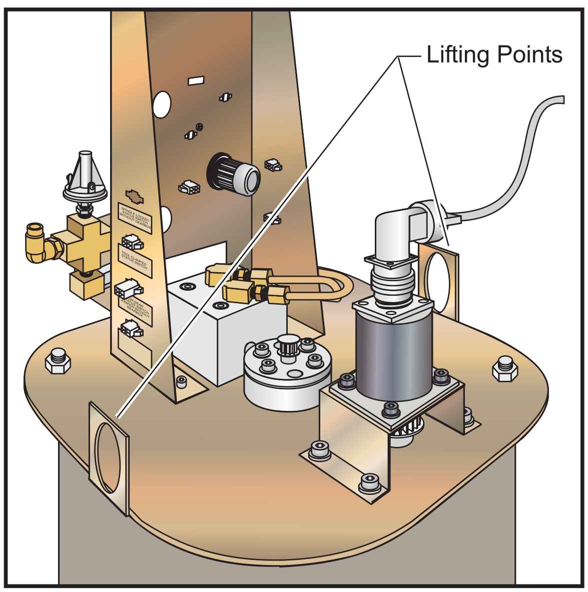


Figure 3.7-1 Direct Drive with lifting eyeholes.

9. Remove the four SHCS and carefully lift the spindle motor assembly off the spindle head. Take care to not damage the drive pulley during removal.

NOTE: It is recommended that the HAAS Transmission Hoist be used in this operation (Refer to the "Hoist Pre-Assembly" section for assembly and setup).

Installation (Direct Drive)

1. Carefully lower the motor assembly down to just above the spindle head casting, taking care not to damage the drive pulley or pinch the drive belt.
2. Place the drive belt on the motor's drive pulley and lower the motor down onto the spindle head casting.
3. Insert and tighten down the four SHCS attaching the motor to the spindle head casting. Adjust the drive belt as noted in "Belt Assembly" before tightening down completely.
4. Refer to the appropriate section and set the spindle orientation.
5. Check for proper orientation of the machine and be aware of any unusual noises or vibration that may occur because of incorrect belt tension.
6. Reattach the cable carrier to the solenoid bracket and reconnect all electrical and fluid lines. Replace any leaking or damaged lines at this time, if necessary.

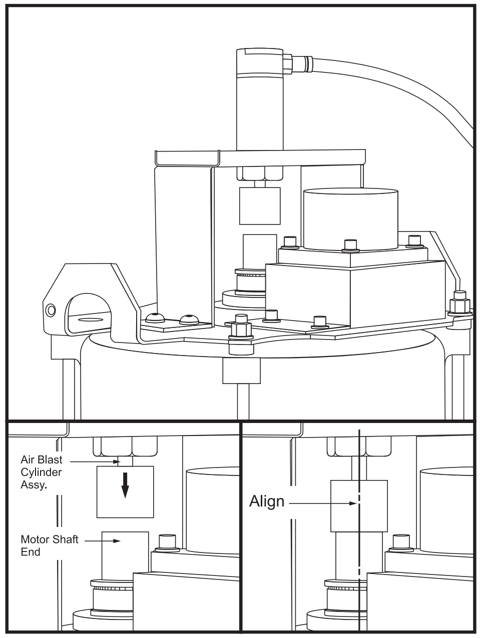
NOTE: Ensure the orient ring has an adequate layer of grease around the circumference before starting operation.

In-Line Drive Installation

1. Sweep the spindle before the motor installation is started.
2. Check the condition of the coupler hub on top of the spindle, and the condition of the coupler spider. Lift the motor up and position it just above the TRP using a forklift or hoist. Check the condition of the coupler hub on the motor, and align it with the coupler on the spindle. Inspect the transfer tube for damage and the O-rings for deterioration. Replace, if necessary.

Note: Insure that the transfer tube has been installed prior to motor installation.

3. Lower the motor towards the TRP. The couplers should engage with very little interference. It may be necessary to move the spindle back and forth slightly to line up the coupler hubs or rock the motor housing back and forth to square the assemblies. Do this using your hand on the spindle dogs, at the nose of the spindle.
4. Once the coupler hubs are mated, put the bolts in that hold the motor to the spacer blocks; leave them loose. Join all the motor cables to the harness of the machine. Command a spindle speed of 1000 rpm, the motor mounting bolts are to be left loose. Let the spindle run for about 5 minutes, this allows the spindle assembly to seat and will help the final alignment. Snug bolts while spindle is rotating then stop the spindle and torque the bolts.
5. Install the airblast (purge) bracket and solenoid on top of the motor. Ensure the cylinder is centered over the motor shaft, adjust as necessary. Connect the air line to the solenoid.



Hoist Pre-Assembly

1. Attach the mast support to the support base, using the four 3/8-16 x 1¼" SHCS, four 3/8" flat washers, four split washers, and the four 3/8-16 hex nuts. Ensure the bolts are securely tightened.

2. Attach the boom modification plates to the mast using the three ½-13 x 4½" HHB, three ½" split washers, three ½-13 hex nuts, and the three spacers.

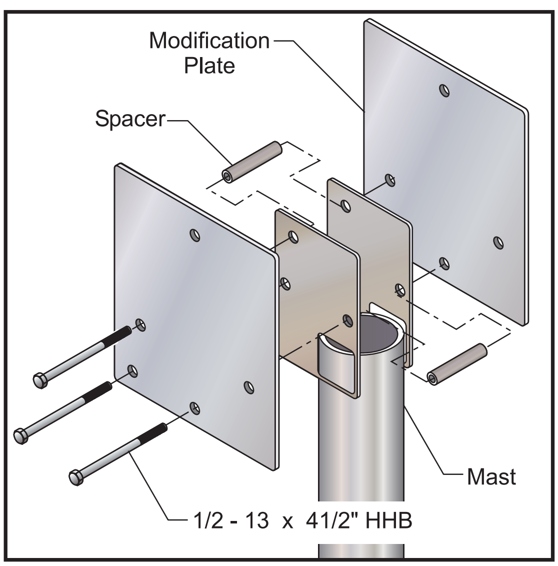


Figure 3.7-2 Support base/mast support assembly.

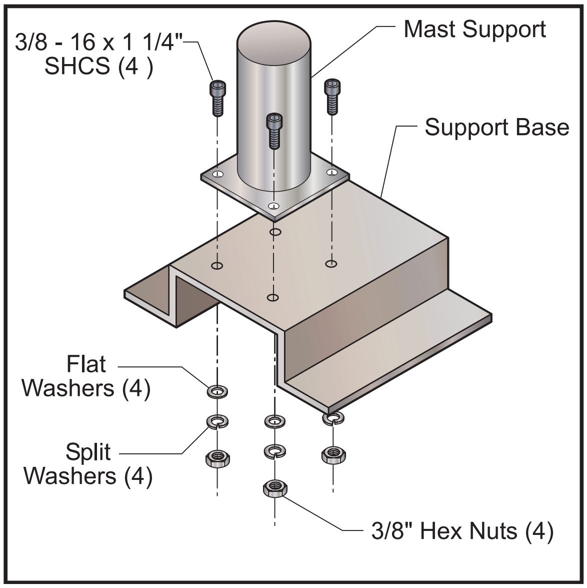


Figure 3.7-3 Exploded view of boom modification plate components.

3. Assemble the boom assembly as follows:
   A. Lubricate the components of the assembly:
      1) Using a grease brush, apply grease to the through-hole and the side surface of the pulley wheel.
      2) Wipe a thin coat of oil on the entire cable.
      3) Lubricate all clevis pins with a thin layer of grease.
      4) Oil all bearings on the winch and apply grease to the gear teeth.

   B. Place the pulley wheel inside the cable guide and place this subassembly into the end of the boom. Ensure the clevis pin through-hole is toward the top of the boom and the rounded end of the cable guide is toward the outside. Slide the clevis pin through the hole and fasten with the 1/8" x 1" cotter pin.
   C. Attach the winch base to the boom with the two 3/8-16x1" SHCS, two 3/8" lock washers, and the two 3/8" hex nuts. See owner's manual for mounting of left-or right-handed operation.
   D. Feed the free end of the cable (without hook) between the pulley and cable guide and through the inside of the boom.

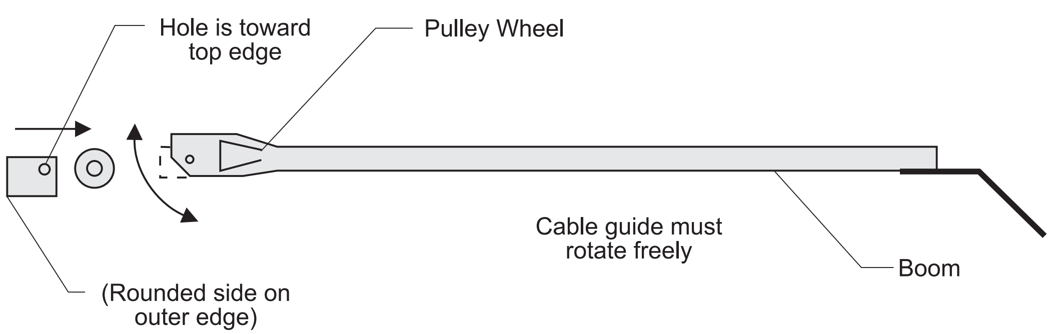


Figure 3.7-4 Mounting cable guide and pulley wheel to boom.

E. Attach the cable to the winch as follows:

1) FOR LEFT-HAND OPERATION -
Pass the cable under the winch drum and through the hole in the drum flange. Form a loop of cable and securely anchor it in place using the tie-down clasp, carriage bolt, and hex nut. The cable must be underwound on the winch drum.

2) FOR RIGHT-HAND OPERATION -
Pass the cable between the frame rod and the countershaft of the winch, over the winch drum, and through the hole in the drum flange. Form a loop of cable and securely anchor it in place using the tie-down clasp, carriage bolt, and hex nut. The cable must be over wound on the winch drum.

F. Ensure all hex nuts and cap nuts are securely tightened and all cotter pins are properly bent to secure them in place. Make sure all pivots and rotation points are well-lubricated and refer to the winch owner's manual for proper lubrication before operating.

4. Place the transmission lift fixture on top of the transmission, with the rod at each end in the two lifting eyeholes of the transmission. Tighten the fixture onto the transmission by turning the handle at the end. **Do not overtighten.**

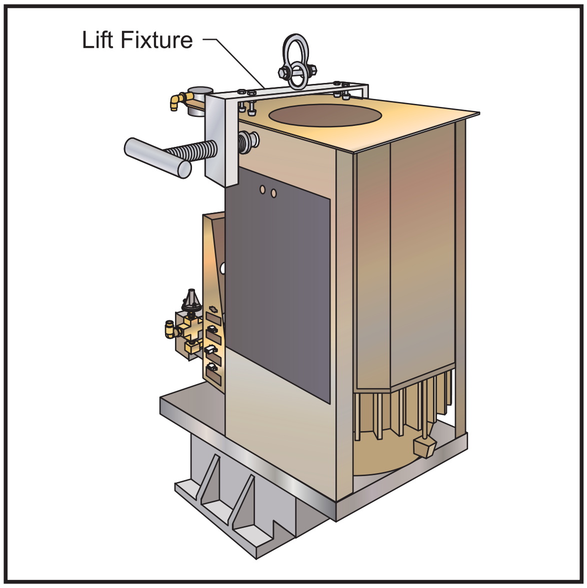


Figure 3.7-5 View of transmission lift fixture.

TRANSMISSION REMOVAL

NOTE: This procedure is not for direct drive machines.

1. Ensure the VMC is ON. You will need to raise and lower the head stock to remove the transmission. At this time, raise the Z-axis to the full up position.

2. Remove the cover panels from head stock area ("Head Covers Removal" section).

3. If machine is equipped with the Through the Spindle Coolant option, remove the pressure regulator, check valve assembly, and bracket from the old transmission, so they can be installed later on new transmission.

4. Remove the tool release piston assembly ("Tool Release Piston" section).

5. Loosen the six SHCS holding the transmission to the head casting. Slide the transmission forward enough to release the drive belt from the transmission and spindle pulleys.

6. Press the POWER OFF button on the control panel and turn the main breaker off. If there is an external breaker box, turn it off and lock it up.

7. Disconnect all electrical lines and air lines from the transmission solenoid bracket. Disconnect the electrical and oil lines from the oil pump. Plug the oil lines to prevent contamination. Most of the lines should be marked and identified. If not marked, do so as it is removed.

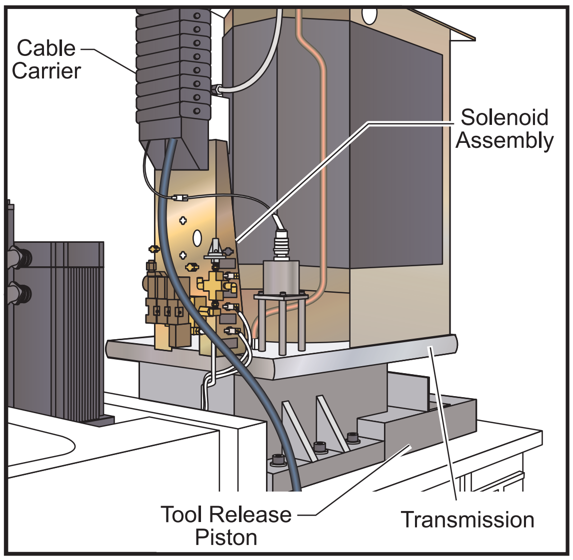


Figure 3.7-6 Solenoid bracket with all lines connected.

8. Remove the two SHCS holding the cable carrier to the solenoid bracket and position the cable carrier so as to not interfere with the transmission removal. It may be necessary to tie the cable carrier back to the Z-axis motor to keep it in place.

9. Remove the protective cardboard from the mill table and install the support base assembly on the table, using the four SHCS, four ½" flat washers, and the four T-nuts.

CAUTION! Ensure the protective rubber pads on the bottom of the mounting base are in place and in good condition, or damage to the mill table may result.

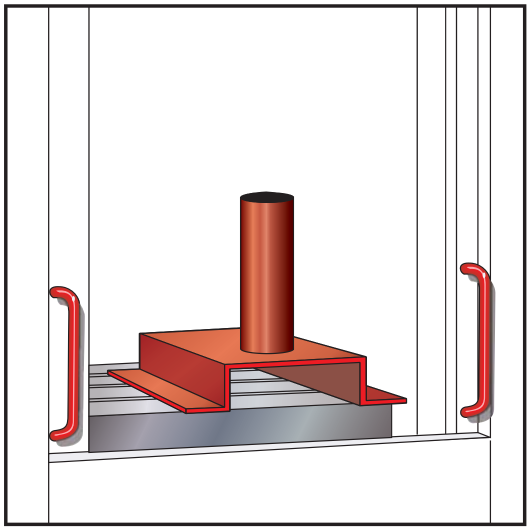


Figure 3.7-7 Support base/mast support assembly location.

10. With the boom modification plate in place, insert the mast into the mast support. Using the two clevis pins, attach the boom to the mast.

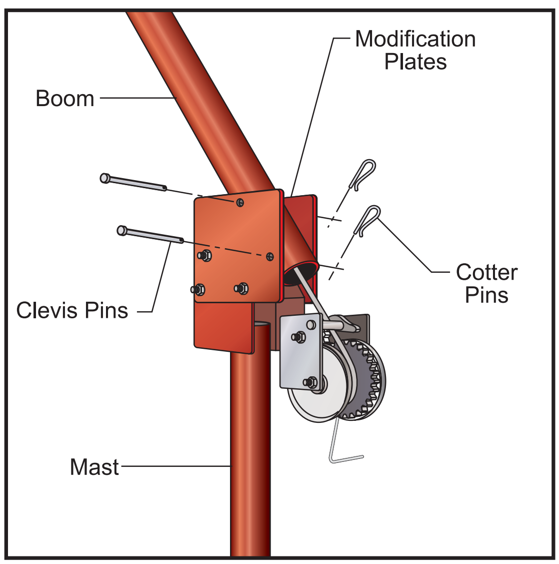


Figure 3.7-8 Mounting boom assembly to mast.

11. Place the hoist directly over the transmission and attach the hook to the cradle's eye bolt.

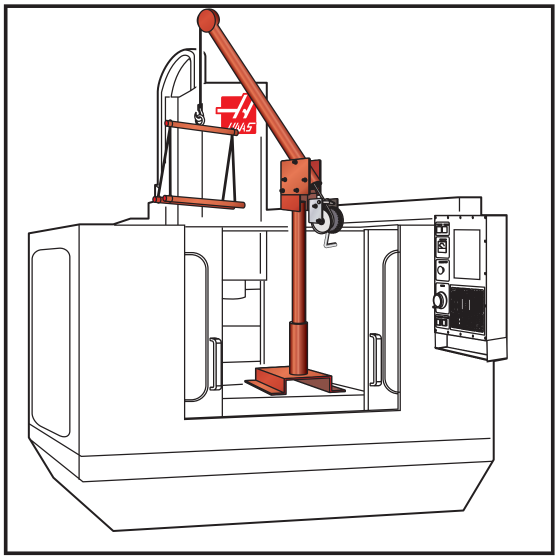


Figure 3.7-9 Fully assembled hoist in position

12. Remove the six SHCS holding the transmission to head casting. Raise the transmission, ensuring the hoist is being lifted in the locking position, clearing the enclosures. Swing the boom toward the front of the machine and lower onto the wood blocks.

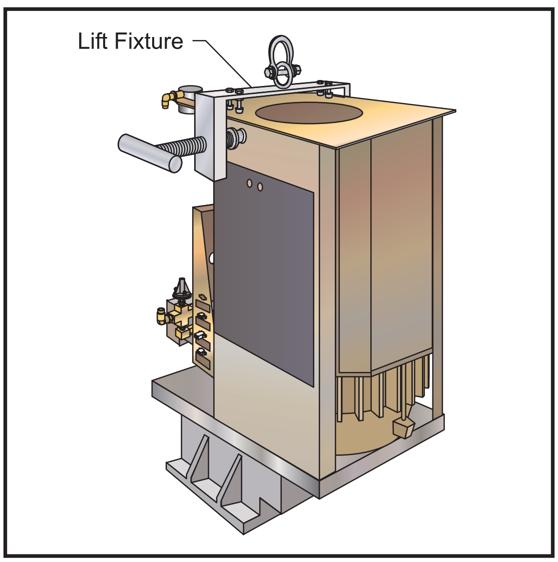


Figure 3.7-10 Lifting position for VF-1 through 4.

13. For VF-1-4: Place the hoist hook in the bar's lifting eye and place the two hooks on either end of the bar into diagonally opposite lifting holes in the motor shroud. Lift just enough to ensure the hooks are seated properly, then carefully lift the motor and transmission assembly up enough to clear the VMC. Swing the boom toward the front of the machine and lower onto the wood blocks.

Transmission Installation

1. If machine is equipped with Through the Spindle Coolant option, reinstall the pressure regulator, check valve assembly, and bracket. Install two cable ties on the replacement transmission as follows:

   • Place one cable tie around the limit switch cable.
   • Place the second cable tie through the first one, forming a loop.
   • Tighten the first cable tie. **NOTE:** The loop of the second cable tie must allow the drain line to slip through.

2. Place cradle under new transmission and lift just enough to put tension on the cables.

3. Ensure new transmission is seated securely and lift. Only lift high enough to clear the enclosure and to swing into place.

4. Slowly swing boom around to center the cradle and transmission over the spindle head.

NOTE: Inspect the gearbox isolators to ensure the spacer is flush with the bushing on the underside of the housing.

5. Lower the transmission carefully to just above the spindle head. Place the drive belt onto the transmission pulley.

6. Lower the transmission into the spindle head, taking care not to crush or bind the drive belt as you lower.

7. Insert and tighten down the six SHCS attaching the transmission to the spindle head. If these screws include gearbox isolators, ensure the 3/8" fender washer is **NOT** touching the gearbox housing.

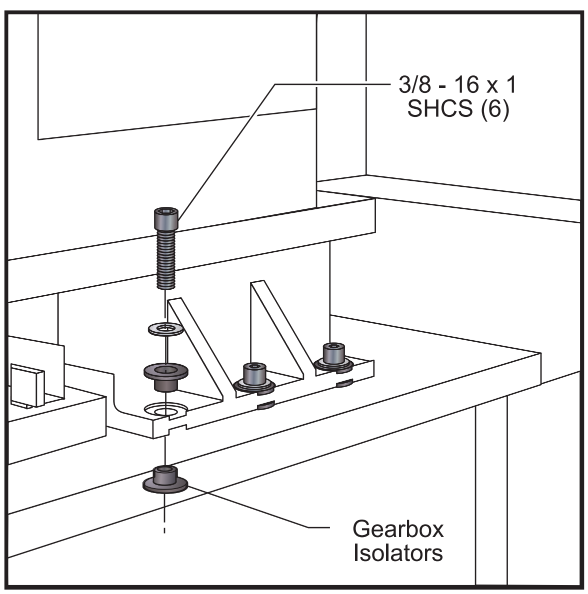


Figure 3.7-11 Gearbox isolators.

8. Adjust the drive belt tension as noted in "Belt Assembly" section before tightening screws down completely.

9. Reattach the cable carrier to the solenoid bracket and reconnect all electrical and fluid lines. Replace any leaking lines at this time, if necessary.

10. Fill the transmission.

NOTE: The hoist must be disassembled before removing from the mill table. Break down the hoist by removing the boom assembly, then the mast. It will not be necessary to completely break down the hoist after the first assembly.

NOTE: Ensure the positioning ring has an adequate layer of grease around the circumference before starting operation.

Transmission and Motor Replacement - 50 Taper

Removal

1. Lower the Z-axis travel to its full negative value (full down). Position the mill table so that it is centered on the X-axis and as close to the doors as possible (full -Y). This will allow the best working surface.

2. Clean the mill table of any grease, coolant, or chips. You will be standing on the mill table during this procedure and need firm footing.

3. Power OFF the machine. Remove all air and power service from the machine.

4. Remove the head covers. Refer to the “Head Covers Removal / Installation” section.

5. Remove the TRP assembly. Refer to the “50 Taper Spindle TRP Removal” section.

CAUTION! The TRP assembly is very heavy. When moving, ensure you have a place to set the assembly when removed.

NOTE: Make sure you collect all washers and spacers from beneath the TRP assembly. Keep these separated in sets.

6. Remove the TSC extension tube if the machine is equipped with Through the Spindle Coolant option. Refer to the “Through The Spindle Coolant System” section.

NOTE: The TSC union and extension shaft are **reverse** thread.

7. If your machine is equipped with TSC, remove the 3/16” SHCS that attach the TSC valve bracket to the right side of the motor. Let the TSC valve bracket hang off the right side of the spindle head, ensuring that the hoses do not get kinked.

8. Remove the SHCS that attach the TRP solenoid assembly to the top of the motor lift plate. Cable tie the assembly to the rear sheetmetal or column to prevent damage while removing the transmission/motor assembly.

9. Remove the quick-disconnect electrical plug panel from the rear of the motor. This is attached by four 3/16” SHCS. Gently push the plug panel behind the motor and cable tie it to the rear sheetmetal or column.

10. Remove the plug for the gear change solenoid.

11. Remove the Encoder-to-Transmission Shaft belt. This can most easily be accomplished by removing the four SHCS that attach the Encoder bracket to the spindle head (located inside the spindle head cavity between the drive belts). Use a universal swivel joint and hex-head socket for these SHCS.

12. Break loose the four large SHCS that attach the transmission mount plate to the spindle head. Remove the SHCS and set aside. Pull the transmission/motor assembly towards the front of the machine slightly. This will remove the tension on the drive belts.

13. Remove the Encoder belt and the drive belts.

CAUTION! Measure the distance between the bottom of the Z-axis motor and the ballscrew anchor mount. Cut a wood block to the proper length and put in place. This is necessary to counteract the Hydraulic Counterbalance mechanism when the transmission/motor assembly is lifted off the machine.

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14. Mark and remove the power cables from the motor.

15. Attach a heavy chain to the lifting eyeholes of the top motor plate using hooks or C-clips of appropriate weight rating (approximately 250 lbs.).

CAUTION! Before proceeding, make sure you have appropriate lifting equipment to safely lift 250 lbs., room to maneuver it, and a stable place to set the transmission/motor assembly once it is removed.

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16. Lift off the transmission/motor assembly.

Installation

CAUTION! Before proceeding, make sure you have appropriate lifting equipment to safely lift 250 lbs. and room to maneuver.

---

1. Lift the transmission/motor assembly into place. The next five steps (2-6) can be performed with the transmission/motor assembly turned slightly to ease installation of accessory parts.

2. Connect the power wires.

3. Attach the electrical plug panel to the rear of the motor. Reattach any Molex plugs to the panel, if removed during the previous procedure.

4. Slide on the drive belts.

5. Place and secure the TRP solenoid assembly to the top of the motor lift plate using the removed SHCS.

6. Place and secure the TSC valve bracket to the right side of the motor lift plate using the removed SHCS (if equipped).

7. Properly orient the transmission/motor assembly, if necessary. Insert the four SHCS that attach the transmission mount plate to the spindle head.

8. Use a Belt Tensioning Tool to tighten drive belts. Do not overtighten the drive belts!

9. Slip on the Encoder belt. Reattach the Encoder bracket.

10. Replace the TRP assembly. See "50 Taper Spindle TRP Installation".

11. Replace the TSC union and extension shaft. Refer to the "Through The Spindle Coolant System" section.

NOTE: The TSC union and extension shaft are **reverse** thread.

12. Lubricate any new or removed parts if necessary. Remove the wood spacer (if used). Check to make sure all connections are secure.

13. Reconnect air and power services. If equipped with TSC, check drawbar for runout. See the "Adjusting Extension Tube Runout" section.

14. Replace sheetmetal.

15. Set spindle orientation. Refer to the "Spindle Orientation" section.

16. Check Toolchanger function.

3.8 Axis Motor Removal / Installation

Please read this section in its entirety before attempting to remove or replace the motors.

Tool Required

- Z-Axis: Cylinder shaft stop (P/N 99-7562 - VF-1 through 4, P/N 93-9962 - VF-6 through 11)

X-Axis Motor Removal

1. Turn the VMC ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

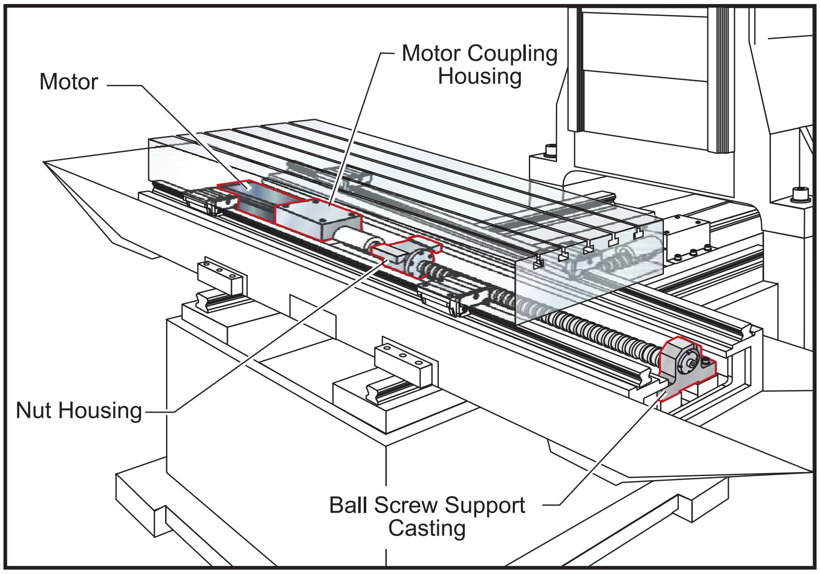


Figure 3.8-1 X-axis motor and components.

2. Move the table to the far left position. Loosen the SHCS and remove the right way cover.
3. Move the table to the far right position. Loosen the SHCS and remove the left way cover.
4. Remove the side enclosure panels.
5. On the motor housing, remove the four BHCS and remove the cover plate.
6. Loosen the SHCS on the motor coupling at the ball screw.
7. Turn the machine power OFF.
8. On the motor housing, loosen the four SHCS and remove the motor from the housing.
9. Disconnect all wiring from the motor.

INSTALLATION -

1. Slide motor into motor housing, inserting the end of the ball screw in the motor coupling.

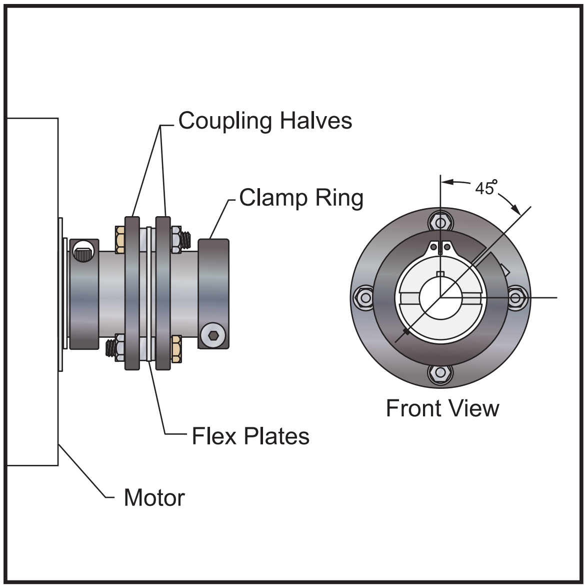


Figure 3.8-2 Motor coupling components.

2. Reinstall and tighten down the four SHCS that hold the motor to the housing.

3. Reconnect the motor wiring.

4. Visually inspect the coupler flex plates to ensure they are parallel to the coupling halves.

NOTE: The slot in the locking collar must be positioned 45 degrees between the bolt hole pattern of the coupler. If improperly aligned, the coupler will not have enough clamping force on the ballscrew or motor shaft.

Tighten the SHCS on the motor coupling at the ball screw. (Place a drop of blue Loctite® on the screw before inserting.)

5. Replace the cover plate and fasten with the four BHCS.

6. Move the table to the far right position. Replace the left way cover with the SHCS.

7. Move the table to the far left position. Replace the right way cover with the SHCS.

8. Reinstall the side enclosures.

9. Check for backlash in the X-axis ball screw (Troubleshooting section) or noisy operation.

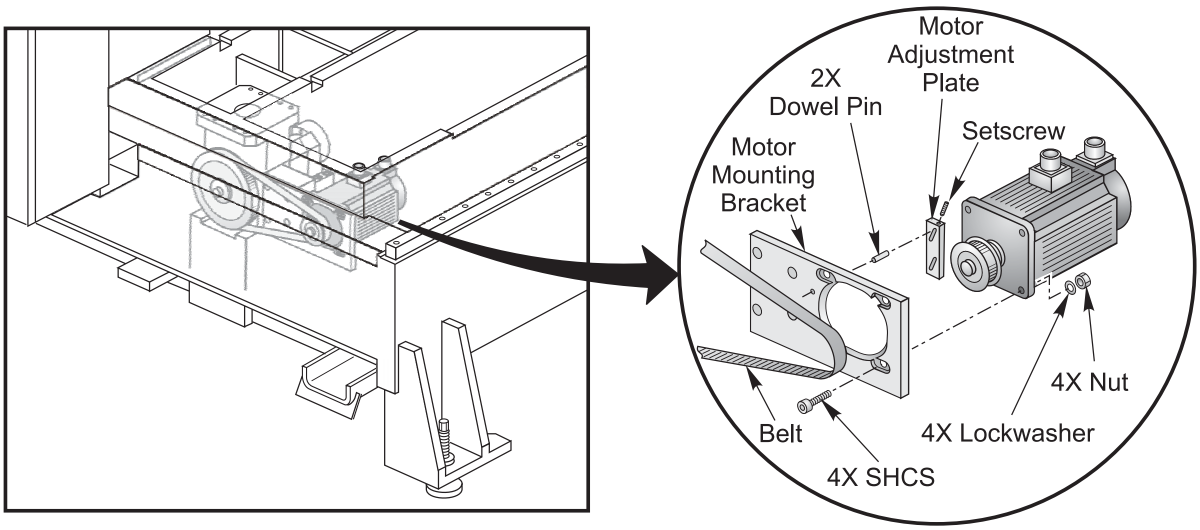
10. Zero X axis and set grid offset.

GR-Series X-Axis Motor Replacement

Removal

Note: Work is done from under the mill.

1. Power down the machine
2. Disconnect both motor cables.
3. Remove the four SHCS that secure the motor to the mounting bracket.



4. Loosen the setscrew on top of the motor adjustment plate. The adjustment plate is not fastened to the motor or the bracket, therefore it may fall off the dowel pins once the motor is removed.
5. Disconnect the belt from the pulley.

Installation

1. Position the motor in the motor mounting bracket, and loosely install the bolts.
2. Attach the belt. Route the belt over the motor pulley first and then over the ballscrew pulley.
3. Reinstall the motor adjustment plate.
3. Snug the motor mounting bolts. Tighten the setscrew in the motor adjustment plate to set proper belt tension. Belt tension should be 15 to 20 lbs at 1/4” deflection
4. Tighten the motor bolts (30 ft. lb.).
5. Recheck the belt tension.
6. Install the two motor cables.
7. Zero return the X-axis and set the grid offset as described in the “Grid Offset Calculation” section of this manual.

Y-Axis Motor Removal

1. Turn the machine power ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

2. Move the table to the farthest forward position. Using a 5/32" hex wrench, remove the SHCS on the way cover at the rear of the saddle.

3. Slide the way cover back against the machine. Remove the two roller brackets from the base. Pull the way cover forward and off of the base.

4. If the bearings are to be serviced, move the table to the rear of its travel and remove the SHCS holding the front way covers to the saddle. Slide the way cover to the forward position.

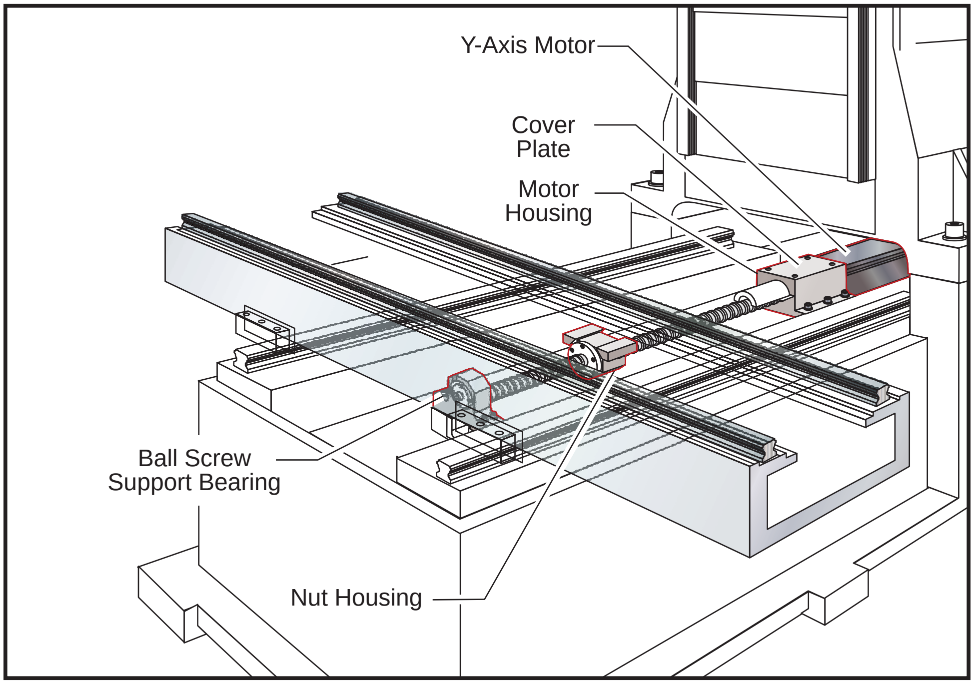


Figure 3.8-3 Y-axis motor and components.

REMOVING LUBE / AIR PANEL -

5. Turn the machine off and disconnect all air lines to panel.

6. Disconnect the spindle air/lube line.

7. Using a 3/8" open-end hex wrench, disconnect the oil line connecting the base to the lubrication system panel.

8. Disconnect the two air lines from the panel (quick-disconnect fittings) by hand.

9. Disconnect the three connections labeled 'limit switches' and remove the cords from the panel.

10. Disconnect the limit switch connection and the Y-axis connection at the side of the control panel.

11. While holding the lube/air panel assembly at the bottom edge, loosen the two SHCS and remove the panel assembly.

CAUTION! On machines with only two SHCS, remove one screw at a time. Replace the screw to hold the cabinet in place before removing the other screw. Failure to do this will result in damage to the cabinet.

12. On the motor housing, remove the four BHCS and remove the cover plate.

13. Loosen the SHCS on the motor coupling at the ball screw.

14. On the motor housing, loosen the 4 SHCS, remove all wiring from the motor and remove the motor from the housing.

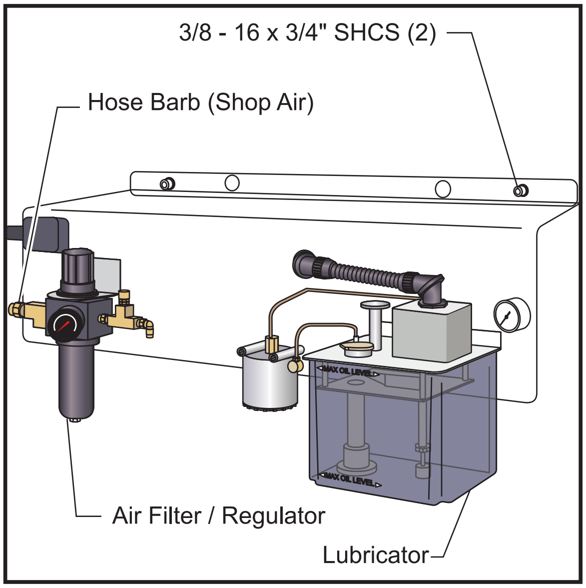


Figure 3.8-4 Lube/Air Panel.

INSTALLATION -

1. Slide motor into motor housing, inserting the end of the ball screw in the motor coupling.

2. Replace and tighten down the four SHCS that hold the motor to the housing and reconnect the cables to the motor.

3. Visually inspect the flex plates to ensure they are parallel to the coupling halves.

NOTE: The slot in the locking collar must be positioned 45 degrees between the bolt hole pattern of the coupler. If improperly aligned, the coupler will not have enough clamping force on the ball screw or motor shaft.

Tighten the SHCS on the motor coupling at the ball screw. (Place a drop of blue Loctite® on the screw before inserting.)

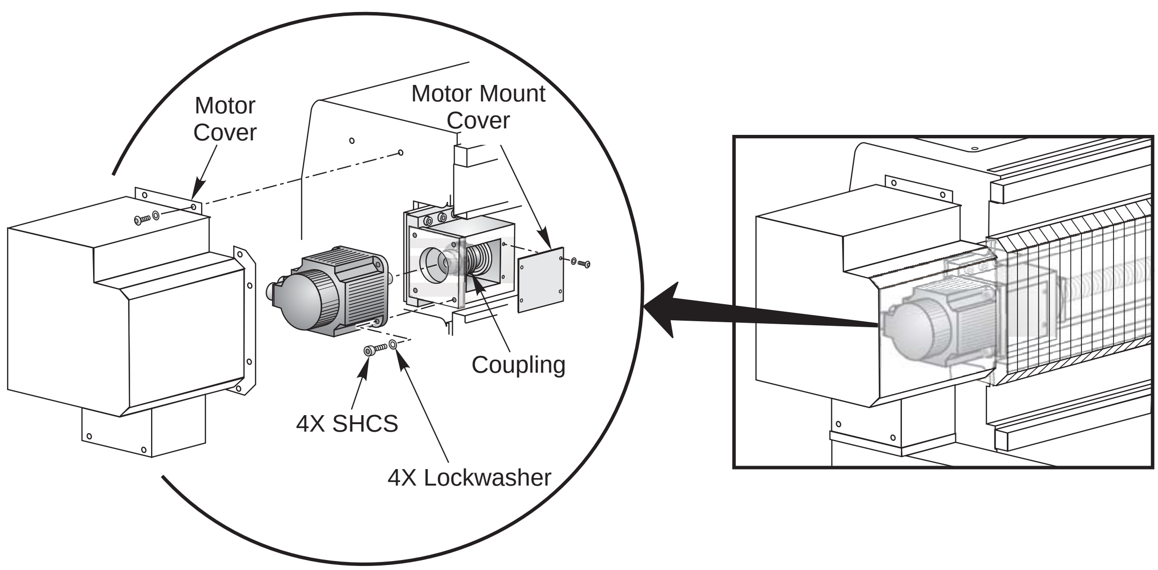
4. Replace the cover plate and fasten with the four BHCS.

5. Replace the lube system panel with the two SHCS that mount it.
6. Plug in the limit switch connection and Y-axis connection at the side of the control panel.
7. Reconnect the three connections labeled "limit switches" to the panel.
8. Reconnect the two air lines to the panel, and the solenoid to the front of the panel.
9. Reconnect the oil line that connects the lube system panel to the base.
10. If the front way cover was removed, slide it back into position, and replace the SHCS that holds it to the saddle.
11. Move the table to the fully forward position. Replace the rear way cover.
12. Replace the two roller brackets onto the base.
13. Slide the way cover back into place, and attach to the saddle with the SHCS.
14. Check for backlash in the Y-axis ball screw (Troubleshooting section) or noisy operation.
15. Zero return the Y axis and set grid offset according to section.

GR-Series Y-Axis Motor Replacement

Removal

1. Power down the machine.
2. Remove motor cover, and slide the way-cover towards the center of the machine.



3. Remove the cover from the motor mount, and loosen the single bolt on the motor side of the coupling.
4. Remove the two motor cables.
5. Remove the 4 bolts that secure the motor to the motor mount, and remove the motor.

Installation

1. Install the motor into the coupling. Use care in doing so, forcing the motor in to the coupling can damage the coupling.
2. Install the four motor mounting bolts and lock washers and torque (30 ft. lb.).
3. Tighten the coupling bolt.
4. Install both of the motor cables.
5. Install the motor mount cover
6. Install the way cover and motor cover.
7. Zero return the Y-axis and set the grid offset as described in the "Grid Offset Calculation" section of this manual.

Z-Axis Motor Removal

Machines are currently equipped with either a hydraulic counterbalance system or an electric brake motor. Care must be taken, in either case, to avoid damaging the machine or severely injuring yourself. Heed all warnings and cautions and read all the steps of the procedure before starting any disassembly.

WARNING! MACHINES WITHOUT A COUNTER BALANCE

If debug is on and the Z -axis is disabled the spindle head will fall. This is extremely dangerous and should be avoided at all costs.

CAUTION! Always block the hydraulic cylinder with shaft stop block before servicing any Z-axis components.

1. Turn the machine power ON. Zero return (ZERO RET) all axes and put the machine in HANDLE JOG mode.
2. Loosen the six SHCS that attach the rear head cover to the side covers, and remove from the spindle head.

NOTE: If machine is equipped with a hydraulic counterbalance, remove entire spindle head cover for VF-1/2, or right side spindle head cover for VF-3/4.

3. Remove the SHCS attaching the Z-axis way cover to the spindle head and slide the cover to the bottom position. VF 1-4 remove the rear spindle head cover.
4. Lower the spindle head to its lowest position.
5. **a.** If the machine is equipped with a hydraulic counterbalance, install cylinder shaft stop (See Fig. 3.8-6). HANDLE JOG Z-axis up until shaft stop blocks axis.

   b. Machine with Brake motors: Position table under the spindle head and insert a 4" x 4" x 14" wood block under the spindle head and lower head casting on to it. Emergency stop the machine.

6. At the motor housing, loosen the four BHCS and remove the cover plate.

7. Visually check the motor coupling. Align the coupler so that SHCS on the ball screw can be easily accessed. This can be done by turning the ball screw manually.

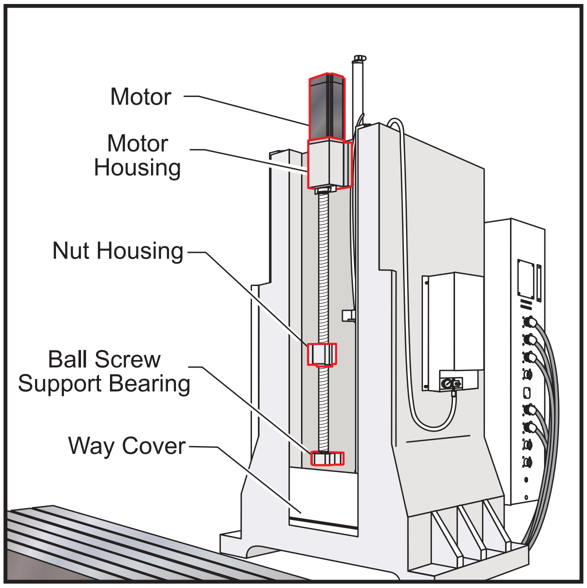


Figure 3.8-5 Z-axis motor and components.

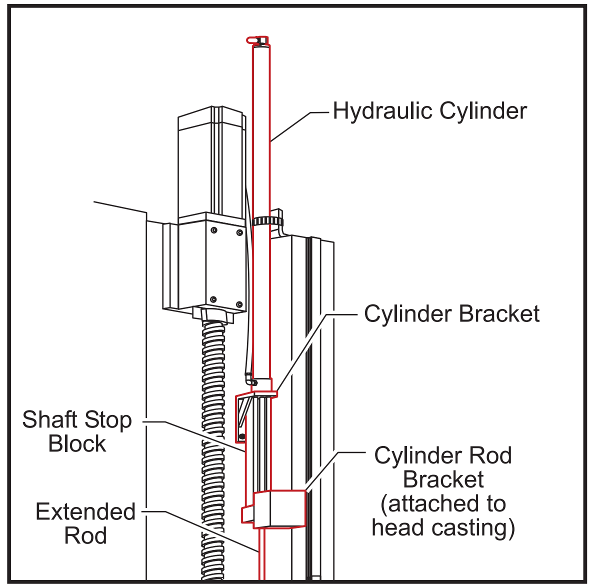


Figure 3.8-6 Z-axis motor and components for machines equipped with hydraulic counterbalance.

8. Disconnect electrical power. Caution: If the machine is equipped with a Z-axis brake motor the spindle head may drop slightly.

9. On the motor housing, loosen the four SHCS and remove the motor from the housing.

10. Disconnect the Z-axis connection from the control panel.

11. Remove cableing from the motor.

INSTALLATION -

1. Slide motor into motor housing, inserting the end of the ball screw in the motor coupling.

2. Replace and tighten down the four 5/16-18 x 1¼" SHCS that hold the motor to the housing and connect cables to the motor.

3. Visually inspect the flex plates to ensure they are parallel to the coupling halves.

NOTE: The slot in the locking collar must be positioned 45 degrees between the bolt hole pattern of the coupler. If improperly aligned, the coupler will not have enough clamping force on the ball screw or motor shaft.

Tighten the SHCS on the motor coupling at the ball screw. (Place a drop of blue Loctite® on the screw before inserting.)

4. Replace the cover plate and fasten with the four BHCS.

5. Reconnect electrical power.

6. Remove shaft stop, if necessary.

7. If the front way cover was removed, slide it back into position, and replace the 10-32x3/8" SHCS that holds it to the saddle.

8. Move the table to the fully forward position. Replace the rear way cover.

9. Replace the two roller brackets onto the base.

10. Slide the way cover back into place, and attach to the saddle with the 10-32x3/8" SHCS.

11. Check for backlash in Z-axis ball screw (Troubleshooting section), or noisy operation.

12. Zero return Z axis and set grid offset and parameter 64 (section 3.6).

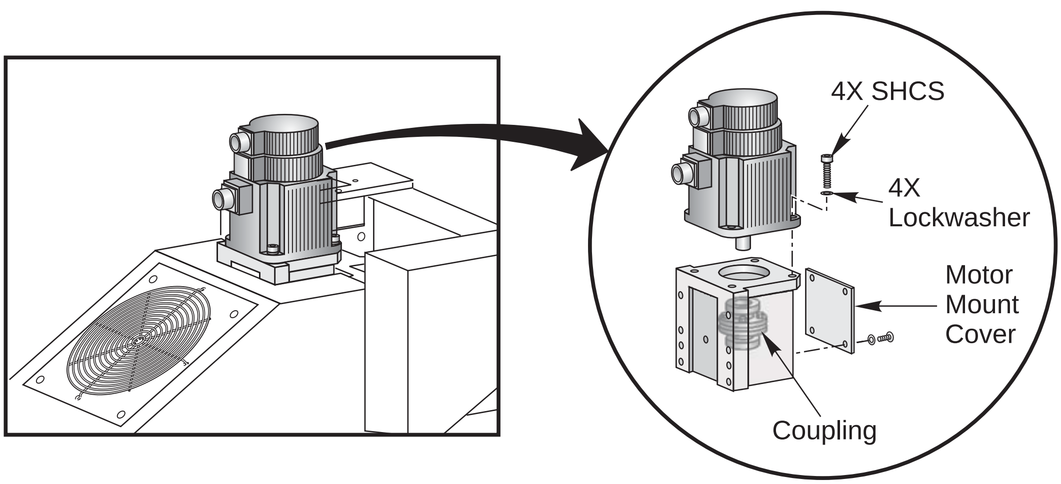
GR-Series Z-Axis Motor Replacement

Removal

1. Block the head up and power down the machine.

2. Remove the spindle head cover. See the section on spindle head cover removal.

3. Remove the motor mount cover.



4. Remove the cover from the motor mount, and loosen the single bolt on the motor side of the coupling.

5. Remove the two motor cables.

6. Remove the 4 bolts that secure the motor to the motor mount, and remove the motor.

Installation

1. Install the motor into the coupling. Use care in doing so, forcing the motor in to the coupling can damage the coupling.

2. Install the four motor mounting bolts and lock washers and torque (30 ft. lb.).

3. Tighten the coupling bolt.

4. Install both of the motor cables.

5. Install the motor mount cover and the spindle head cover.

6. Zero return the Z-axis and set the grid offset as described in the “Grid Offset Calculation” section. Also reset the value for parameter 64, described in this manual.

Coupler Replacement

WARNING!

Machines without a counter balance: If debug is on and the Z -axis is disabled the spindle head will fall. This is extremely dangerous and should be avoided at all costs.

1. Remove the axis motor in accordance with "Axis Motor Removal/Installation" section.

2. Loosen the 10-32 x ½" SHCS on the two coupling rings and remove the coupling.

3. For installation: Visually inspect the flex plates to ensure they are parallel to the coupling halves. Slide the new coupling onto the motor shaft until the coupling half is flush to the end of the shaft.

NOTE: The slot in the locking collar must be positioned 45 degrees between the bolt hole pattern of the coupler. If improperly aligned, the coupler will not have enough clamping force on the ball screw or motor shaft.

Tighten the SHCS on the motor coupling at the ball screw. (Place a drop of blue Loctite® on the screw before inserting.)

4. Reinstall the axis motor.

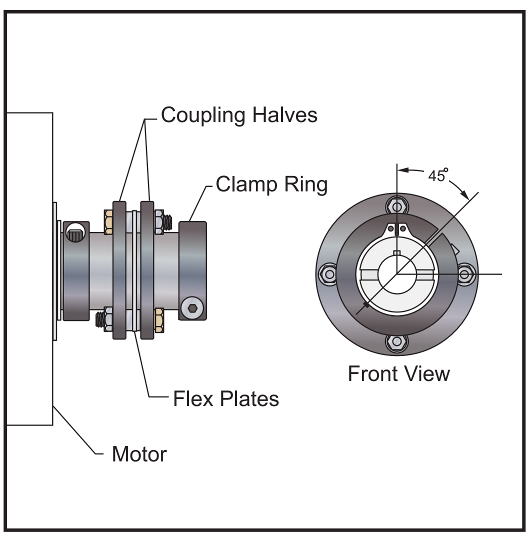


Figure 3.8-7 Motor Coupling.

3.9 Ball Screw Removal and Installation

Please read this section in its entirety before attempting to remove or replace the ball screws.

TOOLS REQUIRED

- Spanner wrench (32 mm or 40/50 mm)
- 2" x 4" wood block (21"-23 1/2" long)
- Shaft lock (32 mm or 40/50 mm)
- Torque tester
- Z-Axis: Cylinder shaft stop (P/N 99-7562 - VF-1 through 4, P/N 93-9962 - VF-6 through 10)

NOTE: Certain steps in the following procedures apply only to 40 and 50 mm ball screws.

X-Axis Ball Screw Removal

1. Turn the machine ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.
2. Remove the side enclosures.
3. Loosen the SHCS and remove the chip tray from the mill table.
4. Jog the table to the far right position. Loosen the SHCS and remove the right way cover.
5. Jog the table to the far left position. Loosen the SHCS and remove the left way cover.
6. If applicable, remove the hard stop from the bearing housing on the ball screw.

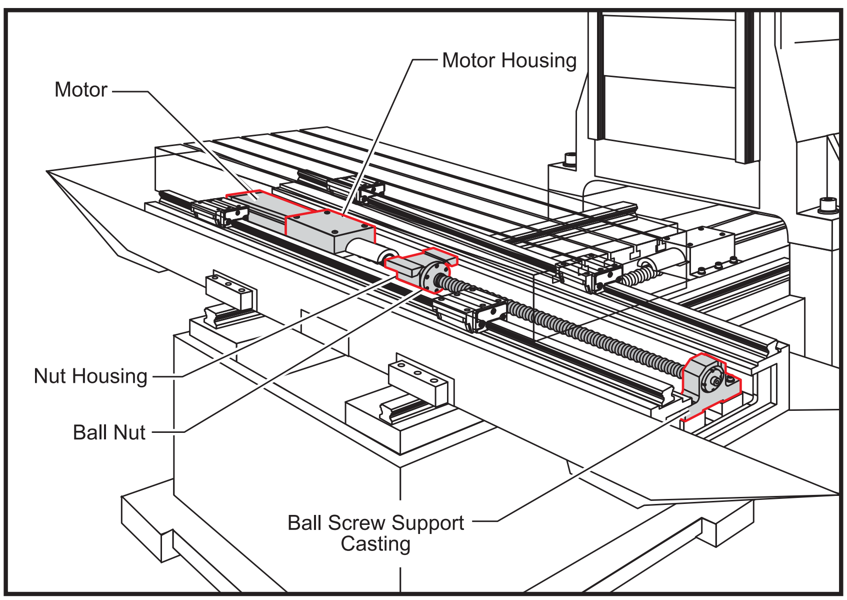


Figure 39-1. X-axis ball screw and components.

7. Disconnect the oil line from the ball nut.
8. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the ball screw support bearing end.

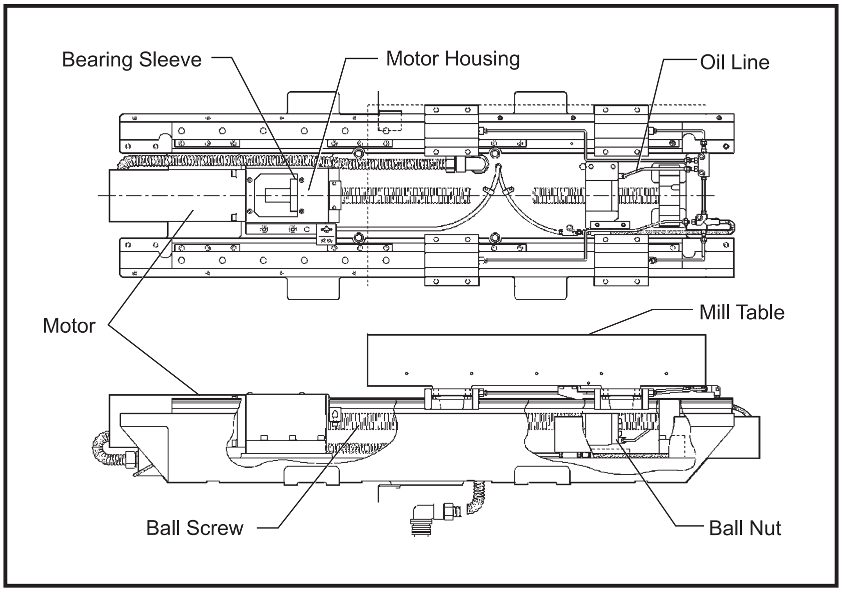


Figure 3.9-2 Ball screw assembly.

9. Remove the axis motor in accordance with "X-Axis Motor Removal".

NOTE: The motor's electrical connections do not need to be removed for this operation. After removing motor from the housing, set it to one side.

10. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the ball screw in the motor housing.

11. **For 32 mm ball screws:**
 • Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the ball screw to loosen.
 •Push the mill table towards the motor end until the ball screw clears the bearing support. Remove the SHCS from the ball nut and remove the ball screw by pulling from the bearing support end.

CAUTION! Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or ball screw will result.

For 40 and 50 mm ball screws:
•Loosen the SHCS that mount the bearing support to the saddle, and remove. Remove the pull pins from the bearing support.
•Loosen the five SHCS in the ball nut and remove the ball screw by pulling from the bearing support end.

This procedure assumes that the nut and motor housing will not be removed.

INSTALLATION -

1. Center the mill table on the saddle.

2. Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing, and ball nut are free of dirt, burrs, grease, or other contaminants.

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

3. Insert the ball screw through the nut housing and motor housing (See Fig. 3.9-3), taking care not to make contact with the screw threads, which will cause possible damage.

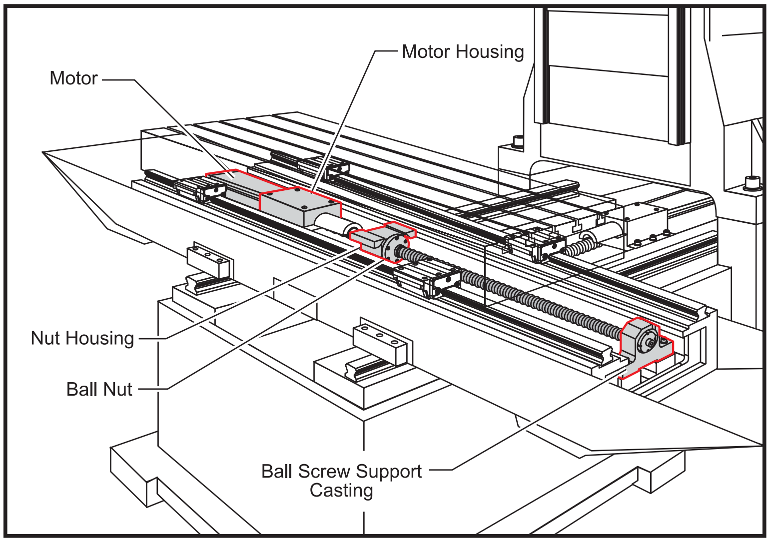
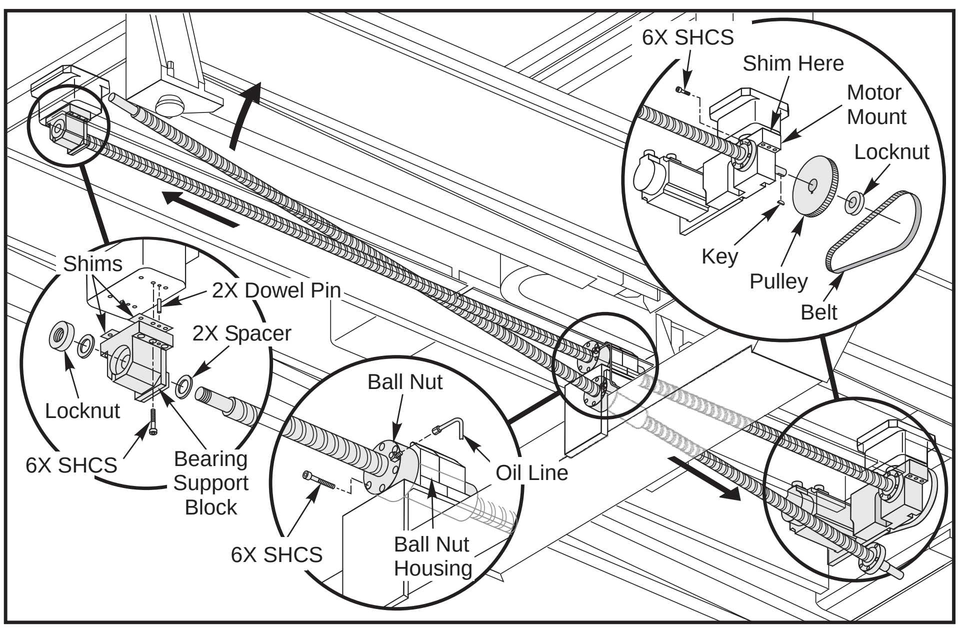


Figure 3.9-3 Install ball screw from right side.



GR-Series X-axis Ballscrew

4. **If 40 or 50 mm ball screw:**
•Mount the bearing support to the saddle with six SHCS, but do not tighten completely. Replace the pull pins in the bearing support.
•Install the spacer ring on the motor end of the ball screw.
•Insert the 5/16-18 x 3/4" (or M10 x 25 mm) SHCS, attaching the ball nut to the nut housing, but do not tighten completely. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

5. Place the bearing sleeve in the motor housing as shown. (It may be necessary to align the bearings in the sleeve to facilitate mounting on the ball screw.)

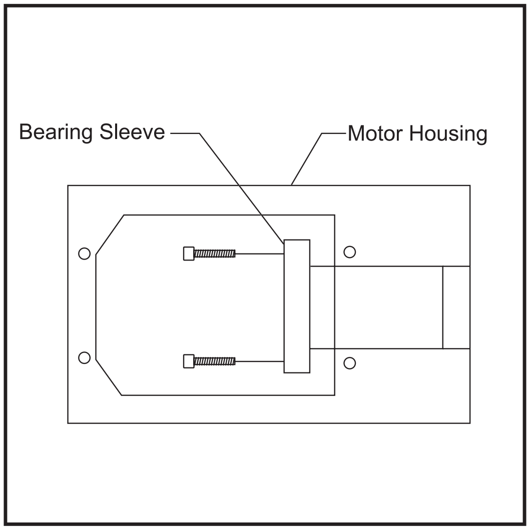


Figure 3.9-4 Bearing sleeve mounting location.

6. Insert the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten to torque specification.

CAUTION! Do not use more than one drop of Loctite®. An excessive amount will cause a film between the sleeve and housing, which could result in backlash.

7. Move mill table as far right as possible. Insert, but DO NOT TIGHTEN, the five ¼-20 x 1" (or ¼-20 x ¾") SHCS attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

CAUTION! Do not run mill table pads past the end of the linear guides! If this occurs, cease all operations and contact the manufacturer at once.

8. The following sequence is important to ensure proper installation of the ball screw:
•Tighten the clamp nut, hand tight, on the motor end.
•Install and tighten clamp nut on bearing support. Ensure the nut **does not** touch the support bearing.
•Install the shaft lock onto the bearing support end of the ball screw. This will keep the ball screw from turning while torquing the clamp nut.
•Place a spanner wrench on the clamp nut at the motor end of the assembly.
•Torque the clamp nut to 15 FT-LBS.

NOTE: The 40/50 mm ballscrew clamp nut should be torqued to 50 FT-LBS.

•Tighten the clamp nut screw and mark with yellow paint on motor support end.
•Remove the shaft lock.
•Torque support mounting bolts to proper specifications.
•Loosen the clamp nut screw and clamp nut at the bearing support end and tighten to 4 IN-LBS against the bearing. Retighten the clamp screw.

9. **For 40 and 50 mm ball screws only:**
•Move the table all the way to the right. Tighten down completely the SHCS that mount the bearing support to the saddle.
•Loosen the clamp nut on the bearing support end. Adjust the nut until it seats on the bearing. Retighten the clamp nut hand-tight, then 1/8 turn more (If you have a torque screwdriver, torque the clamp nut to 4 in-lbs).

10. Reinstall the motor according to "Axis Motor Removal and Installation".

11. Torque the SHCS attaching the ball nut to the nut housing.

12. Reconnect oil line to the ball nut

13. Check ball screw torque at bearing support end with torque tester. Jog the table all the way to the right. Check the ball screw torque again. It should be the same as the previous reading.

14. Reinstall the way covers and chip tray. If applicable, replace the hard stop.

15. Check for backlash in the ball screw ("Accuracy/Backlash" section) or noisy operation.

16. Zero return X axis and set grid offset.

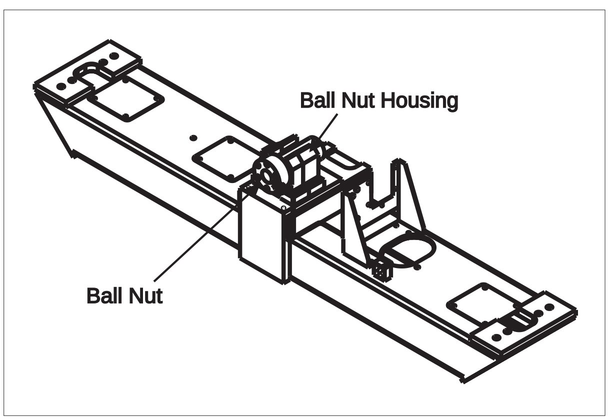
GR Series X-Axis Alignment

Be sure that machine is level before starting this procedure.

1. Verify levelness of machine and remove the back sheet metal cover from the top of the base.

2. Move all axes to their machine zero locations.

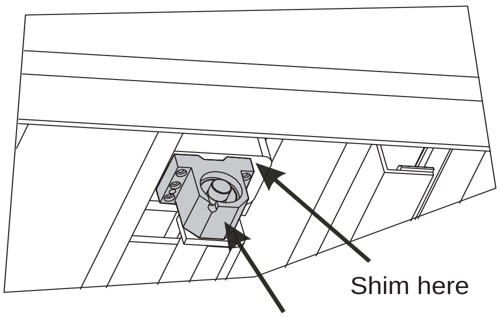
3. Remove any binding in the nut by slightly loosening the ball nut and ball nut housing and retightening them.

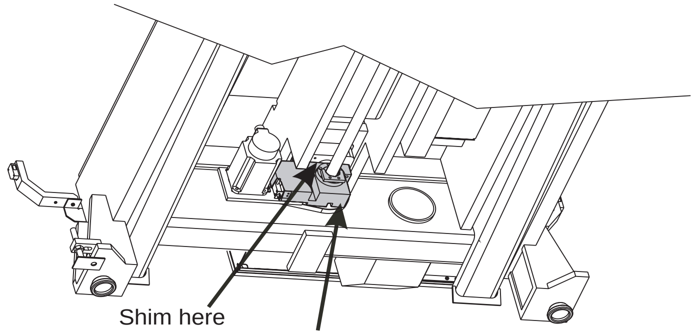


4. Jog the saddle (X-axis) all the way to the other end (max. travel). Remove the six (6) SHCS from the bearing support block.

5. Remove the dowel pins from the bearing support block.

6. If the bearing support block is loose in this state, shim the support block (both sides evenly) and re-tighten the six (6) SHCS. Do not replace the dowel pins.





7. If the bearing support block is not loose in this state:

• Replace the six (6) SHCS (do not replace the dowel pins).
• Jog the X-axis to machine zero.
• Loosen the six (6) SHCS on the motor mount but do not remove the dowel pins.
• Shim the motor mount .005 and retighten the screws. Make sure both sides are shimmed the same.

8. Repeat steps 3, 4, and 7 until the bearing support block becomes loose.

• Once the bearing support block is loose, tighten the six (6) SHCS and jog the X-axis to machine zero.
• Remove the last set of shims that were added and tighten the motor mount.
• With the X-axis at machine zero, loosen and retighten the screws on the ball nut and the ball nut housing.

9. Check the servo motor loads:

• Hand jog the X-axis from machine zero to the maximum travel.
• Check the servo motor loads on the X-axis servo motor. View the current command page. The load should not deviate more than 5%. If necessary, repeat this process.

Y-Axis Ball Screw Removal

1. Turn the machine ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

2. If applicable, remove the hard stop from the ball screw support bearing end of the ball screw.

3. Disconnect the oil line at the ball nut.

4. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the ball screw bearing support end.

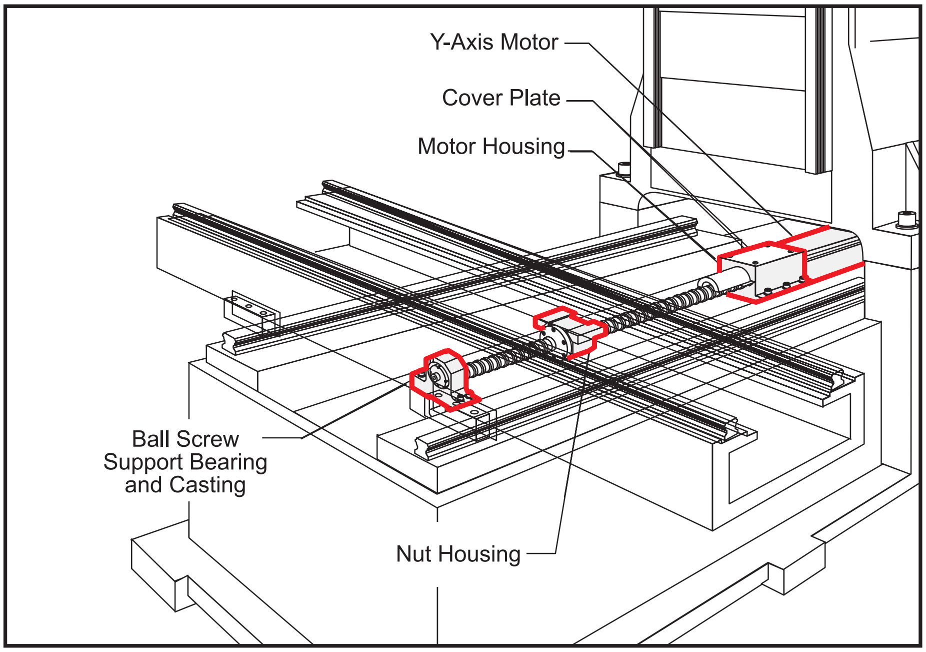


Figure 3.9-5 Y-axis ball screw and components.

5. Remove the motor in accordance with "Y-Axis Motor Removal".

NOTE: The motor's electrical connections do not need to be removed for this operation. After removing motor from the housing, set it to one side.

6. Loosen the 10-32 x 1/2" SHCS and remove the clamp nut on the ball screw in the motor housing.

7. **For 32 mm ball screws:**
•Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the ball screw to loosen.

CAUTION! Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or ball screw will result.

•Remove the five SHCS attaching the ball nut to the nut housing.
•Hand-turn the ball screw toward the rear of the machine until the front end of the ball screw clears the bearing by approximately six inches (6").
•Carefully pull the ball screw forward, to the right of the support bearing, under the front way cover until the rear of the ball screw clears the nut housing. Shift the rear end of the ball screw to the right side of the nut housing and move the ball screw to the rear of the machine until it clears the front way cover. Remove ball screw from the machine.

For 40 and 50 mm ball screws:

•Loosen the SHCS that mount the bearing support to the saddle, and remove. Remove the pull pins from the bearing support.
•Loosen the five SHCS in the ball nut and remove the ball screw by pulling from the bearing support end.

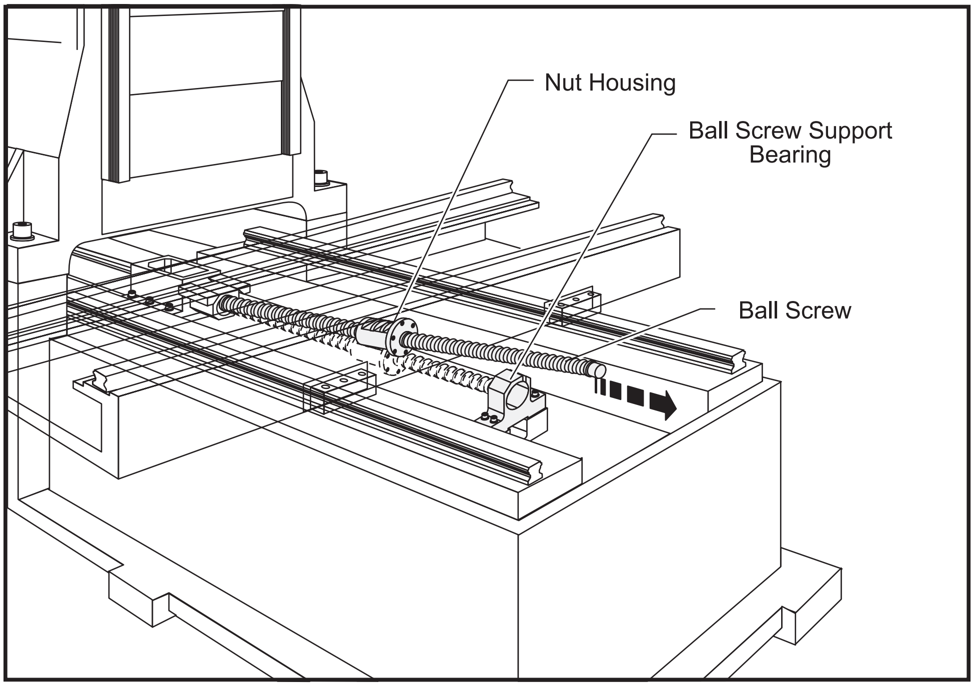
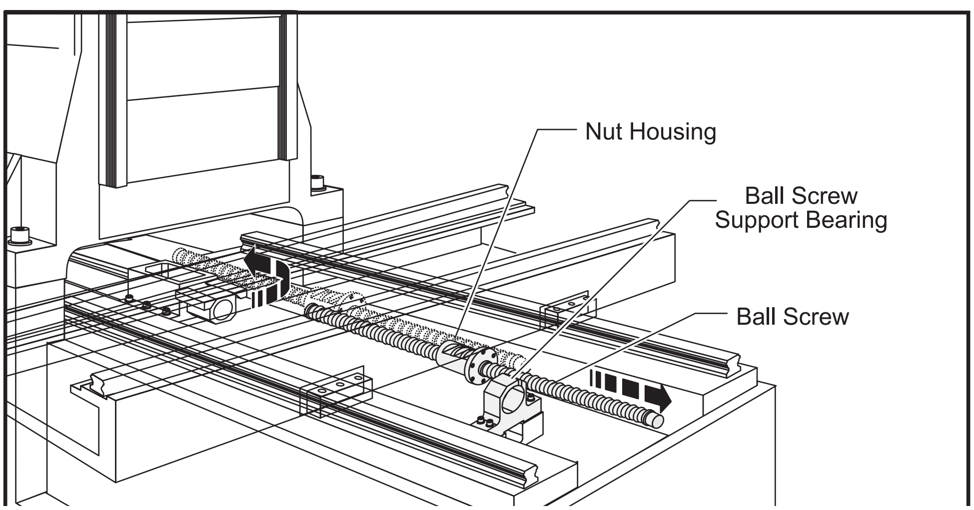


Figure 3.9-6 Pull ball screw forward around bearing support,...



...push back into the machine, then pull out forward.

THIS PROCEDURE ASSUMES THAT THE NUT AND MOTOR HOUSING WILL NOT BE REMOVED.

INSTALLATION -

1. Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing, and ball nut are free of dirt, burrs, grease, or other contaminants.

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

2. Slide the motor end of the ball screw under the saddle, taking care not to damage the screw threads. Position the ball screw to the right side of the nut housing and slide toward the rear of the machine as far as it will go.

3. Pull the ball screw forward until it is against the front way covers. Place the motor end of the ball screw through the nut housing and push the ball screw toward the back of the machine until the ball nut is seated in the nut housing.

4. **If 40 or 50 mm ball screw:**
   • Mount the bearing support to the saddle with six SHCS, but do not tighten completely. Replace the pull pins in the bearing support.
   •Install the spacer ring on the motor end of the ball screw.
   •Insert the 5/16-18 x 3/4" (or M10 x 25 mm) SHCS, attaching the ball nut to the nut housing, but do not tighten completely. (Place a drop of blue Loctite® on each of the SHCS before inserting.).
   •Skip to Step 8.

5. Place the bearing sleeve in the motor housing as shown. (It may be necessary to align the bearings in the sleeve to facilitate mounting on the ball screw.)

6. Insert the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten to torque specifications.

CAUTION! Do not use more than one drop of Loctite®. An excessive amount will cause a film between the sleeve and housing, which could result in backlash.

7. Move mill table as far forward as possible. Insert, but DO NOT TIGHTEN, the five 1/4-20 x 1" (or 1/4-20 x 3/4") SHCS attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

CAUTION! Do not run mill table pads past the end of the linear guides! If this occurs, cease all operations and contact the manufacturer at once.

8. The following sequence is important to ensure proper installation of the ball screw:
   • Tighten the clamp nut, hand tight, on the motor end.
   • Install and tighten clamp nut on bearing support. Ensure the nut **does not** touch the support bearing.
   • Install the shaft lock onto the bearing support end of the ball screw. This will keep the ball screw from turning while torquing the clamp nut.
   • Place a spanner wrench on the clamp nut at the motor end of the assembly.
   • Torque the clamp nut to 15 FT-LBS.

NOTE: The 40/50 mm ballscrew clamp nut should be torqued to 50 FT-LBS.

• Tighten the clamp nut screw and mark with yellow paint.
• Remove the shaft lock.
• Torque support mounting bolts to proper specifications.
• Loosen the clamp nut screw and clamp nut at the bearing support end and tighten to 4 IN-LBS. against the bearing. Retighten the clamp screw.

9. Move the mill table to the far back position (motor end). Tighten down completely the five SHCS attaching the ball nut to the nut housing.

10. **For 40 and 50 mm ball screws only:**
• Move the table all the way forward. Tighten down completely the SHCS that mount the bearing support to the base.
• Loosen the clamp nut on the bearing support end. Adjust the nut until it seats on the bearing. Retighten the clamp nut hand-tight, then 1/8 turn more (If you have a torque screwdriver, torque the clamp nut to 4 in-lbs).

11. Reinstall the motor according to "Axis Motor Removal and Installation". If applicable, replace the hard stop from the ball screw support bearing end of the ball screw.

12. Reconnect oil line to the ballnut.

13. Check ball screw torque at bearing support end with torque tester. Jog the table all the way to the front. Check the ball screw torque again. It should be the same as the previous reading.

14. Check for backlash in the ball screw ("Accuracy/Backlash" section) or noisy operation.

15. Zero return Y axis and set grid offset.

Z-Axis Ball Screw Removal

Machines are currently equipped with either a hydraulic counterbalance system or an electric brake motor. Care must be taken, in either case, to avoid damaging the machine or severely injuring yourself. Heed all warnings and cautions, and read all the steps of the procedure before starting any disassembly.

WARNING!

IF THE MACHINE IS EQUIPPED WITH A HYDRAULIC CYLINDER, A SHAFT STOP BLOCK MUST BE USED TO SECURE THE SPINDLE HEAD.

DO NOT MOVE THE SPINDLE DURING BALL SCREW SERVICE.

WARNING! MACHINES WITHOUT A COUNTER BALANCE

If debug is on and the Z -axis is disabled the spindle head will fall. This is extremely dangerous and should be avoided at all costs.

1. Turn the machine ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

2. Loosen the six SHCS that attach the rear cover to the side covers, and remove from the spindle head. Remove the three SHCS attaching the Z-axis way cover to the spindle head and slide the cover to the bottom position.

3. **a.** Machines with hydraulic counter balance cylinders: Lower the spindle head to its lowest position. Install cylinder shaft stop. Handle jog Z-axis up until the shaft stop blocks the axis.

   b. Machine with Brake motors: Remove the rear Y-axis way cover and brace the spindle head up with a 4" x 4" x 14" block of wood.

4. Disconnect electrical power.

5. If applicable, remove the hard stop from the bearing housing on the ball screw.

6. Disconnect the oil line at the ball nut.

7. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the ball screw support bearing end.

8. Remove the axis motor in accordance with "Z-Axis Motor Removal".

NOTE: The motor's electrical connections do not need to be removed for this operation. After removing motor from the housing, set it to one side.

9. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the ball screw in the motor housing.

10. **For 32 mm ball screws:**
    • Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the opposite end of the ball screw to loosen.

CAUTION! Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or ball screw will result.

•Hand-turn the ball screw to move the screw up until the bottom end clears the support bearing by approximately six inches (6").
•Remove the SHCS from the ball nut and lower the ball screw down and to the right of the support bearing, past the Z-axis way cover. For the VF-6, remove the ball screw from top of column.

CAUTION! Do not damage the threads on the ball screw.

For 40 and 50 mm ball screws:

- Loosen the SHCS that mount the bearing support to the column, and remove. Remove the pull pins from the bearing support.
- Loosen the five SHCS in the ball nut and remove the ball screw by pulling from the bearing support end.

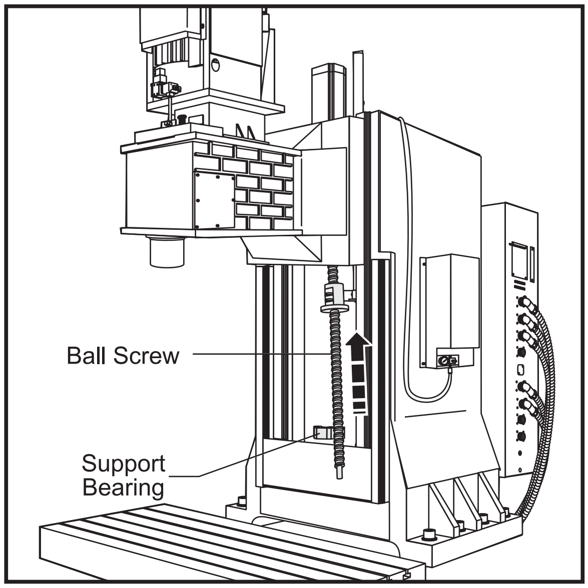


Figure 3.9-7 Z-axis ball screw and components.

INSTALLATION -

1. Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing, and ball nut are free of dirt, burrs, grease, or other contaminants.

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

---

2. **If 40 or 50 mm ball screw:**
   • Insert the ball screw into the bearing support. Screw the clamp nut on a few turns.
   • Insert the ball screw, with the bearing support attached, into place on the column. Ensure the ball screw goes through the ball nut housing and the bearing sleeve.
   • Mount the bearing support to the column with SHCS, but do not tighten completely. Replace the pull pins in the bearing support.
   • Install the spacer ring on the motor end of the ball screw.
   • Hand-turn the ball nut until it comes into contact with the nut housing mounting surface. If necessary, turn the ballscrew to correctly position lube fitting of the ball nut. Insert, but DO NOT TIGHTEN, the 5/16-18 x 3/4" (or M10 x 25 mm) SHCS, attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)
   • Skip to Step 7.

3. Slide the ball screw up into the nut housing and gently lower it until it is resting in the support bearing.

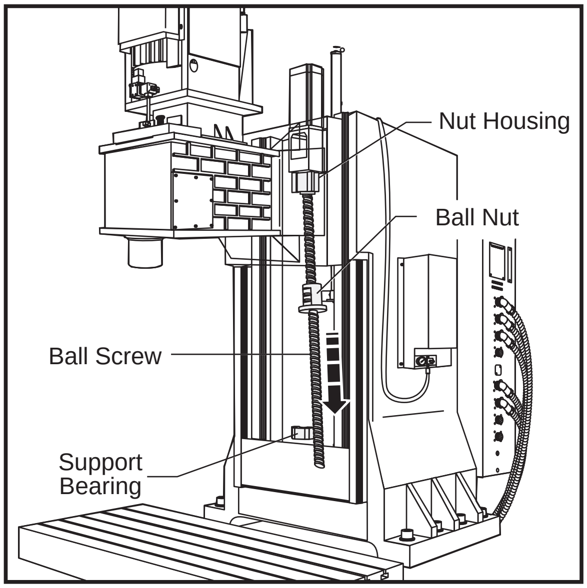


Figure 3.9-8 Reinstalling the ball screw.

4. Place the bearing sleeve in the motor housing as shown. (It may be necessary to align the bearings in the sleeve to facilitate mounting on the ball screw.)

5. Insert the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

CAUTION! Do not use more than one drop of Loctite®. An excessive amount will cause a film between the sleeve and housing, which could result in backlash.

6. Hand-turn the ball nut until it comes into contact with the nut housing mounting surface. If necessary, turn the ballscrew to correctly position lube fitting of the ball nut. Insert, but DO NOT TIGHTEN, the five ¼-20 x 1" (or ¼-20 x ¾") SHCS attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

7. The following sequence is important to ensure proper installation of the ball screw:
   •Tighten the clamp nut, hand tight, on the motor end.
   •Install and tighten clamp nut on bearing support. Ensure the nut **does not** touch the support bearing. It will be used to hold the ball screw while the other end is tightened.
   • Install the shaft lock onto the bearing support end of the ball screw. This will keep the ball screw from turning while torquing the clamp nut.
   • Place a spanner wrench on the clamp nut at the motor end of the assembly.
   • Torque the clamp nut to 15 FT-LBS.

NOTE: The 40/50 mm ballscrew clamp nut should be torqued to 50 FT-LBS.

•Tighten the clamp nut screw and mark with yellow paint.
•Remove the shaft lock.
•Torque support mounting bolts to proper specifications.
•Loosen the clamp nut screw and clamp nut at the bearing support end and tighten to 4 IN-LBS (32 mm ball screws) against the bearing. Retighten the clamp screw.

8. Tighten down completely the five SHCS attaching the ball nut to the nut housing.

9. Reinstall the motor according to "Z-Axis Motor Removal and Installation". Reinstall the hard stop at the support bearing end of the ball screw.

10. Reconnect the oil line to the ball nut.

11. Reconnect electrical power.

12. **a.** Machines with counterbalances: Jog the spindle down and remove the cylinder shaft stop.

    b. Machines with brake motors: Jog the spindle up slightly, just above the block of wood and push Emergency stop. Watch to see if the spindle head drops. If it does, check motor installation and electrical connections, and make proper repair.

13. **For 40 and 50 mm ball screws only:**
    •Jog the spindle head towards the bearing support end.
    •Tighten down completely the SHCS that mount the bearing support to the column.
    •Loosen the clamp nut on the bearing support end. Adjust the nut until it seats on the bearing. Retighten the clamp nut hand-tight, then torque the clamp nut to 10 ft-lbs).

14. Check ball screw torque at bearing support end with torque tester. Jog the spindle head to its highest position. Check the ball screw torque again. It should be the same as the previous reading.

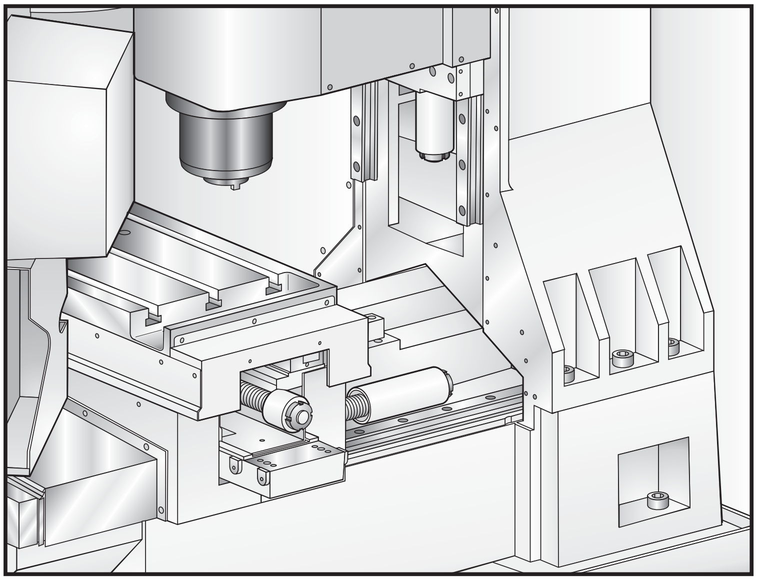
15. Check for backlash in the ball screw ("Accuracy/Backlash" section) or noisy operation.

16. Zero return Z axis and set grid offset and parameter 64 (section 3.6).

Mini Mill Ball Screws

Replacement of the mini-mill ballscrews follow the same procedures as the other mills. The ballscrews are only supported at the motor end, thereby simplifing the alignment procedure.

1. Use a standard ballscrew support bearing assembly to prevent the ballscrew for sagging, and to allow the use of the shaft lock for tightening the clamp nut at the motor end. Use only one screw to fasten the support bearing assembly (no dowel pins are necessary) to prevent it from rotating while the shaft lock is in place and tighten the clamp nut at the motor end.
2. Remove the fastener from the support bearing assembly to allow it to float on its support surface. Position the ballscrew nut toward the motor end to allow it to self align to the motor housing bearing assembly.
3. Tightening the five screws to the nut housing.
4. Install the ballscrew bumpers.
5. Install the shaft lock on the clamp nut at the motor end and allow it to wedge itself in the coupler cavity. Torque the clamp nut to 15 ft-lbs.



Ball Screw Compensation

1. Unlock the machine parameters (Setting 7).
2. Starting at zero, move the machine across its full travel.
3. Measure the error registered on the calibration device. A laser, step gauge, or similar measuring tool is necessary to complete this task
4. Divide the error by the travel of the machine. For example, a machine has 30 inches of travel and has an error of +0.003 at full travel. The machine has an error of (0.003/30) or 0.0001 inches per inch.
5. Multiply the error per inch calculated in the step above by 1,000,000,000. In this case above, the calculated value would be 100,000.
6. Go to parameter 229, 230 or 231 (depending on the axis being compensated) and type the value computed from the step above in to the display and press “Enter”. This will compensate for any scaling error in the machine. Note that no values will appear in the lead screw compensation tables.

3.10 Bearing Sleeve Removal and Installation

Please read this section in its entirety before attempting to remove or replace the bearing sleeve.

TOOLS REQUIRED

- **Spanner wrench**
- **Pre-load fixture**
- **Wood block (16" long)**
- **Z-Axis: Cylinder shaft stop (P/N 99-7562 - VF-1 through 4, P/N 93-9962 - VF-6 through 10)**

NOTE: For machines equipped with 40 or 50 mm ball screws, the ball screw must be removed in order to remove the bearing sleeve. Refer to the "Ball Screw Removal/Installation" section for instructions.

X-Axis Bearing Sleeve Removal

1. Turn the VMC ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

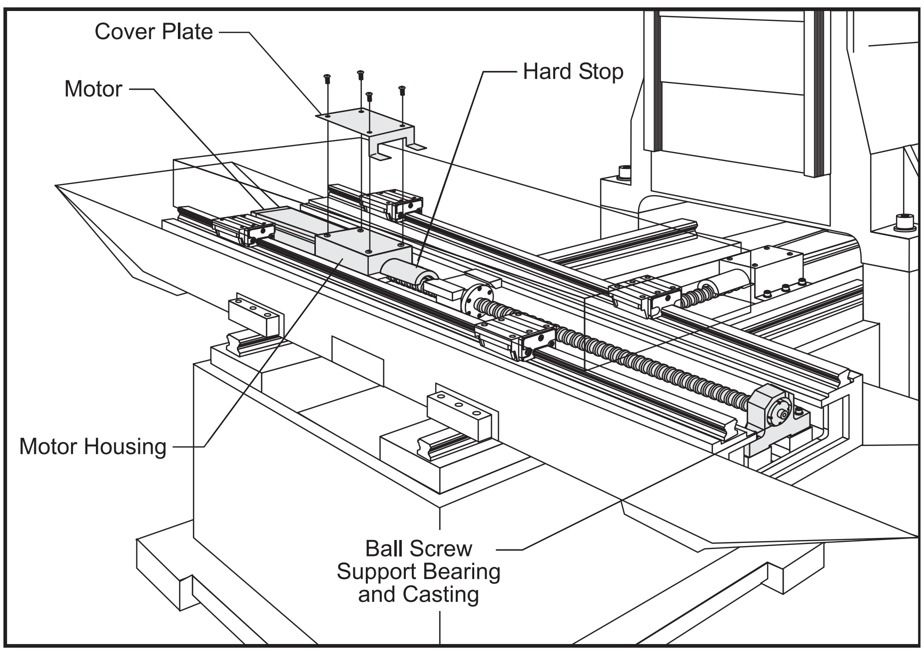


Figure 3.10-1 X-axis ball screw and components.

2. Loosen the SHCS and remove the chip tray from the mill table.

3. Jog the table to the left and remove the right way cover

4. Remove the axis motor in accordance with "X-Axis Motor Removal".

NOTE: The motor's electrical connections do not need to be removed for this operation. After removing from the motor housing, set it to one side.

5. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the ball screw in the motor housing.

6. Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the ball screw to loosen.

CAUTION! Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or ball screw will result.

INSTALLATION -

1. Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing, and ball nut are free of dirt, burrs, grease, or other contaminants.

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

2. Move mill table to the far right.
3. Place the bearing sleeve in the motor housing as shown. (It may be necessary to align the bearings in the sleeve to facilitate mounting.)

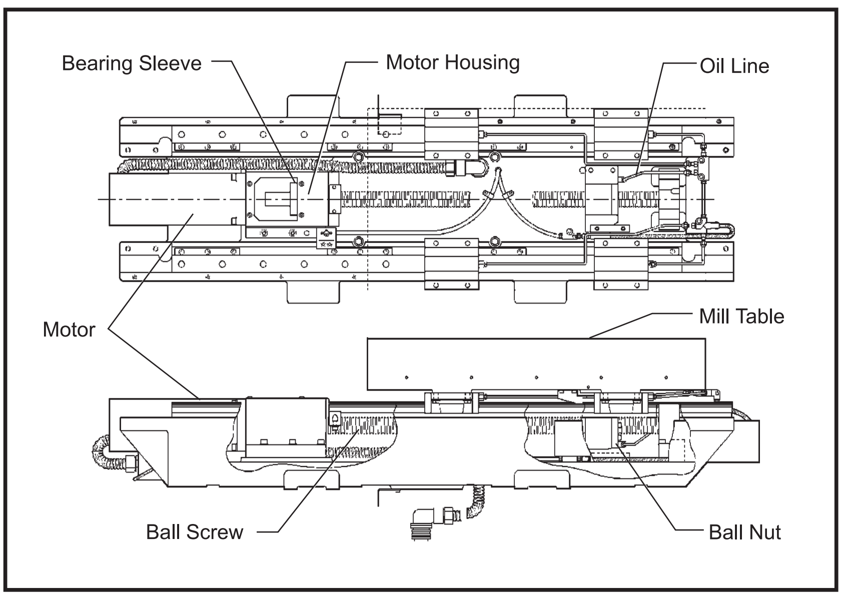


Figure 3.101-2 Ball screw assembly.

4. Insert the six ¼-20 x 1" SHCS, attaching the bearing sleeve to the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

CAUTION! Do not use more than one drop of Loctite®. An excessive amount will cause a film between the sleeve and housing, which could result in backlash.

5. Start the clamp nuts on both ends of the ball screw. Do not tighten.
6. Hand-turn the mill table to the far left position.

7. Loosen the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing and retighten completely. DO NOT SKIP THIS STEP. It ensures the ball screw is installed and runs parallel and flat to the linear guides and the saddle.

NOTE: For the angular contact design bearing, no pre-load is necessary. Do the following:

- Tighten the clamp nut on the motor housing to 15 foot-pounds.
- Tighten the SHCS on the clamp nut.
- Tighten the clamp nut on the support bearing end of the ball screw until it contacts the bearing, then tighten further approximately 1/8 of a turn.
- Tighten the SHCS on the clamp nut.

8. Reinstall the axis motor in accordance with "X-Axis Motor Removal".

9. Reinstall the way covers and chip tray.

10. Check for backlash in the X-axis ball screw (Troubleshooting section) or noisy operation.

11. Zero X axis and set grid offset.

Y-Axis Bearing Sleeve Removal

1. Turn the VMC ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

2. Remove the axis motor in accordance with "Y-Axis Motor Removal".

3. Remove the hard stop from the bearing housing on the ball screw.

4. Loosen the 10-32 x ½" SHCS and remove the clamp nut from the bearing support end of the ball screw.

5. Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the ball screw to loosen.

CAUTION! Do not pry the bearing sleeve away from the motor housing. Damage to the sleeve, bearing, or the ball screw will result.

INSTALLATION -

1. Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing, and ball nut are free of dirt, burrs, grease, or other contaminants.

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

2. Slide the bearing sleeve into the motor housing and start all six ¼-20 x 1" SHCS into the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

CAUTION! Do not use more than one drop of Loctite®. An excessive amount will cause a film between the sleeve and housing, which could result in backlash.

3. Move the table to the rear of its travel.

4. Tighten the six ¼-20 x 1" SHCS that attach the bearing sleeve to the motor housing.

5. Loosely install the clamp nut on the ball screw at the motor housing end

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NOTE: For the angular contact design bearing, no pre-load is necessary (follow the procedure in "X-axis bearing sleeve" section).

6. Reinstall the axis motor.

7. Check for backlash in the Y-axis ball screw (Troubleshooting section) or noisy operation.

8. Zero Y axis and set grid offset.

Z-Axis Bearing Sleeve Removal

WARNING!

ALWAYS BLOCK THE HYDRAULIC CYLINDER WITH SHAFT STOP BLOCK BEFORE SERVICING ANY Z-AXIS COMPONENTS.

1. Turn the machine power ON. Zero return (ZERO RET) all axes and put the machine in HANDLE JOG mode.

2. Loosen the six SHCS that attach the rear cover to the side covers, and remove from the spindle head.

NOTE: If machine is equipped with a hydraulic counterbalance, remove entire spindle head cover for VF-1/2, or right side spindle head cover for VF-3/4.

3. If the bearings are to be serviced, remove the three SHCS attaching the Z-axis way cover to the spindle head and slide the cover to the bottom position.

4. Remove the hard stop from the bearing housing on the ball screw.

5. Loosen the 10-32 x ½" SHCS and remove the clamp nut from the bearing support end of the ball screw.

6. Raise the spindle head until the bottom edge is approximately sixteen inches (16") above the mill table.

7. Install cylinder shaft stop. HANDLE JOG Z-axis up until shaft stop block axis.

8. Place the wood block beneath the spindle head and lower the spindle head until it is resting on the block.

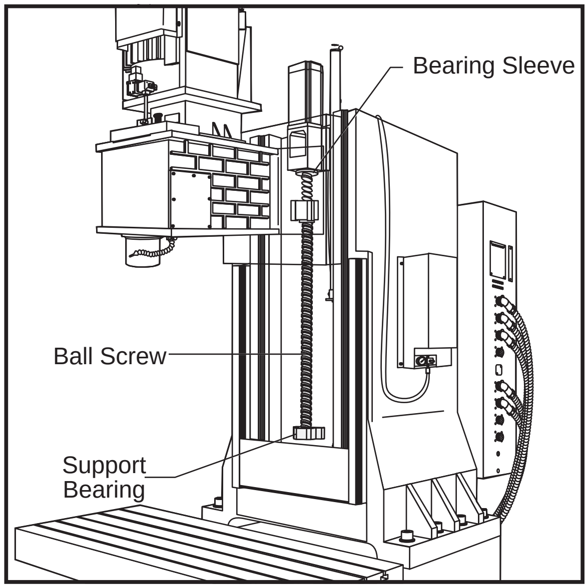


Figure 3.10-3 Z-axis bearing sleeve.

9. Perform Steps 6-10 of "Z-Axis Motor Removal".

NOTE: The motor's electrical connections do not need to be removed for this operation. After removing from motor housing, set it to one side.

10. Loosen the 10-32 x ½" SHCS and remove the clamp nut from the motor housing end of the ball screw.

11. Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Hand-turn the ball screw in an upward direction to push the bearing sleeve out of the motor housing.

CAUTION! Do not pry the bearing sleeve away from the motor housing. Damage to the sleeve, bearing, or the ball screw will result.

INSTALLATION -

1. Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing, and ball nut are free of dirt, burrs, grease, or other contaminants.

CAUTION! MATING SURFACES MUST BE CLEAN OR MISALIGNMENT MAY OCCUR, SERIOUSLY AFFECTING THE PROPER OPERATION OF THE MACHINE.

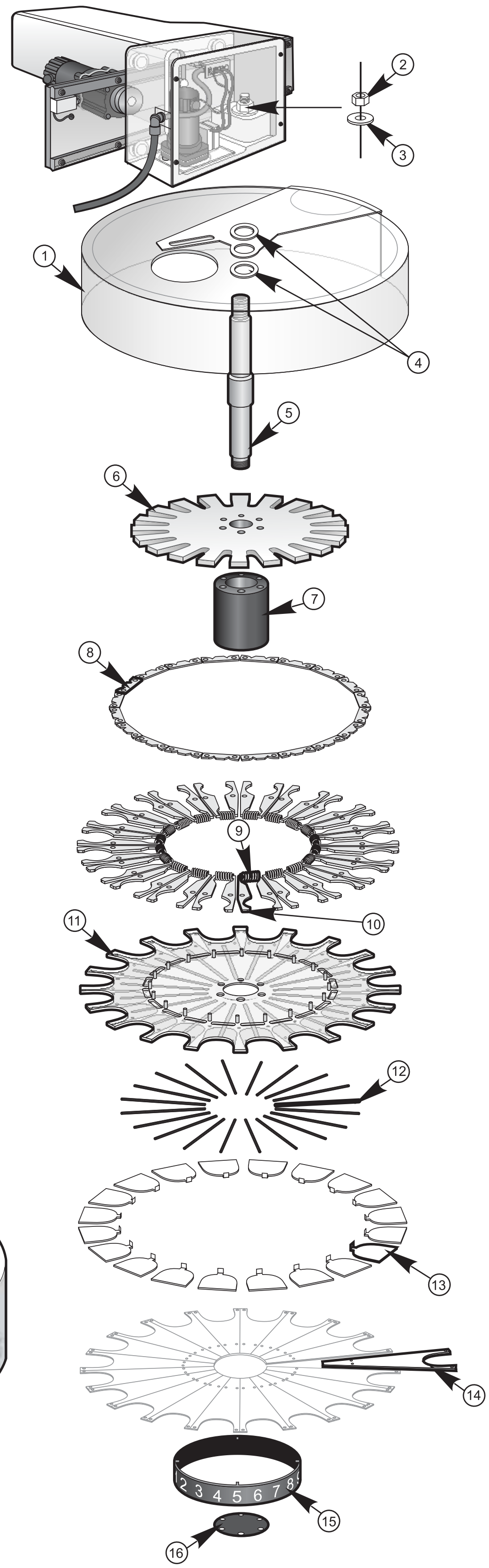
2. Slide the bearing sleeve into the motor housing and start all six ¼-20 x 1" SHCS into the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

CAUTION! Do not use more than one drop of Loctite®. An excessive amount will cause a film between the sleeve and housing, which could result in backlash.

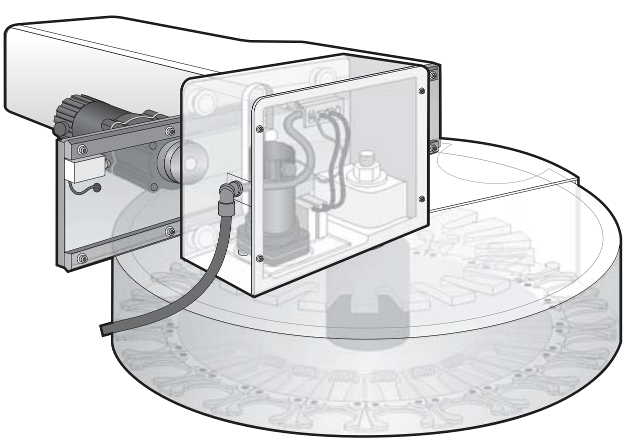
3. Tighten the six ¼-20 x 1" SHCS that attach the bearing sleeve to the motor housing.
4. Loosely install the clamp nut on the ball screw at the motor housing end.
5. Reinstall the hard stop on the bearing housing end of the ball screw.

NOTE: For the angular contact design bearing, no pre-load is necessary. Follow the procedures as outlined in "X-Axis Bearing Sleeve" section.

6. Reinstall the axis motor in accordance with "Z-Axis Motor-Installation".
7. Remove shaft stop.
8. Check for backlash in the Z-axis ball screw (Troubleshooting section) or noisy operation.
9. Zero return Z axis and set grid offset and parameter 64 according to section 3.6.



1. Toolchanger Trap Door
2. Loc Nut Elastic
3. Washer
4. Nylon Washer
5. Vertical Axle
6. 2 Pin Geneva Star
7. Bearing Housing
8. Extractor Key
9. Extractor Spring
10. Extractor Finger
11. 20 Pocket Carousel
12. Toolchanger Door Spring
13. Sliding Panel
14. Sliding Panel Cover
15. Number Ring
16. Cap, Toolchanger



Carriage Casting Replacement

TOOLS REQUIRED

- Two-jaw puller
- 1-2-3 Block
- Hydraulic jack
- Cardboard

NOTE: If the carriage casting is damaged in a crash, it must be replaced. Look specifically for broken bosses where the roller bolts mount to the casting. If the carriage casting is broken off of the holding plate but not damaged, only the roller bolts need be replaced.

1. Turn the machine power off.

2. Remove the left side enclosure panel of the machine.

3. Disconnect all cables from the carriage casting and remove any bolts holding the ATC to the holding plate.

NOTE: If the carriage casting has been damaged, replacement is necessary; move the ATC to a bench and remove all components from the damaged carriage casting and place in the new casting. Skip to Step 6 for replacement.

4. Place a piece of cardboard over the machine's table, and carefully lower the carriage casting (with carousel) onto the machine table.

5. If the carriage casting has crashed and/or has been broken off of the holding plate, it should be inspected for damage before going any further.

6. Remove any damaged roller bolts from the carriage casting. Replace with new bolts.

7. With a lifting device, carefully lift the ATC assembly up and onto the holding plate.

NOTE: Ensure the cam follower on the slip clutch engages the slot on the carriage casting.

8. With the ATC assembly securely supported, install the lower roller bolts and adjust in accordance with "Roller Bolt Replacement".

9. Repair or replace any cables damaged and adjust the ATC. Align the ATC assembly in accordance with the following sections, and set Parameter 64 in accordance with "Spindle Motor and Transmission" section.

Roller Bolt Replacement

1. Remove the shuttle motor cover from the back of the machine (VF-1, VF-2).

2. Place a support under the center of the carousel.

3. Loosen the eccentric locks on the bottom roller bolts.

CAUTION! Ensure the ATC is securely supported, otherwise it may fall when an upper roller bolt is removed.

4. Carefully remove the damaged roller bolt from the ATC shuttle and replace with a new bolt.

NOTE: REPLACE ONLY ONE ROLLER BOLT AT A TIME. Carefully inspect the V-groove rollers for roughness or damage, and replace if necessary.

5. Tighten the eccentric locks on the bottom rollers until there is no play between the rollers and the V-guide on the ATC holding plate.

6. Set the tool change offset (Parameter 64) in accordance with "Setting Parameter 64" section.

7. Verify the ATC alignment in accordance with the following section.

8. Reinstall the shuttle motor cover (VF-1, VF-2).

Automatic Tool Changer (ATC) Alignment

1. Verify that the spindle orientation is correct (Refer to appropriate section).

2. Command an automatic tool change, and press EMERGENCY STOP when the shuttle is in the full in position.

3. Verify that the spindle dog lines up to the alignment key in the ATC, in the Y plane.

NOTE: If the spindle dog and alignment key do not line up, loosen the four HHB that hold the ATC holding arm to the column.

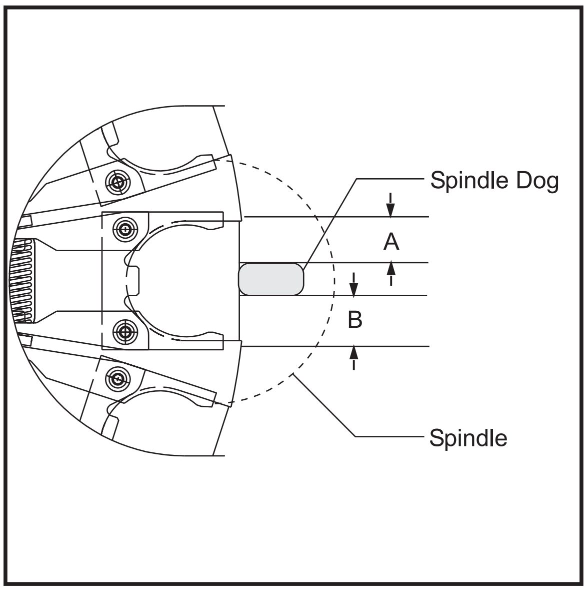


Figure 3.11-1. Underside showing centering measurements.

4. Move the entire tool changer until the tool alignment key lines up with the spindle dog. Tighten the four HHB.

NOTE: Parameter 64 must be checked, and adjusted if necessary, when the ATC is aligned.

5. Make at least 50 tool changes after the alignment is complete. Verify that the tools are being picked up squarely.

Shuttle Stroke Adjustment

6. Move the ATC away from the spindle and loosen the four HHBs in the ATC holding arm in the X-axis plane.

7. Push the cam follower to its full upward stroke, then push the entire ATC assembly in by pushing on the tool changer holding plate until ATC is fully engaged on the tool holder.

8. Ensure the extractor is making full contact on the tool flange.

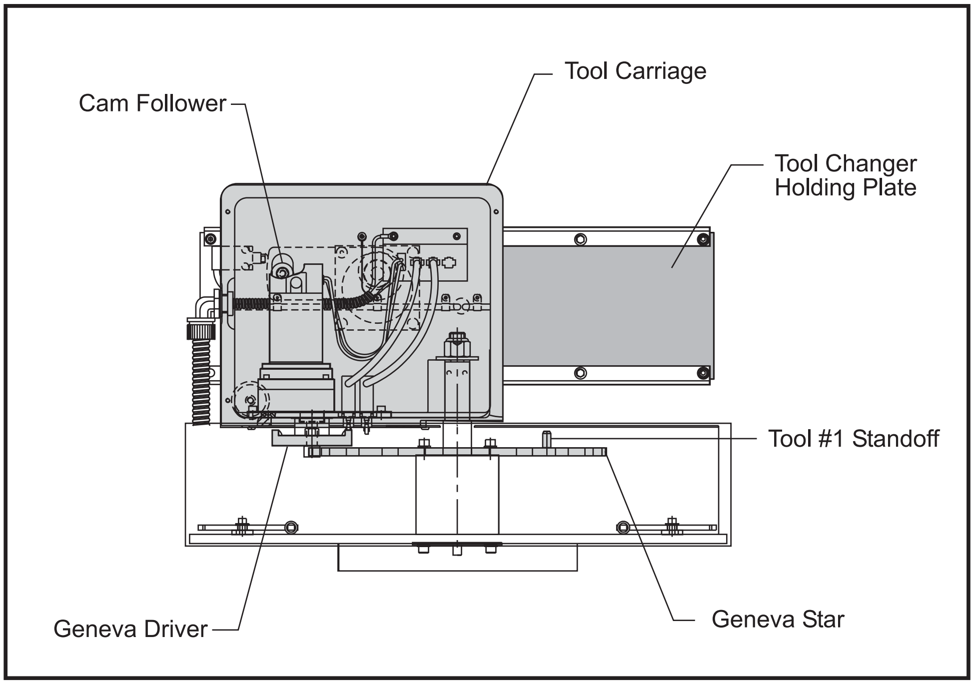


Figure 3.11-2 Automatic Tool Changer - Mechanical Assembly (Side View)

Extractor Fork Replacement

NOTE: Extractor forks that do not hold the tool holders firmly, or forks that are bent, must be replaced. Damage to the ATC will result if not replaced.

1. With no tool holders in the spindle or in the ATC, command "ATC FWD" until the extractor fork needing replacement is facing the spindle.

2. Command "ATC FWD" again, but press the EMERGENCY STOP after the spindle head lifts up off the carousel

NOTE: At this point, the shuttle should be in and the spindle should be about 4½" above the carousel.

3. Loosen the SHCS that attach the damaged extractor fork to the ATC carousel.

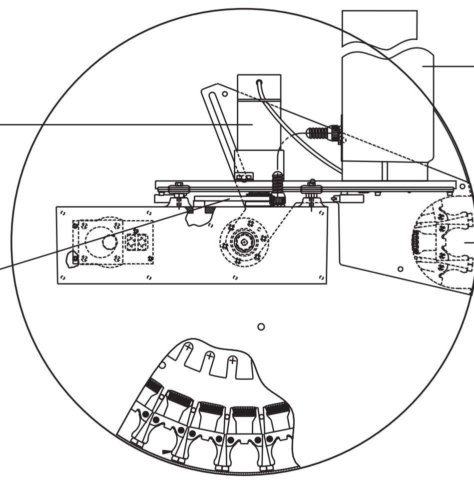


Figure 3.11-3 Automatic Tool Changer - Mechanical Assembly (Top View)

4. With the extractor fork removed, inspect the alignment key mounted under the extractor. If it is damaged due to improper spindle orientation, replace it and correct the orientation (Refer to appropriate section) after the extractor fork has been replaced.

5. Put a drop of blue Loctite on each of the SHCS and attach the new extractor fork to the ATC with the SHCS. **DO NOT OVER-TORQUE!** Ensure the distance from the edge of the extractor fork to the edge of the pocket in the carousel is the same on both sides in accordance with the following section.

6. Test run the ATC to ensure proper operation.

Sliding Cover Replacement

NOTE: If any of the sliding covers on the ATC do not slide freely or are bent in a crash, they must be replaced.

1. Loosen the four screws that attach the sliding panel cover to the carousel. Be careful to not lose the spring that holds the sliding cover closed or the number plate on the ATC carousel.
2. Inspect the cover for any galling or damage. Inspect the spring for damage.
3. Loosely install the two innermost screws that attach the number plate and the cover to the carousel and slide the spring into position in the slot in the ATC carousel.
4. Put the replacement sliding panel in place, making certain that the tongue on the panel pushes on the end of the spring.
5. Tighten the two rear screws completely and install the two front screws.
6. Ensure the sliding panel moves freely.

NOTE: If the sliding door is bent, determine the cause before resuming normal operation.

Shuttle Motor Removal

1. Turn the VMC off.
2. Remove the cover from the tool carriage casting.
3. Remove the hex bolt that attaches the cam follower to the slip clutch (see Fig. 3.11-2).
4. Push the tool changer in as far as it will go.
5. Loosen the set screw that secures the slip clutch assembly to the shuttle motor (see Fig. 3.11-3).
6. Using a small two-jaw puller, pull the slip clutch assembly (see Fig. 3.11-3) off the shuttle motor shaft.
7. Remove the SHCS attaching the cover to the holding arm casting on the tool changer.
8. Remove the cover from the wire channel inside the holding arm casting and unplug the shuttle motor from the wiring harness.

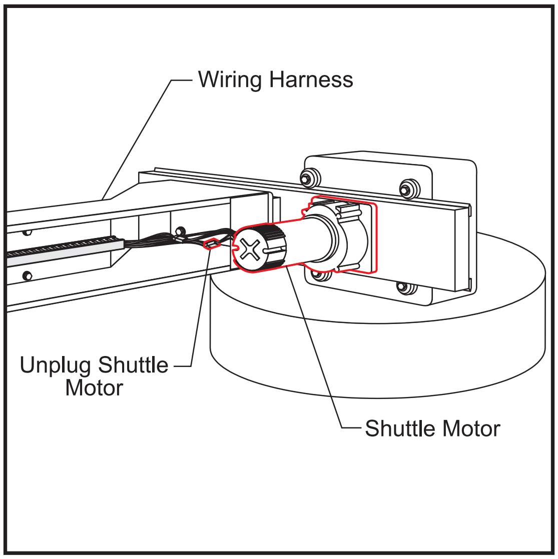


Figure 3.11-4 Wiring harness for shuttle motor.

9. Remove the four FHCS attaching the shuttle motor to the holding plate on the tool changer. The FHCS are visible from the front of the VMC. Do not remove the HHBs holding the shuttle motor gear box together.

Shuttle Motor Installation

1. Install the new motor on the tool changer holding plate using the four 10-32 x ¾" FHCS. Before inserting the FHCS, place a drop of blue Loctite® on each screw.
2. Reattach the shuttle motor connection to the wiring harness in the holding arm casting.
3. Replace the cover on the holding arm casting.

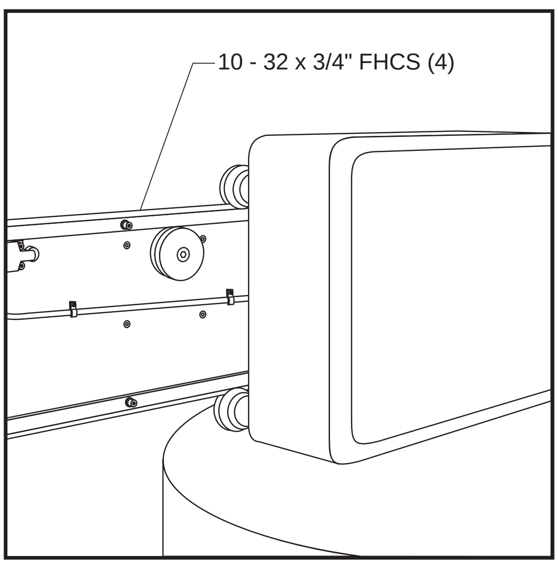


Figure 3.11-5 Front view of holding plate showing FHCS location.

4. Reattach the slip clutch assembly to the shuttle motor shaft. Before placing on the shaft, put two or three drops of red Loctite® on the slip clutch hub.

5. Insert and tighten down the set screw holding the slip clutch assembly to the shuttle motor shaft. Before inserting the set screw, put a drop of blue Loctite® on the set screw.

6. Ensure the actuating arm on the slip clutch assembly contacts the shuttle IN and OUT limit switches.

7. Ensure the hub of the slip clutch assembly does not interfere with the face plate on the shuttle motor.

8. Start the VMC and go through a performance check consisting of at least 30 tool changes, assuring correct operation.

Turret Motor Removal

1. Power on the VMC and put it in MDI mode.

2. Zero Return all axes (ZERO RET - AUTO ALL AXES).

3. Press ATC FWD then the EMERGENCY STOP after the spindle head has moved during the tool change cycle. At this time, the tool changer should be at the full in position and the spindle head should be above the tool changer.

4. Turn the VMC power OFF.

5. Remove the 10-32 SHCS from the carriage casting cover and remove the cover.

6. Tag both limit switch connections for reassembly, then unplug the limit switches and the power connections at the carriage casting.

7. Remove the four SHCS attaching the turret motor and mounting plate to the tool carriage casting.

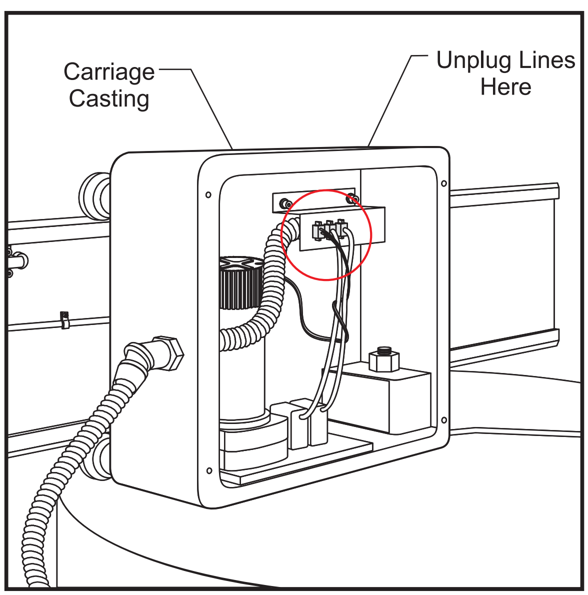
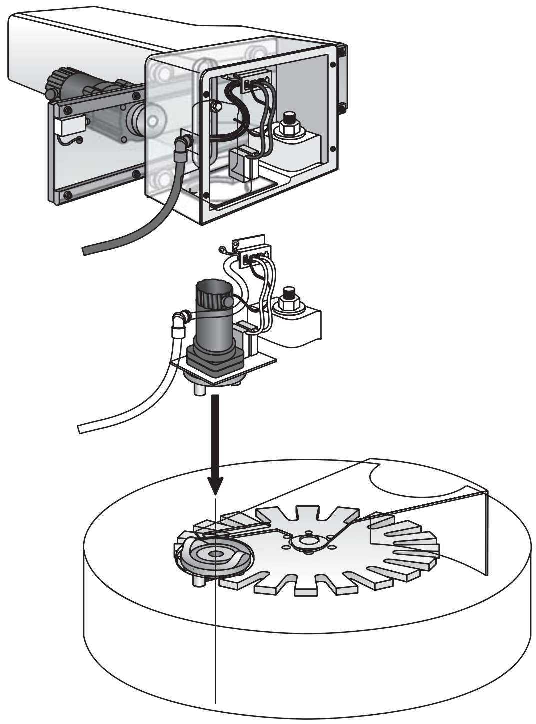


Figure 3.11-6 Carriage casting with cover removed.

8. Carefully lift the turret motor assembly off of the tool carriage casting.

NOTE: The gear motor should never be disassembled and is not field-serviceable. All gear motors should be returned to Haas for evaluation and rebuilding.

INSTALLATION -



1. Grease the locking element and drive pin on the Geneva driver. Also, grease the teeth on the Geneva star.

2. Rotate the Geneva driver until the cam depresses the limit switch on the turret motor assembly.

3. Place a narrow strip of paper around the locking element of the Geneva driver and install the turret motor assembly onto the casting. Be certain that the locking element of the Geneva driver is seated against the star with the paper strip acting as a shim.

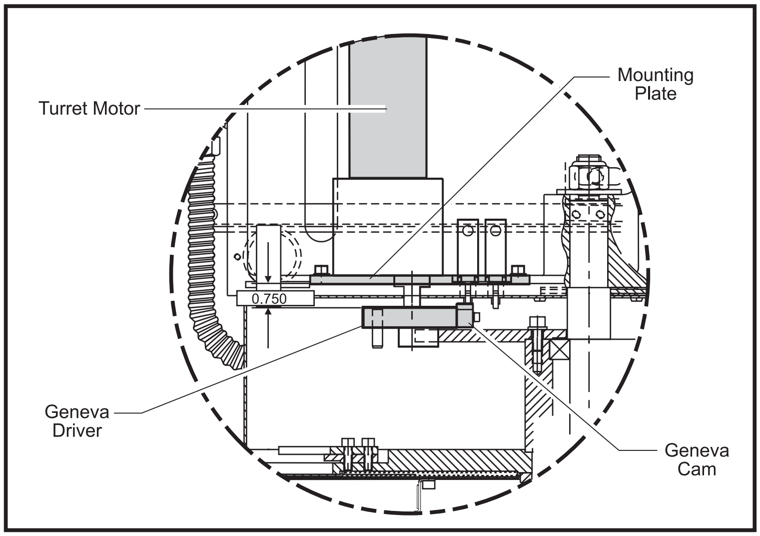


Figure 3.11-7 Required spacing for Geneva driver.

4. Attach the turret motor assembly to the carriage casting with the four SHCS.

5. Reconnect the power and limit switch lines to the turret motor.

6. Power on the VMC and ZERO RETURN all axes (ZERO RET - AUTO ALL AXES).

7. Go to MDI mode and press "T - 1 - ATC FWD".

NOTE: The machine may alarm at this time (Alarm 115 or 127). If this occurs, ZERO RETURN the Z-axis (ZERO RET - SINGL AXIS) and repeat step 8. This step may need to be repeated two times to clear all possible alarms.

8. Press "T - 9 - ATC FWD". The tool changer should go to tool nine. If the tool changer travels to tool seven, the turret motor is wired backwards. Reverse motor leads and repeat steps 7-10. Also, the turret should run quietly with no strain in the motor, banging, or vibration.

9. Reinstall the tool carriage casting cover.

10. Test the tool changer for proper operation.

Geneva Star Replacement

NOTE: If the ATC Geneva star is damaged or worn in its driven slots, it must be replaced.

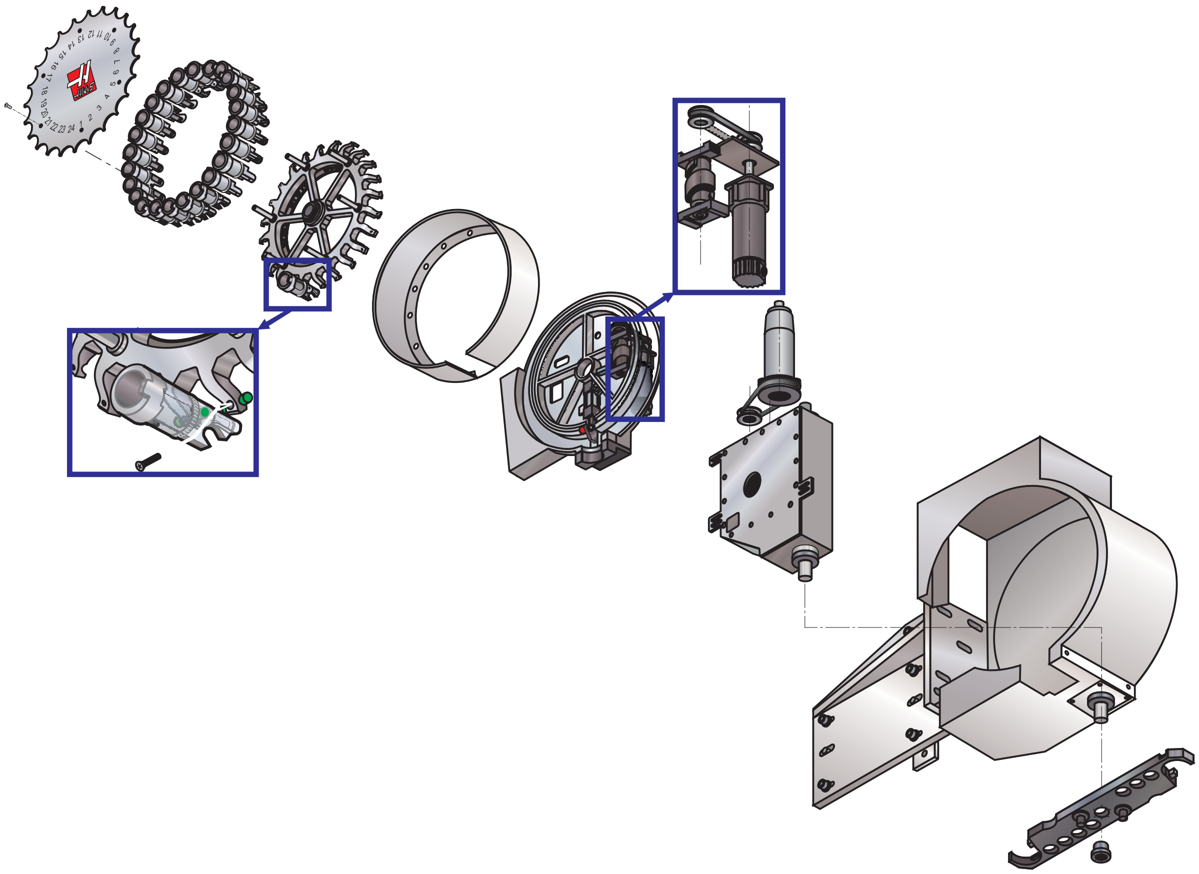
1. Turn the machine power off.
2. Remove the cover from the front of the ATC shuttle.
3. Remove the turret motor assembly (Refer to previous section).
4. Place a support for the ATC under the center of the carousel.
5. Loosen the nut inside the carriage casting that attaches the ATC carousel assembly to the casting. There is a socket head in the top of the shaft to hold it stationary while loosening the nut.
6. Place the cardboard over the mill table and carefully lower the carousel until it rests on the table.
7. Remove the six SHCS that attach the Geneva star to the bearing housing on the ATC carousel.
8. Install the Tool #1 standoff on the replacement Geneva star.
9. Install the replacement Geneva star. Check the concentricity of the star to the shaft on the carousel assembly; it must be within 0.005". If the star is not within tolerance, loosen the SHCS and adjust the alignment until it is acceptable.
10. Installation is reverse of removal. Be certain to grease the perimeter of the star before installation and readjust the ATC in accordance with "Alignment Preparation" and "Shuttle Stroke Adjustment", if necessary.

ATC Trap Door Replacement

NOTE: If the ATC trap door is damaged in a crash, it must be replaced.

1. Turn the machine power off.
2. Remove the turret motor assembly in accordance with the previous section.
3. Place a support for the ATC under the center of the carousel.
4. Loosen the nut inside the carriage casting that attaches the ATC carousel assembly to the casting. There is a socket head in the top of the shaft to hold it stationary while loosening the nut.
5. Place the cardboard over the mill table and carefully lower the carousel until it rests on the table.
6. Remove the two SHCS that attach the guide pin for the ATC trap door to the ATC holding plate and remove the guide pin.
7. Slide the trap door from between the carousel cover and the shuttle casting. Be careful to not lose the two nylon washers that sandwich the trap door between the carousel cover and the shuttle casting.
8. Installation is reverse of removal. When installing the guide pin, ensure the mounting slot is approximately central to the mounting screws and be certain the pin does not interfere with the top of the ATC carousel cover. Grease the carousel cover where the plastic standoffs ride, the slot in the ATC shutter, the guide pin, and the nylon washers where the shutter pivots. The position of the ATC may need to be readjusted after installation.

3.12 40 Taper Carousel Side Mount Tool Changer



Special Tools Required:
- **Lifting Device (1000lb capacity for ATC removal)**
- **Spanner Wrench**
- **Split Tools**

40 Taper Carousel Removal and Installation

Removal:

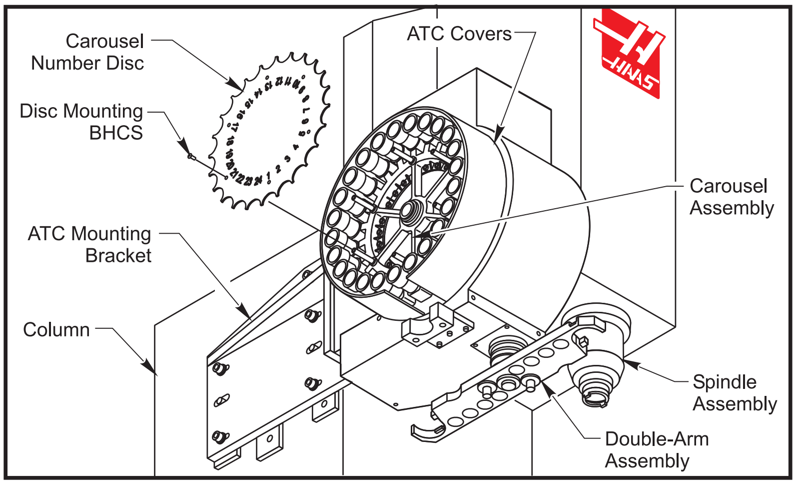


Figure 3.12-1 ATC Assembly, Carousel Removal

1. Power Off machine.

2. Unscrew the BHCS from the carousel number disc and remove. Refer to Figure 3.12-1.

3. Using a spanner wrench, remove nut on the center shaft of the carousel.

4. Carefully pull carousel assembly from the ATC center shaft. Lift carousel away from the machine and carefully avoid hitting the sheet metal covers. Place assembly in service area.

CAUTION! Be careful not to bend the tool pocket orientation tabs when storing the carousel assembly.

---

5. Unscrew the FHCS for each tool pocket. Remove the tool pocket holders from carousel. Refer to Figure 3.12-3.

Installation:

1. Carefully lift and place carousel on to the center shaft.

2. Install new carousel retaining nut on to the ATC center shaft and torque to 85 ft-lbs (place the locking portion of the nut towards the end of the shaft). Remove the pocket stop and slider.

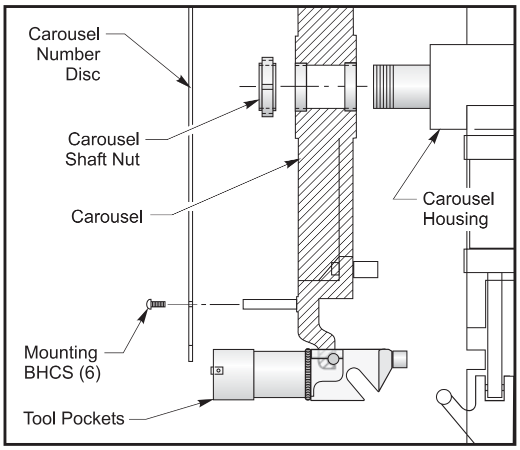


Figure 3.12-2 Carousel Assembly

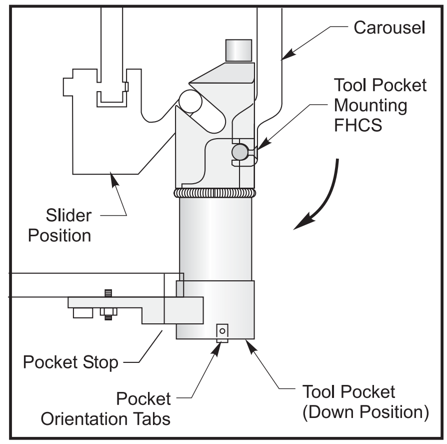


Figure 3.12-3 Carousel and Tool Pocket Installation

3. Install each tool holder through the spindle. Attach the tool pocket to the carousel. Apply blue loctite to the Torx and torque to 15 ft-lbs (1/4-20) / 23 ft-lbs (5/16-18). Manually rotate the carousel for each tool pocket installation. Re-install the pocket stop and slider. Refer to Figure 3.12-3. The carousel can be rotated by manually rotating the carousel pulley by hand. See Figure 3.12-4

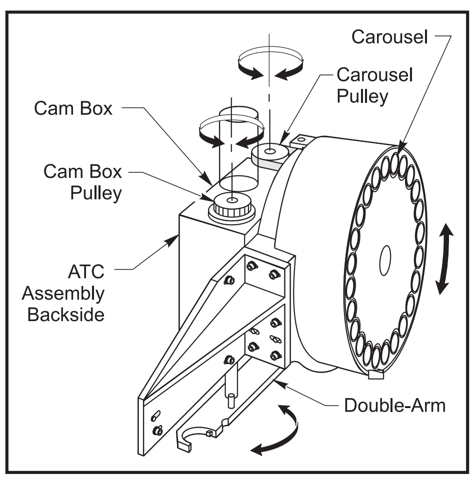


Figure 3.12-4 Pulley locations and ATC movement

4. Re-attach the carousel number disc with the BHCS. Apply blue loctite to the BHCS and tighten.

5. Re-check slider adjustment. Refer to section on tool pocket slider adjustment.

50 Taper Carousel Removal and Installation

Removal

CAUTION! Do not attempt to remove the carousel with the pockets installed.

1. Remove sheetmetal disc covering the carousel. Press <**TOOL CHANGER RESTORE**>. Press <**Y**> three times to enter Tool Changer Recover Mode.

2. Remove all tool changer pockets. See the **50 Taper SMTC Pocket Removal and Installation** in this section.

NOTE: The carousel can be manually rotated by turning the carousel drive motor by hand while in <**E-STOP**>.

3. Remove the center bearing nut using Haas tool P/N 1357.

4. Remove the carousel using a suitable lifting device.

CAUTION! The carousel is extremely heavy. Ensure you have an appropriate lifting device and straps capable of lifting the carousel weight.

Installation

1. Using a suitable lifting device, place the carousel onto the tool changer body.

2. Use a new bearing nut and thread onto the carousel shaft. Torque to 80 ft./lbs.

3. Install pockets into the carousel following the **50 Taper SMTC Pocket Removal and Installation** section.

4. Rotate the carousel by hand to the next pocket. Line up the pocket mounting finger with the actuator shaft (or micro switch) on the flat spot on the carousel cam.

ATC Assembly Removal / Installation

Removal:

1. Power Off machine.

2. Remove all ATC assembly sheet metal covers and fasteners.

3. Remove the tool changer amphenol connection at the control box and tool pocket air line at the top of the carousel. Wrap and tie the amphenol connector to the top of the carousel cam box.

4. Insert an eye-bolt into the threaded 1/2-13 hole at the top of the carousel housing. Attach the lifting device to the eye-bolt and support the ATC assembly (Refer to Figure 3.12-5). Remove the five carousel mounting SHCS from the ATC mounting bracket and move ATC assembly away from the column (Refer to Figure 3.12-6).

5. Carefully raise the ATC assembly until it is out of the machine. Avoid catching the double-arm on other machine parts.

6. Lower the ATC assembly with the back side of the cam box towards the ground. See Figure 3.12-5.

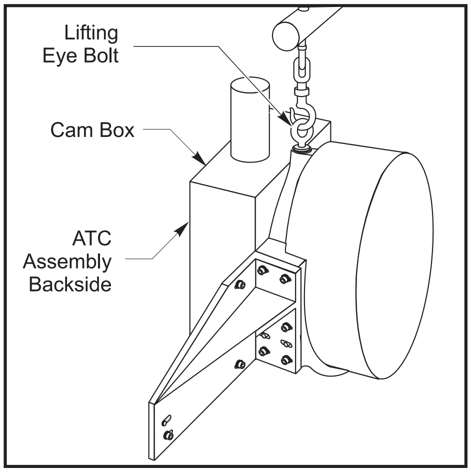


Figure 3.12-5 ATC Assembly Lifting Position

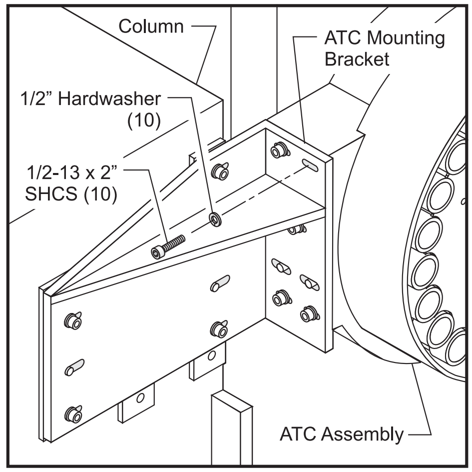


Figure 3.12-6 ATC Mounting Bracket

Installation:

1. Power Off machine.
2. Clean mounting surfaces of the ATC mounting bracket and the ATC.
3. Align the ATC with the mounting bracket and attach with SHCS. Only snug the SHCS.
4. Reconnect the tool changer amphenol connector to the control and re-attach the air line to the carousel assembly.
5. Align the ATC assembly according to section on ATC alignment.
6. Torque the SHCS to 100 ft-lbs.
7. Replace all carousel sheet metal covers and fasteners. Apply blue loctite to all fasteners and tighten.

ATC Alignment for 40 and 50 Taper

Servo tool changer, like those used on Super Speed machines, must have the grid offset and tool change offset set before starting the alignment procedure. See the followign section, “Servo Tool Changer Offsets” for the necessary steps.

Use Split Tool P/N T-2086 for 40 taper, CT type
T-2087 for 40 taper, BT type
T-2089 for 50 taper, CT type
T-2088 for 50 taper, BT type

Cam Box to Tool Pocket Alignment:

1. Remove all cam box sheet metal fasteners and covers. Place protective covers on the machine table.
2. Power Up machine. Raise Z-axis to top of travel. Set the machine control to Tool Change Recovery Mode (TCR) .
3. Push the ARROW DOWN button, to activate the tool pocket down (insure proper tool pocket operation). Refer to figure 3.12-7.

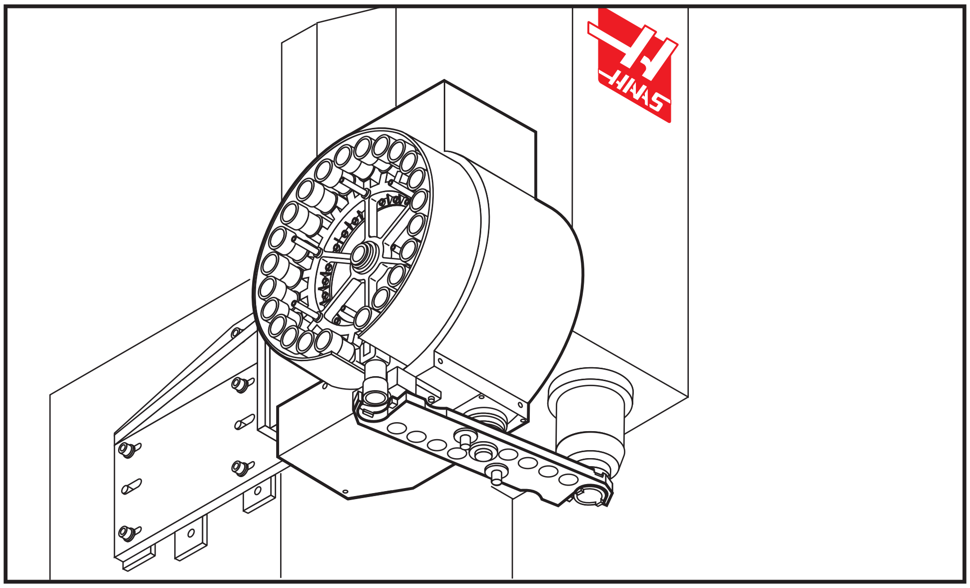


Figure 3.12-7 Double Arm Alignment

4. POWER OFF the machine. Disconnect the air supply line at the rear of the machine. The tool pocket will raise once the air is disconnected.
5. At the top of the ATC assembly, reverse the two air lines going from the solenoid valve to the air cylinder. See Figure 3.12.8. Reconnect the air supply line at the rear of the machine. (The tool pocket holder in the tool change position should move down)

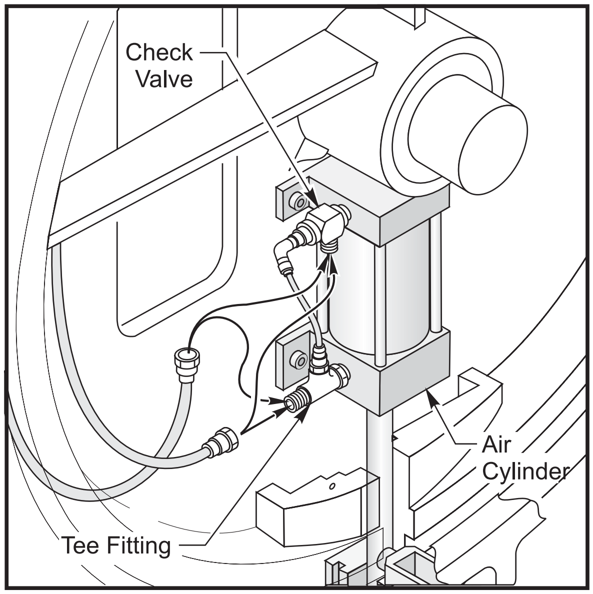


Figure 3.12-8 Airline connection location

6. At the top of the ATC assembly, manually rotate the cam box pulley clockwise until the output shaft is lowered and just before it begins to rotate 180^0.

7. Align the double-arm underneath the tool pocket and the spindle with the unlocking finger buttons facing upward. Place the double-arm on to the shaft and snug the lock ring on the bottom of the double-arm with the SHCS.

8. Place the split tool into the double arm end beneath the tool pocket. The split tool P/Ns for 40T are T-2084 for CT type and T-2087 for BT type; P/Ns for 50T are T-2089 for CT type or T-2088 for BT type. Depress the tool release button on top of the double-arm and insert the split tool. Slightly push the double-arm in the clockwise direction to remove backlash in the drive assembly. Refer to Figure 3.12-9.

Radial alignment of Double Arm to Carousel:

9. Rotate the cam box pulley counter-clockwise to raise the double-arm into the split tool. Visually check the centerline alignment of the split tool to the centerline of the tool pocket.

10. In order to adjust the radial alignment of the split tool to the double arm, loosen the lock ring SHCS and adjust the double-arm. Refer to Figure 3.12-9.

11. If the double arm is not aligned in the Y-axis with the centerline of the split tool, loosen the four cam box SHCS and insert a pry-bar between the slots. Adjust the cam box until the centerline of the split tool is aligned with the centerline of the tool pocket.

12. Torque the cam box SHCS to 100 ft-lbs.

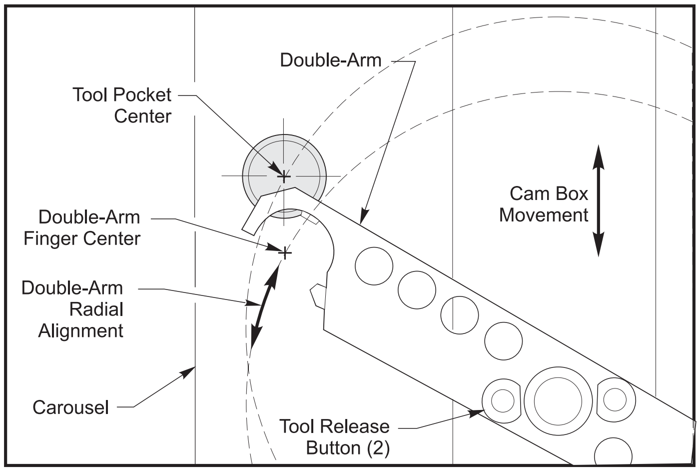


Figure 3.12-9 Cam Box / Double Arm Alignment, top view.

Checking Parallelism of Double-arm to Table:

13. Rotate the cam box pulley clockwise to lower the double arm. Remove the split tool from the double arm.

14. Rotate the cam box pulley counter-clockwise to raise the double arm back to its home position.

15. Remove the air supply line from the rear of the machine. **Switch the inlet and outlet airlines back to their original positions at the top of the ATC assembly.** Re-attach the air supply line (the tool pocket holder should retract to its home position).

16. POWER ON the machine and enter TCR mode. For more information on TCR mode refer to the TCR flow chart located in the Technical Reference section.

17. Press the ATC FORWARD button until the arm lowers and is parallel to the x-axis. Insert a split tool into the double arm by pressing the tool release button located near the shaft. Refer to Figure 3.12-9

Place a magnetic base and indicator on to the machine table. Measure the bottom of thesplit tool to the nearest .001."

18. Move the split tool and indicator setup to the other end of the double-arm. Measure the bottom of the split tool to the nearest .001." The maximum allowable height tolerance between the two ends is .030." Adjust the alignment as necessary. Repeat this test with the arm rotated 180^0.

19. Remove the split tool from the double-arm. Return the double-arm to the home position.

Setting the Double-arm Height:

20. Press the DOWN ARROW to command the tool pocket down. Place the split tool with the pull stud into the tool pocket. In TCR mode, rotate the double arm near the tool pocket.

21. Visually check the height alignment of the double arm to the V-groove on the split tool. If necessary loosen the lock ring SHCS and adjust the height of the double arm. Torque the lock ring SHCS to 15-17 ft-lbs.

22. Repeat steps 9 & 10 to re-check radial alignment.

23. Return the double-arm to the home position.

Double-Arm to Spindle Alignment:

1. ZERO RETURN the Z-axis.
2. In TCR mode, lower the double arm and re-insert the split tool into the double arm. Orient the spindle dogs for a tool change. (If the orientation has changed reset Parameter 257. Refer to section on setting spindle orientation). If spindle dogs are not aligned with the tool holder slot, manually rotate the spindle dogs.
3. Raise and lower the double-arm to move the tool in and out of the spindle. Check for alignment. Refer to Figure 3.12-10.
4. Check the X-axis alignment of the split tool to the spindle center. Refer to Figure 3.12-10.

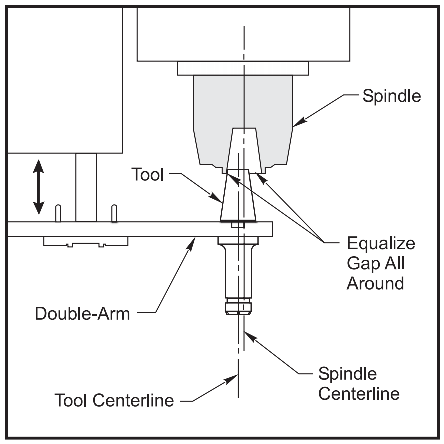


Figure 3.12-10 Double Arm to Spindle Center Alignment, along the Y-axis.

5. If necessary, loosen the five ATC mounting SHCS. Refer to Figure 3.12-11.

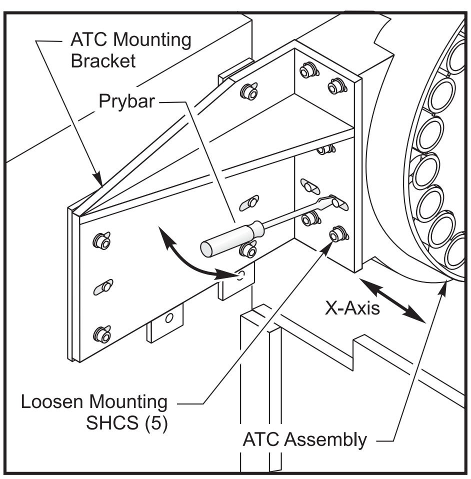


Figure 3.12-11 ATC Assembly X-axis alignment

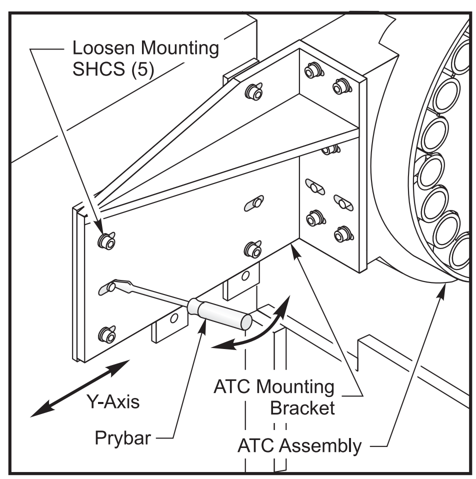


Figure 3.12-12 ATC Assembly Y-axis alignment.

6. Insert a pry-bar between the locating pins and the ATC mounting bracket. Adjust the bracket to align the split tool in the double arm to the center of the spindle in the X-axis. Refer to Figure 3.12-11.

7. Torque the SHCS to 80 ft-lbs.

8. Check the Y-axis alignment of the split tool to the spindle.

9. If necessary, loosen the five ATC SHCS (Refer to Figure 3.12-12). Insert a small pry bar between the locating pins and the mounting bracket. Adjust the ATC along the mounting slots and align the tool and spindle's center.

10. Check the spindle tool change height. If the spindle tool change height has changed, reset Parameter 64 (section 3.6).

11. Return to normal operation. Insert tool holders through the spindle and perform several tool changes. Observe the tool changer during operation and make any adjustments if necessary.

12. Torque the ATC mounting SHCS to 100 ft-lbs. Replace all cam box sheet metal covers and fasteners. Apply blue loctite to the fasteners and tighten.

Setting Spindle Orientation

1. POWER UP machine. Go to PARAMETERS. Unlock PARAMETERS and change the value under PARAMETER 257 to "0."

2. Place a tool into the spindle. Enter TCR mode. Align the spindle dogs to the double-arm key (refer to Figure 3.12-13). Press the ATC FORWARD button until the double arm engages the tool (manually rotate the spindle dogs if necessary).

3. Enter DEBUG mode. Record the encoder value under "spindle orientation position". Refer to Figure 3.12-13.

4. Return to Parameter 257. Enter the spindle orientation value from DEBUG and lock parameters.

5. In TCR mode, press the ATC REVERSE button until the double arm is in the home position. Return to normal operation mode.

6. Manually insert tools into spindle and perform several tool changes. Observe for any misalignment.

7. Adjust the PARAMETER 257 setting value if necessary.

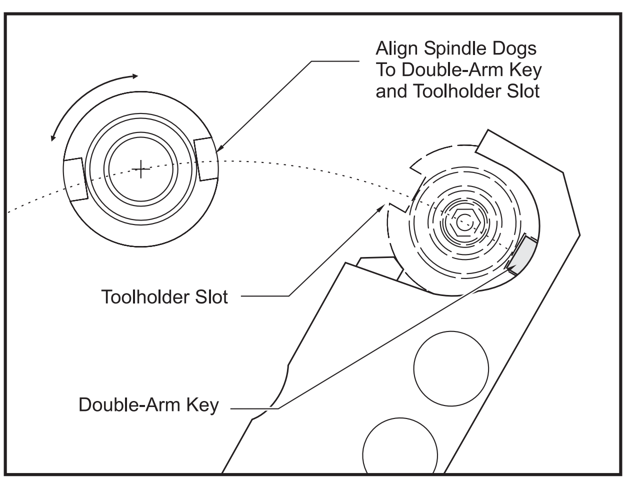


Figure 3.12-13 Spindle Orientation Setting

Double Arm Removal and Installation

Removal

1. In TCR mode, lower the double arm. POWER OFF machine.

2. Underneath the double-arm, loosen the six SHCS from the lock ring. Insert four new jack screws into the lock ring (Coat the jack screw threads and tips with moly grease).

3. Slowly tighten the jack screws in order to push the double-arm away from the lock ring. If necessary, tap the center of the double arm from underneath with a soft mallet until the double-arm breaks free.

4. Once the double-arm is loose, pull the double arm assembly off the shaft.

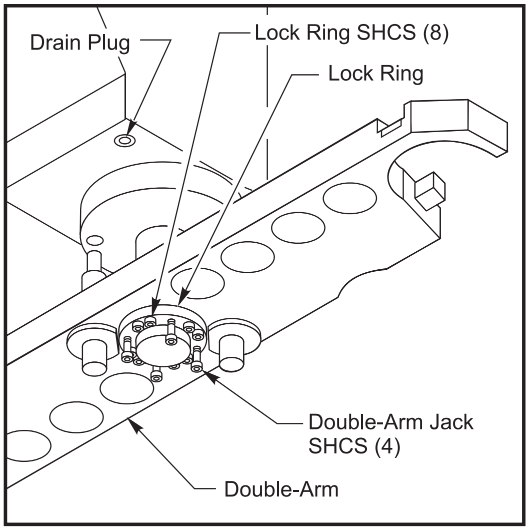


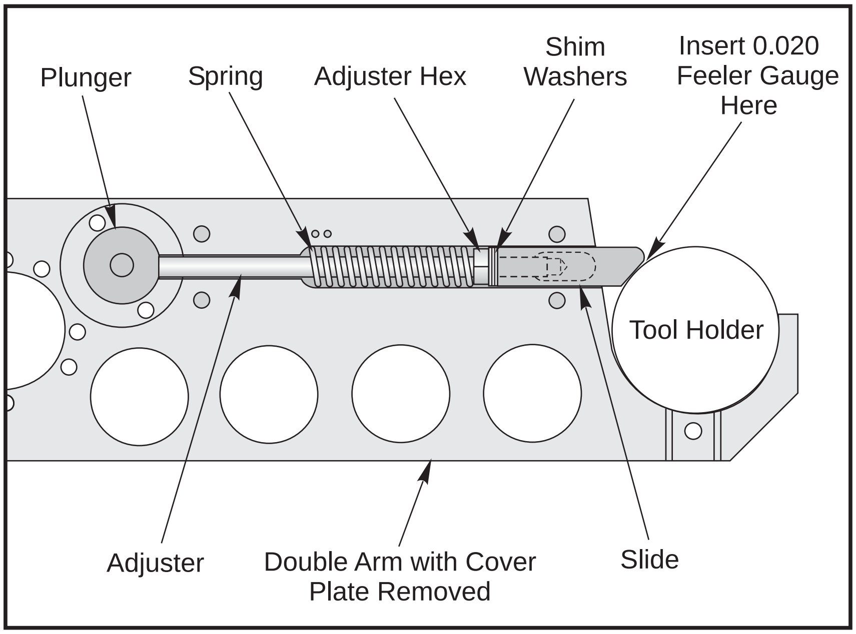
Figure 3-12-14 Removal of the Double Arm

Installation

1. Place the double-arm onto output shaft. Align the double-arm to the home position, then slide the lock ring onto the shaft.

2. Reattach the lock ring to the double-arm with eight (8) SHCS. Tighten in a star pattern to 15 ft-lbs, repeat this sequence 3 times to seat the arm lock bushing. Verify the slides are correctly adjusted on the double arm with the following procedure:

   With the double arm lowered, and the split tool inserted into the double arm, a 0.020 feeler gauge should fit between the slide and the tool flange O.D. The plunger should be able to rise fully to the locked position with the gauge between the split tool and the plunger.



The plunger will not return reliably to the fully raised locked position when the tool is inserted, if there is insufficient clearance. The split tool will be excessively loose in the doublearm if there is too much clearance.

To adjust the clearance, remove the slide and the cover by removing the cover plate and lifting the slide out at an angle. Be careful not to lose the spring. Loosen the adjuster and correct the clearance by adding or removing shim washerd. Apply blue Locctite and retighten. Grease the spring and the slide assembly and reinstall them both. Reattach the cover plate and recheck the clearance. Both ends of the double arm are separately adjusted.

3. Re-align the double-arm to the spindle and tool pocket. Refer to double arm alignment instructions in the previous "ATC alignment" section.

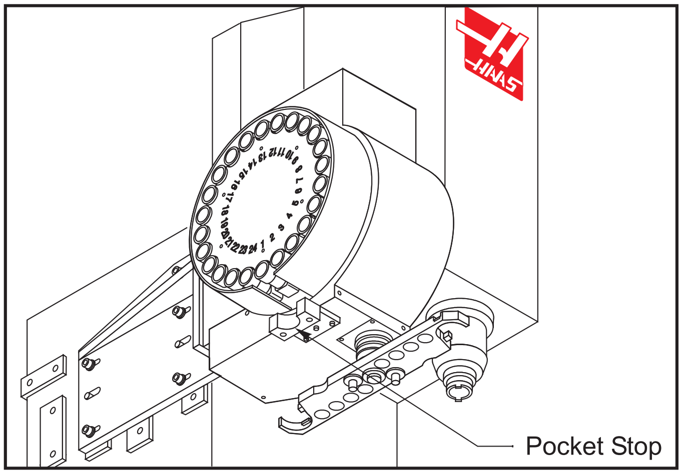
40 Taper SMTC Pocket Removal and Installation

Removal

1. Turn the machine on and rotate the carousel to the pocket you want to change. Remove the sheetmetal in order to gain access to pocket limit switches. Remove the sheetmetal disc covering the carousel.

2. Press <**Tool Changer Restore**>. Press <**Y**> three times.

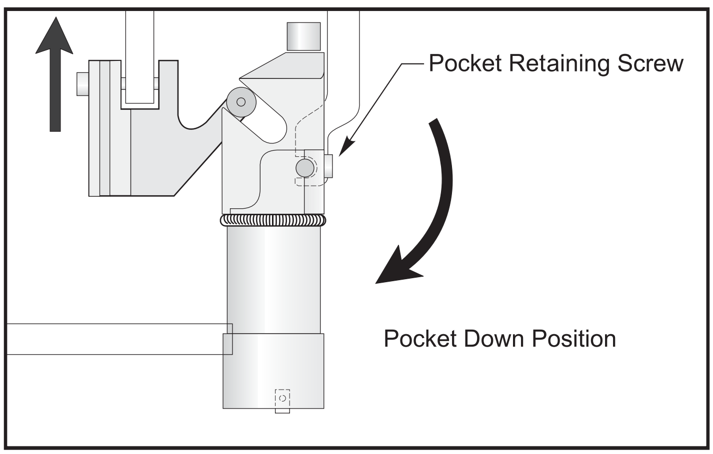
3. Remove the four SHCS that hold the pocket stop. See the following figure:



4. Remove the shoulder bolt from the back of the pocket slide.

NOTE: The machine must be in Tool Changer Recovery Mode to perform the next step.

5. Press <**v**> to retract the air cylinder shaft. Manually lower the pocket and remove the pocket retaining screw. See the following figure:



6. Remove the tool changer pocket by carefully maneuvering the pocket out of the carousel, taking care not to drop the pocket slide.

NOTE: If the carousel is to be replaced, skip to the Carousel Removal and Installation section.

Installation

7. Replace the damaged pocket with a new one. Apply grease to the shaft. Install the pocket slide and pocket into the carousel. Apply a drop of Red Loctite to the pocket retaining screw and install. Torque to 14 ft./lbs.

8. Clear all alarms. Return to Tool Changer Recovery Mode and press <**^**>. This will extend the air cylinder shaft. Install the pocket slide shoulder bolt, taking care not to pinch the microswitch roller. Ensure that the microswitch roller rests on the shoulder bolt head.

9. Install the pocket stop, using Blue Loctite and torquing the four SHCS to 40 ft./lbs. Activate the pocket up and down several times. Restore the machine to automatic mode and perform a tool change by pressing <**MDI**> and then <**ATC FWD**>. Check for any binding or interference of installed parts.

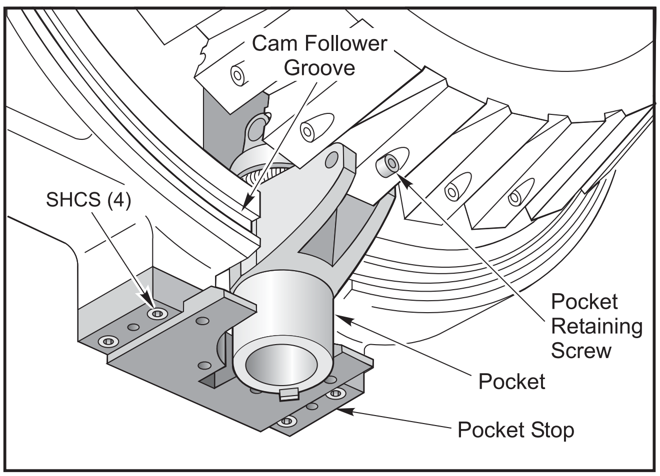
50 Taper SMTC Pocket Removal and Installation

Removal

1. Turn the machine on and rotate the carousel to the pocket you want to change. Remove the sheetmetal disc covering the carousel.

2. Press <**Tool Changer Restore**>. Press <**Y**> three times.

3. Remove the four SHCS that hold the pocket stop. See the Figure below:



NOTE: Do not remove the set screws. Doing so will change the pocket slide and groove alignments.

4. Manually rotate the carousel to the affected pocket by manually rotating the carousel motor and disconnect air from the machine. Remove the pocket retaining screw. See the Figure below:

5. Remove the tool changer pocket by carefully maneuvering the pocket out of the pocket slide fingers, taking care not to drop the pocket.

NOTE: If the carousel is to be replaced, skip to the Carousel Removal and Installation section.

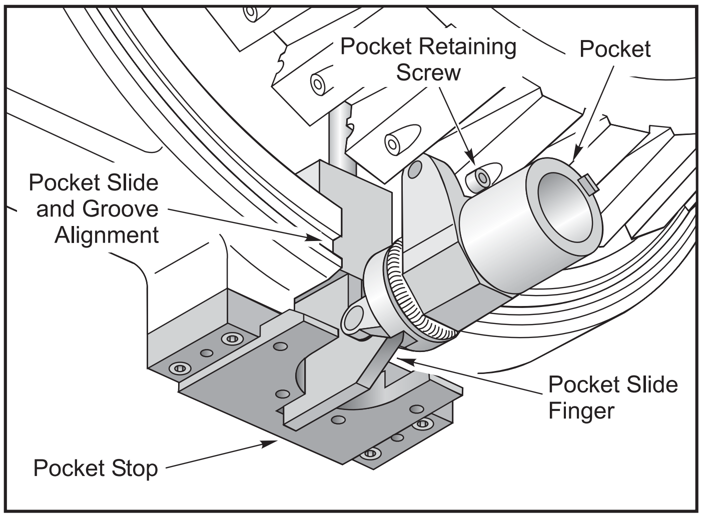
Installation

1. Replace the damaged pocket with a new one. Apply grease to the shaft. Install the pocket into the pocket slide fingers. Apply a drop of Blue Loctite to the pocket retaining screw and install. Torque to 23 ft./lbs. Reconnect air to the machine.

2. Press <^>. This will extend the air cylinder shaft and raise the pocket.

3. Install the pocket stop, using Blue Loctite and torquing the four SHCS to 45 ft./lbs. Activate the pocket up and down several times. Restore the machine to automatic mode and perform a tool change. Check for any binding or interference of installed parts.

4. Raise the pocket and verify that the pocket slide groove matches the casting groove. See the following figure.



Tool Pocket Slider Adjustment

The slider set-screw is used to adjust the tool pockets' end-of-stroke with the circular path on the carousel housing.

1. Rotate carousel by turning the carousel cam pulley by hand. Refer to Figure 3.12-4.

2. Visually check for mis-alignment (tool pockets should move smoothly). Refer to Figure 3.12-15

3. If necessary, loosen the set-screw nut. Adjust the set-screw in or out until the tool pocket is aligned with the circular path on the carousel housing. Advance the tool pocket and observe for proper alignment.

4. Tighten set-screw lock nut.

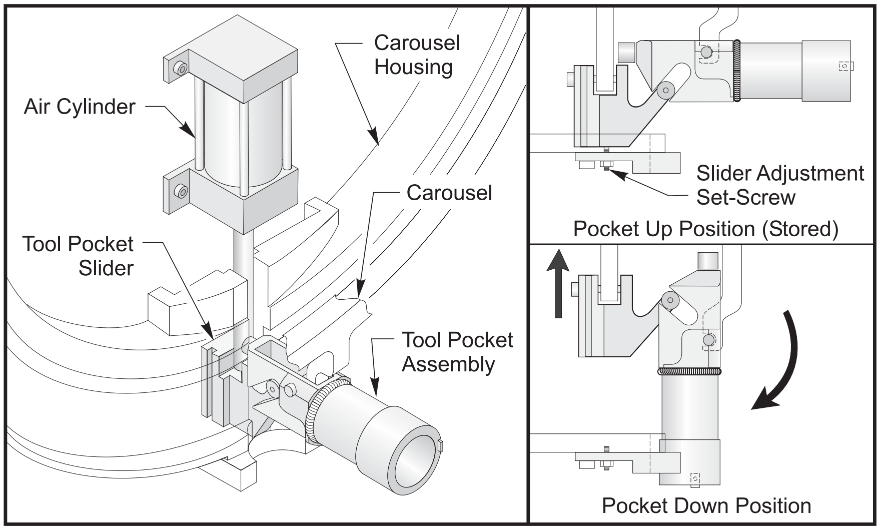


Figure 3.12-15 Tool Pocket Orientation / Set-Screw Adjustment

Proximity Switch Removal / Installation

Removal

1. Power Off machine. Remove the carousel number disc and the top cover plate.
2. Remove the 1/4"NPT plug near the cam box output shaft and drain the cam box oil.
3. Disconnect the proximity switch connector from the bracket on the top of the assembly.
4. Loosen the double nuts retaining the proximity switch. Carefully remove the proximity switch from the cam box assembly. Refer to Figure 3.12-16.

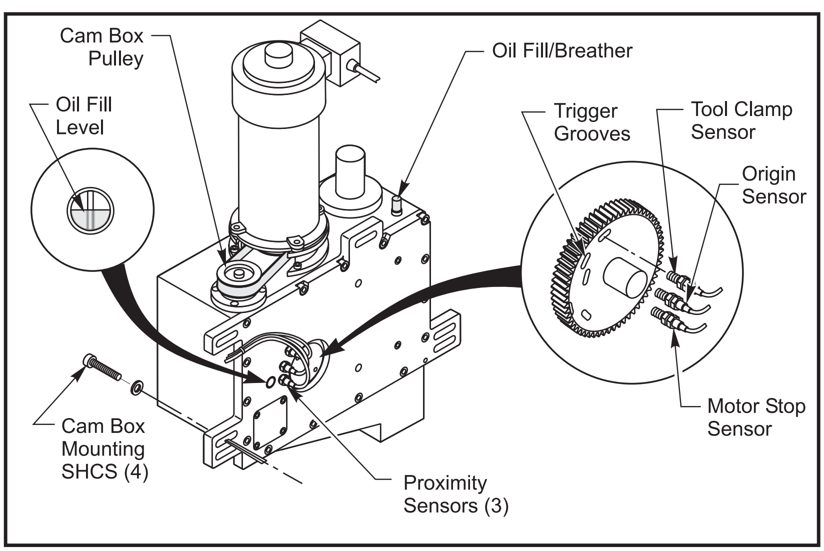


Figure 3.12-16 Proximity Sensor Switch Location

Installation

The proximity trigger disk inside the cam box determines the sensor operation. The sensor must be approximately .030” away from a flat surface on the disk to function properly. An L.E.D. light will come on at the back of the sensor when it is triggered.

1. Look through the sensor hole and rotate the cam box pulley by hand until the groove is not visible.
2. Screw two nuts to the threaded section of the proximity switch. Snug the two nuts together and apply thread sealant to the threads. Carefully screw the switch into the cam box. Connect the proximity switch connector to the plug on the switch bracket. Refer to Figure 3.12-17.

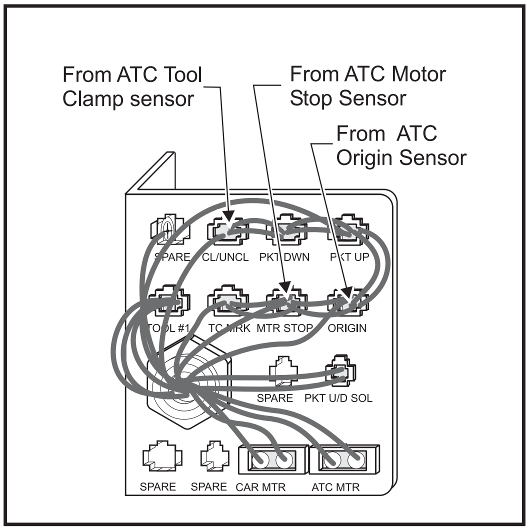


Figure 3.12-17 Proximity Switch Connection Bracket.

3. Power On machine. Press E-Stop.
4. Screw the proximity sensor into the cam box an additional 1/8 turn after the L.E.D light comes on. Loosen both nuts then re-tighten the inner nut against the cam box housing. Tighten the outer nut against the inner nut.
5. Repeat this procedure for each proximity sensor switch.
6. Refill the cam box with oil (Penzgear 320) to the fill level line. See Figure 3.12-16.
7. Check for correct operation of the tool changer and alignment. Adjust as necessary.
8. Replace the carousel disc and top cover plate. Apply blue loctite to the fasteners and tighten.

SETTING PARAMETER 64

On machines eqipped with 40 taper or 50 taper side mount tool changers this distance is:
(Distance from Home in Inches) X (Line Encoder Constant) = Z-axis tool change position setting

Example:
.625 x 138718 = 861699

To reset Parameter 64 (Z-axis tool change position) if a ATC assembly has been installed or replaced.

1. Enter PARAMETERS page and record original Parameter 64 setting value.
2. (Make sure there are no tools in the spindle head or tool pocket positions). Command the spindle head to its tool change height. Enter DEBUG and record Z-axis spindle height value.
3. Enter TCR mode. Press the DOWN ARROW, command a tool pocket down. Manually insert a tool into the tool pocket.

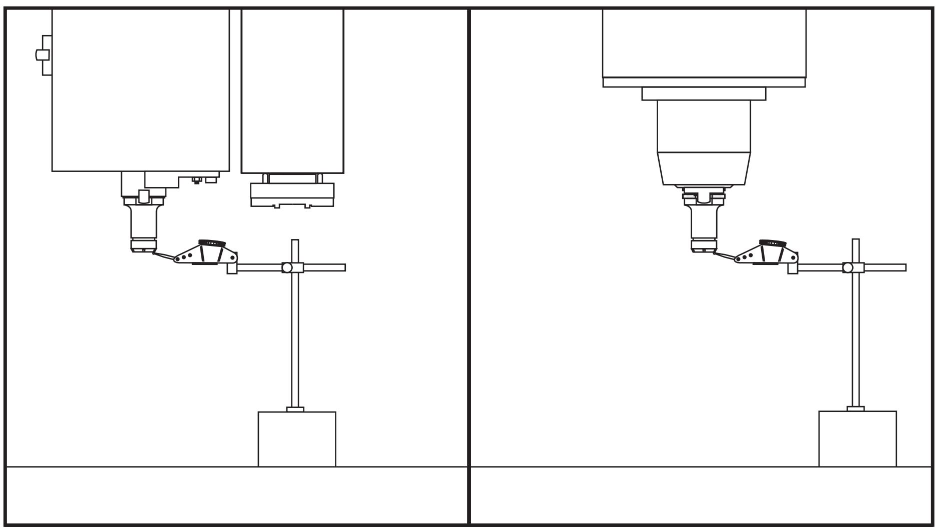


Figure 3.12-18 Setting Parameter 64, indicator reference measurement.

4. Place a 0.0005" indicator with an extended arm base on to the machine table. Indicate the bottom of the tool with the indicator to the nearest 0.001." Record the measurement.
5. Remove indicator from the table and the tool holder from the tool pocket. Insert the tool into the spindle head position. Place the measurement indicator under the spindle head.
6. Enter DEBUG. Jog handle the Z-axis up or down until the end of the tool is at the same height as the measured value found when the tool was placed in the tool pocket. Record the Z-axis spindle height value. Refer to Figure 3.12-18.
7. Take the difference in the spindle height values found in DEBUG mode and add the encoder count value to the original value for PARAMETER 64 setting.

Example: 40 Taper SMTC

(Difference in Z-axis encoder counts) + (Old Z-axis Tool Change Setting) = New Z-axis Tool Setting
20681 + 861699 = 882380

8. Enter PARAMETERS page. UNLOCK settings and write new setting value for Parameter 64. LOCK parameter settings.

9. Perform a tool change and observe for misalignment. Adjust the PARAMETER 64 setting if necessary.

Servo Tool Changer Offsets

Invisible Axis Explanation

The SMTC uses an invisible axis to control the double arm. If the axis is made visible to service or adjust it, the safety interlocks are disabled, and the automatic operation of the tool changer is prohibited. Be sure the spindle head is out of the way before rotating the double arm.

Offsets

Both the Tool Change Offset and the Grid Offset must be set before using the tool changer. The Grid Offset must be set first.

Setting the Grid Offset

The control can calculate grid offset parameters with a 'GRID' command. A grid offset is an offset that is applied to the home position of an axis so that the zero location for that axis is re-defined to be half an encoder revolution away from the home switch. It is recommended that the GRID command be used on each axis separately.

1. Zero Return all the axis
2. Turn the machine off and back on. This will un-zero all the axes.
3. Select the ALARMS screen and enter DEBUG mode.
4. Perform a ZERO SINGLE AXIS on the Tt axis. Ignore the ZERO RET MARGIN TOO SMALL alarm if it occurs. The tool arm is out of position and must be repositioned using tool change recovery, if a tool arm fault is generated.
5. Select the Positions screen, enter "GRID TT" and press ENTER. The message GRID OFSET DONE should appear and the GRID OFFSET parameters for the homed axes will have been updated. If the message "NO ZERO" appears, this indicates that none of the axes had been zeroed.

Setting the Tool Change Offset

1. Set the Tool changer axis to "Visible". This is done by setting bit 18 of Parameter 462 to zero.
2. Make sure the spindle head is up out of the way
3. Go to the Discrete Inputs page and look at the cambox origin display.
4. Handle jog (rate .01) the TT (B) axis until "Origin" and Motor Stop" are "1".
5. Handle jog in the positive direction, until both the "Motor Stop" and "Origin" are "0". Switch displays to the Position page and continue jogging the axis 3-5 degrees, in the same direction, past this position.

6. Handle jog the axis in the negative direction (.01 degrees per pulse) until both “Motor Stop” and “Origin” are ”1”. Note that you cannot back up if the mark is missed. If the mark has been missed go back to step 5.

7. Go to the Pos Raw Data page. Under the “Command” header the display shows the “B” axis encoder counts. Write down the current number.

8. Go back to the Discrete Inputs page. Watch “Motor Stop” and “Origin”. Handle jog in negative direction, until one of them changes to “0” (the first one to change).

9. Go back to the Position page and write down the current number from the same column as step 7. Add both numbers and divide by 2, this is the amount of tool change offset, but with the wrong sign.

10. Return to the Discrete Inputs page and handle jog the axis back until the “Motor Stop” and “Origin” are “1”.

11. Enter the calculated number, as a negative number in the TT axis, Parameter 487 (not the B-axis).

12. Return the axis to “Invisible”, set parameter 462 to 1, and cycle power.

13. Zero return the TT axis. The double arm should be in the middle of the home position.

3.13 Grid Offset Calculation

Please read this section in its entirety before attempting to set the grid offset.

GUIDELINES -

The encoder Z channel signal must occur between 1/8 and 7/8 revolution from where the home switch is released. If DISTANCE TO GO is less than 1/8 (.0295) or greater than 7/8 (.2065) of a revolution, it will alarm to "Zero Return Margin Too Small".

In ZERO RETURN mode, the DISTANCE TO GO is the amount the encoder rotated from when the switch was released until it found the Z channel signal. The ideal amount for the DISTANCE TO GO is .118 (This equals ½ of a revolution of the encoder).

SETTING THE OFFSET -

1. Set the grid offset to zero. (Parameter 125,126, 127, 128, or 170, depending on the axis being set.) Setting #7 (PARAMETER LOCK) must be OFF to reset grid offset.

2. Press ZERO RET and ZERO SINGL AXIS the axis you are setting (X, Y, Z, A, or B).

3. Calculate the grid offset using the following formula, and write the result in Parameter 125,126, 127, 128, or 170 (depending on the axis being set).

(DISTANCE TO GO - .118) x Ratio = Grid Offset

The Ratio (steps/unit) for the X, Y, Z, A, and B axes are the values in Parameters 5, 19, 33, 47, and 155, respectively.

4. ZERO RET the axis again to use this offset.

NOTE: If Z-axis grid offset is reset, Parameter 64 should be checked and adjusted accordingly.

Setting the Offset using the Grid Feature

The control will calculate grid offset parameters (125, 126, 127, and so on) using the 'GRID' command. It is recommended that the GRID command be used on each axis separately as follows:

1) Turn the machine off and back on. This will un-zero all the axes.

2) Select the ALARMS screen and enter DEBUG mode.

3) Perform a ZERO SINGLE AXIS on each of the desired axes individually. Ignore any ZERO RET MARGIN TOO SMALL alarms. Note: if a SERVO ERROR TOO LARGE alarm was generated, this indicates that a GRID OFFSET parameter is out of range (make sure it is -138718 to +138718.)

4) Select the Positions screen, enter GRID and press ENTER. The message GRID OFSET DONE should appear and the GRID OFFSET parameters for the homed axes will have been updated. If the message "NO ZERO" appears, this indicates that none of the axes had been zeroed.

5) Perform AUTO ALL AXIS and verify that the DIST TO GO value for each of the selected axes is now close to 0.118".

3.14 Enclosure Replacement

Please read this section in its entirety before attempting to replace the doors or windows.

TOOLS REQUIRED

- Trim installation tool (dull-edged knife or caulking spatula)

Door Replacement

CAUTION! If possible, have two people performing this operation, as the weight of the doors may be a factor in removal.

REMOVAL -

1. Turn the machine power off.
2. Slide the doors to the full open position.
3. Remove the tension springs (2) connecting the two swivel roller brackets at the top and bottom of the door.
4. Slide the door to the fully closed position. Loosen the two upper roller hex nuts, and disengage the upper swivel roller brackets from the top roller guide.
5. Lift the door from the bottom roller guide and remove.

INSTALLATION -

6. Ensure that the lower roller hex fasteners are wrench tight and the upper roller fasteners are finger tight in the middle of their adjusting slots. Place the door into the enclosure, and position with the lower rollers resting on the lower roller guide.
7. Rotate the door to the upright position, and engage the top rollers onto the top roller guide.
8. Replace the tension springs onto the upper and lower roller swivel brackets. Tighten the upper roller fasteners.
9. Verify that the door travels smoothly. If it does not:
   - Check that all roller wheels are seated and roll on their tracks.
   - If all roller wheels are seated on their tracks, it will be necessary to adjust the door travel by loosening the upper and lower roller hex fasteners.

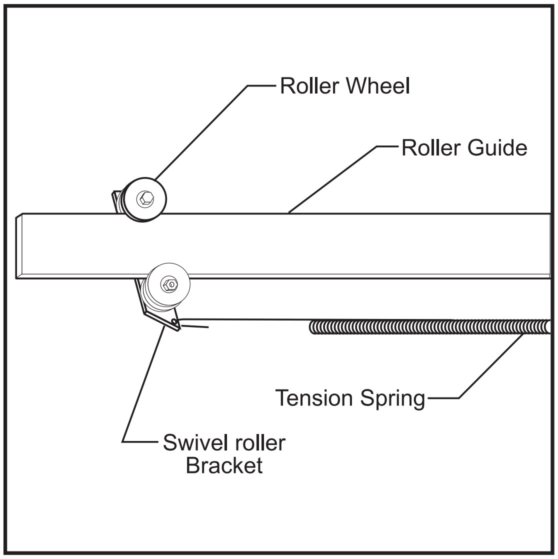


Figure 3.13-1 Roller/roller guide assembly.

DOOR ADJUSTMENTS -

10. Close both doors and check that the vertical gap between them is uniform. If it is not:
    - Determine which door must be adjusted.
    - Loosen the door's outer lower roller attachment and pivot the door on the inner lower roller wheel.
    - When the door is in the desired position (the vertical gap is uniform), tighten the lower outer roller fastener.

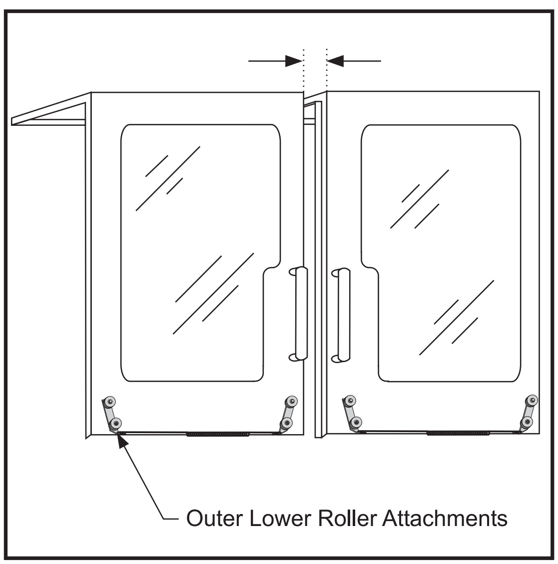


Figure 3.13-2 View of vertical gap between front doors.

11. Check the gap between the door and the front panel flange, and verify it is 5/8" throughout the travel of the door. If it is not:
    - Loosen the door's upper roller fasteners and tilt the door forward or back, as necessary, to adjust door position.

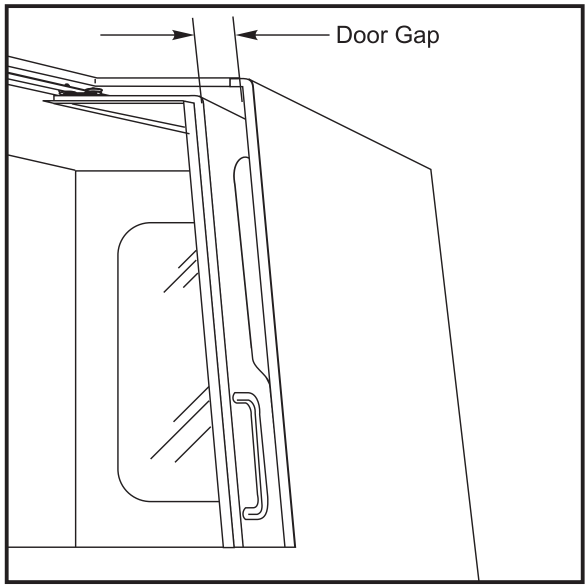


Figure 3.13-3 View of gap between front of door and front panel flange.

SWITCH ADJUSTMENT -

12. Move the door to the fully closed position. Go to the "Diagnostics" page on the control panel, and ensure "DOOR S" reads "0". Move the door to the open position, and ensure "DOOR S" reads "1". If either reading is incorrect:
    - Loosen the SHCS that mounts the switch actuator bracket to the top of the door. (**NOTE:** It is possible to access this bracket from the side window.)
    - Move the bracket in its slot to the proper position and tighten the SHCS.

Window Replacement

REMOVAL -

1. Turn the machine power off.

2. Move the door to the fully closed position so the window is accessible. Use a trim installation tool to pull the locking tab out of the inside of the window seal (the tab is a part of the seal).

3. Remove the window panel from the seal. The tool can be placed between the window panel and the seal to aid in removing the window panel.

4. Remove the seal from the enclosure's cutout.

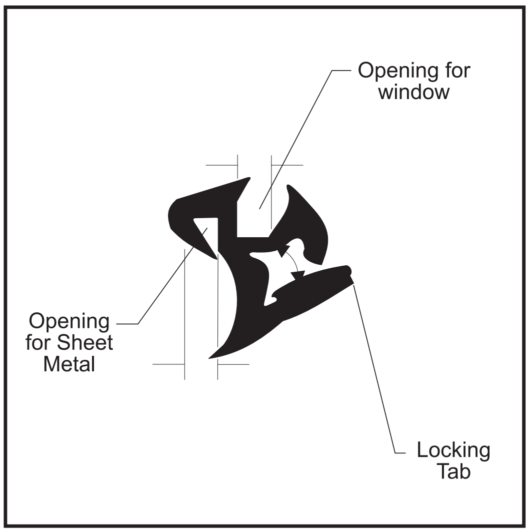


Figure 3.13-4 Cross-section of window seal.

INSTALLATION -

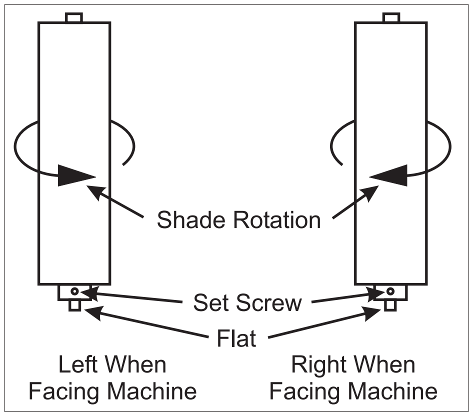
1. Replace the seal around the enclosure's cutout, with the locking tab facing the inside of the machine.

2. Replace the window panel into the seal. The tool can be placed between the window panel and the seal to aid in replacing the window panel into the seal.

Shade Canister Adjustment

This procedure applies to the Mill Drill.

The front of the column on either side of the spindle, is covered by heavy shades kept taut by spring loaded canisters. If the shades should need adjusting, apply the following procedure.



1 Clamp the shaft at the flat with clamping pliers or other such clamping device to hold the shaft when adjusting of the spring tension.

2. Loosen the set screw so that the spring tension may be adjusted.

3. Rotate the shaft one complete revolution against the forse of the spring (counter clockwise for the left canister and clockwise for the right canister). Retighten the set screw.

4. Check the tension of the shade. Repeat this process as needed for proper tension one revolution at a time. Do not overtighten the spring.

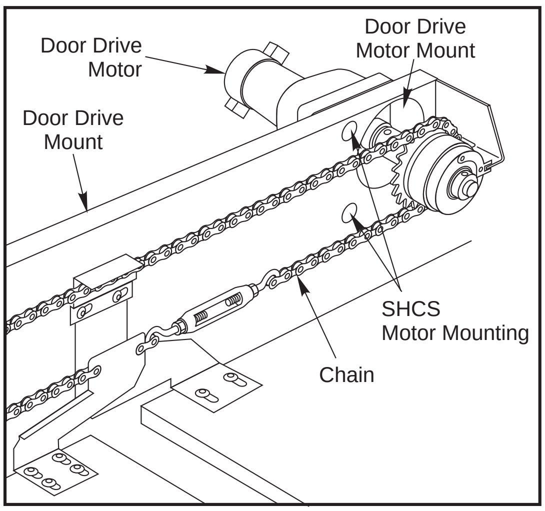
3.15 Auto Door Removal and Replacement

The following section describes the removal and replacement of the Auto-Door motor, clutch, and chain, and how to adjust the action of the door.

Motor Replacement

Motor Removal

1. Shut off power to the machine.
2. Detach the motor cable from the extension cable 33-1320.
3. Turn the turn buckle to loosen the tension on the chain and remove the chain from the clutch sprocket.
4. Detach the clutch and shaft adapter from the motor shaft by loosening the two (2) SSS on the shaft adapter.
5. Remove the four (4) SHCS and lock washers that mount the motor to the door drive motor mount and remove the motor.



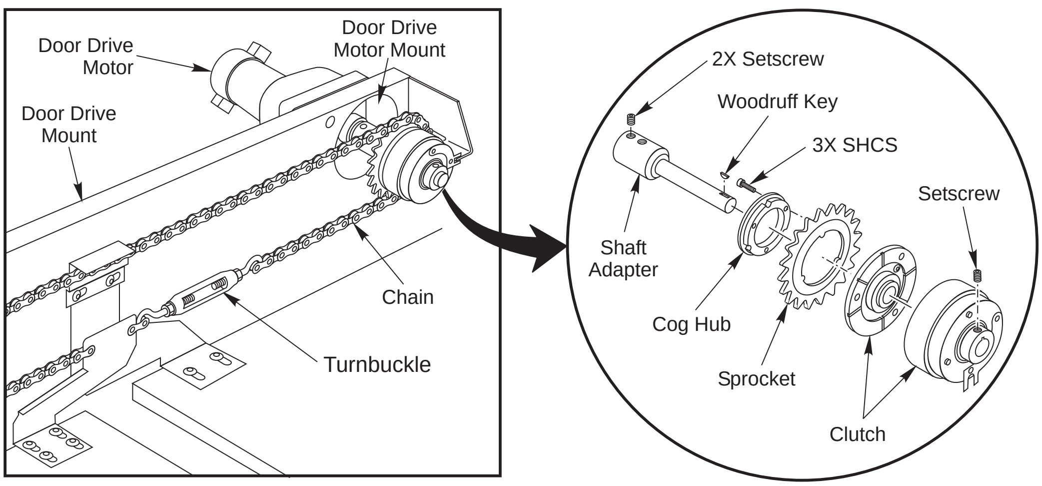
Motor Replacement

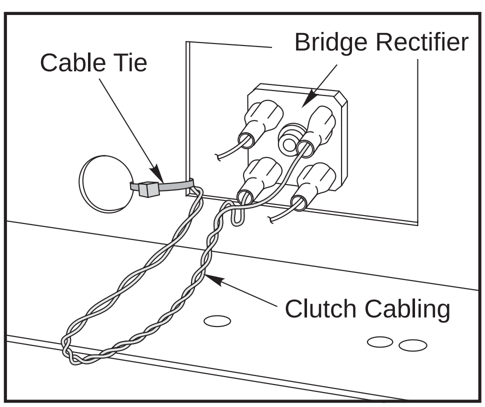
6. Remount the motor to the motor mount by the way in which it was removed.
7. Reassemble the clutch with the shaft adapter to the new motor.
8. Reassemble the chain to the motor assembly. See the Chain Replacement and Adjustment section for instructions.
9. Reattach the motor cable to the extension cable 33-1320.

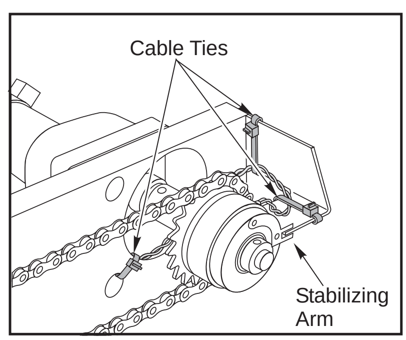
Clutch Replacement

Clutch Removal

1. Shut off power to the machine.
2. Unplug both of the clutch cables from the bridge rectifier on the motor mount.
3. Turn the turn buckle to loosen the tension on the chain and remove the chain from the clutch sprocket.
4. Cut the cable ties that fasten the clutch cable to the motor mount. Loosen the two (2) set screws on the shaft adapter and remove the clutch assembly.
5. Loosen the set screw on the front end of the clutch assembly and dismantle the clutch with the sprocket from the shaft adapter. Be careful not to lose the woodruff key on the shaft.
6. Remove the three (3) SHCS that fasten the sprocket and cog hub to the clutch (the clutch is in two parts).







Clutch Replacement

7. Replace the clutch as it was removed. When tightening the set screw on the clutch, make sure that the sprocket turns freely.

8. Hook the clutch stabilizing arm to the flange on the right side of the door drive mount. Fasten the clutch cable with ties. See the previous figure.

9. See the Chain Replacement and Adjustment section to reattach the chain.

10. After the clutch has been installed and the chain adjusted properly manually open the door(s). While holding the door open command the door to close. This can be done by pushing a button on the side of the pendant or executing a program. Hold the door open until the machine alarms out. Repeat this three times.

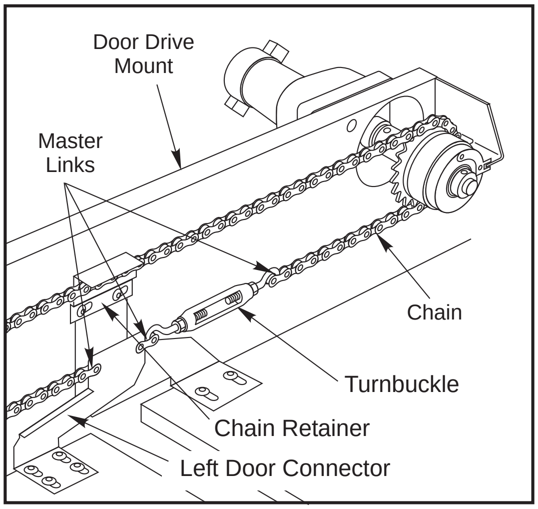
Chain Replacement and Adjustment

Chain Removal

1. Shut off power to the machine.

2. Remove the two (2) FBHCS that fasten the chain retainer to the right door connector.

3. Detach the master chain link from the left door connector and from the turn buckle, and remove the chain.



Chain Replacement

4. Reattach the chain to the left door connector and to the turn buckle. Make sure that the chain is placed over the sprocket on the left end of the rail and over the sprocket on the motor assembly.

5. Replace the chain retainer.

6. Adjust the tension with the turn buckle.

7. If the chain can be heard grinding on the sprockets, it is too tight. Adjust as necessary

Adjust Parameters

The movement of the Auto-Door is controlled by parameters 292, 293, and 251. See the parameters chapter in this manual for their descriptions.

Adjust the parameters to assure that the door opens and closes properly:

1. Be sure that setting 131 is set to ON.
2. Set parameters 292 and 293 to a value of 3 (50ths of a second).
3. Set parameter 251 to a value of 3000. This number means that the door travel time will be 3 seconds. The time needed to fully open or close the door depends on the size of the machine.
4. Test the door by running a short program:

```
G04 P3.;
M30;
```

5. When closing, the door should stop about one inch [2.54cm] before reaching the end. Adjust parameter 251 as necessary.
6. Adjust parameters 292 and 293 as necessary for proper closure.

3.16 Hydraulic Counterbalance

TOOLS REQUIRED

•(1) 4 x 4 x 14" head support block

•Hydraulic counterbalance service kit, consists of:
•Pressure tank with manifold assembly, prefilled with (2) quarts DTE-25 hydraulic oil
•Hydraulic cylinder with hose attached (if necessary)

Hydraulic Tank Replacement

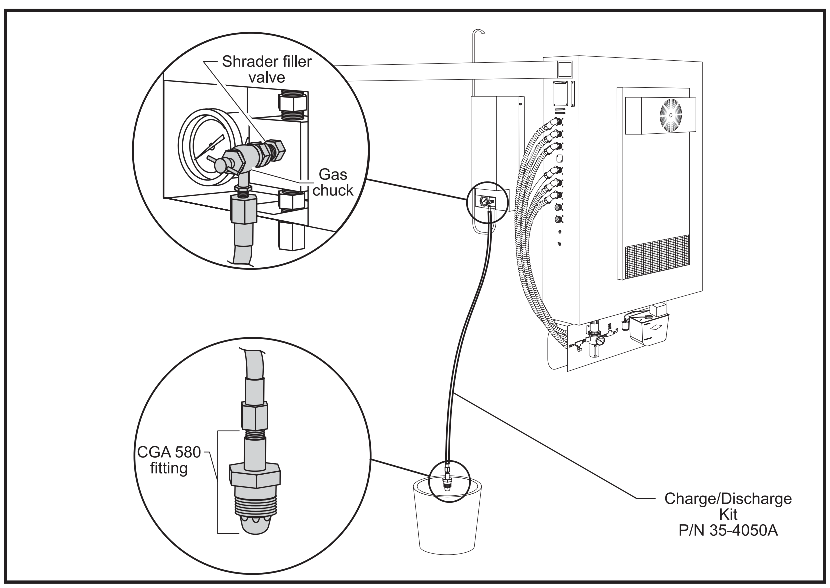
REMOVAL -

CAUTION! While performing this procedure, the spindle head may drop if the control loses power or alarms.

1. Raise spindle head by HANDLE JOG up to 14.5" above table. Insert wood block and lower head casting onto it. EMERGENCY STOP the machine. Head should rest securely on table block. Power OFF VMC.

NOTE: Do not lower spindle onto block.

2. Disconnect the two-pin end of the pressure sensor cable(s) to the pressure sensor(s), if tank is equipped with sensor.



Hydraulic counterbalance charge/discharge kit (shown in place to discharge system).

3. Remove cap to Schrader filler valve.

4. Ensure T-handle of the gas chuck is turned completely counterclockwise. Attach charge/discharge kit by tightening gas chuck to the Schrader valve finger tight, then wrench lightly to tighten (see the previous figure).
5. Place the CGA 580 end of charge/discharge kit into a bucket to the contain the hydraulic oil while discharging the system.
6. Slowly turn the T-handle clockwise until the system begins to discharge. Complete discharge may take up to 10 minutes. Verify tank gauge reads 0 psi.
7. Turn the T-handle completely counterclockwise and remove the charge/discharge kit from the Schrader valve.
8. Disconnect the hydraulic hose from the tank assembly.
9. Remove the tank assembly from the column by removing the four SHCS from the tank mount.

INSTALLATION -

1. Connect the hose to the tank before mounting the tank in the inverted position. This prevents hydraulic oil from spilling.

NOTE: For a positive seal, ensure the hose-to-tank connection is straight, and not skewed.

2. Mount the tank assembly to the column with the tank mount and four SHCS. Ensure the hydraulic hose is not twisted.
3. Connect the two-pin end of the pressure sensor cable(s) to the pressure sensor(s).
4. Use cable ties to secure the cable to the hydraulic hose.

NOTE: For this step, use regulated dry nitrogen gas (welding grade acceptable) that accepts a right-hand thread CGA 580 fitting.

5. Attach the CGA 580 fitting end of the charge/discharge kit to the source pressure. Ensure T-handle of the gas chuck is turned completely counterclockwise. Attach charge/discharge kit by tightening gas chuck to the Schrader valve finger tight, then wrench lightly to tighten. Pressurize the system to required pressure as listed in the following tank pressure requirements chart.

NOTE: For VF-6/8 follow installation procedure for each hydraulic tank.

NOTE: •Do not use compressed air, oxygen or flammable gas.
•Refer to the table below and verify pressure according to machine and spindle head position.
•Verify cylinder is seated in counterbore.

	VF-3/4	VF-6-11	VF-6/7/10 w/50T Spindle	VF-8/9/11 w/50T Spindle	VF-5 w/40T Spindle	VF-5 w/50T Spindle	VR	VS
Machine at top of travel	1150 psi	750 psi	1150 psi	1550 psi	875 psi	1100 psi	1800 psi	1250 psi

Tank pressure requirements.

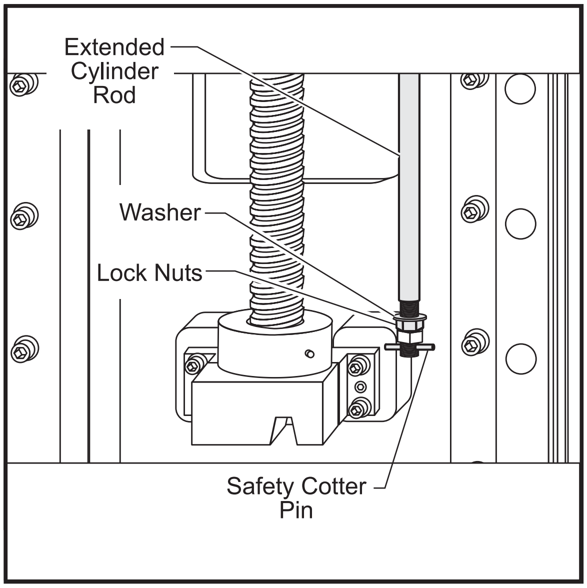
6. Power on the machine and zero return (ZERO RET) Z-axis only. Check for any leaks or abnormal noises. Verify tank pressure at top of travel. Remove charging system and replace valve cap.

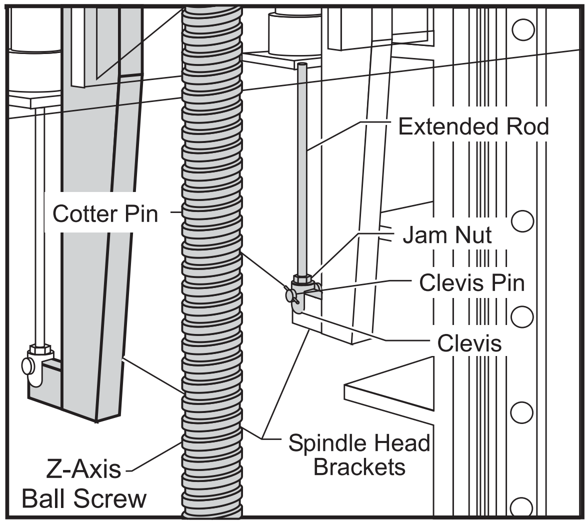
NOTE: If there is an E-stop alarm that will not reset, check for correct system pressure and the correct tank assembly.

Hydraulic Cylinder Replacement

REMOVAL-

1. Remove the hydraulic tank as described in previous section.
2. To gain access to the cylinder rod, remove the three SHCS holding the Z-axis way cover to the spindle head.
3. Remove the cotter pin and lock nuts from the threaded end of the cylinder rod.



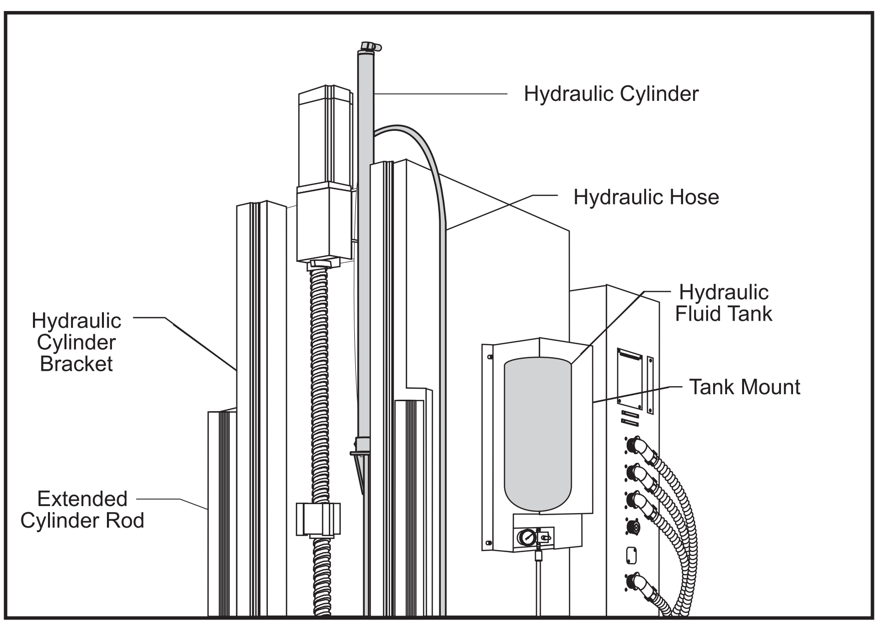


Hydraulic Cylinder Rod Installation for VF-1 through 4 and (VF-6/8).

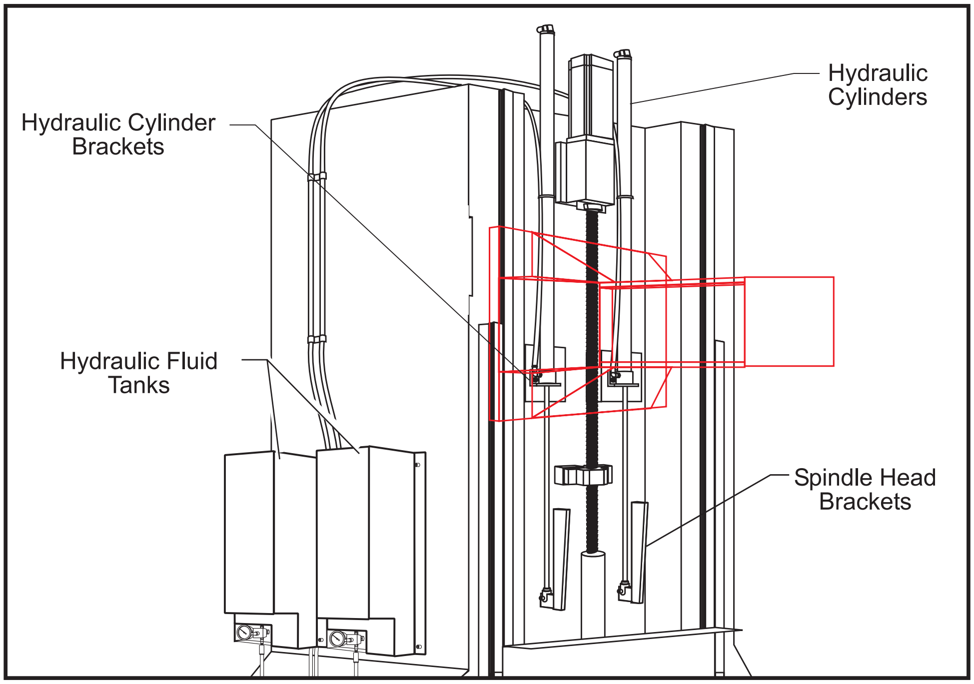
NOTE: For VF-6/8 loosen jam nut from clevis then remove the cotter pin, clevis pin, clevis and jam nut.

4. Remove the band clamp that holds the cylinder to the stabilizer bracket. Loosen the two SHCS that attach the bracket to the column.

5. Remove the hydraulic cylinder from the top of the column.



VF-Series hydraulic counterbalance - right side view.



VF-Series hydraulic counterbalance view - left side view.

NOTE: Do not disassemble unit. Keep the hose attached to the cylinder.

6. Return complete assembly to HAAS Automation.

INSTALLATION-

1. Install cylinder with cylinder rod extended from top of column.

NOTE: Cylinder rod should pass through column bracket and spindle head bracket. Cylinder body must rest in column bracket counterbore.

2. Orient cylinder body with hydraulic hose facing away from ball screw.

NOTE: For VF-6/8 orient cylinder bodies with hydraulic hose facing the ball screw.

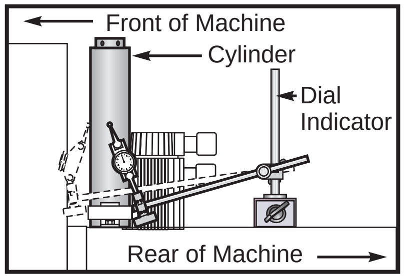
3. Install lock nuts, at threaded end of cylinder rod, wrench tight. Install safety cotter pin.

NOTE: For VF-6/8 install jam nut and clevis at end of cylinder rod then attach to spindle head bracket with clevis pin. Install safety cotter pin and lock the clevis by tightening jam nut.

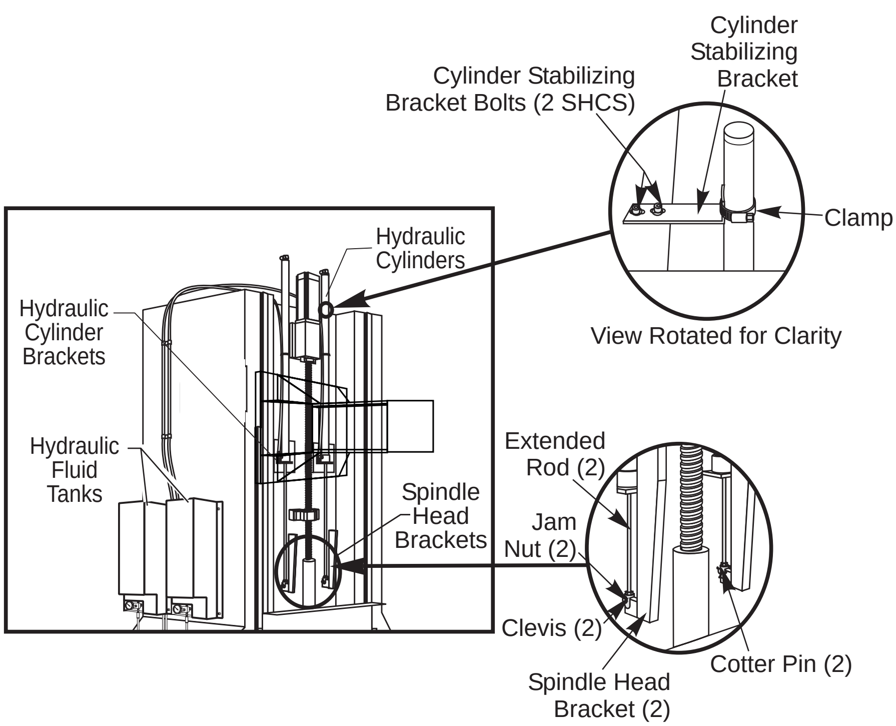
4. Install the hydraulic tank as described in the previous section, but **DO NOT power up the machine**.

5. Power on the machine and zero return (ZERO RET) Z-axis only. Observe cylinder body for motion or abnormal noises. Check for fluid at manifold, cylinder hose connection and cylinder rod. Verify tank pressure at top of travel. Remove charging system and replace valve cap.

6. Loosely install the band clamp and tighten the two SHCS that attach the stabilizer bracket to the column.
7. Place a mag base with a dial indicator on top of the column (not the spindle head). Position the tip of the indicator on the front of the cylinder and jog the Z axis up and down to verify alignment. Note that when jogging the Z axis the counter balance will shift slightly in the bracket. The cylinder shift should not exceed .015in.



8. If the spindle head brackets have been moved from the original location it will be necessary to check for side to side alignment. Place an dial indictor the same as in step 7 and position the tip of the indicator on the side of the cylinder. Jog the Z axis up and down to verify alignment. The cylinder shift should not exceed .015in.
9. When the side to side alignment of the cylinder is correct, tightening the spindle head brackets. Be careful not to move the cylinder out of alignment while tightening the spindle head brackets.



10. When the cylinder has been aligned correctly, finish tightening the band clamp. Be careful not to move the cylinder out of alignment while tightening the band clamp.

11. Zero return (ZERO RET) machine. HANDLE JOG Z-axis in 0.1 increments. Verify full Z travel.
12. Cycle Z-axis, using the following program, for five minutes and check for oil leaking at top of cylinder and cylinder rod.

    G28, G54, Z-14.
    M99
    50% Rapid

13. If Z-axis overcurrents alarm during travel, verify and correct system pressure.

NOTE: •If Z-axis overcurrent alarm at top or bottom of travel, call HAAS Automation Service Department immediately for assistance.
•If fluid leaks from hydraulic fittings, check that fittings are tight.
•If leaking continues, call HAAS Automation Service Department for assistance.

14. Reinstall Z-axis way cover with three SHCS that hold it to the spindle head.

3.17 Through The Spindle Coolant System - Adjustments

TOOLS REQUIRED

•Tool holder with small TSC drill or restrictor (with a small orifice #T-1461)
•TSC Gauge Kit (P/N 93-9011), includes:
0-15 PSI Precharge pressure gauge
0-160 PSI Purge pressure gauge (Not used on newer TSC machines)
0-600 Coolant pressure gauge
Ball valve

Precharge Regulator Adjustment

1. **CAUTION!** Extreme care must be taken in making this delicate adjustment. Insert a short piece of 1/4" plastic tubing into the 0-15 psi pressure gauge. Insert the short tube into the precharge pressure regulator (located on top of the transmission) and connect the plastic precharge tube (leading to the TRP) to the pressure gauge.

2. Manually turn on the precharge air by pushing the plunger on the precharge solenoid valve.

3. Hold down the precharge solenoid valve for at least 20 seconds to allow the pressure reading to stabilize, then set the precharge pressure to 4.0 psi (±0.4 psi). Release the solenoid and hold it down again for 20 seconds and re-check the precharge pressure. Repeat this a few times to ensure the pressure setting remains stable. Be sure the regulator adjustment knob is securely locked in place.

4. Remove the pressure gauge and short 1/4" hose. Reattach the precharge tube to the regulator.

Priming the TSC System

NOTE: When machine is ready to operate, with coolant in the coolant tank, prime the Through the Spindle Coolant (TSC) system according to the following procedure. This procedure should also be performed whenever the pump has sucked in air (e.g. low coolant).

50 Taper TSC (old system)

1. With no tool in the spindle, switch to MDI mode.
2. Close the programmable coolant (P-Cool) and lock line shut-off valves.
3. Press the COOLNT key to turn on the main coolant pump; this will prime the TSC pump.
4. Wait 20-30 seconds for the TSC pump to fill.
5. Press the AUX CLNT key to turn on the TSC. Wait for coolant to flow from the spindle at full force.
6. Press the reset key to shut off the system. The TSC system will continue to hold its prime.

High pressure TSC 40 and 50 taper

1. With no tool in the spindle, switch to MDI mode.
2. Press the AUX CLNT button to turn on TSC. Wait for coolant to flow from the spindle.
3. Allow coolant to flow for at least one minute.
4. Press the AUX CLNT button again to turn off TSC.

Checking Pump Pressure

NOTE: If the coolant pressure with no tool in the spindle is 60 psi or less, replace the pump assembly (30-3281A). Old TSC system uses pump head (93-3280B).

1. Insert the 0-600 psi coolant pressure gauge into the coolant line between the coolant filters and the TSC pump hose. Use wrenches to tighten the fittings snug. DO NOT OVERTIGHTEN !!

2. With no tool in the spindle, prime the TSC system as described above.

3. Insert a standard (no through hole in pull stud) tool holder into the spindle.

4. Turn on TSC.

5. Check for leaks while TSC is still running. Shut off TSC.

6. Remove pressure gauge and reconnect the pump to the machine.

If the pump relief valve has been changed, adjust the relief valve in the following manner:

1. Remove the sealing cap from the pump relief valve. Loosen the lock nut.

2. Start with the pressure below 300 psi. Adjust the pressure relief valve until the pressure on the gauge rises to 300 psi. Tighten the lock nut, and replace the sealing cap. Setting range is 280-300psi.

3. Mark across the pump and sealing cap with a paint marker. This will indicate any future tampering.

Testing the Coolant Pressure Switch

1. Insert the ball valve and pressure gauge into the TSC pump outlet. The ball valve must be **between** the pump and pressure gauge. Connect the other end to the machine. For high pressure TSC, the connectors must be tightened snug with wrenches. DO NOT OVERTIGHTEN.

2. Run TSC system for one minute to purge air

3. Insert a TSC type tool holder (with a small TSC drill or restrictor) in the spindle. **CAUTION!** Changing tools after running TSC can cause coolant to spray out. Wear safety glasses.

WARNING!

Do not put your hands in the high pressure coolant stream as coolant and particles can be blown into your skin.

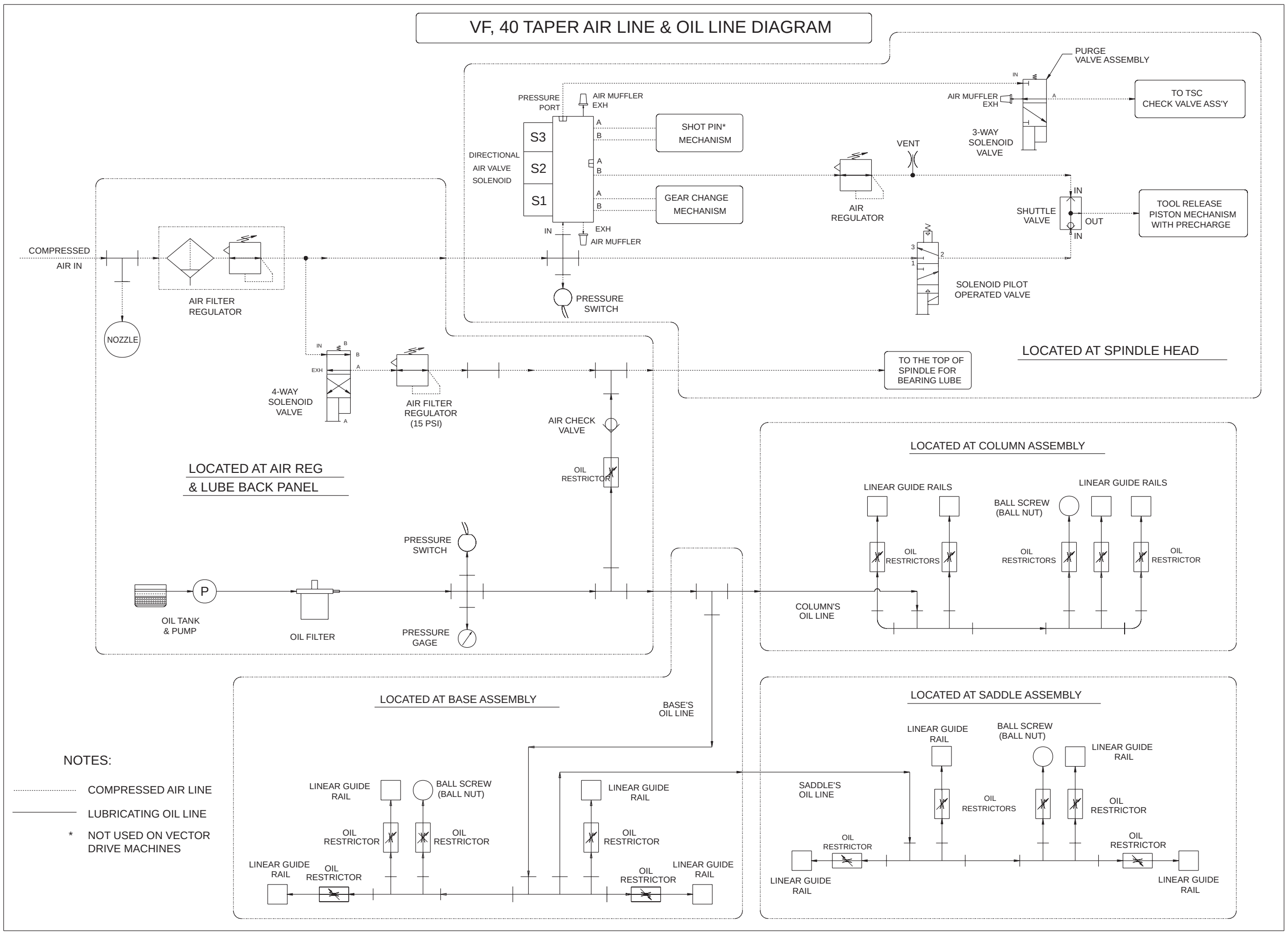
4. Set Parameter 236 to 100.

5. Turn on TSC. Test low coolant pressure switch by slowly shutting off the ball valve in the coolant line (pump should shut off at 40 psi +/- 5 psi). If the switch is outside this range, replace the switch.

NOTE: Test the electrical continuity of the pressure switch cable and the control function by shorting the leads of the cable. The "LO CLNT" bit on the Diagnostics page should change from "1" to "0". Check this before replacing the pressure switch.

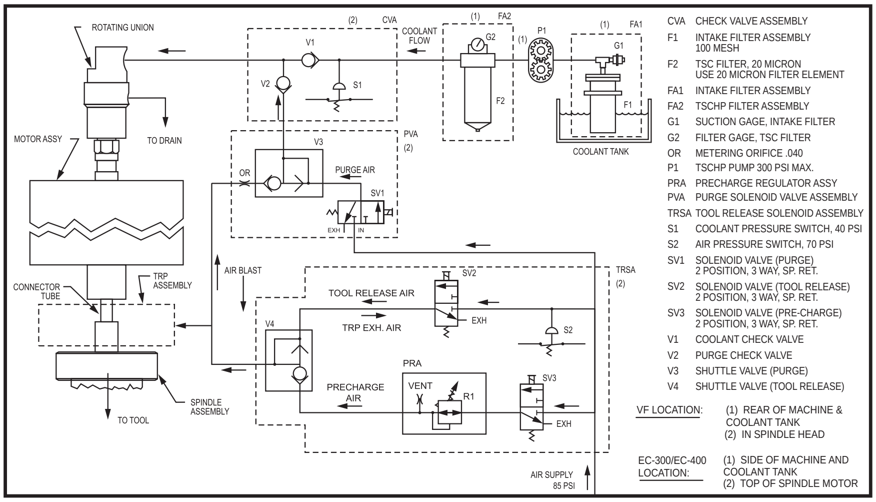
6. Reset Parameter 236 to 1000.

3.18 Air / Oil Line Diagram

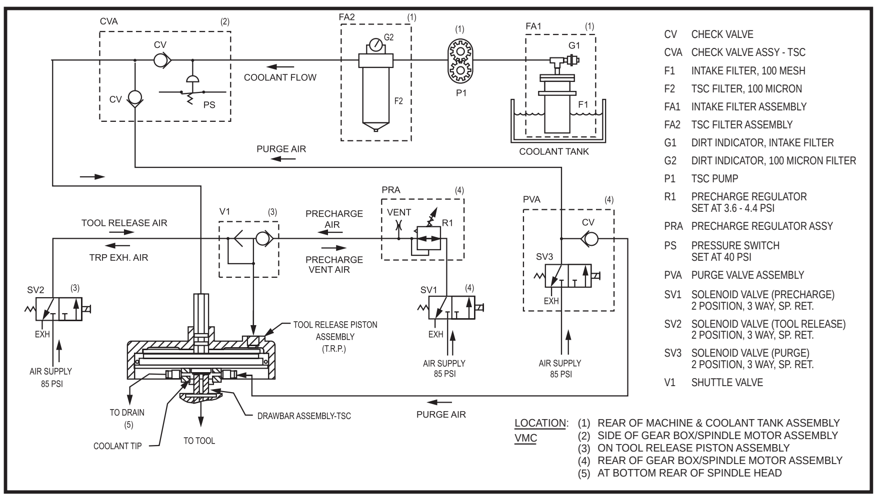


3.19 Through The Spindle Coolant System Flow Diagram

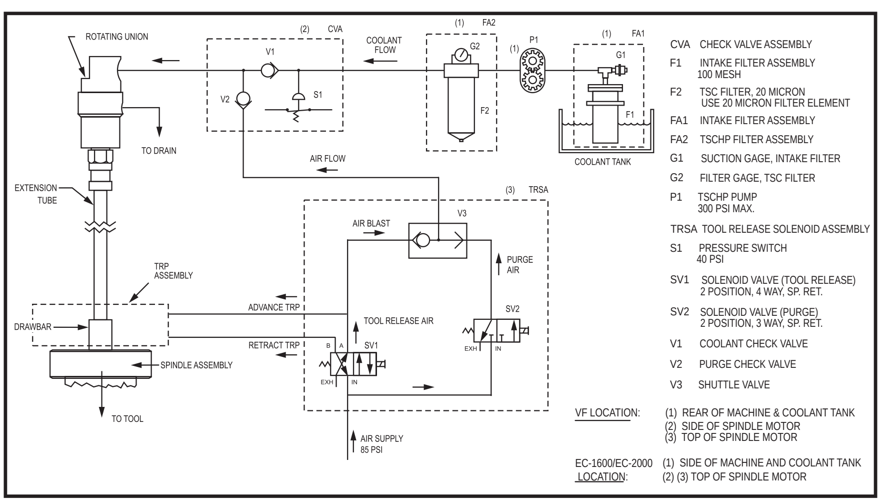
In-Line Drive



40 Taper



50 Taper



3.20 Automatic Pallet Changer (APC)

Disconect the APC motor wire on the **left** side of the Quad APC mills. The pallets will be difficult to manually move if this is not done. The motor cable is located under the APC base.

Pallet Replacement

TOOLS REQUIRED:
- **Hoist**
- **Straps or Chains**
- **Eyebolts (2)**

CAUTION! Be careful when changing out pallets, each pallet weighs approx. 300lbs.

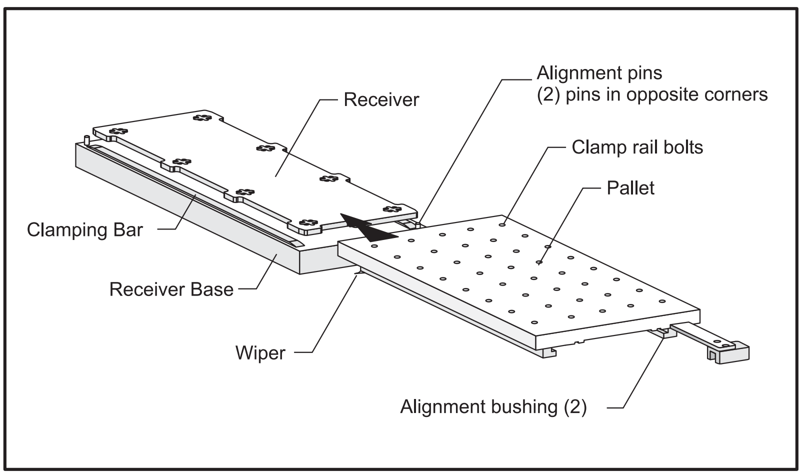
NOTE: Pallets that have been replaced must be re-aligned to the receiver. Pallets shipped with the VMC from the factory have been machined perpendicular to the spindle. It is recommended that replacement pallets be machined after aligning them to the receiver.

1. Remove the old pallet from the APC using the supplied eyebolts and a hoist.

2. Set the new pallet on the APC, aligning the roller grooves on the bottom of the pallet with the rollers on the APC.

3. Loosen the clamp rail bolts on the new pallet (the bolts should be snug and not overtighten).

4. Run new pallet into the receiver. Clamp and unclamp the pallet a few times (this will allow the pallet to center on the guide pins). Torque the clamp rail bolts to 50 FT-LB while the pallet is clamped to the receiver.



Pallet Replacement

IMPORTANT! New pallets should be machined on the VMC in order for them to be perpendicular to spindle.

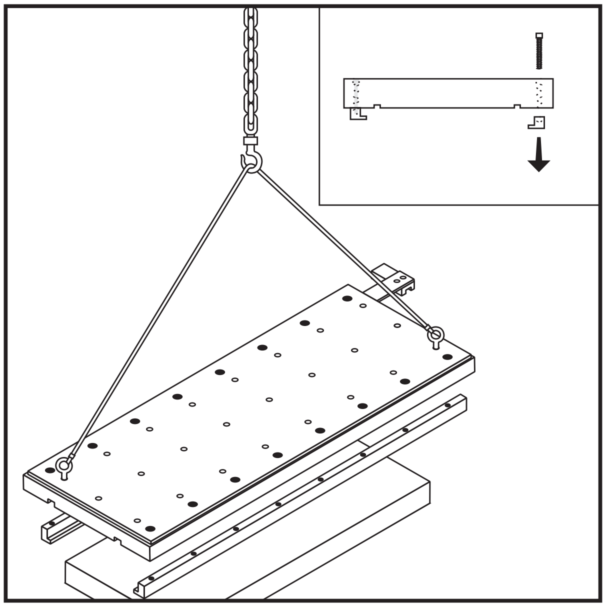
Pallet Clamp Rail Replacement

TOOLS REQUIRED:

- **•Hoist**
- **•Straps or Chains**
- **•Eyebolts (2)**

NOTE: This procedure must be performed with the pallets on the APC.

1. Loosen the clamp rail bolts.
2. Screw the eyebolts into place and lift the pallet carefully.
3. Remove the clamp rails from the pallets.



4. Verify the condition of the wipers and determine if they need replacing.
5. Re-install the new rails leaving the bolts loose.
6. Carefully place the pallet back onto the APC using the hoist.
7. Position the pallet back onto the receiver and clamp/unclamp the pallet several times to allow the rails to center themselves on to the guide pins.
8. Finish torquing the clamp rail bolts.

ALIGNMENT PIN REPLACEMENT

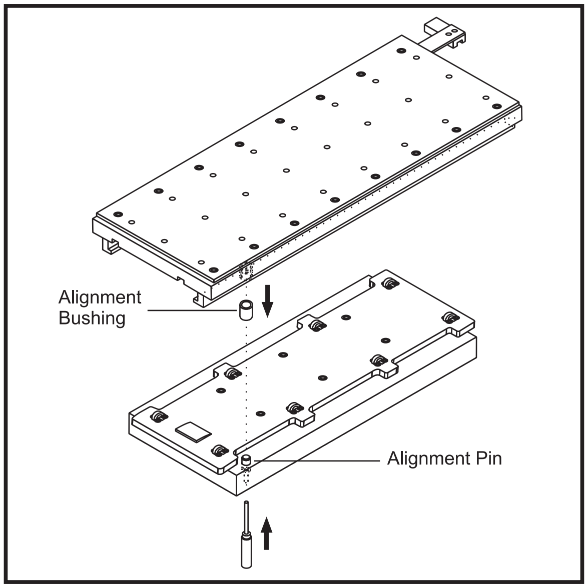
TOOLS REQUIRED:

- **Hoist**
- ***Straps or Chains***
- **Eyebolts (2)**

CAUTION! Be careful when changing out pallets, each weighs approx. 300lbs.

NOTE: The receiver must be removed in order to access the alignment pins.

1. Both pallets must be on the APC in order to access the receiver.
2. Position the receiver to the front of the machine.
3. Disconnect the air from the machine.



Alignment Pin Removal

4. Remove the six (6) receiver mounting bolts.
5. Use a hoist and the two eyebolts supplied with the APC, lift the receiver off the table.
6. Use a punch to remove the alignment pins.
7. Install the new pins using a brass hammer. The pins should bottom out in the holes. Pin height from the base of the receiver to the top of the pin should be within .450 to .490.
8. Position the receiver back onto the table.
9. Install the six mounting bolts.
10. Reconnect the air to the machine.

11. Position a pallet onto the receiver and clamp/unclamp the pallet to the receiver several times. Check for the pallets sticking during this process. If the pallets are sticking, loosen the clamp rail bolts and clamp/unclamp the pallet several times to center the alignment pin to the rails.

NOTE: Because the receiver has been removed from the VMC, any tooling on the pallets must be re-aligned.

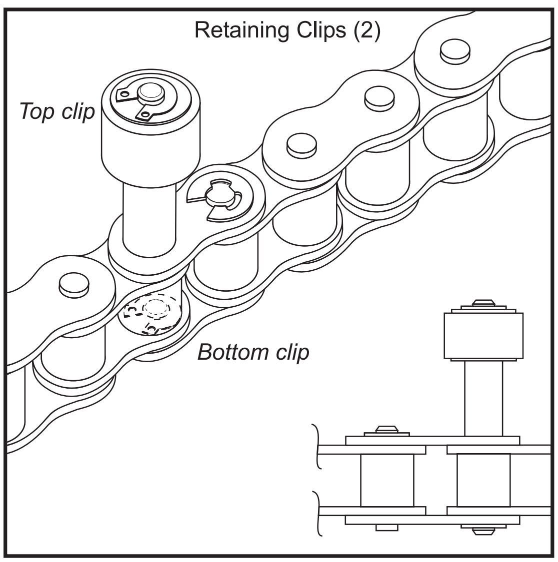
Drive Pin Replacement

NOTE: If the drive pin assembly is damaged due to a crash or from excessive wear, all components should be checked for damage and replaced.

NOTE: The chain must be loosened in order to remove the entire drive pin assembly.

1. Power off the machine.

2. Remove the drive pin retaining clip.



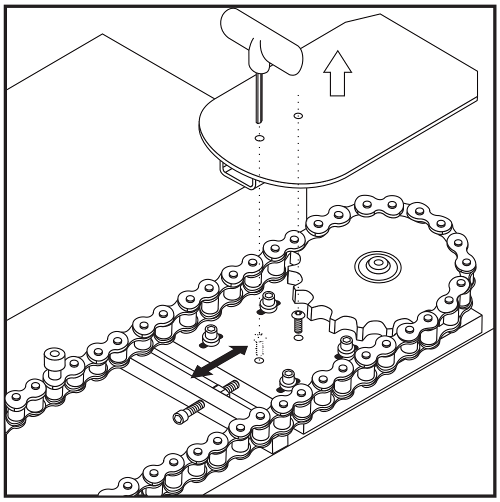
Drive Pin Assembly

3. Remove 5/16" washer.

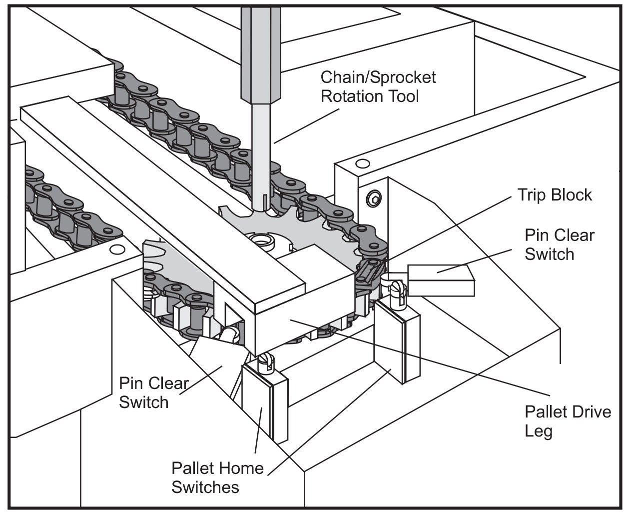
4. The cam follower is lightly pressed onto the pin. The spacer should slide off easily.

LOOSENING THE CHAIN

5. Remove the two screws that mount the coverplate over the sprocket located at the far end of the APC as shown.



Loosening Chain Sprocket

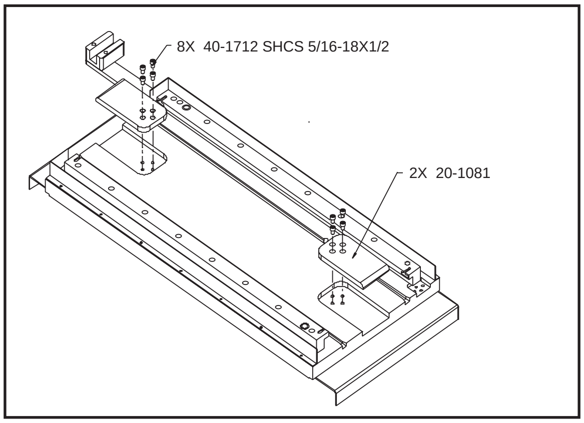


With the pallet clamped, the trip block must engage the switch

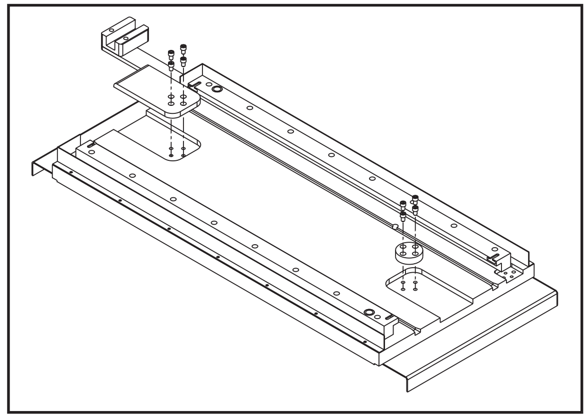
6. Loosen the 4 bolts that mount the sprocket bracket to the casting.
7. Loosen the chain sprocket tensioner screw slightly.
8. At this point there should be enough slack in the chain to slide the drive pin out.
9. Re-assemble the drive pin assembly according to the assembly drawing.
10. Re-tension the chain in the reverse order. **Note:** The trip block must be engaging the switch as shown in the figure above.

APC PALLETS

There are two different designs of pallets for use with the APC. This difference in design is for locating the pallet on to the receiver. The earlier method uses two friction blocks to slow the pallet and locate it correctly as it enters the machine (part number 20-0053, or 20-0579 for a metric pallet). The current design uses a pin and latch to locate the pallet (part number 20-0053A, or metric 20-0579A). Current method pallets can be used on earlier machines by replacing the location stub (part number 20-1082), with a friction block (part number 20-1081). See the following figures.



Pallet Part number 20-0053 (metric 20-0579)



Pallet Part number 20-0053a (metric 20-0579a)

The spare pallet, P/N – PAL40, will come with two filler blocks (20-1081) and one APC Location Stub (20-1082). If the machine has an existing pallet with part number 20-0053 (Metric 20-0579), then the two filler blocks (20-1081) will be used and the Location Stub (20-1082) will not be used. See the figures.

If the machine has an existing pallet with a part number 20-0053A (Metric 20-0579A), then one filler block (20-1081) will be used, one Location Stub (20-1082) will be used, and one filler block (20-1081) will not be used. See the figures.

NOTE: The bolts used for the filler block are – 40-1712 SHCS 5/16-18 X ½ (QTY 4). Torque to 35 ft-lb.
The bolts for the Location Stub are – 40-16385 SHCS 5/16-18 X ¾ (QTY 4). Torque to 35 ft-lb.

MILL DRILL PALLET CHANGER DISASSEMBLY

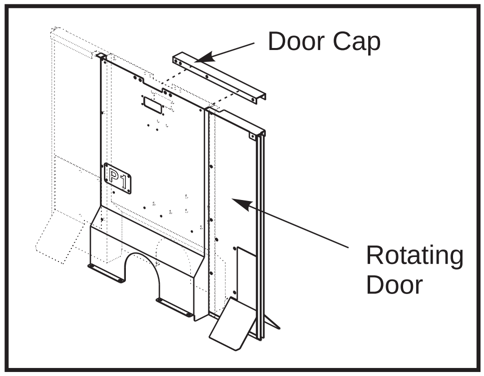
Pallet Changer Disassembly can be done from the “Load Station” of the MDC without removing any enclosure parts.

1. Enter “M-17” in MDI mode and press “Cycle Start” to un-clamp the pallet (recommend 25% rapid). Wait until the assembly has fully risen to its highest point and begins to rotate and press "Emergency Stop." Rotate the pallet as required to remove the components.

2. Remove the sheet metal guards on top of the “clam shell” cover.

3. Remove the clam shell by unbolting the twenty (20) screws in the rotating door and along the bottom of the clam shell.

4. Remove the two door caps on top of the door panel (rotate the door 90°).

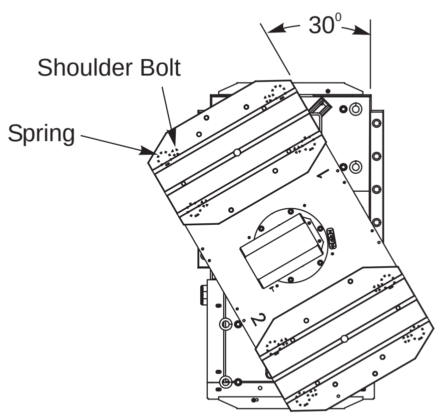


5. Remove rotating doors and the white plastic cable fairlead. (The doors come off in 2 halves). Keep cables out of the way. The Harmonic Drive Assembly can be removed at this point by removing the (6) six 3/8-24 socket head cap screws holding the Flange Plate to the frame support and lifting the entire assembly straight out. **Mark the orientation of the plate first as it must be reassembled exactly as it was.**

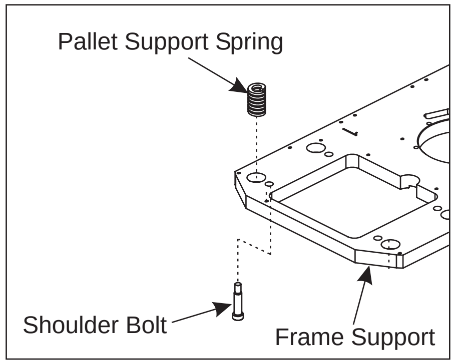
NOTE: Power off before disconnecting anything.

NOTE: If the Servo Motor has been removed, the "Grid Offset" has to be re-calculated in order to assure that there is no mis-allignment after re-assembling the motor. Refer to the "Pallet Changer Grid Offset" section of this manual.

6. The Pallet Table assembly must be rotated aprox. 30° away from the home position to access the 5/8" shoulder bolts underneath.



7. Remove the pallet changer tables by unbolting the (4) 5/8" shoulder bolts between the pallet changer and the frame support. After removing the shoulder bolts, the pallet is loose on the pallet support springs and can be lifted off using 2 “eye” bolts. (The table weighs aprox. 160 lbs. each).



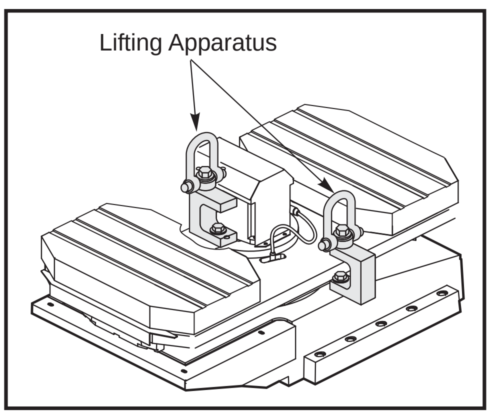
8. Remove the 2 Sheet Metal guards under and around the table area.

NOTE: Air pressure must stay connected throughout this process. **Do not** initiate a pallet change under any circumstance and only rotate assembly by hand.

Frame Support Removal: Disconnect the Home Switch. The frame support can be removed with the "Servo Motor" and "Flange Plate" still connected. The frame supports weigh approximately 195 lbs. and should be lifted out carefully.

To service the Pallet Clamp Piston assembly the entire pallet changer assembly must be removed.

NOTE: If enough lift capacity is available- 2,000 lbs. on an extended arm- the pallets and frame support may stay in place, otherwise they must be removed (described in steps 6-8).



1. Remove the air lines located on the lower left of the Pallet Changer base and remove the 7 bolts that attach the piston to the shaft.

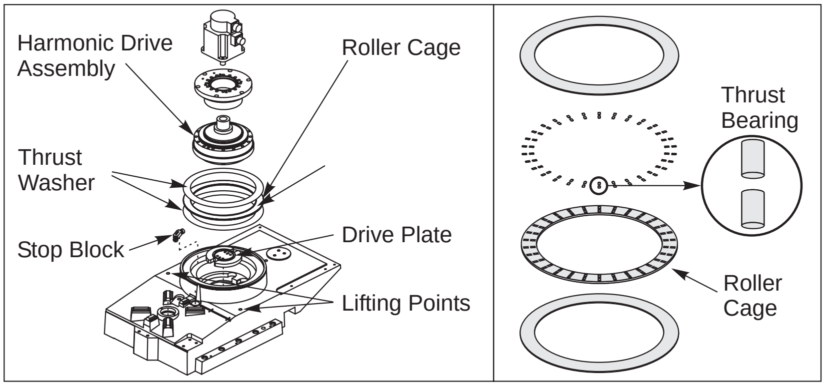
NOTE: Mark the air lines for proper re-assembly.

2. Disconnect the pallet clamp switch and remove the (10) 5/8 –16 socket head bolts holding the Pallet Changer base to the main base casting.

3. Bolt-in lifting tools and lift out. Disconnect the "un-clamp" air fitting on the bottom side of the Piston Cover Plate. Remove the Piston Cover, the Pallet Clamp Piston and Pallet Clamp Shaft to service the assembly.

To service the “Thrust Bearing” assembly, see "Frame Support Removal" and steps 1-8 in the Pallet Changer Disassembly section to remove the support frame which will expose the thrust bearings and thrust washers.

Note: The weight of the table rests on the thrust bearing.



If the thrust bearing and washers *have to* be removed, remove the unit as a whole so as not to loose the bearings. Inevitably, some bearings will fall out therefore it is advisable to have spare bearings for replacement.

To service the “Air Blast” assembly, the pallets must be rotated perpendicular to the home position and at least 1 Pallet table must be removed. After removing the pallet rotate the frame assembly with the empty pallet space back over clamp plate and remove the clamp plate followed by the air blast ring.

To service the Pallet Clamp Switch, follow steps above for servicing the "Air Blast" then unbolt the 4 socket screws and pull the assembly out.

To service the air tubing, remove the motor, motor flange plate and the harmonic drive assembly.

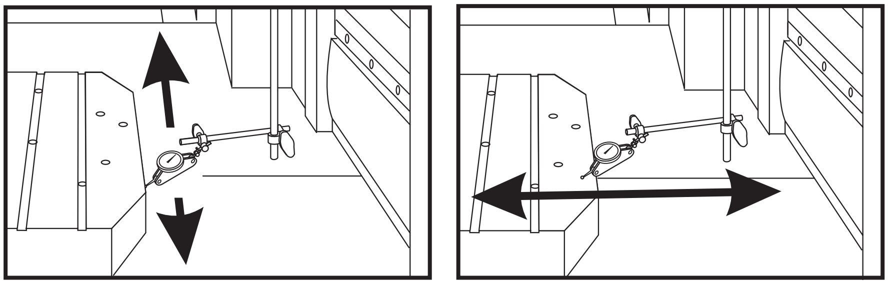
Re-assembly

APC Spring Seating Procedure (Pallet 1)

1. In MDI mode write a simple program (M17; M18;M99) to clamp and unclamp pallet.
2. While P1 is clamped, loosen but do not remove shoulder bolts retaining springs
3. In single block mode, cycle program to observe the direction of table movement.
4. Adjust spring location by gently tapping springs in the opposite direction of the table movement. Run the program to verify adjustment.
5. Repeat previous step until all pallet movement is gone, then torque shoulder bolts to 75 ft/lbs. Run the program again to verify the adjustment was not affected.
6. Repeat this procedure for the other pallet.

NOTE: For more information on the indexer see the "Trouble Shooting" chapter of this manual.

Squaring The Pallet



1. Loosen all bolts from Pallet Changer to the base and align front-machined surface of pallet parallel to X-axis (NTE 0.002" overall). Perform a pallet change and verify other side.

2. Level the pallet along the X-axis by indicating across the pallet in the X-axis direction. Both pallets should be parallel to within 0.002"/10" of each other.

3. If the pallets are not level, shim between the pallet changer and base as required and tighten the pallet changer base bolts.

4. Rotate Pallet Changer and verify the other pallet.

5. Level the pallet along the Y-axis by indicating across the pallet in the Y-axis direction.

6. If necessary, adjust the shims between the pallet changer and base as required ensure all of the bolts are tight before continuing.

7. Rotate the Pallet Changer and verify the other pallet.

Pallet Changer Grid Offset

1. Make sure that Bit #28 in Parameter 209 has a value of 1. The pallet will stay up.

2. Verify that the Pallet Changer Type in Parameter 605 is 3.

NOTE: The APC is on the B-axis on machines with single Mocon PC board or the W-axis on machines with two Mocon PC boards.

3. The Grid offsets in parameter 445 should be the W -axis, and the offsets in parameter 170 should be the B-axis. Respectively, tool Changer offsets in parameter 451 should be the W-axis, and the offsets in parameter 213 should be the B-axis.

4. "Zero return" the appropriate axis, and set the "Grid Offset" for the (individual axis only) on "Zero return" again.

5. Press the "E-stop" and manually rotate the APC so that the locators on "Pallet 1" are aligned with the locators on the APC.

6. Lower the pallet onto the locators by lowering the air pressure at the main regulator. **Be careful** not to damage either the locators or the pallet.

7. Enter "Debug Mode," go to the "POS RAW DATA" page and take the **actual** value from the appropriate axis. Enter this value into the "Tool Change" offset parameter.

8. Restore the air pressure and "zero return" the axis.

9. Verify that the pallet is aligned over the locators.

10. Change the Parameter 209 value to 0.

3.21 Air Regulator Servicing

CAUTION: Disconnect or shut off air supply and exhaust the primary and secondary pressure before servicing unit. Turning the adjustment knob counterclockwise Does Not vent downstream pressure. Downstream pressure must be vented before servicing the regulator.

NOTE: Use mineral based grease or oil ONLY. Do Not use synthetics or silicones.

NOTE: After servicing unit, turn on air supply and adjust regulator to the desired downstream pressure. Check for leaks. If leakage occurs, Do Not operate – conduct repairs.

SERVICING THE FILTER ELEMENT & CLEANING THE BOWL ASSEMBLY:

Use the pictures on the following page to assist with the following steps.

1. Unscrew the bottom threaded Collar and remove the Bowl Assembly. Use care as not to loose the O-ring (a).

2. Unscrew the Baffle and then remove the Element.

3. Clean the internal parts and Bowl Assembly before reassembling. To clean the Bowl Assembly use mild soap and water ONLY! Do Not blow with air as loss or damage may occur to O-rings.

a. Remove the Drain Nut from the Dump Valve and remove it from the Bowl Assembly. Use care as not to loose the O-ring (b).

b. Soak the Dump Valve in a mild soap and water mix to clean. Rinse in water and allow to air dry.

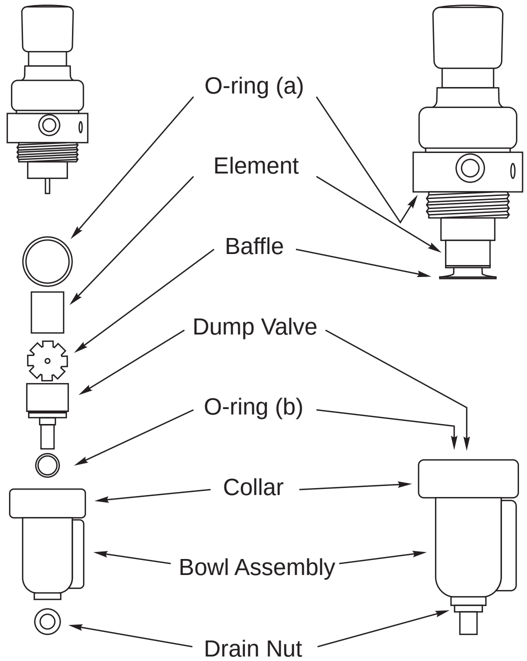
c. After cleaning the Bowl Assembly reassemble the Dump Valve in the Bowl Assembly. Care should be taken so as not to pinch the O-ring (b). Do not over tighten the plastic Drain Nut.

4. Install the New Element.

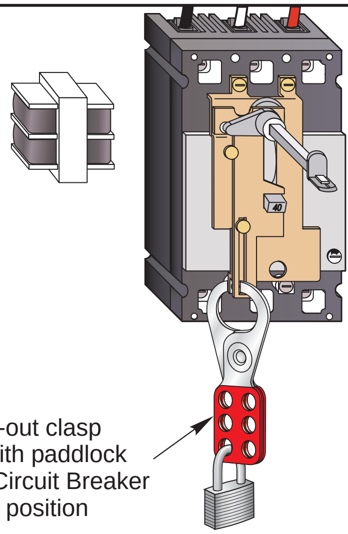
5. Attach the Baffle and finger tighten firmly.

6. Inspect/Replace O-ring (a). Lightly lubricate O-ring (a) to assist with retaining it in position.

7. Install the Bowl Assembly into the body and tighten the Collar; hand tight, plus ¼ turn.


O-ring (a)
Element
Baffle
Dump Valve
O-ring (b)
Collar
Bowl Assembly
Drain Nut

4. ELECTRICAL SERVICE



Install lock-out clasp and lock with paddlock to secure Circuit Breaker in the OFF position

Make sure the circuit breaker is locked in the off position before attempting any electrical work to avoid possible shock.

4.1 Solenoids

Please read this section in its entirety before attempting to replace any solenoid assemblies.

Air Solenoid Assembly

REMOVAL -

1. Turn machine power on and raise spindle head to uppermost position. Turn power off.
2. Remove spindle head covers (Mechanical Service).
3. Remove air supply from machine.
4. Disconnect all air lines going to and from the air solenoid assembly on the bottom rear of the solenoid bracket. Do not remove the fittings --- remove the lines from the fittings.
5. Disconnect the two leads to the low air pressure sensor.
6. Unplug the wiring leading to the plug marked on the solenoid bracket as "880 FROM I/O PCB TO SOLENOID VALVES" and the plug marked "SPARE".

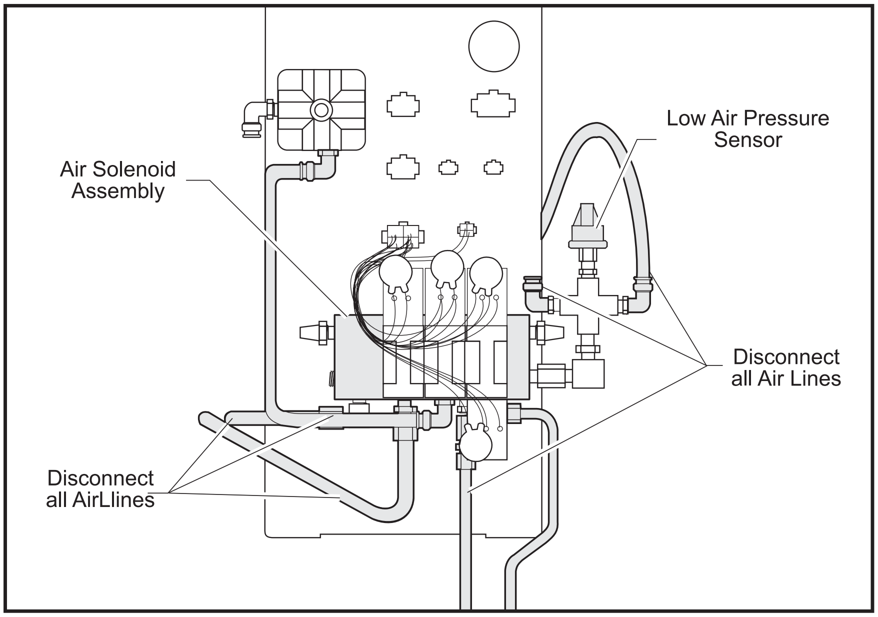


Figure 4.1-1 Air solenoid assembly.

7. Remove the SHCS holding the assembly to the bracket and remove the assembly.

INSTALLATION:

1. Replace the air solenoid assembly and attach to the bracket with the SHCS previously removed. Tighten securely.
2. Reconnect all air lines at this time, ensuring that all connections are tight and do not leak.
3. Reconnect the two leads to the low air pressure sensor.
4. Reconnect the wiring to the plugs on the solenoid bracket (see Step 6).
5. Reconnect air supply to the machine.

Tool Release Piston Assembly Air Solenoid

1. Turn machine power on and raise spindle head to uppermost position. Turn power off.
2. Remove spindle head covers (See the procedure in the Mechanical Service section).
3. Remove air supply from machine.
4. Remove the tool release piston assembly (See the procedure in the Mechanical Service section).
5. Unscrew the air solenoid assembly from the tool release piston assembly, taking care to not disturb the position of the clamp/unclamp switches.
6. Unscrew the air solenoid from the air solenoid assembly.

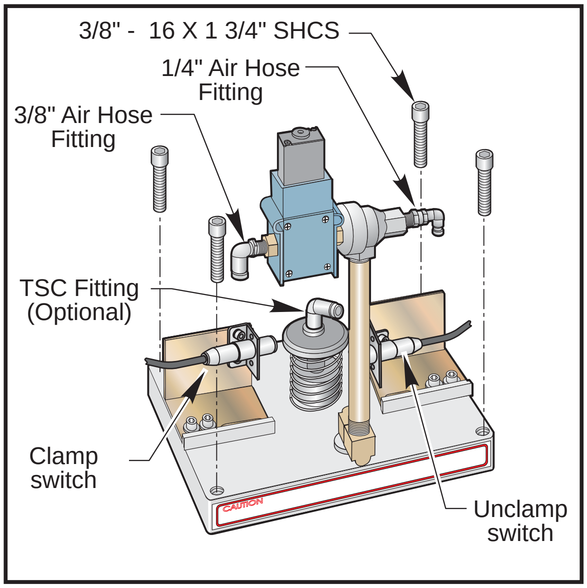


Figure 4.2-2 Tool release piston assembly with air solenoid assembly.

7. Install the new air solenoid on the air solenoid assembly. Reinstall the air solenoid assembly onto the tool release piston assembly. Take care to not disturb the position of the clamp/unclamp switches.

8. Reinstall the tool release piston assembly (Mechanical Service).

9. Ensure all air lines are reconnected to their proper fittings.

1. Turn the machine power off and remove the air supply from the machine.

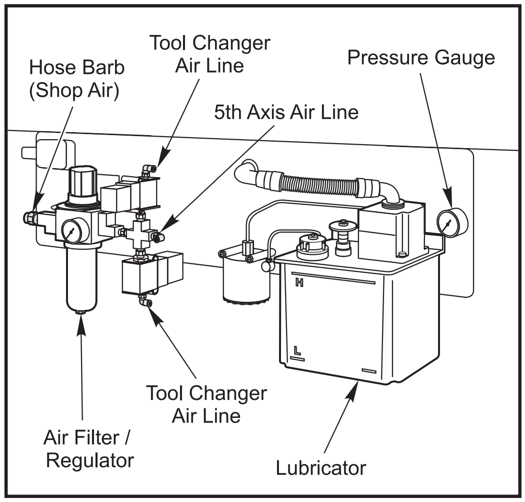


Figure 4.1-3 Front side of lube/air panel.

2. Disconnect the air lines from the spindle lube air solenoid assembly.

3. Unplug the electrical leads at the quick-disconnect. You will have to slide the wiring channel cover back to disconnect the leads.

4. Unscrew the assembly from the T-fitting.

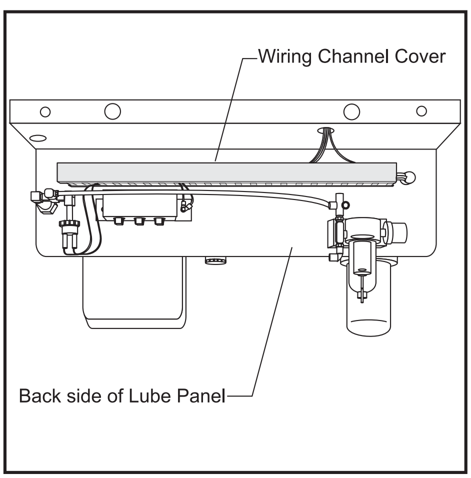


Figure 4.1-4 Top view of spindle lube/air solenoid assembly.

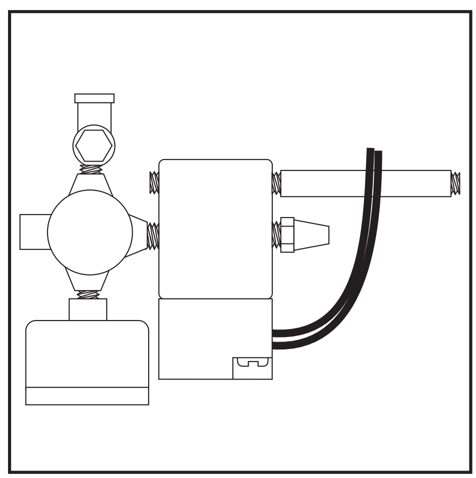


Figure 4.1-5 Top view of spindle lube/air solenoid assembly.

5. Replace the assembly, ensuring it is approximately horizontal to the floor, and tighten fittings securely.

6. Reconnect all air lines.

7. Reconnect wiring leads at the quick-disconnect in the wiring channel. Slide cover back into place.

8. Restore air supply to the machine.

4.2 Line Voltage Adjustments

Please read this section in its entirety before attempting to adjust the line voltage.

TOOLS REQUIRED

- Large flat tip screwdriver
- Digital voltmeter

ADJUSTING VOLTAGE

NOTE: The machine must have air pressure at the air gauge, or a "Low Air Pressure" alarm will be present on power up.

CAUTION! Working with the electrical services required for the VMC can be extremely hazardous. The electrical power must be off and steps must be taken to ensure that it will not be turned on while you are working with it. In most cases this means turning off a circuit breaker in a panel and then locking the panel door. However, if your connection is different or you are not sure how to do this, check with the appropriate personnel in your organization or otherwise obtain the necessary help BEFORE you continue.

WARNING!

The electrical panel should be closed and the three screws on the door should be secured at all times except during installation and service. At those times, only qualified electricians should have access to the panel. When the main circuit breaker is on, there is high voltage throughout the electrical panel (including the circuit boards and logic circuits) and some components operate at high temperatures. Therefore extreme caution is required.

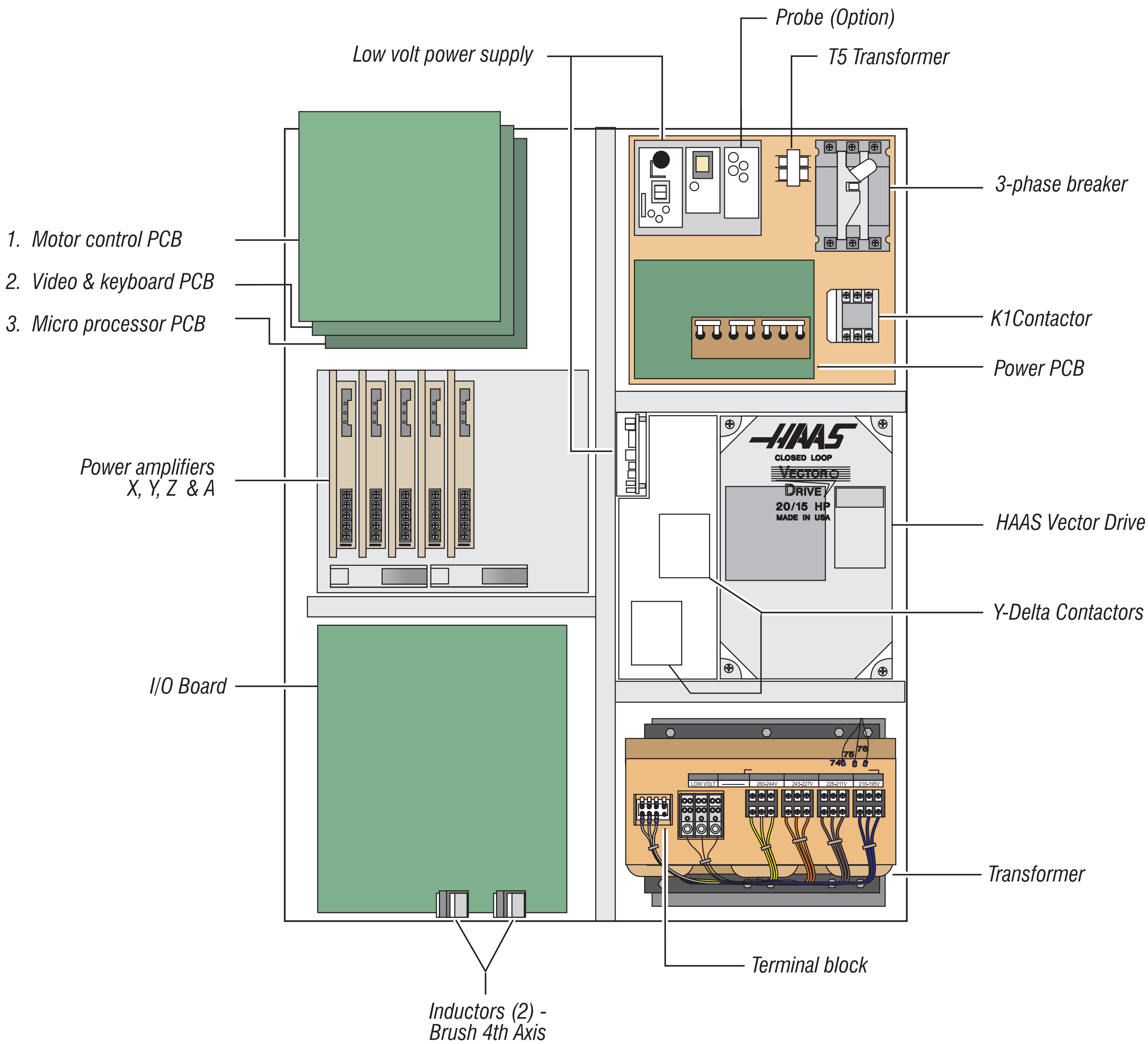


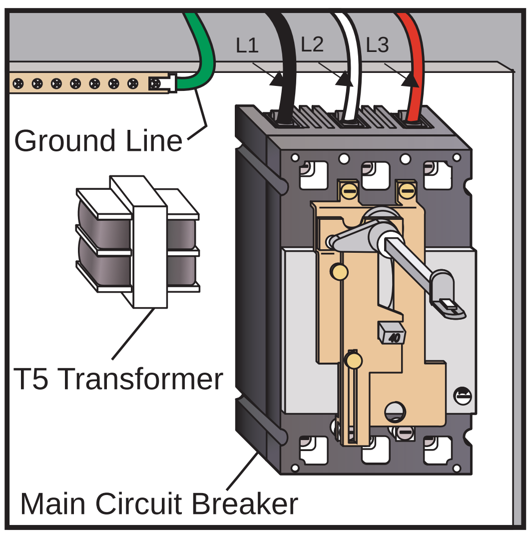
Figure 4.2-1 Control cabinet general overview.

NOTE: The machine must have air pressure at the air gauge, or a "Low Air Pressure" alarm will be present on power up.

CAUTION! Working with the electrical services required for the VMC can be extremely hazardous. The electrical power must be off and steps must be taken to ensure that it will not be turned on while you are working with it. In most cases this means turning off a circuit breaker in a panel and then locking the panel door. However, if your connection is different or you are not sure how to do this, check with the appropriate personnel in your organization or otherwise obtain the necessary help BEFORE you continue.

WARNING!

The electrical panel should be closed and the three latches on the door should be secured at all times except during installation and service. At those times, only qualified electricians should have access to the panel. When the main circuit breaker is on, there is high voltage throughout the electrical panel (including the circuit boards and logic circuits) and some components operate at high temperatures. Therefore, extreme caution is required.



1. Hook up the three power lines to the terminals on top of the main switch at upper right of electrical panel and the separate ground line to the ground bus to the left of the terminals.

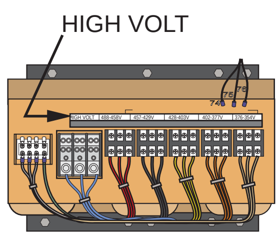
NOTE: Make sure that the service wires actually go into the terminal-block clamps. (It is easy to miss the clamp and tighten the screw. The connection looks fine but the machine runs intermittently or has other problems, such as servo overloads.) To check, simply pull on the wires after the screws are tightened.

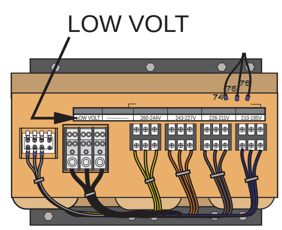
2. After the line voltage is connected to the machine, make sure that main circuit breaker (at top-right of rear cabinet) is OFF (rotate the shaft that connects to the breaker counterclockwise until it snaps OFF). Turn ON the power at the source. Using an accurate digital voltmeter and appropriate safety procedures, measure the voltage between all three pair phases at the main circuit breaker and write down the readings. The voltage must be between 195 and 260 volts (354 and 488 volts for high voltage option).

NOTE: Wide voltage fluctuations are common in many industrial areas; you need to know the minimum and maximum voltage which will be supplied to the machine while it is in operation. U.S. National Electrical Code specifies that machines should operate with a variation of +5% to -5% around an average supply voltage. If problems with the line voltage occur, or low line voltage is suspected, an external transformer may be required. If you suspect voltage problems, the voltage should be checked every hour or two during a typical day to make sure that it does not fluctuate more than +5% or -5% from an average.

CAUTION! Make sure that the main breaker is set to OFF and the power is off at your supply panel BEFORE you change the transformer connections. Make sure that all three black wires are moved to the correct terminal block and that they are tight.

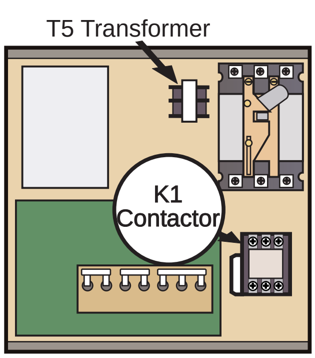
3. Check the connections on the transformer at the bottom-right corner of the rear cabinet. The three black wires labeled **74, 75,** and **76** must be moved to the terminal block triple which corresponds to the average voltage measured in **step 2** above. There are four positions for the input power for the 260 volt transformer and five positions for the 480 volt transformer. The labels showing the input voltage range for each terminal position are as shown in the following illustrations:

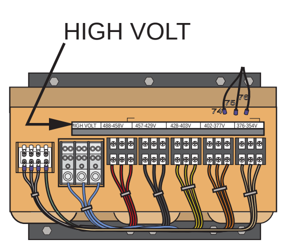


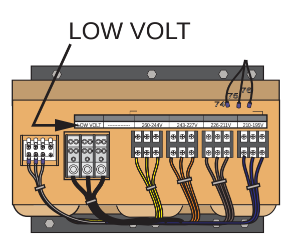


4. Transformer T5 supplies 24VAC used to power the main contactor. There are two versions of this transformer for use on 240 and 400V machines (32-0964B and 32-0965B, respectively). The 240V transformer has two input connectors located about two inches from the transformer, which allow it to be connected to either 240V or 200V. Users that have 220V-240V RMS input power should use the connector labeled 200V. Users with the External High Voltage Option should use the 240V connector if they have 420V-510V 60Hz power or the 200V connector if they have 50Hz power. Failure to use the correct input connector may result in either overheating of the main contactor or failure to reliably engage the main contactor.

5. Set the main switch to ON (rotate the shaft that engages the handle on the panel door clockwise until it snaps into the ON position). Check for evidence of problems, such as the smell of overheating components or smoke. If such problems are indicated, set the main switch to OFF immediately and call the factory before proceeding.







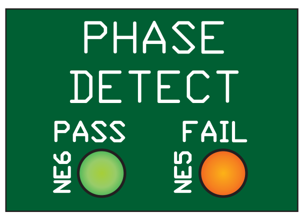
WARNING!

Through the Spindle Coolant (TSC) pump is a three phase pump and must be phased correctly! Improper phasing will cause damage to the TSC pump and void the warranty. Refer to the TSC start up section IF YOUR MACHINE IS EQUIPPED WITH TSC.

6. After the power is on, measure the voltage across the upper terminals on the contactor K1 (located below the main circuit breaker). It should be the same as the measurements where the input power connects to the main breaker. If there are any problems, check the wiring.

7. Apply power to the control by pressing the Power-On switch on the front panel. Check the high voltage buss on the Vector Drive (pin 2 with respect to pin 3 on the terminal bus at the bottom of the drive). It must be between 310 and 360 volts. If the voltage is outside these limits, turn off the power and recheck steps 2 and 3. If the voltage is still outside these limits, call the factory. Next, check the DC voltage displayed in the second page of the Diagnostic data on the CRT. It is labeled DC BUS. Verify that the displayed voltage matches the voltage measured at pins 2 and 3 of the Vector Drive +/- 7 VDC.

8. Electrical power must be phased properly to avoid damage to your equipment. The Power Supply Assembly PC board incorporates a "Phase Detect" circuit with neon indicators, shown below. When the orange neon is lit (NE5), the phasing is incorrect. If the green neon is lit (NE6), the phasing is correct. If both neon indicators are lit, then you have a loose wire. Adjust phasing by swapping L1 and L2 of the incoming power lines at the main circuit breaker.



WARNING!

ALL POWER MUST BE TURNED OFF AT THE SOURCE PRIOR TO ADJUSTING PHASING.

9. Turn off the power (rotate the shaft that engages the handle on the panel door counterclockwise until it snaps into the OFF position). Also, set the main switch handle on the panel door to OFF. (Both the handle and the switch must be set to OFF before the door can be closed). Close the door, lock the latches, and turn the power back on.

10. Remove the key from the control cabinet and give it to the shop manager.

Installation Procedure for External 480V Transformer

Introduction

The external transformer adds to overall machine reliability and performance, however it does require extra wiring and a place to locate it. The external transformer provides electrostatically shielded isolation. This type of transformer acts to isolate all common mode line transients and improve EMI conducted emissions.

The external transformer has a 45 KVA rating.

Installation

The transformer should be located as close to the machine as possible. The input and output wiring of the transformer should conform to the local electrical codes and should be performed by a licensed electrician. The following is for guidance only, and should not be construed to alter the requirements of local regulations.

The input wire should not be smaller than the 6AWG for the 45KVA transformer. Cable runs longer than 100" will require at least one size larger wire. The output wire size should be 4 AWG.

The transformer is 480V to 240V isolation transformers with delta wound primary and secondary windings. The primary windings offer 7 tap positions, 2 above and 4 below the nominal input voltage of 480V.

For domestic installations and all others using 60Hz power, the primary side should be wired as follows:

Input Voltage Range	Tap
493-510	1 (504)
481-492	2 (492)
469-480	3 (480)
457-468	4 (468)
445-456	5 (456)
433-444	6 (444)
420-432	7 (432)

This should produce a voltage on the secondary side of 234-243 V RMS L-L. Verify this and readjust the taps as required. At the machine, connect the cables at the input of the internal 230V transformer to the 227-243V taps. Apply power to the machine and verify that the DC voltage between pins 2 and 3 of the Vector Drive (2nd and 3rd pins from the left) is 329-345VDC. If not, return to the 480V isolation transformer and readjust the taps as required. Do not use the taps on the internal 230V transformer to adjust the voltage.

50Hz Installations

The external transformers are 60Hz rated, and cannot be used at 50Hz without derating the input voltage. For these applications, the internal 230V transformer should be tapped on the lowest setting (195-210V RMS). The external transformer should be tapped according to the table shown below. If these tap setting do not produce a DC bus voltage between pins 2 and 3 on the Vector Drive between 320 and 345VDC, readjust the taps on the external transformer as required. DO NOT move the taps on the internal transformer from the lowest position.

Input Voltage Range	Tap
423-440	1 (504)
412-422	2 (492)
401-411	3 (480)
391-400	4 (468)
381-390	5 (456)
371-380	6 (444)
355-370	7 (432)

4.3 Fuse Replacement

Please read this section in its entirety before attempting to replace any fuses.

Overvoltage Fuse

WARNING!

The electrical panel will have residual voltage, even after power has been shut off and/or disconnected . Never work inside this cabinet until the small red CHARGE light on the servo drive assembly goes out. The servo drive assembly is on the left side of the main control cabinet and about halfway down. This light is at the top of the circuit card at the center of the assembly. Until this light goes out, there are dangerous voltages in the assembly EVEN WHEN POWER IS SHUT OFF.

1. Turn machine power off.

2. Turn the main switch (upper right of electrical cabinet) to the off position.

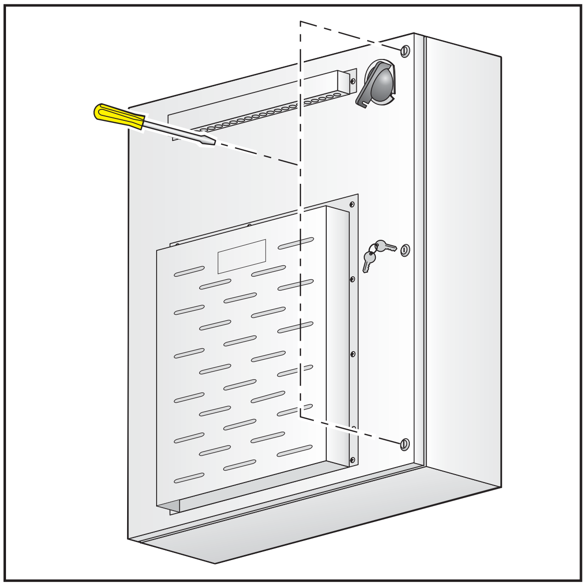


Figure 4.3-1. Unscrew the three screws to open the cabinet door. (Control cabinets may require a key)

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until at the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.

4. On the POWER SUPPLY board there are three fuses located in a row at the upper right of the board; these are the overvoltage fuses. An orange light will be on to indicate the blown fuse(s).

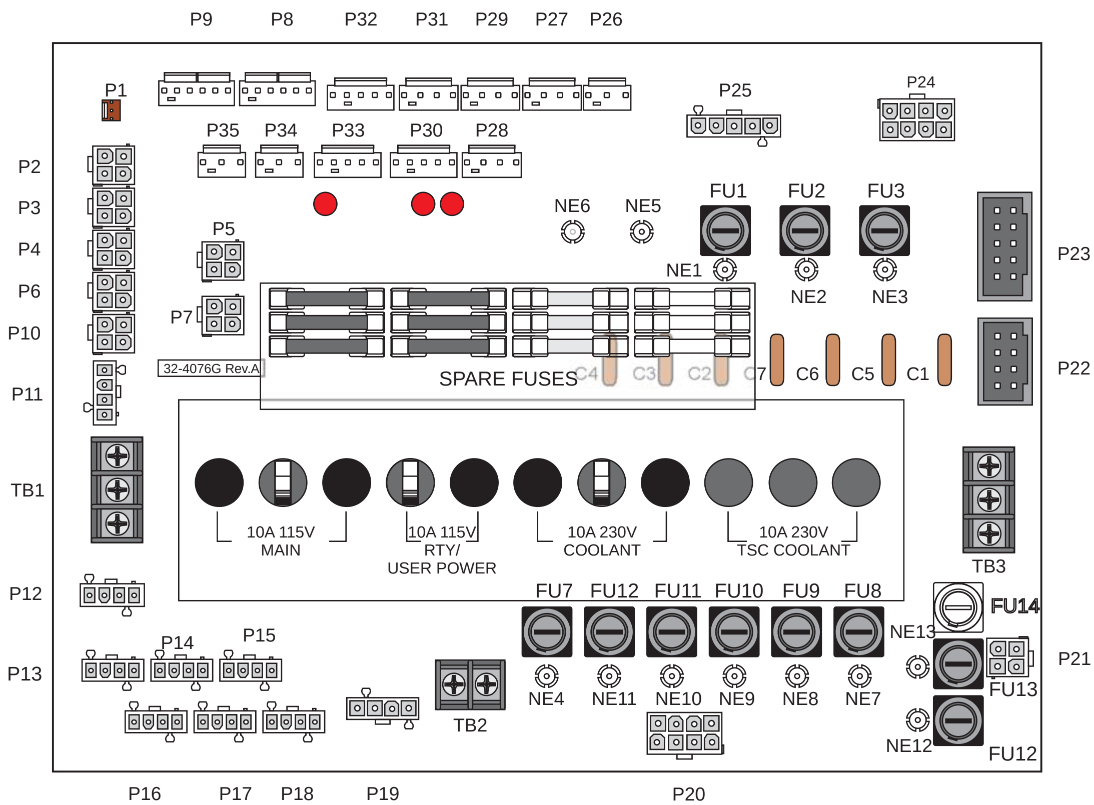


Figure 4.3-2 Power supply board; fuse locations.

5. Using a flat tip screwdriver, turn the fuse(s) counterclockwise to remove and replace the blown fuse(s) with ones having the same type and rating (½ amp, type AGC, 250V).

CAUTION! When the left fuse is blown, it is still possible to operate the machine, thereby making an overvoltage situation possible. VERIFY absolute voltage to the machine does not exceed 200 volts (Max 260 leg to leg or leg to ground, or 400 volts on high voltage machines-max 520 volts leg to leg of leg to ground).

Servo Driver Fuses

1. Turn the main switch (upper right of electrical cabinet) to the off position.

2. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until at least the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.

3. On the SERVO DRIVE ASSEMBLY, there are three individual fuses on each of the SERVO DRIVE boards (See Fig. 4.3-3; the F3 fuses are not shown).

4. On each of the SERVO DRIVER boards, the fuses (F1, F2, F3) may be replaced by simply pulling out the fuses by hand and replacing with fuses of the same type and rating (F1, F2: 20 amp, type ABC, 250V; F3: 10 amp, type ABC, 250V).

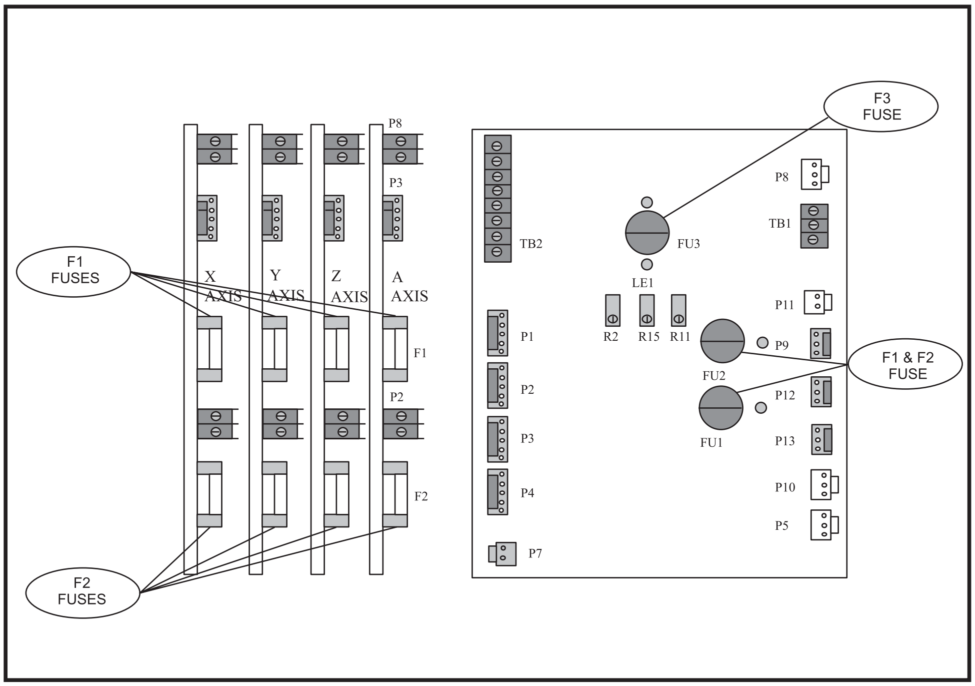


Figure 4.3-3 Servo Drive Assembly; fuse locations

4.4 PCB Replacement

Please read this section in its entirety before attempting to replace any PCBs.

Microprocessor, MOCON (MOTIF) & Video / Keyboard

NOTE: The arrangement of these boards may differ from the order of replacement that follows. The steps for replacement will only differ in which board may need to be removed before getting to the necessary board.

WARNING!

The electrical panel will have residual voltage, even after power has been shut off and/or disconnected . Never work inside this cabinet until the small red CHARGE light(s) on the servo amplifiers (servo drive assembly for brush machines) goes out. The servo drive assembly is on the left side of the main control cabinet and about half-way down. This light is at the top of the circuit card at the center of the assembly. Until this light goes out, there are dangerous voltages in the assembly EVEN WHEN POWER IS SHUT OFF.

MOCON (or MOTIF) BOARD

NOTE: Refer to "Cable Locations" for a diagram of this board.

1. Turn machine power off.
2. Turn the main switch (upper right of electrical cabinet) to the off position.
3. Loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until the red CHARGE light on the servo amplifiers (servo drive assembly on brush machines) goes out before beginning any work inside the electrical cabinet.
4. Disconnect all leads to the Motor Controller (MOCON), or Motor Interface (MOTIF) board (for brush machines). Ensure all cables are properly labeled for reconnecting later.
5. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.

NOTE: If the VIDEO / KEYBOARD or PROCESSOR boards need replacing, please skip the next step.

6. Replace the MOCON (or MOTIF) board, attaching it to the VIDEO / KEYBOARD (beneath the MOCON / MOTIF board) with the standoffs.
7. Reconnect all leads (previously removed) to their proper connections.

VIDEO / KEYBOARD

NOTE: Refer to "Cable Locations" for a diagram of this board.

8. Remove the MOCON (or MOTIF) board as described in Steps 1-5.
9. Disconnect all leads to the Video / Keyboard. Ensure all cables are properly labeled for reconnecting later. The following illustration shows all cable numbers and the locations on the Video / Keyboard.
10. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.

NOTE: If the PROCESSOR board needs replacing, please skip the next step.

11. Replace the Video / Keyboard, attaching it to the PROCESSOR board (beneath the Video / Keyboard) with the standoffs.
12. Reconnect all leads (previously removed) to their proper connections.

PROCESSOR BOARD

NOTE: Refer to "Cable Locations" for a diagram of this board.

13. Remove the MOCON (or MOTIF) board as described in Steps 1-5, and the Video / Keyboard as described in Steps 8-9.
14. Disconnect all leads to the Processor (68020) board. Ensure all cables are properly labeled for reconnecting later. The following illustration shows all cable numbers and the locations on the 68030 board.
15. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.
16. Replace the Processor (68030) board, attaching it to the electrical cabinet (beneath the 68030 board) with the standoffs.
17. Reconnect all leads (previously removed) to their proper connections.

SERVO DRIVER

WARNING!

The electrical panel will have residual voltage, even after power has been shut off and/or disconnected. Never work inside this cabinet until the small red CHARGE light on the servo drive assembly goes out. The servo drive assembly is on the left side of the main control cabinet and about halfway down. This light is at the top of the circuit card at the center of the assembly. Until this light goes out, there are dangerous voltages in the assembly EVEN WHEN POWER IS SHUT OFF.

1. Turn machine power off.
2. Turn the main switch (upper right of electrical cabinet) to the off position.
3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.

SERVO DRIVER BOARDS

NOTE: Refer to "Cable Locations" for a diagram of this board.

1. Follow all precautions noted previously before working in the electrical cabinet.
2. Turn the main switch (upper right of electrical cabinet) to the off position.
3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.
4. Disconnect all leads to the Servo Driver (DRIVER) board that you wish to replace. Ensure all cables are properly labeled for reconnecting later.

NOTE: When replacing any DRIVER board, it will be necessary to disconnect all leads on all DRIVER boards in order to remove or replace the board.

5. Remove the board by first removing the two screws that fasten it to the cabinet. Take care to hold the board in place until both screws have been removed.
6. Replace the DRIVER board, attaching it to the cabinet with the two screws previously removed.
7. Reconnect all leads to all boards at this time. Ensure the red and black leads go to the appropriate connections.

I/O BOARD

NOTE: Refer to "Cable Locations" for a diagram of this board.

1. Follow all precautions noted previously before working in the electrical cabinet.
2. Turn the main switch (upper right of electrical cabinet) to the off position.
3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

4. Disconnect all leads to the Input/Output board and move aside for removal. Ensure all cables are properly labeled for reconnecting later. The illustration in the Cable Locations section shows all cable numbers and their locations on the I/O board.

5. Remove the board by first removing the twelve screws that fasten it to the cabinet. Take care to hold the board in place until all screws have been removed.

6. Replace the I/O board, attaching it to the cabinet with the twelve screws previously removed.

7. Reconnect all leads to the I/O board at this time.

Power & Low Voltage Supply

POWER BOARD

NOTE: Refer to "Cable Locations" for a diagram of this board.

1. Follow all precautions noted previously before working in the electrical cabinet (See warning at beginning of "Servo Driver" section).

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

4. Disconnect all leads to the Power Distribution (POWER) board and move aside for removal. Ensure all cables are properly labeled for reconnecting later. The illustration on the following page shows all cable numbers and the locations on the POWER board.

5. After all cables have been disconnected, remove the seven screws holding the POWER board to the cabinet and remove the board. Take care to hold the POWER board in place until all screws have been removed.

NOTE: If you need to replace the LOW VOLTAGE POWER SUPPLY board, please skip the next step.

6. Replace the POWER board, attaching it with the seven screws previously removed. Don't forget to use the lower left screw for a ground connection.

7. Reconnect all cables to the POWER board at their proper location.

LOW VOLTAGE POWER SUPPLY

8. Remove the Power Distribution (POWER) board as described in Steps 1-5.

9. Disconnect all leads to the Low Voltage Power Supply (LVPS) board. Ensure all cables are properly labeled for reconnecting later. The illustration in the Cable Locations section shows all cable numbers and their locations on the LVPS board.

10. After all cables have been disconnected, unscrew the two standoffs at the bottom of the board. Unscrew the remaining two screws at the top of the LVPS board, taking care to hold the board in place until all screws have been removed.

11. Replace the LVPS board, attaching it to the cabinet with the two screws and two standoffs previously removed.

12. Replace the POWER board as described in Steps 6-7.

RS-232 PCB

NOTE: Refer to "Cable Locations" for a diagram of this board.

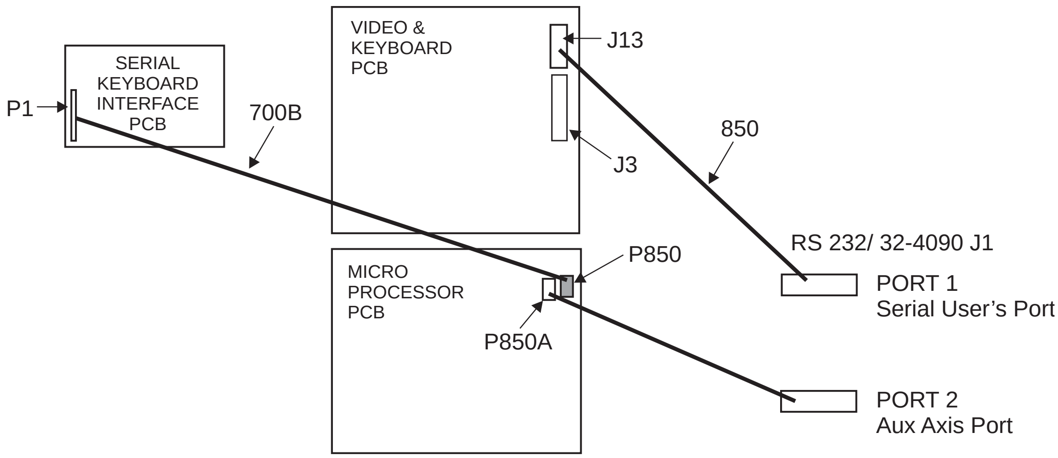
1. Follow all precautions noted previously before working in the electrical cabinet (See warning at beginning of "Servo Driver" section).

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

NOTE: It is suggested to make use of a step ladder high enough to allow you to work from the top of the electrical cabinet. It will be necessary, when replacing the RS-232 board, to work from the inside and outside of the cabinet at the same time.

4. On the left side of the cabinet, at the top of the side panel are two serial port connections labeled "SERIAL PORT #1" and "SERIAL PORT #2", SERIAL PORT #1 being the upper connection.



* Serial interface replaces cable 700 with cable 700B.

Figure 4.4-1 RS-232 wiring pictorial (with serial keyboard).

5. To remove the RS-232 board, unscrew the two hex screws (on the exterior of the cabinet) holding the connector to the cabinet. From the inside of the cabinet, pull the connector through the panel, and disconnect the cable.

6. Replace the RS-232 board by first connecting the appropriate cable to the board (850 to SERIAL PORT #1, 850A to SERIAL PORT #2, then inserting the board (cable side up) through the left side panel. Attach with the two hex screws previously removed. Ensure the board for Serial Port #1 is the upper connector and the board for Serial Port #2 is the lower connector.

7. Replace the Serial Keyboard Interface (KBIF) board, using the four screws previously removed, starting at the top right. Attach the screw and standoff loosely, then all other screws and standoffs, until all are mounted. Tighten down completely.

8. Reconnect all cables to the Serial KBIF board at their proper locations.

RS-232 Serial Interface

There are two connectors used for the RS-232 interface. The RS-232 connector on the back of most PC's is a male DB-25, so only one type of cable is required for connection to the controller, or between controllers. This cable must be a DB-25 male on one end and a DB-25 female on the other. Pins 1, 2, 3, 4, 5, 6, 7, 8, and 20 must be wired one-to-one. It cannot be a Null Modem cable, which inverts pins 2 and 3. To check cable type, use a cable tester to check that communication lines are correct. The controller is DCE (Data Communication Equipment). This means that it transmits on the RXD line (pin 3) and receives on the TXD line (pin 2). The RS-232 connector on most PC's is wired for DTE (Data Terminal Equipment), so no special jumpers should be required.

The Down Line DB-25 connector is only used when more than one controller is to be used. The first controller's down line connector goes to the second controller's up line connector, etc.

The RS-232 interface sends and receives **seven data bits, even parity, and two stop bits**. The interface must be set correctly. The data rate can be between 110 and 19200 bits per second. When using RS-232, it is important to make sure that Parameters 26 (RS-232 Speed) and 33 (X-on/X-off Enable) are set to the same value in the controller and PC.

If Parameter 33 is set to **on**, the controller uses X-on and X-off codes to control reception, so be sure your computer is able to process these. It also drops CTS (pin 5) at the same time it sends X-off and restores CTS when is sends X-on. The RTS line (pin 4) can be used to start/stop transmission by the controller or the X-on/X-off codes can be used. The DSR line (pin 6) is activated at power-on of the controller and the DTR line (pin 20 from the PC) is not used. If Parameter 33 is 0, the CTS line can still be used to synchronize output.

When more than one HAAS controller is daisy-chained, data sent from the PC goes to all of the controllers at the same time. That is why an axis selection code (Parameter 21) is required. Data sent back to the PC from the controllers is OR'ed together so that, if more than one box is transmitting, the data will be garbled. Because of this, the axis selection code must be unique for each controller.

RS-232 Remote Command Mode

Parameter 21 must be non-zero for the remote command mode to operate as the controller looks for an axis select code defined by this parameter. The controller must also be in RUN mode to respond to the interface. Since the controller powers-on in RUN mode, remote unattended operation is thus possible.

RS-232 Line Noise

To minimize line noise on the serial port, reroute the cables; route them straight up the left-hand side of the control to the processor stack. Do not run them above the I/O PCB or up the center wire channel to the processor.

The best way to minimize transmission errors is to have a good common ground between the PC and CNC control

4.5. Front Panel

Please read this section in its entirety before attempting to replace any component of the control panel.

CRT Assembly Replacement

1. Turn the power off and disconnect power to the machine.
2. Remove the screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.
3. At this time, remove the end cap on the support arm and unplug the white cable at the connection inside, then unplug the black cable at the connection in the control panel. It may be necessary to cut straps off the black cable's connector to unplug.
4. Unscrew the four hex nuts on the bottom row of the CRT bracket and remove, along with the washers. Set aside in a safe place.
5. While holding up the CRT assembly, remove the four hex nuts on the top row of the CRT bracket, along with the washers.

CAUTION! Take extreme care to not drop or damage the CRT assembly when removing from the control panel.

6. CAREFULLY pull the CRT assembly out toward the rear until it is clear of the control panel and all wiring. Set CRT assembly down in a safe place so as not to damage.
7. Use gloves to avoid getting fingerprints on the new LCD. Replace by sliding the new assembly onto the eight bolts (four each on top and bottom). Starting with the bottom right, place the washers and hex nuts on the bolts to hold in place. Refer to Fig. 4.5-1. Once all washers have been attached and nuts have been hand-tightened, tighten down completely with the socket.

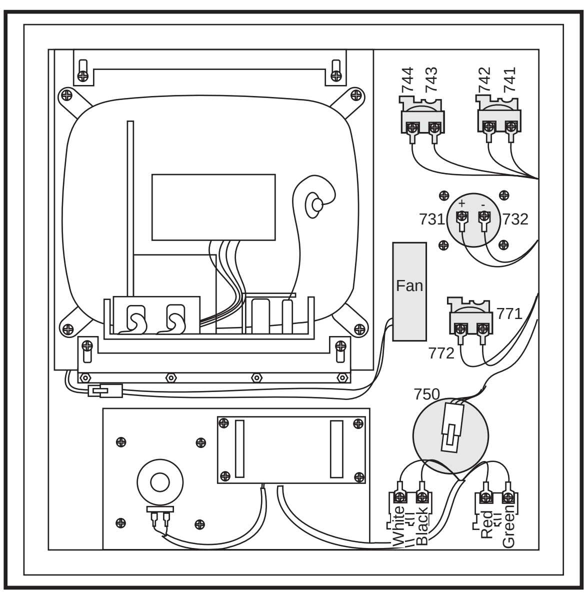


Figure 4.5-1 Interior of control panel (rear).

8. Plug the black cable and white cable into the matching cables. Feed the white cable through the opening in the top of the control panel.

9. Replace the back cover panel and attach with the four screws previously removed.

LCD Assembly Replacement

CAUTION! Use an electro-static discharge (ESD) strap on wrist when working inside the pendant.

1. Turn the power off and disconnect power to the machine.

2. Remove the screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Disconnect the data cable from the receiver board on the LCD assembly (J3).

4. Disconnect the power cable and ground wire from the power supply board on the LCD assembly (TB1).

5. Disconnect the cables to the keyboard from the receiver assembly (P1) and power supply (TB2) on the LCD assembly.

6. Remove the four (4) hex nuts and washers beginning with the bottom, then remove the LCD assembly and set aside in a safe place.

CAUTION! Take extreme care to not drop or damage the LCD assembly when removing from the control panel.

7. Replace by sliding the new assembly onto the four bolts (two each on top and bottom). Place the washers and hex nuts on the bolts to hold in place. Refer to Fig. 4.5-1. Once all washers have been attached and nuts have been hand-tightened, tighten down completely.

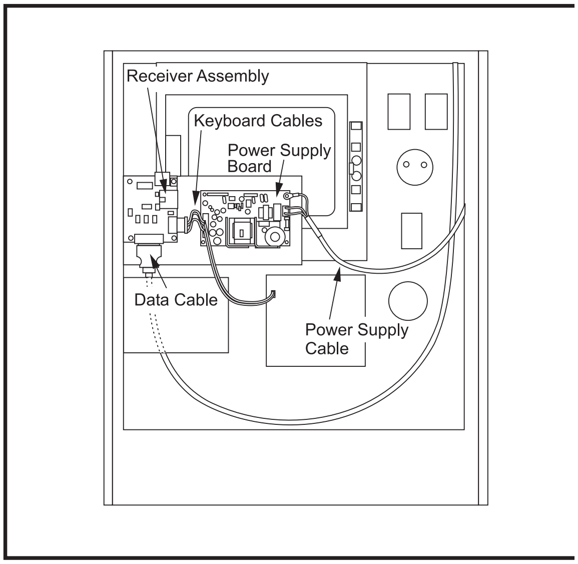


Figure 4.5-1 Interior of control panel (rear).

8. Plug the keyboard cables into the new receiver board (P1) and the power supply (TB2).

9. Plug the power cable into the power supply board (TB1) and attach the green wire to ground.

10. Plug the data cable into the receiver board (J3).

11. Replace the back cover panel and attach with the four screws previously removed.

Jog Handle Replacement

The Jog handle is actually a 100-line-per-revolution encoder. We use 100 steps per revolution to move one of the servo axes. If no axis is selected for jogging, turning of the crank has no effect. When the axis being moved reaches its travel limits, the handle inputs will be ignored in the direction that would exceed the travel limits.

Parameter 57 can be used to reverse the direction of operation of the handle.

1. Turn the machine power off.

2. Remove the screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Unplug the cable leading to the jog handle encoder. **IMPORTANT!** The blank pin side of the connector must face as shown in Fig. 4.5-2 when reconnecting; otherwise, damage may occur to the machine.

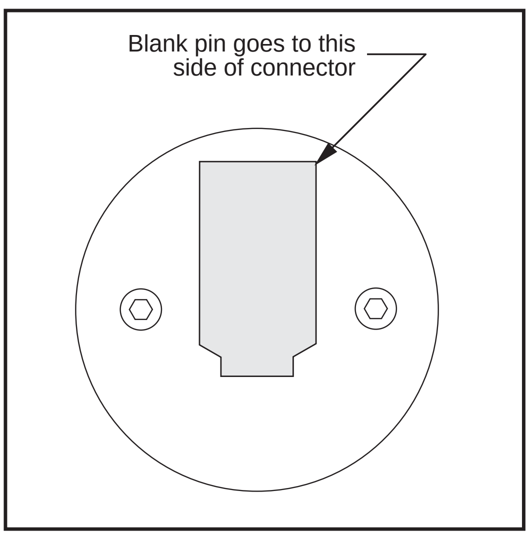
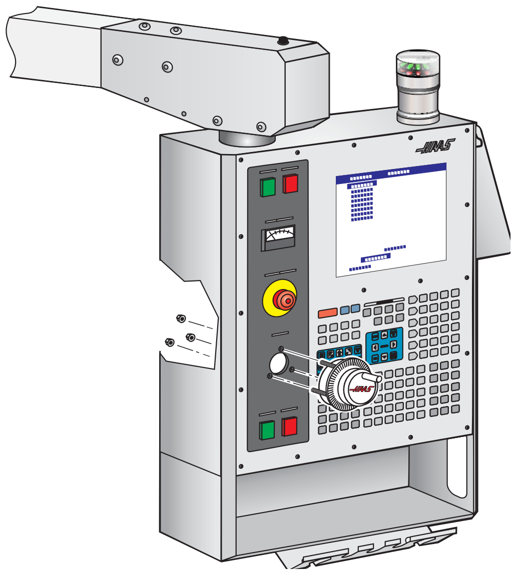


Figure 4.5-2 Jog handle encoder.

4. Using a 5/64" allen wrench, loosen the two screws holding the knob to the control panel and remove.



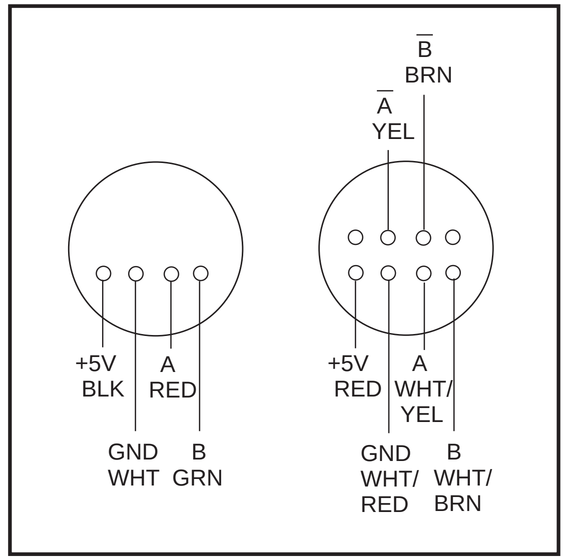


Figure 4.5-3 Jog Handle removal

Figure 4.5-4. Jog Handle wiring diagram

5. Remove the three screws holding the jog handle encoder to the control panel and remove.

6. Replacement is reverse of removal. Keep in mind the important notice in Step 3.

Switch Replacement

NOTE: This section is applicable for the POWER ON, POWER OFF, EMERGENCY STOP, CYCLE START, and FEED HOLD switches.

1. Turn the machine power off.

2. Remove the screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Disconnect all leads to the switch's connectors. Ensure all leads are properly marked for reconnecting later. Refer to Fig. 4.5-1 for proper locations.

4. Unscrew the two small set screws, one on top and one on the bottom, and turn the switch counterclockwise to loosen. Separate from the front portion and pull out.

5. For replacement, screw the front and rear portions together (reverse of removal) and tighten down the two small set screws when the switch is properly positioned.

NOTE: The POWER ON, POWER OFF, and EMERGENCY STOP switches must all have the connectors on the bottom of the switch.

6. Reconnect all leads to the correct switch.

7. Replace the back panel of the pendant.

Spindle Load Meter Replacement

1. Turn the power off and disconnect power to the machine.

2. Remove the screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Disconnect the two leads at the back of the spindle load meter assembly. Ensure the two leads are properly marked for reconnecting later.

4. Unscrew the four screws that hold the spindle load meter assembly to the control panel. Take care to hold the assembly in place until all screws have been removed. Remove the assembly.

5. Installation is reverse of removal. Ensure leads go the correct location.

Keypad Replacement

1. Turn the power off and disconnect power to the machine.

2. Remove the four screws holding the rear cover panel to the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Unplug the keypad's 24-pin ribbon cable from the Keyboard Interface board.

4. Remove the screws from the front of the control panel. Take care to hold the front cover panel in place until all screws have been removed. Remove the pieces and set aside in a safe place.

5. Using a flat, blunt tool, such as putty knife, pry the keypad away from the control panel. Pull the ribbon cable through the opening in the control to remove.

6. To replace, first put the bezel spacer in place and fasten temporarily with screws in the top corners.

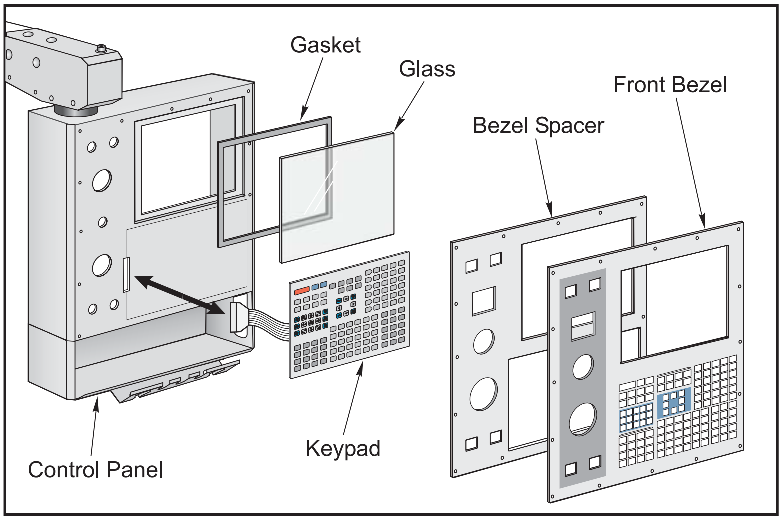


Figure 4.5-5. Keypad installation.

7. Insert the ribbon cable through the opening in the control panel. Expose the adhesive strip on the back of the keypad and press the keypad in place in the upper right corner of the keypad recess. Press to the control panel to mount. Plug the ribbon cable into the Keyboard Interface board, taking care to not bend the pins on the board.

8. Replace the front and rear cover panels and fasten with the screws that were previously removed.

Serial Keyboard Interface (KBIF)

NOTE: Refer to "Cable Locations" for a diagram of this board.

1. Follow all precautions noted previously before working in the control cabinet (See warning at beginning of Section 5).

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Remove the screws on the back of the control box, then remove the cover panel. Take care to hold the panel in place until all screws have been removed.

4. Disconnect all leads to the Serial Keyboard Interface (KBIF) board. Ensure all cables are properly labeled for reconnecting later.

5. After all cables have been disconnected, unscrew the four screws holding the Serial KBIF board to the control box. Take care to hold the board in place until all screws have been removed. Place the screws and standoffs aside for later use.

6. Replace the Serial KBIF board, using the four screws previously removed, starting at the top right. Attach the screw and standoff loosely, then all other screws and standoffs, until all are mounted. Tighten down completely.

7. Reconnect all cables to the Serial KBIF board at their proper locations.

4.6 Spindle Encoder Replacement

Please read this section in its entirety before attempting to remove or replace encoder.

Removal

1. Turn machine power on. Raise or lower spindle head to a position that will allow you to easily work on the encoder (must be above the enclosures). Turn machine off.

2. Remove head covers (See the procedure in the Mechanical Service section).

3. Disconnect the encoder cable at the top of the encoder.

4. Unscrew and remove the four 10-32 screws holding the encoder to the four standoffs (VF-1, VF-2, VF-3,VF-4) or mounting bracket (direct drive machines). Remove the encoder, leaving the belt on the pulley at the orient ring.

Installation

If you wish to install an encoder on a machine start at step 1; if this is just a replacement, skip to step 13. Please note the differences in installation between the VF-1, VF-2, and the VF-3,VF-4.

1. For the VF-1, VF-2, and VF-3, VF-4, put some blue Loctite on the threads of the four set screws and screw approximately halfway into the standoffs. Screw the hex end of the set screws into the standoffs.

2. Screw the standoffs into the four holes located at the rear of the transmission's top plate.

3. On direct drive machines, place the mounting bracket in place. Fasten to the top plate with the four screws and four lock washers.

4. Place the 18-tooth pulley onto the pulley bushing and tighten down. Place the SHCS through the center axis of the pulley.

5. Screw this assembly into the spindle orientation ring.

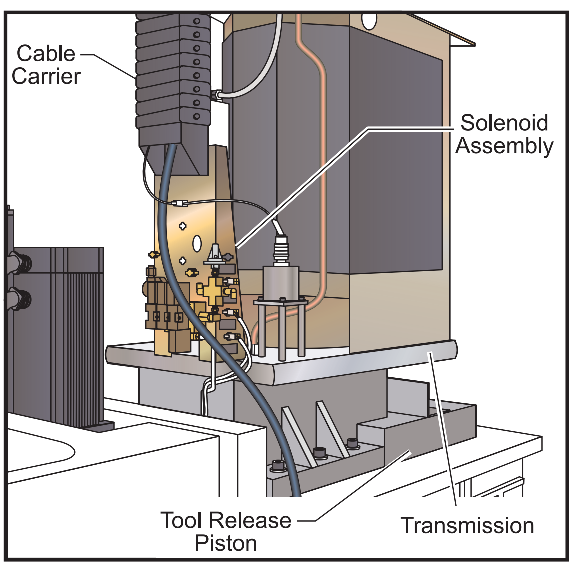


Figure 4.6-1 Spindle encoder installation (VF-1/VF-2).

6. Place the 36-tooth pulley onto the encoder, making the top of the pulley flush with the end of the shaft. Tighten down with the 5/64" hex wrench.

7. Unscrew the four screws and remove the cover panel on the box at the base of the flexible tube.

8. Feed the encoder cable through the flexible tube and connect at the plug in the box on top of the electrical cabinet.

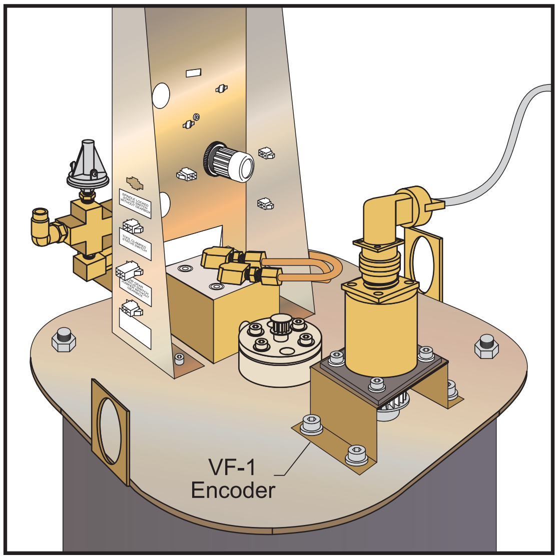


Figure 4.6-2 Encoder installation for direct drive machines

9. Carefully install the pulley onto the new encoder aligning the setscrew hole with the flat on the encoder shaft. Use only one setscrew to hold the pulley on the shaft. Remove the setscrew and apply a small drop of removable grade loctite to the setscrew threads. Some pulleys may have two setscrew holes and screws, remove the unused setscrew.

10. Place the belt on the 36-tooth pulley, then loop over the 18-tooth pulley. Place the encoder assembly on the four standoffs (mounting bracket on the direct drive machines) and attach with the four 10-32 SHCS, placing the #10 lock washers between the socket head and the encoder base. Belt tension is very critical to the proper performance of the encoder. Do not create an excessive amount of tension on the belt. The maximum radial load (side load) for the encoder shaft is 13-1/2 lbs (60 N). Exceeding this maximum radial load may damage the encoder.

11. Connect the encoder cable to the encoder assembly.

5. TECHNICAL REFERENCE

5.1 Tool Changer

Tools are always loaded through the spindle and should never be installed directly in the carousel in order to avoid crashes. The pocket open to the spindle must always be empty in the retracted position.

Low air pressure or insufficient volume will reduce the pressure applied to the tool unclamp piston and will slow down tool change time or will not release the tool. The air pressure is now checked prior to moving the carousel on a mill with a side mount tool changer and alarm 120 LOW AIR PRESSURE is generated if such a problem exists.

WARNING

AN INADEQUATE AIR SUPPLY
WILL CAUSE TOOL CHANGER FAULTS

FOLLOW THESE GUIDELINES:
- MINIMUM AIR SUPPLY PRESSURE TO MACHINE IS 100 PSI.
- OBSERVE GAGE DURING TOOL CHANGE - 10 PSI MAX. DROP.
- USING THE AIR GUN DURING TOOL CHANGES MAY CAUSE FAULTS IF THE AIR SUPPLY TO THE MACHINE IS MARGINAL.
- ALLOW 2 HP OF AIR COMPRESSOR PER MACHINE, (I.E., 5 MACHINES REQUIRE A 10 HP AIR COMPRESSOR).
- USE MINIMUM 3/8 ID HOSE FOR 40 TAPER MACHINES,
  MINIMUM 1/2 ID HOSE FOR 50 TAPER & HS MACHINES.
- AVOID QUICK DISCONNECTS IN SUPPLY LINES - THEY ARE RESTRICTIVE.

If the shuttle should become jammed, the control will automatically come to an alarm state. To correct this, push the EMERGENCY STOP button and remove the cause of the jam. Push the RESET key to clear any alarms. Press "Tool Changer Restore" button, to automatically reset the tool changer after a crash. Never put your hands near the tool changer when powered unless the EMERGENCY STOP button is pressed.

There is a fuse for the tool changer motors. It might be blown by an overload or jam of the tool changer. Operation of the tool changer can also be interrupted by problems with the tool clamp/unclamp and the spindle orientation mechanism. Problems with them can be caused by low air pressure or a blown solenoid circuit breaker.

CAUTION! Never put your hands near the tool changer when powered unless the EMERGENCY STOP button is pressed.

CAUTION! Do not exceed the Maximum Specifications given below!

SIDE-MOUNT TOOL CHANGER SPECIFICATIONS

	40-Taper VF 0-4	40-Taper VF 5-11	50-Taper VF 5	50-Taper VF 6-11,VS-3
Maximum Tool Diameter with all pockets full	3"	3"	4"	4"
Maximum Tool Diameter if tool is declared oversized	5"	6"	7"	10"
Maximum Tool Length from gauge line	13"	16"	16"	16"
Maximum Tool Weight	12 lb	12 lb	30 lb	30 lb
Tool Capacity	25 (41 opt VF 3/4)	25 (41 optional)	31 tools	31 tools
Number of Tool Pockets	24 (40 opt VF 3/4)	24 (40 optional)	30	30

SHUTTLE TOOL CHANGER SPECIFICATIONS

	20-Pocket	32-pocket (16 pocket)
Maximum Tool Weight	12 lb	12 lb
Maximum Total Tool Weight	120 lb	200 lb

CAUTION!
- Extremely heavy tool weights should be distributed evenly
- Ensure there is adequate clearance between tools in the tool changer before running an automatic operation. This distance is 3.6" for the 20 pocket, 3.4" for the 32 pocket, 6" for the 16 pocket.

When a tool change operation is performed, the following sequence of events occurs:

1) Z axis moves up to machine zero,
2) If the spindle is turning, it is commanded to stop; coolant stopped,
3) Spindle oriented to Tool Changer,
4) Turn TSC pump off, (optional)
5) Turn purge on and off (optional)
6) Pre-charge is on (40 taper spindle only),
7) Tool unclamps,
8) Z axis moves up,
9) Tool Changer rotates,
10) Z axis moves down,
11) Tool clamps,
12) Pre-charge off (40 taper spindle only),

Tool Changer Lubrication

Place lubricating grease on the outside edge of the guide rails of the tool changer and run through all tools.

Shuttle In/Out Motor

A DC brush motor is used to move the tool changer assembly towards and away from the spindle. This is called the shuttle. The motor is geared down to a low RPM and then connected to an arm that rotates through 180° and pushes the shuttle in and out.

NOTE: This motor should never be disassembled.

Turret Rotation Motor

A DC brush motor is used to rotate the tool turret between tool changes. This motor is geared down to a low RPM and connected to a Geneva mechanism. Each 1/2 revolution of the Geneva mechanism moves the tool turret one tool position forward or backward.

NOTE: This motor should never be disassembled.

Side Mount Tool Changers

The tool changer is controlled with a single axis control mounted inside the control.

Carousel Rotation Motor

A DC brush motor is used to rotate the carousel between tool changes. The motor has an encoder and is driven by the single axis control mounted inside the control.

NOTE: This motor should never be disassembled.

Tool Changer Position Switches

Two switches are used to sense the position of the tool changer carousel. One switch is activated when the carousel is moved full travel inward and one is activated when it is full travel outward. These switches are normally closed so that both will be closed between in and out. The diagnostic display will show this status of this input switch. A “1” indicates the associated switch is activated or open.

5.2 Tool Clamp/Unclamp

The tool holder drawbar is held clamped by spring pressure. Air pressure is used to release the tool clamp. When the tool is unclamped, air is directed down the center of the spindle to clear the taper of water, oil, or chips. Tool unclamp can be commanded from a program (but this is quite dangerous), from the keyboard, and from the button on the side of the spindle head. The two manual buttons only operate in MDI or JOG modes.

Tool Clamp/Unclamp Air Solenoids

A single solenoid controls the air pressure to release the tool clamp. When the tool clamp relay is activated, 115V AC is applied to the solenoid. This applies air pressure to release the tool. The relay is on the I/O PCB. A circuit breaker will interrupt power to this solenoid.

Tool Clamp/Unclamp Sense Switches

There are two switches used to sense the position of the tool clamping mechanism. They are both normally closed and one will activate at the end of travel during unclamping and the other during clamping. When both switches are closed, it indicates that the draw bar is between positions.

A tool change operation will wait until the unclamped switch is sensed before the Z-axis pulls up from the tool. This prevents any possibility of breaking the tool changer or its support mounts.

The diagnostic display can be used to display the status of the relay outputs and the switch inputs.

The Precharge and Through the Spindle Coolant system applies low air pressure and releases the clamped switch (with 40 taper spindle only).

Remote Tool Unclamp Switch

The Remote Tool Unclamp switch is mounted on the side of the cover to the spindle head. It operates the same as the button on the keyboard. It must be held for ½ second before the tool will be released and the tool will remain released for ½ second after the button is released.

While the tool is unclamped, air is forced down the spindle to clear chips, oil, or coolant away from the tool holder.

5.3 Spindle Operation

Spindle speed functions are controlled primarily by the **S** address code. The **S** address specifies RPM in integer values from 1 to maximum spindle speed (Parameter 131). NOT TO BE CHANGED BY USER! When using the Through the Spindle Coolant option, the maximum spindle speed is 7500 RPM (5000 RPM for 50 taper spindles).

Speeds from S1 to the Parameter 142 value (usually 1200) will automatically select low gear and speeds above Parameter 142 will select high gear. Two **M** codes, M41 and M42 can be used to override the gear selection. M41 for low gear and M42 for high gear. Low gear operation above S1250 is not recommended. High gear operation below S100 may lack torque or speed accuracy. Spindle speed accuracy is best at the higher speeds and in low gear.

If there is no gear box in your machine the gear box is disabled by parameters, it is always in high gear, and M41 and M42 commands are ignored.

The spindle is hardened and ground to the precise tool holder dimensions providing an excellent fit to the holder.

Spindle Warm-Up Program

All spindles, which have been idle for more than 4 days, must be thermally cycled prior to operation above 6,000 RPM. This will prevent possible overheating of the spindle due to settling of lubrication. A 20-minute warm-up program has been supplied with the machine, which will bring the spindle up to speed slowly and allow the spindle to thermally stabilize. This program may also be used daily for spindle warm-up prior to high-speed use. The program number is O02020 (Spindle Warm-Up).

```
O02020 (Spindle Warm–Up)
S500M3;
G04 P200.;
S1000M3;
G04 P200.;
S2500M3;
G04 P200.;
S5000M3;
G04 P200.;
S7500M3;
G04 P200.;
S10000M3;
G04 P200.;
M30;
```

Spindle Run-In Program

All spindles must go through a run-in cycle at the time of machine installation prior to operating the spindle at speeds above 1,000 RPM. A program has been supplied with the machine that will run-in the spindle during machine installation and should also be used after long periods of machine down-time (two weeks or more). The program number is O02021 (Spindle Run-In). Cycle Time: 2 hours. See Installation Section for copy of the program.

These programs can be used for all spindle types. Adjust spindle speed override depending on maximum spindle speed of machine: Set override at 50% for 5,000 RPM machines; Set at 100% for 7,500 and 10,000 RPM machines; Set at 150% for 15,000 machines.

Spindle Orientation

Orientation is performed electrically and no shot pin or solenoid is required for locking the motor in place. Orientation of the spindle is automatically performed for tool changes and can be programmed with M19 commands. Orientation is performed by turning the spindle until the encoder reference is reached, the spindle motor holds the spindle locked in position. If the spindle is orientated and locked, commanding spindle forward or reverse will release the lock.

15K High Speed Spindle

Non-Serviceable, Anti-Rotation Drawbar

The drawbar and the spindle are not serviceable as separate items on the 15K Spindle. The 15K Spindle comes with TSC and an extra high clamp drawbar and may be used in both TSC and non-TSC applications. If there is a need to replace the spindle or the drawbar the entire spindle must be replaced.

NOTE: The spindle and the drawbar are balanced at the factory as a matched assembly.

The anti-rotation drawbar does not allow the drawbar to turn in the spindle shaft. By not changing the position of the drawbar changes in vibration output of the spindle are minimized. The balance is also retained when the drawbar does not turn.

Oil Flow

The specification for oil flow is 0.15-0.18 cc per 0.5 hour when measured from the spindle restrictor with no airflow. This oil flow is measured on each machine. The flow rate is adjusted by changing the restrictor used and by changing the total output of the pump. The pump nominally puts out 3cc per 0.5 hour. The pump has a 0.5 hour cycle time. The pump runs only when the spindle is running or one of the axes is moving. Different sized restrictors are used to control flow. A 3/0 restrictor has twice the flow of a 4/0, which has twice the flow of a 5/0 restrictor.

A, B Axis Re-Alignment

Gimbaled head mills only

If tramming the A/B axes is neccessary, sweep a 10” diameter circle on the table with a dial indicator mounted to the spindle.

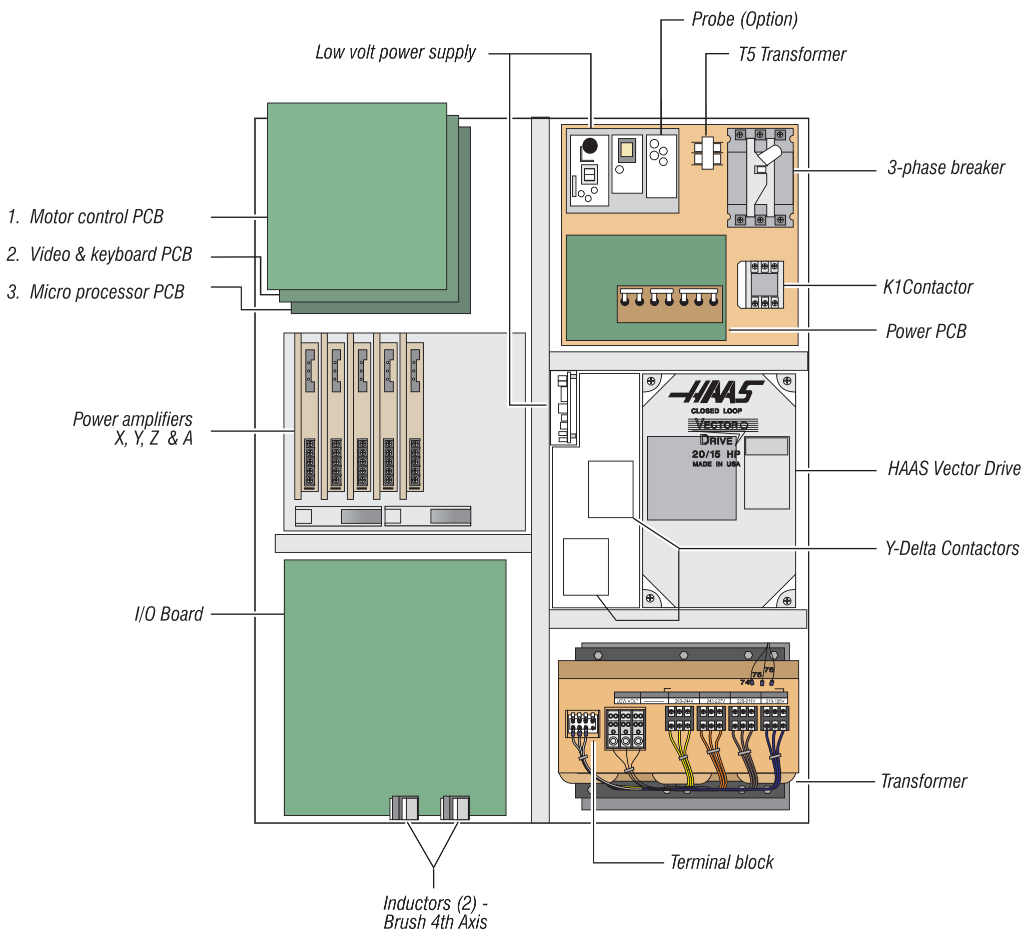
To select A or B axis when in the jog mode, use the shift key on the keyboard then select A or B axis.

The display will indicate which axis is enabled. It is recommended that when jogging the A and B axes, the operator use only the .0001, .0010, or .0100 increments.

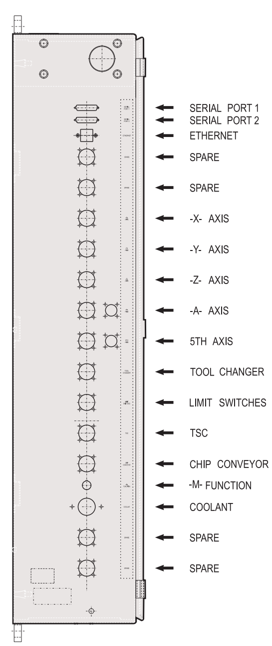
The rule of thumb is that for every .001” out of position, you **add or subtract** 100 from the appropriate parameter. This will re-calibrate the distance from the A/B axes home switch. Parameters 212 and 213 are the tool change offset parameters for the A and B-axis. These parameters also control the tram of the A-axis and B-axes. It is advised that you record the factory set values before changing parameters 212 and 213 in the event that you enter an invalid number and have to start over.

When adjusting the tram, it is recommended that you use same feedrate to home the A/B axes between checking the sweep. This will allow the machine to repeat more accurately. The A-axis and B-axis should be trammed individually to reduce the possibility of error.

5.4 Control Cabinet



Control cabinet general overview.



Connectors on side of control cabinet.

5.5 Servos Brush / Brushless

Servo Encoders

Haas machines are equipped with brushless motors, which provides for better performance, and no maintenance. In addition to the performance differences, these machines differ from brush type machines, which have already been discussed, in the following areas:

The brushless motors have 8192 line encoders built in, which result in a resolution of 32768 parts per revolution.

The motor controller board has a dedicated processor which does all the servo control algorithm.

There is no servo distribution board anymore, therefore there is no CHARGE light present. Care should still be taken however, since there are high voltages present on the amplifiers, even when power is shut off. The high voltage comes from the spindle drive, which does have a CHARGE light.

The servo drive cards are replaced by Brushless Servo Amplifiers, and are controlled differently.

A low voltage power supply card is added to the servo drive assembly to supply the low voltage requirement to the amplifiers.

The user interface and motion profiling have not changed however, and the user should not see any functional differences between a brush type machine and a brushless machine.

Servo Amplifiers

The brushless servo amplifier is a Pulse Width Modulation (PWM) based current source. The PWM outputs control the current to a three phase brushless motor. The PWM frequency is either 12.5 KHz or 16 KHz. The amplifiers are current limited to 30 amps peak (45A peak for a medium amplifier). However there are fuse limits both in hardware and software to protect the amplifiers and motors from over current. The nominal voltage for these amplifiers is 320 volts. Therefore the peak power is about 9600 watts or 13 H.P. The amplifiers also have short circuit, over temperature and over voltage protection.

There is a 15 amp (20A for a medium amplifier) supply fuse for failure protection. This fuse is relatively slow, therefore it can handle the 30 amp peak. Current limit to the motor is controlled by software.

The user should never attempt to replace these fuses.

Commands to the amplifier are +/-5 volts current in two legs of the motor and a digital enable signal. A signal from the amplifier indicates drive fault or sustained high current installed motor.

The connectors on the amplifiers are:

+H.V.	+320 volts DC
-H.V.	320 volts return
A	motor lead phase A
B	motor lead phase B
C	motor lead phase C
J1	Three pin Molex connector used for +/-12 and GND.
J2	Eight pin Molex connector used for input signals.

5.6 Input/Output Assembly

The IOPCB contains a circuit for electronically turning the tool changer power on and off. This prevents any arcing of the tool changer relays and increases their life tremendously. This includes an adjustable current limit to the tool changer. Potentiometer R45 adjusts the current limit to the tool changer motors. R45 should be set to limit current to between four and six amps.

The IOPCB also contains a circuit for sensing a ground fault condition of the servo power supply. If more than 0.5 amps is detected flowing through the grounding connection of the 160V DC buss, a ground fault alarm is generated and the control will turn off servos and stop.

Relay K6 is for the coolant pump 230V AC It is a plug-in type and is double-pole. Relays K9 through K12 are also plug in types for controlling the tool changer.

The Input/Output Assembly consists of a single printed circuit board called the IOPCB.

5.7 Two-Speed Gear Transmission

The spindle head contains a two-speed gear transmission. The spindle motor is directly coupled to the transmission and the transmission is cog belt-coupled to the spindle.

Gear Box Lubrication

Gear Box: Mobil DTE 25 oil.

The gear box uses an oil sump and is cooled by gear oil.

Gear Box Air Solenoids

There is a double solenoid valve controlling air to the gear box shifter. This solenoid sends air to select either the high gear or the low gear. When power is removed from the solenoids, the valve remains in its last state. Air is always required to ensure the gears are held in either high of low gear. A circuit breaker will interrupt power to these solenoids. Power is left on the solenoid which is commanded last.

On machines equipped with a **50 taper spindle**, an electric motor drives the gearbox shifter into high or low gear.

Gear Box Sense Switches

There are two switches in the gear box used to sense the position of the gears. One switch indicates HIGH by opening and the other indicates LOW by opening (**50 Taper machines** indicate high or low gear by opening). Between gears, both switches are closed indicating a between-gear condition. The diagnostic display shows the status of these switches and the CURNT COMDS display shows which gear is selected. If the switches indicate that the gear box is between gears, the display will indicate “No Gear”.

Gear Change Sequence

When a gear change is performed, the following sequence of events occurs:

1) If the spindle is turning, it is commanded to stop,
2) Pause until spindle is stopped,
3) Gear change spindle speed is commanded forward,
4) Pause until spindle is at speed,
5) Command high or low gear solenoid active,
6) Pause until in new gear or reversal time,
7) Alarm and stop if max gear change time elapsed,
8) If not in new gear, reverse spindle direction,
9) Turn off high and low gear solenoids

5.8 Control Pendant

Jog Handle

The JOG handle is actually a 100-line-per-revolution encoder. 100 steps per revolution is used to move one of the servo axes. If no axis is selected for jogging, turning of the crank has no effect. When the axis being moved reaches its travel limits, the handle inputs will be ignored in the direction that would exceed the travel limits.

Parameter 57 can be used to reverse the direction of operation of the handle.

Power On/Off Switches

The POWER ON switch engages the main contactor. The on switch applies power to the contactor coil and the contactor thereafter maintains power to its coil. The POWER OFF switch interrupts power to the contactor coil and will always turn power off. POWER ON is a normally open switch and POWER OFF is normally closed. The maximum voltage on the POWER ON and POWER OFF switches is 24V AC and this voltage is present any time the main circuit breaker is on.

Spindle Load Meter

The Load meter measures the load on the spindle motor as a percentage of the rated continuous power of the motor. There is a slight delay between a load and the actual reflection of the meter. The eighth A-to-D input also provides a measure of the spindle load for cutter wear detection. The second page of diagnostic data will display % of spindle load. The meter should agree with this display within 5%. The spindle drive display #7 should also agree with the load meter within 5%.

There are different types of spindle drive that are used in the control. They are all equivalent in performance but are adjusted differently.

Emergency Stop Switch

The EMERGENCY STOP switch is normally closed. If the switch opens or is broken, power to the servos will be removed instantly. This will also shut off the tool changer, spindle drive, and coolant pump. The EMERGENCY STOP switch will shut down motion even if the switch opens for as little 0.005 seconds.

Be careful of the fact that Parameter 57 contains a status switch that, if set, will cause the control to be powered down when EMERGENCY STOP is pressed.

You should not normally stop a tool change with EMERGENCY STOP as this will leave the tool changer in an abnormal position that takes special action to correct.

Note that tool changer alarms can be easily corrected by first correcting any mechanical problem, pressing RESET until the alarms are clear, selecting ZERO RETURN mode, and selecting “AUTO ALL AXES”.

If the shuttle should become jammed, the control will automatically come to an alarm state. To correct this, push the EMERGENCY STOP button and remove the cause of the jam. Push the RESET key to clear any alarms. Push the ZERO RETURN and the AUTO ALL AXES keys to reset the Z-axis and tool changer. Never put your hands near the tool changer when powered unless the EMERGENCY STOP button is pressed.

Keyboard Beeper

There is a beeper inside the control panel that is used as an audible response to pressing keyboard buttons and as a warning beeper. The beeper is a 2.3 kHz signal that sounds for about 0.1 seconds when any keypad key, CYCLE START, or FEED HOLD is pressed. The beeper also sounds for longer periods when an auto-shut down is about to occur and when the "BEEP AT M30" setting is selected.

If the beeper is not audible when buttons are pressed, the problem could be in the keypad, keyboard interface PCB or in the beeper. Check that the problem occurs with more than one button and that the beeper volume control is not closed.

5.9 Microprocessor Assembly

The microprocessor assembly is in the rear cabinet at the top left position. It contains three large boards. They are: microprocessor, the video and the MOCON. All three boards of the processor assembly receive power from the low voltage power supply. The three PCB's are interconnected by a local buss on dual 50-pin connectors. At power-on of the control, some diagnostic tests are performed on the processor assembly and any problems found will generate alarms 157 or 158. In addition, while the control is operating, it continually tests itself and a self test failure will generate Alarm 152.

Microprocessor PCB (68ECO30)

The Microprocessor PCB contains the 68ECO30 processor running at 40 MHz, one 128K EPROM; 1MB or 16MB of CMOS RAM and betwen 512K and 1.5MB of FAST STATIC RAM. It also contains a dual serial port, a five year battery to backup RAM, buffering to the system buss, and eight system status LED's.

Two ports on this board are used to set the point at which an NMI* is generated during power down and the point at which RESET* is generated during power down.

The eight LED's are used to diagnose internal processor problems. As the system completes power up testing, the lights are turned on sequentially to indicate the completion of a step. The lights and meanings are:

RUN **Program Running Without Fault Exception. (Normally On)**
If this light does not come on or goes out after coming on, there is a problem with the microproces sor or the software running in it. Check all of the buss connectors to the other two PCB's and ensure all three cards are getting power.

PGM **Program signature found in memory.(Normally On)**
If this light does not come on, it means that the main CNC program package was not found in memory or that the auto-start switch was not set. Check that switch S1-1 is on and the EPROM is plugged in.

CRT **CRT/VIDEO initialization complete. (Normally On)**
If this light does not come on, there is a problem communicating with the VIDEO PCB. Check the buss connectors and ensure the VIDEO PCB is getting power.

MSG **Power-on serial I/O message output complete. (Normally On)**
If this light does not come on, there is a problem with serial I/O or interrupts. Disconnect anything on the external RS-232 and test again.

SIO **Serial I/O initialization complete. (Normally On)**
If this light does not come on, there is a problem with the serial ports. Disconnect anything on the external RS-232 and test again.

POR	**Power-on-reset complete. (Normally On)** If this light does not come on, there is a serious problem with the processor PCB. Check that the EPROM is plugged in. Test the card with the buss connectors off.
HALT	**Processor halted in catastrophic fault. (Normally Off)** If this light comes on, there is a serious problem with the processor PCB. Check that the EPROM is plugged in. Test the card with the buss connectors off.
+5V	**+5V logic power supply is present. (Normally On)** If this light does not come on, check the low voltage power supply and check that all three phases of 230V input power are present.

There is 1 two-position DIP switch on the processor PCB labeled S1. Switch S1-1 must be ON to auto-start the CNC operational program. If S1-1 is OFF, the PGM light will remain off.

Switch S2-1 is used to enable FLASH. If it is disabled it will not be possible to write to FLASH.

The processor connectors are:

J1	Address buss
J2	Data buss
J4	Serial port #1 (for upload/download/DNC) (850)
J5	Serial port #2 (for auxiliary 5th axis) (850A)
J3	Power connector
J6	Battery

Memory Retention Battery

The memory retention battery is initially soldered into the processor PCB. This is a 3.3V Lithium battery that maintains the contents of CMOS RAM during power off periods. Prior to this battery being unusable, an alarm will be generated indicating low battery. If the battery is replaced within 30 days, no data will be lost. The battery is not needed when the machine is powered on. Connector J6 on the processor PCB can be used to connect an external battery.

Video Keyboard with Floppy

The VIDEO and KB PCB generates the video data signals for the monitor and the scanning signals for the keyboard. In addition, the keyboard beeper is generated on this board. There is a single jumper on this board used to select inverse video.

Motor Interface PCB (MOTIF) optional

The Motor Interface PCB is used to interface with linear scale encoders.

Motor Controller (MOCON) - Brushless

The brushless machining centers are equipped with a microprocessor based brushless motor controller board (MOCON) that replaces the motor interface in the brush type controls. It runs in parallel with the main processor, receiving servo commands and closing the servo loop around the servo motors.

In addition to controlling the servos and detecting servo faults, the motor controller board, (MOCON), is also in charge of processing discrete inputs, driving the I/O board relays, commanding the spindle and processing the jog handle input. Another significant feature is that it controls 6 axes, so there is no need for an additional board for a 5 axis machine.

5.10 Spindle Drive Assembly

The spindle drive is located in the main cabinet on the right side and halfway down. It operates from three-phase 200 to 240V AC. It has a 10 (or 20) H.P. continuous rating, and a 15 (or 30) H.P. one-minute rating. The spindle drive is protected by CB1. Never work on the spindle drive until the small red CHARGE light goes out. Until this light goes out, there are dangerous voltages inside the drive, even when power is shut off.

For all other data on the spindle drive, refer to the supplied documentation for your drive.

Haas Vector Drive

The Haas vector drive is a current amplifier controlled by the Mocon software, using the C axis output. The vector drive parameters are a part of the machine parameters and are accessible through the Haas front panel. The spindle encoder is used for the closed loop control and spindle orientation, as well as rigid tapping if the option is available. Spindle speed is very accurate, since this is a closed loop control and the torque output at low speeds is superior to non vector drive spindles.

5.11 Resistor Assembly

The Resistor Assembly is located on top of the control cabinet. It contains the servo and spindle drive regen load resistors.

Spindle Drive Regen Resistor

A resistor bank is used by the spindle drive to dissipate excess power caused by the regenerative effects of decelerating the spindle motor. If the spindle motor is accelerated and decelerated again in rapid succession repeatedly, this resistor will get hot. In addition, if the line voltage into the control is above 255V, this resistor will begin to heat. If the resistor is removed from the circuit, an alarm may subsequently occur because of an overvoltage condition inside the spindle drive.

Servo Drive Regen Resistor

A 25-ohm, 300-watt resistor is used by the brush-type servo drives to dissipate excess power caused by the effects of decelerating the servo motors. If the servo motors are accelerated and decelerated again in rapid succession repeatedly, this resistor will get hot. In addition, if the line voltage into the control is above 255V, this resistor will begin to heat. This resistor is overtemp protected at 100^0 C. At that temperature, an automatic control shutdown is begun. If that resistor is removed from the circuit, an alarm may subsequently occur because of an overvoltage condition for the servo buss.

Overheat Sense Switch

There is an over-temperature sense switch mounted near the above-mentioned regen resistors. This sensor is a normally-closed switch that opens at about 100^0 C. It will generate an alarm and all motion will stop. After the time period, specified by parameter 297, of an overheat condition, an automatic shutdown will occur in the control.

5.12 Power Supply Assembly

All power to the control passes through the power supply assembly. It is located on the upper right corner of the control cabinet.

Main Circuit Breaker CB1

Circuit breaker CB1 (see chart for ratings) is primarily used to protect the spindle drive and to shut off all power to the control. The locking On/Off handle on the outside of the control cabinet will shut this breaker off when it is unlocked. A trip of this breaker indicates a SERIOUS overload problem and should not be reset without investigating the cause of the trip. The full circuit breaker ratings are listed in the following chart.

CIRCUIT BREAKER (CB1) AMP RATING		
HP RATING	195-260 VAC	354-488 VAC
20 - 15	40 AMP	20 AMP
40 - 30	80 AMP	40 AMP

Main Contactor K1

Main contactor K1 is used to turn the control on and off. The POWER ON switch applies power to the coil of K1 and after it is energized, auxiliary contacts on K1 continues to apply power to the coil. The POWER OFF switch on the front panel will always remove power from this contactor.

When the main contactor is off, the only power used by the control is supplied through two ½ amp fuses to the circuit that activates the contactor. An overvoltage or lightning strike will blow these fuses and shut off the main contactor.

The power to operate the main contactor is supplied from a 24V AC control transformer that is primary fused at ½ amp. This ensures that the only circuit powered when the machine is turned off is this transformer and only low voltage is present at the front panel on/off switches.

Low Voltage Power Supply

The low voltage power supply provides +5V DC, +12V DC, and -12V DC to all of the logic sections of the control. It operates from 115V AC nominal input power. It will continue to operate correctly over a 90V AC to 133V AC range.

Power PCB (PSUP)

The low voltage power distribution and high voltage fuses and circuit breakers are mounted on a circuit board called the PSUP PCB.

Secondary Circuit Breakers

The following circuit breakers are located on the Power supply assembly.

CB2 controls the 3-phase 115volt distribution. It can be tripped only if there is a short in the control cables or on the IOPCB.

CB3 controls the power to coolant pump only. It can be blown by an overload of the coolant pump motor or a short in the wiring to the motor.

CB5 Controls power to the TSC coolant pump only. It can be tripped by an overload of the TSC coolant pump motor or a short in the wiring to the motor.

CB6 is a single phase 115V protected output for the user. It may be used on Horizontal mills and lathes with a barfeeder.

Power-Up Low Voltage Control Transformer (T5)

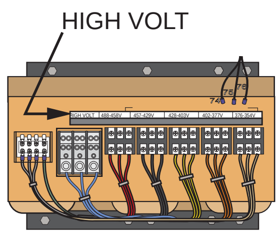
The low voltage control transformer, T5, supplies power to the coil of the main contactor K1. It guarantees that the maximum voltage leaving the Power Supply assembly when power is off is 12V AC to earth ground. It is connected via P5 to the POWER PCB.

5.13 Power Transformer Assembly (T1)

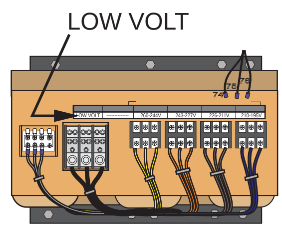
The power transformer assembly is used to convert three-phase input power (50/60Hz) to three phase 230V and 115V power. Two different transformers are used depending on the input voltage range. The low voltage transformer has four different input connections to allow for a range of voltages from 195 V RMS to 260 V RMS. The high voltage transformer has five different input connections and will accept a range of voltages from 354V RMS to 488 V RMS.

The 230 V is used to power the spindle drive, which also develops the 325 VDC power for the axis servo amplifiers. The 115 V is used by the video monitor, solenoids, fans and pumps, in addition to supplying power to the main LVPS used by the control electronics.

The transformer assembly is located in the lower right hand corner of the main cabinet. Besides the high/low voltage variations, two different power levels are available depending on the spindle motor used. The small and large transformers have power ratings of 14 KVA and 28 KVA, respectively. They are protected by the main circuit breaker to the levels shown in the preceding table.



Transformer with 354-488V range



Transformer with 195-260V range

Primary Connection To T1

Input power to T1 is supplied through CB1, the 40 amp three-phase main circuit breaker. Three-phase 230 to T1 is connected to the first three terminals of TB10.

Voltage Selection Taps

There are four labeled plastic terminal blocks. Each block has three connections for wires labeled 74, 75, and 76. Follow the instructions printed on the transformer.

Secondary Connection To T1

The secondary output from T1 is 115V AC three-phase CB2 protects the secondary of transformer T1 and is rated at 25 amps.

Optional 480V 60Hz Transformer

All machines will get the 45KVA transformer.

For domestic installations and all others using 60Hz power, the primary side should be wired as follows:

Input Voltage Range	Tap
493-510	1 (504)
481-492	2 (492)
469-480	3 (480)
457-468	4 (468)
445-456	5 (456)
433-444	6 (444)
420-432	7 (432)

Optional 480V 50Hz Transformer

Input Voltage Range	Tap
423-440	1 (504)
412-422	2 (492)
401-411	3 (480)
391-400	4 (468)
381-390	5 (456)
371-380	6 (444)
355-370	7 (432)

5.14 Fuses

The brushless amplifier has one fuse, F1 15 amps. This fuse protects the amplifier itself from drastic damage. If this fuse is ever blown, the associated motor will stop. A light on the amplifier will tell of a blown fuse. If necessary replace the fuse (Haas p/n 93-1089). If the fuse blows again the amplifier may be damaged, in which case the amplifier needs to be replaced.

The POWER PCB contains three ½-amp fuses located at the top right (FU1, FU2, FU3). If the machine is subject to a severe overvoltage or a lightning strike, these fuses will blow and turn off all of the power. Replace these fuses only with the same type and ratings. FU 4,5 and 5A protect the chip conveyor (FU6 is only used with 3 phase motors).

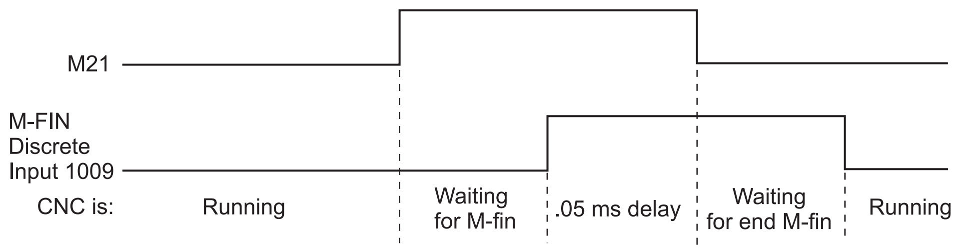
Size	Fuse Name	Type	Rating (amps)	Voltage	Location
5mm	FU1-FU3	Slo-Blo	½	250V	PSUP pcb, upper right
1/4	F1	Ultra fast	15	250V	Amplifier (X,Y,Z,A,B)
5mm	FU4,5	Fast blow	5A	250V	PSUP, bottom right corner

5.15 Spare User M code Interface

The M code interface uses outputs M21-25 and one discrete input circuit. M codes M21 through M25 will activate relays labeled M21-25. These relay contacts are isolated from all other circuits and may switch up to 120V AC at three amps. The relays are SPDT. **WARNING!** Power circuits and inductive loads must have snubber protection.

The M-FIN circuit is a normally open circuit that is made active by bringing it to ground. The one M-FIN applies to all of the user M codes.

The timing of a user M function must begin with all circuits inactive, that is, all circuits open. The timing is as follows:



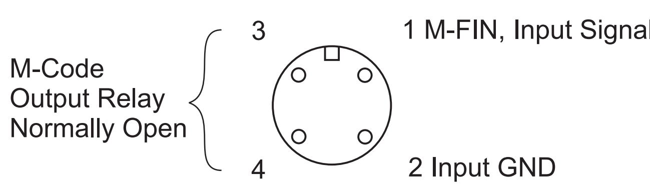
The Diagnostic Data display page may be used to observe the state of these signals.

NOTE: See the 8M option section for more details.

M Function Relays

The I/O PCB has five relays (M21-25) that may be available to the user. M21 is already wired out to P12 at the side of the control cabinet. This is a four-pin DIN connector and includes the M-FIN signal.

NOTE: Refer to the Diagnostic section in the manual for specific machine Inputs and Outputs.



NOTE: Some or all of the M21-25 on the I/O PCB may be used for factory installed options. Inspect the relays for existing wires to determine which have been used. Contact the Haas factory for more details.

M-FIN Discrete Input

The M-FIN discrete input is a low voltage circuit. When the circuit is open, there is +12V DC at this signal. When this line is brought to ground, there will be about 10 milliamps of current. M-FIN is discrete input #1009 and is wired from input #1009 on the I/O PCB. The return line for grounding the circuit should also come from that PCB. For reliability, these two wires should be routed in a shielded cable where the shield is grounded at one end only. The diagnostic display will show this signal a “1” when the circuit is open and a “0” when this circuit is grounded.

TURNING M FUNCTIONS ON AND OFF

The M code relays can also be separately turned on and off using M codes M51-M55 and M61-M65. M51 to M55 will turn on one of the eight relays and M61 to M65 will turn the relays off. M51 and M61 correspond to M21, etc.

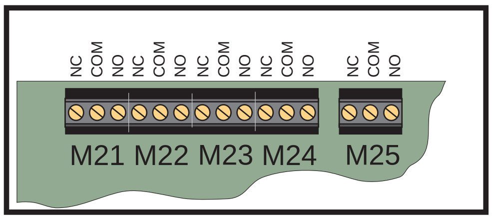
NOTE: Refer to the Diagnostic section in the manual for specific machine Inputs and Outputs.

WIRING THE RELAYS

The relays are marked on the IOPCB, with their respective terminals forward of them. If the optional 8M relay board is installed then the connections on the IOPCB are to be left unused as they are replaced by the relays on the optional board. Refer to the figure, and the Probe Option figure in the Electrical Diagrams section for the terminal labeling.

WARNING!

Power circuits and inductive loads must have snubber protection.



IOPCB Relays

CAUTION! If a screw terminal is already in use **DO NOT** connect anything else to it. Call you dealer.

5.16 LUBRICATION SYSTEM

The lubrication system is a resistance type system which forces oil through metering units at each of the 16 lubricating points within the machine. The system uses one metering unit at each of the lubricating points: one for each linear guide pad, one for each ball screw and one for spindle lubrication. A single oil pump is used to lubricate the system. The pump is powered only when the spindle and/or an axis moves. Once powered the pump cycles approximately 3.2 cc of oil every 30 minutes throughout the oil lines to the lube points. Every lube point receives approximately 1/16 of oil. The control monitors this system through an internal level switch in the reservoir and external pressure switch on the lube panel.

LOW LUBRICATION AND LOW PRESSURE SENSE SWITCHES

There is a low lube sense switch in the oil tank. When the oil is low, an alarm will be generated. This alarm will not occur until the end of a program is reached. There is also a lube pressure switch that senses the lube pressure. Parameter 117 controls the lube pressure check. If Parameter 117 is not zero, the lube pressure is checked for cycling high within that period. Parameter 117 has units of, 1/50 seconds; so 30 minutes gives a value of 90000. Parameter 57, bit "Oiler on/off", indicates the lube pump is only powered when the spindle fan is powered. The lube pressure is only checked when the pump is on.

5.17 Switches

Lamp On/Off Switch

An on/off switch is supplied for the operator's lamp. It is located on the side of the operator's pendant.

Door Open Sense Switch

The DOOR OPEN sense switch is a magnetic reed switch type and consists of two switches; one on each half of the enclosure front doors. These switches are normally closed and wired in series. When the doors open, one or both of these switches will open and the machine will stop with a “Door Hold” function. When the door is closed again, operation will continue normally.

The wiring for the door switches is routed through the front panel support arm and down through the top of the enclosure.

If the doors are open, you will not be able to start a program. Door Hold will not stop a tool change operation or a tapping operation, and will not turn off the coolant pump. Also, if the doors are open, the spindle speed will be limited to 750 RPM.

The Door Hold function can be temporarily disabled by turning Setting 51 **on**, if Parameter 57 bits DOOR STOP SP and SAFETY CIRC are set to zero, but this setting will return to OFF when the control is turned off.

Limit Switches

There are a number of limit switches located on the VMC, and some are difficult to reach. Ensure the problem is the switch before beginning removal procedures. The following is a list of all switches, their general location, and a functional description:

CLAMP/UNCLAMP SWITCHES

[Tool Release Piston Assembly (2)]
There are two switches used to sense the position of the tool clamping mechanism. They are both normally closed and one will activate at the end of travel during unclamping and the other during clamping. When both switches are closed, it indicates that the draw bar is between positions.

A tool change operation will wait until the unclamped switch is sensed before the Z-axis pulls up from the tool. This prevents any possibility of breaking the tool changer or its support mounts.

The diagnostic display can be used to display the status of the relay outputs and the switch inputs.

SPINDLE ORIENT SWITCH

[Top rear of transmission]

NOTE: This switch does not exist on machines that have a Vector Drive.

A normally-open switch that is held closed is used to sense when the pin drops in to lock the spindle. When the pin drops the switch opens, indicating orientation is complete.

The normally-closed side of the same switch that is held open, is wired to the spindle drive and commands it into a "Coast Stop" condition. This is done to ensure the spindle motor is not powered when the pin is locking the spindle.

X, Y, AND Z LIMIT SWITCHES

Prior to performing an POWER UP/RESTART or an AUTO ALL AXES operation, there are no travel limits. Thus, you can jog into the hard stops in either direction for X, Y, or Z. After a ZERO RETURN has been performed, the travel limits will operate unless an axis hits the limit switch. When the limit switch is hit, the zero returned condition is reset and an AUTO ALL AXES must be done again. This is to ensure that if you hit the limit switch, you can still move the servo back away from it.

The limit switches are normally closed. When a search for zero operation is being performed, the X, Y, and Z axes will move towards the limit switch unless it is already active (open); then they will move away from the switch until it closes again; then they will continue to move until the encoder Z channel is found. This position is machine zero.

Auto search for zero in the Z-axis is followed by a rapid move from the limit switch position down to the tool change position. This makes the Z-axis a little different from the other axes. The position found with the limit switch is not machine zero but is the position used to pull tools out of the spindle. Machine zero for Z is below this by Parameter 64. Be careful during the Z zero search and stay clear of that rapid move.

What Can Go Wrong With Limit Switches?

If the machine is operated without connector P5, a LOW LUBE and DOOR OPEN alarm will be generated. In addition, the Home search will not stop at the limit switch and will instead run into the physical stops on each axis.

If the switch is damaged and permanently open, the zero search for that axis will move in the negative direction at about 0.5 in/min until it reaches the physical travel stops at the opposite end of travel.

If the switch is damaged and permanently closed, the zero search for that axis will move at about 10 in/min in the positive direction until it reaches the physical stops.

If the switch opens or a wire breaks after the zero search completes, an alarm is generated, the servos are turned off, and all motion stops. The control will operate as though the zero search was never performed. The RESET can be used to turn servos on but you can jog that axis only slowly.

TOOL CHANGER POSITION SWITCHES

[Inside of Tool Carriage (2)]

GENEVA WHEEL POSITION MARK

The turret rotation mechanism has a switch mounted so that it is activated for about 30^{o} of travel of the Geneva mechanism. When activated, this switch indicates that the turret is centered on a tool position. This switch is normally closed. The diagnostic display will show this status of this input switch as “TC MRK”. A “1” indicates the Geneva wheel is in position.

TOOL #1 SENSE SWITCH

The tool rotation turret has a switch that is activated when tool one is in position or facing towards the spindle. At POWER ON this switch can indicate that tool #1 is in the spindle. If this switch is not active at power-on, the first tool change will rotate the turret until the switch engages and then move to the selected tool. The diagnostic display will show the status of this input switch as “TOOL #1”. A “1” indicates that tool #1 is in position.

SHUTTLE IN/OUT SWITCHES

[Tool Changer Holding Plate (2)]

Two switches are used to sense the position of the tool changer shuttle and the arm that moves it. One switch is activated when the shuttle is moved full travel inward and one is activated when it is full travel outward. These switches are normally closed so that both will be closed between in and out. The diagnostic display will show this status of the input switch. A “1” indicates the associated switch is activated or open.

TRANSMISSION HIGH/LOW GEAR POSITION SWITCHES

[Bottom of Gearbox Assembly (2)]

On machines with a two-speed transmission, there are two switches in the gear box used to sense the position of the gears. One switch indicates HIGH by opening and the other indicates LOW by opening. Between gears, both switches are closed indicating a between-gear condition. The diagnostic display shows the status of these switches and the CURNT COMDS display shows which gear is selected. If the switches indicate that the gear box is between gears, the display will indicate “No Gear”.

NOTE: The Transmission High/Low Gear Position Switches are located at the bottom of the Gearbox Assembly and are extremely difficult to reach. Removal of this assembly is necessary to replace these switches. See Mechanical Service, for Spindle Motor and Transmission removal.

5.18 Z-Axis Brake Motor

The servo brake motor compensates for the weight of the spindle head on machines without a hydraulic counterbalance. The brake is released when the servo motors are activated, however the disk brake engagement spline may produce a small noise when the head is in motion, **this is normal**.

A parameter governs the ability of the brake motor, therefore mills **without** counterbalances must have parameter 39, Z-Axis Torque Preload, set correctly. Check the parameters sections for the correct value.

5.19 Hydraulic Counterbalance

The spindle head weight is balanced by the upward pull of a hydraulic cylinder on machines without a Z-axis brake motor. The hydraulic oil forces the piston to retract into the cylinder body. The oil is then pressurized by a nitrogen reservoir. The system is self contained and passive (no pump is required to maintain the lift). Normal Z-Axis of the gas/oil counter balance has the initial pressure to balance the weight at full system volume, plus an additional 50-75 psi overcharge for longevity.

5.20 Diagnostic Data

The ALARM / MSGS display is the most important source of diagnostic data. At any time after the machine completes its power-up sequence, it will either perform a requested function or stop with an alarm. Refer to the Alarms section for a complete list of alarms, their possible causes, and some corrective action.

If there is an electronics problem, the controller may not complete the power-up sequence and the CRT will remain blank. In this case, there are two sources of diagnostic data; these are the audible beeper and the LED's on the processor PCB. If the audible beeper is alternating a ½ second beep, there is a problem with the main control program stored in EPROM's on the processor PCB. If any of the processor electronics cannot be accessed correctly, the LED's on the processor PCB will or will not be lit.

If the machine powers up but has a fault in one of its power supplies, it may not be possible to flag an alarm condition. If this happens, all motors will be kept off and the top left corner of the CRT will have the message:

POWER FAILURE ALARM

and all other functions of the control will be locked out.

When the machine is operating normally, a second push of the PARAM/DGNOS key will select the diagnostics display page. The PAGE UP and PAGE DOWN keys are then used to select one of two different displays. These are for diagnostic purposes only and the user will not normally need them. The diagnostic data consists of discrete input signals, discrete output relays and several internal control signals. Each can have the value of 0 or 1. In addition, there are up to three analog data displays and an optional spindle RPM display. Their number and functions are described in the following section.

5.21 Discrete Inputs / Outputs

The inputs/outputs that are followed by an asterisk (*) are active when equal to zero (0).

DISCRETE INPUT

#	Name	#	Name
1000	TC Changer In	1023	Spare 3
	SMTC Pocket Down		APC Pin Clr #2
1001	TC Changer Out	1024	Tool Unclmp Rmt*
	SMTC Pocket Up	1025	Spare
1002	Tool One In Pos.	1026	Spare 3A
1003	Low TSC Pressure		APC Pal #2 Home
1004	Tool In Position	1027	Spare 3B
			APC Pal #1 Home
1005	Spindle High Gear	1028	Ground Fault
1006	Spindle Low Gear	1029	G31 Block Skip
1007	Emergency Stop	1030	Spigot Position
1008	Door Safety Switch	1031	Conveyr Overcrnt
1009	M Code Finish*	1032	Spare 4A
	APC: APC Pal Clamp	1033	Spare 4B
1010	Over Voltage (Mini-Mill - P.S. Fault)	1034	Spare 5A
1011	Low Air Pressure	1035	Spare 5B
1012	Low Lube Press.	1036	Spare 6A
1013	Regen Over Heat	1037	Spare 6B
1014	Draw Bar Open	1038	Spare 7A
1015	Draw Bar Closed	1039	Spare 7B
1016	Spare	1040	Spare 8A
1017	Spare	1041	Spare 8B
1018	Spare	1042	Spare 9A (SMTC: Motor stop)
1019	Spare	1043	Spare 9B (SMTC: Origin)
1020	Low Trans Oil Prs	1044	Spare 10A (SMTC: Clamp / Unclamp)
1021	Spare 1	1045	Spare 10B
	APC Door		
1022	Spare 2		
	APC Pin Clr #1		

The inputs are numbered the same as the connections on the inputs printed circuit board.

DISCRETE OUTPUTS

#	Name	#	Name
1100	Powered Servos	1119	TSC Purge
1101	Spare	1120	Unclamp Pre-Chrg
1102	Spare	1121	HTC Shuttle Out (Air Drive Shuttle: Move shuttle in) APC: APC Door
1103	Spare		
1104	Brake 4th Axis	1122	Brake 5TH Axis
1105	Coolant Pump On	1123	CE Door Lock
1106	Auto Power Off	1124	M21
1107	Spind. Motor Fan	1125	M22
1108	Move T.C. In APC Chain Dr Fwd	1126	M23 (Air Drive Shuttle: Move Shuttle Out)
		1127	TSC Coolant
1109	Move T.C. Out APC Chain Dr Rev	1128	Green Beacon On
		1129	Red Beacon On
1110	Rotate T.C. CW	1130	Enable Conveyor
1111	Rotate T.C. CCW	1131	Reverse Conveyor
1112	Spindle Hi Gear	1132	M-fin
1113	Spindle Low Gear	1133	Probe
1114	Unclamp Tool	1134	spare
1115	Spare	1135	spare
1116	Move Spigot CW	1136	spare
1117	Move Spigot CCW	1137	spare
1118	Pal Ready Light	1138	spare
		1139	spare

NOTE: If the machine is equipped with an APC the following inputs and outputs will change:

#	Name	#	Name
1021	APC CE Door	1101	Pallet Clamped
1022	APC Pin CLR #1	1108	APC Chain Drive Forward
1023	APC Pin CLR #2	1109	APC Chain Drive Reverse
1026	APC PAL #2 Home	1121	PAL Clamp
1027	APC PAL #1 Home	1122	Door
1046	APC Door Closed	1125	APC Motor
1047	Door Open	1126	Beeper
1048	APC Pallet Clamped	1137	APC Chain Drive Power Enable
		1138	Air Blast
		1139	APC Beeper

The second page of diagnostic data is displayed using the PAGE UP and PAGE DOWN keys. It contains:

INPUTS 2

Name	Name	Name
X Axis Z Channel	X Overheat	X Cable Input
Y Axis Z Channel	Y Overheat	Y Cable Input
Z Axis Z Channel	Z Overheat	Z Cable Input
A Axis Z Channel	A Overheat	A Cable Input
B Axis Z Channel	B Overheat	B Cable Input
X Home Switch	X Drive Fault	Spindle Z Channel
Y Home Switch	Y Drive Fault	
Z Home Switch	Z Drive Fault	
A Home Switch	A Drive Fault	
B Home Switch	B Drive Fault	

The following inputs and outputs pertain to the Haas Vector Drive. If it is not enabled, these will display a value of *. Otherwise, it will display a 1 or 0.

Spindle Forward
Spindle Reverse
Spindle Lock
Spindle at Speed*
Spindle Stopped
Spindle Fault
Spindle Locked
Spindle Cable Fault
Spindle Over Heat

The following Discrete Inputs / Outputs 2 are available when parameter 278 SMNT BIT 1,2 or 3 (Side Mount Tool Changer) is set and parameter 209 MCD RLY BRD (M-Code relay board) is ON.

DISCRETE INPUTS 2

Name	Name
Spare Input 4A	Spare Input 8A
Spare Input 4B	Serp. Shot Pin*
Spare Input 5A	Motor Stop
Spare Input 5B	Origin
Spare Input 6A	Clamp / Unclamp
Spare Input 6B	Serp. Cam Count
Spare Input 7A	Spare Input 11A
Spare Input 7B	Spare Input 11 B

DISCRETE OUTPUTS 2

Name	Name
Spare Output 32	Spare Output 44
Spare Output 33	Spare Output 45
Spare Output 34	Spare Output 46
Spare Output 35	Spare Output 47
Spare Output 36	Spare Output 48 (SMTC: Serp. ATC Enable)
TC MTR SW	Spare Output 49 (SMTC: Serp. ATC Rev.)
Spare Output 38	Spare Output 50 (SMTC: Serp. Carsl CW)
Spare Output 39	Spare Output 51 (SMTC: Serp. Carsl CCW)
Spare Output 40	Spare Output 52 (SMTC: Serp. Carsl Ena.)
Spare Output 41	Spare Output 53
Spare Output 42	Spare Output 54
Spare Output 43	Spare Output 55

ANALOG DATA

Name	Description
DC BUSS	Voltage from Haas Vector Drive (if equipped)
uP TEMP	Microprocessor enclosure temperature (displayed only when Parameter 278 bit "uP ENCL TEMP" is set to 1)
SP LOAD	Spindle load in %
SP SPEED	Spindle RPM CW or CCW
RUN TIME	Machine total run time
TOOL CHANGES	Number of tool changes
VER X.XXX	Software version number
MOCON	MOCON software version
YY/MM/DD	Today's date
MDL HS__	Machine model

Five Axis Discrete Inputs / Outputs

Diagnostic data, including the discrete inputs and outputs, can be viewed by pressing the PARAM/DGNOS key twice. Descriptions of the inputs/outputs can be found in the "Technical Reference" section of the Operator's Manual.

Two discrete outputs, "4TH BK" and "5TH BK", control the fourth and fifth axis brakes. When motion is commanded in either the **C** or **B** axis, the brake for that axis must first be released. When the brake is released, a relay is activated; these two outputs represent the activation of the brake relays. These outputs normally will read zero (0), but if the **C** or **B** axis brakes are disengaged, these outputs will read "1".

There are two outputs that are specific to the VB-1, and that control the air-driven tool changer shuttle. When Parameter 278 bit AIR DRV SHTL is set to 1, discrete outputs 21 and 26 will appear as "SH IN" and "SH OUT", respectively. When "SH IN" is 1, the tool changer shuttle is in the "in" position, or in the correct position to make a tool change. When "SH OUT" is set to 1, the tool changer shuttle is in the "out" position, or out of position to make a tool change.

5.22 The Equations of Motion

An analysis of the physics of motion of a machine tool can give some important insights into the famous "blocks per second" issue. The following mathematics calculates the block per second requirement in order to achieve a worst case chordal deviation error while moving around a curve made up of a series of points:

Let:

a = acceleration,
v=speed (or feed rate),
r = radius of curvature,
e = error from chordal deviation
l = block length (or travel length from point to point)
b = blocks per second

The following are known:

For a circular motion:

a = v*v/r (1)

and in motion:

v = b * l (2)

which gives:

b = v / l (3)

and

e = r – sqrt(r*r-l*l/4) (4)

which gives:

r*r – 2*r*e + e*e = r*r – l*l/4 (5)

and:

l= sqrt(8*r*e – 4*e*e) (6)

Since r>>e, e*e is small compare to r*e and we can assume:

l = sqrt(8*r*e) (7)

And combining we get:

b = sqrt(a*r) / sqrt (8*r*e) (8)

Or

b = sqrt(a / (8*e)) (9)

Thus, block per second is dependent only on the machine acceleration and the maximum chordal error allowed. For a Haas VF-1, acceleration is about 60 inches per second per second. This means that if the maximum error is 0.00005 (one half of one ten-thousandth), the block per second required is 380 blocks per second. For a VF-9, an acceleration of 30 inches/sec/sec, it would be 269 blocks per second.

Note also that an important equation (7) above is the relationship between radius of curvature (r), chordal error (e) and block length (l). If you have a radius or curvature close to 1/4 inch and your maximum chordal error is 0.00005 inch, the recommended block length is 0.01 inch. This shows that it is not always required to use very short blocks.

5.23 Formulas

TO FIND:

S.F.M

TO FIND THE SFM OF A CUTTER OR WORKPIECE

EXAMPLE: To find the SFM of a cutter rotating at 600 RPM with a diameter of 10 inches.

$$SFM = \frac{3.1416 \times d \times RPM}{12} = .262 \times d \times RPM$$

R.P.M.

TO FIND THE RPM OF A CUTTER OR WORKPIECE

EXAMPLE: To find the RPM of a cutter rotating at 150 SFM with a diameter of 8 inches.

$$SFM = \frac{12 \times SFM}{3.1416 \times d} = \frac{3.82 \times SFM}{d}$$

I.P.M.

TO FIND THE FEED (table travel in inches per minute)

EXAMPLE: To find the feed of a 10 tooth cutter rotating at 200 RPM with a feed per tooth of 0.012”.

IPM = F.P.T. x T x RPM

TO FIND:

F.P.R.

TO FIND THE FEED PER REVOLUTION (in inches) OF A CUTTER.

EXAMPLE: To find the feed per revolution of a cutter rotating at 200 RPM with a table travel of 22 inches per minute.

$$F.P.R. = \frac{I.P.M.}{R.P.M.}$$

F.P.T.

TO FIND THE FEED PER TOOTH OF A CUTTER.

EXAMPLE: To find the feed per tooth of a cutter rotating at 200 RPM with a table travel of 22 inches per minute.

$$F.P.T. = \frac{I.P.M.}{T \times R.P.M.}$$

D = Depth of cut
d = diameter of cutter
I.P.M. = Feed (table travel in inches per minute)
K = Constant (cubic inches per minute per HPc). Power required to remove 1 cubic inch per minute.
HPc = Horsepower at the cutter
F.P.R. = Feed per revolution
R.P.M. = Revolutions per minute
T = Number of teeth in cutter
W = Width of cut (in inches)

6. PARAMETERS

Parameters are seldom-modified values that change the operation of the machine. These include servo motor types, gear ratios, speeds, stored stroke limits, ball screw compensations, motor control delays and macro call selections. These are all rarely changed by the user and should be protected from being changed by the parameter lock setting. If you need to change parameters, contact HAAS or your dealer. Parameters are protected from being changed by Setting 7.

The Settings page lists some parameters that the user may need to change during normal operation and these are simply called "Settings". Under normal conditions, the parameter displays should not be modified. A complete list of the parameters is provided here.

The PAGE UP, PAGE DOWN, up and down cursor keys , and the jog handle can be used to scroll through the parameter display screens in the control. The left and right cursor keys are used to scroll through the bits in a single parameter.

Parameter List

1 X SWITCHES Parameter 1 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 REV ENCODER Used to reverse the direction of encoder data.

1 REV POWER Used to reverse direction of power to motor.

2 REV PHASING Used to reverse motor phasing.

3 DISABLED Used to disable the X-axis.

4 Z CH ONLY With **A** only, indicates that no home switch.

5 AIR BRAKE With **A** only, indicates that air brake is used.

6 DISABLE Z T Disables encoder **Z** test (for testing only).

7 SERVO HIST Graph of servo error (for diagnostics only).

8 INV HOME SW Inverted home switch (N.C. switch).

9 INV Z CH Inverted **Z** channel (normally high).

10 CIRC. WRAP. With **A** only, causes 360 wrap to return to 0.

11 NO I IN BRAK With **A** only, removes **I** feedback when brake is active.

12 LOW PASS +1X Adds 1 term to low pass filter.

13 LOW PASS +2X Adds two terms to low pass filter.

14 OVER TEMP NC Selects a normally closed overheat sensor in motor.

15 CABLE TEST Enables test of encoder signals and cabling.

16 Z TEST HIST History plot of Z channel test data.

17 SCALE FACT/X If set to 1, the scale ratio is interpreted as divided by X; where X depends on bits SCALE/X LO and SCALE/XHI.

18 INVIS AXIS Used to create an invisible axis.

19 ALM ON LM SW Rotary alarms at the limit switch.

20 CK TRAVL LIM A Rotary travel limits are used. On mills with the Gimbaled Spindle (used on the VR series mills), A and B axes CK TRAVL LIM must be set to 1.

21 ROT TRVL LIM Rotary travel limits are used.

22 D FILTER X8 Enables the 8 tap FIR filter. Used to eliminate high frequency vibrations, depending on the axis motor.

23 D FILTER X4 Enables the 4 tap FIR filter. Used to eliminate high frequency vibrations, depending on the axis motor.

24 TORQUE ONLY For HAAS diagnostic use only.

25 3 EREV/MREV The 2 EREV/MREV and 3 EREV/MREV bits have two definitions depending on whether one or two encoders are present. For single encoder systems, the bits are used to define the ratio between the electrical rotation of the spindle motor and the mechanical rotation of the motor. For two encoder systems, the definition is the electrical rotation of the motor to the mechanical rotation of the spindle motor encoder, which includes any pulley ratio between the motor and the motor encoder.

26 2 EREV/MREV The 2 EREV/MREV and 3 EREV/MREV bits have two definitions depending on whether one or two encoders are present. For single encoder systems, the bits are used to define the ratio between the electrical rotation of the spindle motor and the mechanical rotation of the motor. For two encoder systems, the definition is the electrical rotation of the motor to the mechanical rotation of the spindle motor encoder, which includes any pulley ratio between the motor and the motor encoder.

27 NON MUX PHAS For HAAS diagnostic use only.

28 BRUSH MOTOR Enables the brushless motor option.

29 LINEAR DISPL This bit changes the display from degrees to inches (or millimeters) on the A and B axes.

30 SCALE/X LO With SCALE/X HI bit, determines the scale factor used in bit SCALE FACT/X,

31 SCALE/X HI With SCALE/X LO bit, determines the scale factor used in bit SCALE FACT/X. See below:

	HI	LO
0	0	3
0	1	5
1	0	7
1	1	9

2 X P GAIN Proportional gain in servo loop.

3 X D GAIN Derivative gain in servo loop.

4 X I GAIN Integral gain in servo loop.

5 X RATIO (STEPS/UNIT) The number of steps of the encoder per unit of travel. Encoder steps supply four (4) times their line count per revolution. Thus, an 8192 line encoder and a 6mm pitch screw give:

8192 x 4 x 25.4 / 6 = 138718
(5 steps per unit inch/mm ratio)

6 X MAX TRAVEL (STEPS) Max negative direction of travel from machine zero in encoder steps. Does not apply to A-axis. Thus a 20 inch travel, 8192 line encoder and 6 mm pitch screw give:

20.0 x 138718 = 2774360

7 X ACCELERATION Maximum acceleration of axis in steps per second per second.

8 X MAX SPEED Max speed for this axis in steps per second.

9 X MAX ERROR Max error allowed in servo loop before alarm is generated. Units are encoder steps. This is the maximum allowable error in Hz between the commanded speed and the actual speed. The purpose of this parameter is to prevent "motor runaway" in case of phasing reversal, or bad parameters. If this parameter is set to 0, it defaults to 1/4 of parameter 183 Max Frequency.

10 X FUSE LEVEL Used to limit average power to motor. If not set correctly, this parameter can cause an “overload” alarm.

11 X TORQUE PRELOAD TORQUE PRELOAD is a signed number that should be set to a value from 0 to 4095 where 4095 is the maximum motor torque. It is applied at all times to the servo in the same direction. It is used to compensate, in the vertical direction, for gravity on a machine with an axis brake instead of a counterbalance. Normally, the brake is released when the servo motors are activated. When the vertical axis is commanded to move, the brake is released and the servo motors are activated. This parameter specifies the bias torqu needed to compensate for gravity.

12 X STEPS/REVOLUTION Encoder steps per revolution of motor. Thus, an 8192 line encoder gives:

8192 x 4 = 32768

13 X BACKLASH Backlash correction in encoder steps.

14 X DEAD ZONE Dead zone correction for driver electronics. Units are 0.0000001 seconds.

15 Y SWITCHES See Parameter 1 for description.

16 Y P GAIN See Parameter 2 for description.

17 Y D GAIN See Parameter 3 for description.

18 Y I GAIN See Parameter 4 for description.

19 Y RATIO (STEPS/UNIT) See Parameter 5 for description.

20 Y MAX TRAVEL (STEPS) See Parameter 6 for description.

21 Y ACCELERATION See Parameter 7 for description.

22 Y MAX SPEED See Parameter 8 for description.

23 Y MAX ERROR See Parameter 9 for description.

24 Y FUSE LEVEL See Parameter 10 for description.

25 Y TORQUE PRELOAD See Parameter 11 for description.

26 Y STEPS/REVOLUTION See Parameter 12 for description.

27 Y BACKLASH See Parameter 13 for description.

28 Y DEAD ZONE See Parameter 14 for description.

29 Z SWITCHES See Parameter 1 for description.

30 Z P GAIN See Parameter 2 for description.

31 Z D GAIN See Parameter 3 for description.

32 Z I GAIN See Parameter 4 for description.

33 Z RATIO (STEPS/UNIT) See Parameter 5 for description.

34 Z MAX TRAVEL (STEPS) See Parameter 6 for description.

35 Z ACCELERATION See Parameter 7 for description.

36 Z MAX SPEED See Parameter 8 for description.

37 Z MAX ERROR See Parameter 9 for description.

38 Z FUSE LEVEL See Parameter 10 for description.

39 Z TORQUE PRELOAD See Parameter 11 for description.

40 Z STEPS/REVOLUTION See Parameter 12 for description.

41 Z BACKLASH See Parameter 13 for description.

42 Z DEAD ZONE See Parameter 14 for description.

43 A SWITCHES See Parameter 1 for description AND make sure that this parameter is set to enable the fourth axis before you try to enable the fourth axis from settings.

44 A P GAIN See Parameter 2 for description.

45 A D GAIN See Parameter 3 for description.

46 A I GAIN See Parameter 4 for description.

47 A RATIO (STEPS/UNIT) This parameter defines the number of encoder steps required to complete one full rotation of the platter. For example an HRT 210 with a 90:1 gear ratio, a final drive ratio of 2:1, and an encoder count of 2000 lines would be:

2000 x 4 x (90 x 2) / 360 = 4000 steps

for a brushless HRT 210 with a 90:1 gear ratio, a final drive ratio of 2:1 and an encoder count of 8192 the formula would be:

8192 x 4 x (90 x 2) / 360 = 16384 steps

If for example 16384 ended up being 13107.2 (non integer) the user must make sure the single bits SCALE FACT/X and the COMBINATION OF SCALE/X LO and SCALE/X HI are turned on in parameter 43. When the scale factor/x bit is 1 the scale ratio is interpreted as divide by X: where X depends on scale/ x lo and scale/ x hi (see parameter 1 for scale/ x lo and scale x hi values). For example:

8192 x 4 x (72 x 2) / 360 = 13107.2

You would then turn on the scale fact/x bit and the scale/ x lo bit which would give you a factor of 5 thus:

13107.2 x 5 = 65536 encoder steps

48 A MAX TRAVEL (STEPS) See Parameter 6 for description. Normally this parameter would not apply to the A axis, however this parameter is used on mills with a gimbaled spindle (5-axis mills). On a VR-series mill this parameter is used to limit the amount of angular movement of the spindle (A and B axes). The A and B axes are limited in movement to a distance between negative MAX TRAVEL, and positive TOOL CHANGE OFFSET. On 5-axes mills A and B axes ROT TRVL LIM must be set to 1, MAX TRAVEL and TOOL CHANGE OFFSET must be calibrated and set correctly.

49 A ACCELERATION See Parameter 7 for description.

50 A MAX SPEED See Parameter 8 for description.

51 A MAX ERROR See Parameter 9 for description.

52 A FUSE LEVEL See Parameter 10 for description.

53 A BACK EMF See Parameter 11 for description.

54 A STEPS/REVOLUTION See Parameter 12 for description

55 A BACKLASH See Parameter 13 for description.

56 A DEAD ZONE See Parameter 14 for description.

57 COMMON SWITCH 1 Parameter 57 is a collection of general purpose single bit flags used to turn some functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 REVERSE CRANK DIR Reverses direction of jog handle.

1 DISABLE TOOL CHANGER. Disables tool changer operations.

2 DISABLE GEAR BOX Disables gear box functions.

3 POWER OFF AT E-STOP Stops spindle then turns the power off at EMERGENCY STOP

4 RIGID TAPPING Indicates hardware option for rigid tap.

5 REV SPINDLE ENCODER Reverses sense direction of spindle encoder.

6 NETWORK/HD/USB Is used to activate the internal Zip/Enet PC104 board at power-on time. When it is set to 0, the CNC will not access the board. When it is set to 1, the CNC will access it at power-on time and display the message “LOADING” on the Zip/Enet settings page just below setting 139. After some time (2 minutes maximum,) the control will instead display the message “DISK DONE” indicating that communications have been established with the internal PC104 board and the user can now use the control.

7 EXACT STOP MODE CHG Selects exact stop in moves when mode changes.

8 SAFETY CIRCUIT This enables safety hardware, if machine is so equipped.

9 SPINDLE DRV LIN ACCEL Selects linear deceleration for rigid tapping. 0 is quadratic.

10 UNUSED

11 COOLANT SPIGOT Enables coolant spigot control and display.

12 OVER TEMP IS N/C Selects Regen over temp sensor as N.C.

13 SKIP OVERSHOOT Causes Skip (G31) to act like Fanuc and overshoot sense point.

14 NONINV SPINDLE STOP Non-inverted spindle stopped status.

15 SPIND. LOAD MONITOR Spindle load monitor option is enabled.

16 SPIND. TEMP MONITOR Spindle temperature monitor option is enabled.

17 ENABLE ROT & SCALNG Enables rotation and scaling.

18 ENABLE DNC Enables DNC selection from MDI.

19 ENABLE BKGRND EDIT Enables BACKGROUND EDIT mode.

20 ENABLE GROUND FAULT Enables ground fault detector.

21 M19 SPINDLE ORIET This bit makes the P and R codes a protected feature which can only be enabled with an unlock code. The unlock code will be printed on the parameter listing. If this bit is set to 0, an M19 will orient the spindle to 0 degrees regardless of the value of any P or R code in the same block. If this is set to 1, a P code in the block will cause the spindle to be oriented to the specified angle such as P180. Alternately, a decimal R code can be used, such as R180.53. Note that the P and R codes only work on a vector drive machine.

22 ENABLE MACRO Enables macro functions.

23 INVERT SKIP Invert sense of skip to active low=closed.

24 HANDLE CURSOR Enable use of jog handle to move cursor.

25 NEGATIVE WRK OFFSET Selects use of work offsets in negative direction.

26 TRANS OIL LOW PRESS Enables transmission low oil pressure detection.

27 QUICK CODE Enables conversational programming.

28 OILER ON/OFF Enables oiler power when servos or spindle is in motion.

29 OVERVOLT INPUT N/CInverts sense of over voltage signal.

30 SPINDLE ENCODER #2 This parameter bit enables a second encoder that is mounted on the spindle motor and wired into the "C" axis input of the Mocon. It is required to control the vector algorithm on a belted machine when the belts slip at high load.
When two encoders are present, the first is mounted on the spindle or output of the transmission, and is wired to the "spindle" input on the MOCON.
Most mills use a single encoder that is mounted on either the spindle (transmission output) or spindle motor but always connected to the spindle input on the Mocon.

31 DOOR STOP SPINDLE Enables functions to stop spindle and manual operations at door switch.

58 LEAD COMPENS SHIFT Shift factor when applying lead screw compensation. Lead screw compensation is based on a table of 256 offsets; each +\-127 encoder steps. A single entry in the table applies over a distance equal to two raised to this parameter power encoder steps.

59 MAXIMUM FEED Maximum feed rate in inches per minute.

60 TURRET START DELAY Maximum delay allowed in start of tool turret. Units are milliseconds. After this time, an alarm is generated.

On Horizontal mills with a side mount tool changer, this parameter is used to specify the time (in milliseconds) allowed for motor driven motions of the shuttle and arm. If the motion has not completed within the time allowed by this parameter, alarm 696 ATC MOTOR TIME OUT is generated. This parameter should be set to 2000.

61 TURRET STOP DELAY Maximum delay allowed in motion of tool turret. Units are milliseconds. After this time, an alarm is generated.

On Horizontal mills with a side mount tool changer, this parameter is used to specify the time (in milliseconds) allowed for air-pressure driven arm in/arm out moves. If the motion has not completed within the time allowed by this parameter, alarm 695 ATC AIR CYLINDER TIME OUT is generated. This parameter should be set to 10000.

62 SHUTTLE START DELAY This parameter is used to specify the time (in milliseconds) needed to allow the tool pocket to settle (stop bouncing) after being lowered in preparation for a tool change.

63 SHUTTLE STOP DELAY This parameter is also used for vertical mills with a Side Mount Tool Changer. It is used to specify the time allowed (in milliseconds) for the tool arm motor to stop. If the arm has not stopped after the allowed time alarm 627 ATC ARM POSITION TIMEOUT is generated.

64 Z TOOL CHANGE OFFSET
On Vertical mills: For Z-axis; displacement from home switch to tool change position and machine zero. About 4.6 inches, so for an 8192 line encoder this gives:
4.6 x 138718 = 638103
Alternate use for machines with a type 4 servo axis pallet changer. This parameter positions the pallet for a pallet change. For example, the Z-axis travel on the EC400 is done by moving the pallet, not the column, and therefore will not affect a tool change. Also, parameter 64 is generally used during zero return, and that usage is consistent in the EC400.

65 NUMBER OF TOOLS Number of tool positions in tool changer. This number must be set to the configuration machine. The maximum number of tool positions is 32, except Horizontal mills with a side mount tool changer. This parameter must be 60 for the HS 60 SMTC and 120 for the HS 120 SMTC.

66 SPINDLE ORI DELAY Maximum delay allowed when orienting spindle. Units are milliseconds. After this time, an alarm is generated.

67 GEAR CHANGE DELAY Maximum delay allowed when changing gears. Units are milliseconds. After this time, an alarm is generated.

68 DRAW BAR MAX DELAY Maximum delay allowed when clamping and unclamping tool. Units are milliseconds. After this, time an alarm is generated.

69 A AIR BRAKE DELAY Delay provided for air to release from brake on A-axis prior to moving. Units are milliseconds.

70 MIN SPIN DELAY TIME Minimum delay time in program after commanding new spindle speed and before proceeding. Units are milliseconds.

71 DRAW BAR OFFSET Offset provided in motion of Z-axis to accommodate the tool pushing out of the spindle when unclamping tool. Units are encoder steps.

72 DRAW BAR Z VEL UNCL Speed of motion in Z-axis to accommodate tool pushing out of the spindle when unclamping tool. Units are encoder steps per second.

73 SP HIGH G/MIN SPEED Command speed used to rotate spindle motor when orienting spindle in high gear. Units are maximum spindle RPM divided by 4096. This parameter is not used in machines equipped with a Haas vector drive.

74 SP LOW G/MIN SPEED Command speed used to rotate spindle motor when orienting spindle in low gear. Units are maximum spindle RPM divided by 4096. This parameter is not used in machines equipped with a Haas vector drive.

75 GEAR CHANGE SPEED Command speed used to rotate spindle motor when changing gears. Units are maximum spindle RPM divided by 4096.

76 LOW AIR DELAY Delay allowed after sensing low air pressure before alarm is generated. Alarm skipped if air pressure returns before delay. Units are 1/50 seconds.

77 SP LOCK SETTLE TIME Required time in milliseconds that the spindle lock must be in place and stable before spindle orientation is considered complete.

78 GEAR CH REV TIME Time in milliseconds before motor direction is reversed while in a gear change.

79 SPINDLE STEPS/REV Sets the number of spindle encoder steps per revolution of the spindle. This number takes into account the pulley ratio between transmission and spindle, plus transmission and encoder.

80 MAX SPIN DELAY TIME The maximum delay time control will wait for spindle to get to commanded speed or to get to zero speed. Units are milliseconds.

81 M MACRO CALL O9000 M code that will call O9000. This parameter can contain a value from 1 through 98, inclusive, zero causes no call. However it is best to use a value that is not already in use (see current M code list). Using M37 the value 37 would be entered in parameter 81 (for example). A program would be written to include the M37, such as:

```
G X0...
M37
.
.
M30
```

The control would run the program until it got to the M37, It would call program O9000, run that, and then return to the point that it left, and continue the main program.
Be aware that, if program O9000 contains another M37, it will call itself, and keep calling until it fills the stack (9 times) and then alarm out with 307 SUBROUTINE NESTING TOO DEEP.
Note that if M33 (for example) is used, it would override the normal M33 Conveyor Stop function.

82 M MACRO CALL O9001 See parameter 81 for description

83 M MACRO CALL O9002 See parameter 81 for description

84 M MACRO CALL O9003 See parameter 81 for description

85 M MACRO CALL O9004 See parameter 81 for description

86 M MACRO CALL O9005 See parameter 81 for description

87 M MACRO CALL O9006 See parameter 81 for description

88 M MACRO CALL O9007 See parameter 81 for description

89 M MACRO CALL O9008 See parameter 81 for description

90 M MACRO CALL O9009 See parameter 81 for description

91 G MACRO CALL O9010 G code that will call O9010. This parameter can contain a value from 1 through 98, inclusive, zero causes no call. However it is best to use a value that is not already in use (see current G code list). Using G45 the value 45 would be entered in parameter 91 (for example). A program would be written to include the G45, such as:

```
G X0...
G45
.
.
M30
```

The control would run the program until it got to the G45, It would call program O9010, run that, and then return to the point that it left, and continue the main program.
Be aware that, if program O9010 contains another G45, it will call itself, and keep calling until it fills the stack (4 times) and then alarm out with 531 MACRO NESTING TOO DEEP.
Note that if G84 (for example) is used, it would override the normal G84 Tapping Canned Cycle.

92 G MACRO CALL O9011 See parameter 91 for description

93 G MACRO CALL O9012 See parameter 91 for description

94 G MACRO CALL O9013 See parameter 91 for description

95 G MACRO CALL O9014 See parameter 91 for description

96 G MACRO CALL O9015 See parameter 91 for description

97 G MACRO CALL O9016 See parameter 91 for description

98 G MACRO CALL O9017 See parameter 91 for description

99 G MACRO CALL O9018 See parameter 91 for description

100 G MACRO CALL O9019 See parameter 91 for description

101 X AXIS IN POSITION LIMIT How close the motor must be to the endpoint before any move is considered complete when not in exact stop (G09 or G61). Units are encoder steps. As of mill version 9.06, this parameter does not apply to feeds. This parameter should be equivalent to .050 inches.

102 Y AXIS IN POSITION LIMIT See Parameter 101 for description

103 Z AXIS IN POSITION LIMIT See Parameter 101 for description

104 A AXIS IN POSITION LIMIT See Parameter 101 for description

105 X AXIS MAX CURRENT Corresponds to maximum peak current provided by the amplifier. 4095 = 30A (small amp) 45A (Medium amp) 60A (large amp).

106 Y AXIS MAX CURRENT See Parameter 105 for description

107 Z AXIS MAX CURRENT See Parameter 105 for description

108 A AXIS MAX CURRENT See Parameter 105 for description

109 D*D GAIN FOR X Second derivative gain in servo loop.

110 D*D GAIN FOR Y Second derivative gain in servo loop.

111 D*D GAIN FOR Z Second derivative gain in servo loop.

112 D*D GAIN FOR A Second derivative gain in servo loop.

113 X ACC/DEC T CONST Acceleration time constant. Units are 1/10000 seconds. This parameter provides for a constant ratio between profiling lag and servo velocity at the endpoint of a rapid motion.

114 Y ACC/DEC T CONST See Parameter 113 for description

115 Z ACC/DEC T CONST See Parameter 113 for description

116 A ACC/DEC T CONST See Parameter 113 for description

117 LUB CYCLE TIME If this is set nonzero, it is the cycle time for the lube pump and the Lube pressure switch option is checked for cycling in this time. It is in units of 1/50 seconds.

118 SPINDLE REV TIME Time in milliseconds to reverse spindle motor.

119 SPINDLE DECEL DELAY Time in milliseconds to decelerate spindle motor.

120 SPINDLE ACC/DECEL Accel/decel time constant in 200ths of a step/ms/ms for spindle motor.

121 X PHASE OFFSET The motor phase offset for **X** motor. This is arbitrary units.

122 Y PHASE OFFSET See Parameter 121 for description.

123 Z PHASE OFFSET See Parameter 121 for description.

124 A PHASE OFFSET See Parameter 121 for description.

125 X GRID OFFSET This parameter shifts the effective position of the encoder **Z** pulse. It can correct for a positioning error of the motor or home switch.

126 Y GRID OFFSET See Parameter 125 for description.

127 Z GRID OFFSET See Parameter 125 for description.

128 A GRID OFFSET See Parameter 125 for description.

129 GEAR CH SETTLE TIME Gear change settle time. This is the number of one millisecond samples that the gear status must be stable before considered in gear.

130 GEAR STROKE DELAY This parameter controls the delay time to the gear change solenoids when performing a gear change.

131 MAX SPINDLE RPM This is the maximum RPM available to the spindle. When this speed is programmed, the D-to-A output will be +10V and the spindle drive must be calibrated to provide this.

132 Y SCREW COMP. COEF. This is the coefficient of heating of the ball screw and is used to decrease or shorten the screw length.

133 Z SCREW COMP. COEF. This is the coefficient of heating of the ball screw and is used to decrease or shorten the screw length.

134 X EXACT STOP DIST.

135 Y EXACT STOP DIST.

136 Z EXACT STOP DIST.

137 A EXACT STOP DIST. These parameters control how close each axis must be to its end point when exact stop is programmed. They apply only in G09 and G64. They are in units of encoder steps. A value of 34 would give 34/ 138718 = 0.00025 inch.

NOTE: To change the values of parameters 134-137 permanently the machine must be rebooted.

138 X FRICTION COMPENSATION

139 Y FRICTION COMPENSATION

140 Z FRICTION COMPENSATION

141 A FRICTION COMPENSATION These parameters compensate for friction on each of the four axes. The units are in 0.004V.

142 HIGH/LOW GEAR CHANG This parameter sets the spindle speed at which an automatic gear change is performed. Below this parameter, low gear is the default; above this, high gear is the default.

143 DRAW BAR Z VEL CLMP This parameter sets the speed of the Z-axis motion that compensates for tool motion during tool clamping. Units are in encoder steps per second.

144 RIG TAP FINISH DIST This parameter sets the finish tolerance for determining the end point of a rigid tapping operation. Units are encoder counts.

145 X ACCEL FEED FORWARD

146 Y ACCEL FEED FORWARD

147 Z ACCEL FEED FORWARD

148 A ACCEL FEED FORWARD These parameters set the feed forward gain for the axis servo. They have no units.

149 PRECHARGE DELAY This parameter sets the delay time from precharge to tool release. Units are milliseconds.

150 MAX SP RPM LOW GEAR Max spindle RPM in low gear.

151 B SWITCHES See Parameter 1 for description.

152 B P GAIN See Parameter 2 for description.

153 B D GAIN See Parameter 3 for description.

154 B I GAIN See Parameter 4 for description.

155 B RATIO (STEPS/UNIT) See Parameter 47 for description.

156 B MAX TRAVEL (STEPS) See Parameter 6 for description. Normally this parameter would not apply to the A axis, however this parameter is used on mills with a gimbaled spindle (5-axes mills). On a VR-series mill this parameter is used to limit the amount of angular movement of the spindle (A and B axes). The A and B axes are limited in movement to a distance between negative MAX TRAVEL, and positive TOOL CHANGE OFFSET. On 5-axes mills A and B axes ROT TRVL LIM must be set to 1, MAX TRAVEL and TOOL CHANGE OFFSET must be calibrated and set correctly.

157 B ACCELERATION See Parameter 7 for description.

158 B MAX SPEED See Parameter 8 for description.

159 B MAX ERROR See Parameter 9 for description.

160 B FUSE LEVEL See Parameter 10 for description.

161 B BACK EMF See Parameter 11 for description.

162 B STEPS/REVOLUTION See Parameter 12 for description.

163 B BACKLASH See Parameter 13 for description.

164 B DEAD ZONE See Parameter 14 for description.

165 B AXIS IN POSITION LIMIT Same definition as Parameter 101.

166 B AXIS MAX CURRENT Same definition as Parameter 105.

167 D*D GAIN FOR B Second derivative gain in servo loop.

168 B ACC/DEC T CONST Same definition as Parameter 113.

169 B PHASE OFFSET See Parameter 121 for description.

170 B GRID OFFSET See Parameter 125 for description.

171 B EXACT STOP DIST. See Parameters 134 for description.

172 B FRICTION COMPENSATION See Parameter 138 for description.

173 B ACCEL FEED FORWARD Same description as Parameter 145.

174 B SCREW COMP. COEF. This is the coefficient of heating of the ball screw and is used to decrease or shorten the screw length.

175 B AIR BRAKE DELAY Delay provided for air to release from brake on B-axis prior to moving. Units are milliseconds.

NOTE: The C-axis parameters (176-200) are used to control the Haas Vector Drive. Parameter 278 bit HAAS VECT DR must be set to 1 for these parameters to be available.

176 C SWITCHES See Parameter 1 for description.

177 C P GAIN See Parameter 2 for description.

178 C D GAIN See Parameter 3 for description.

179 C I GAIN See Parameter 4 for description.

180 C SLIP GAIN The slip rate calculated depends on two other variables: speed and current.

Slip rate = slip gain x (speed/max speed) x (current/max current)

The slip gain value is the value that slip rate would assume at maximum speed, and maximum current (16.384=1 Hz).

181 C MIN SLIP The minimum value allowed from the slip rate. From the equation:

Slip rate = slip gain x (speed/max speed) x (current/max current)

It can be seen that at a zero speed, the slip rate would become zero. Therefore a minimum value for slip rate is required. (16.384 =1Hz).

182 C ACCELERATION Maximum acceleration of axis. The value is the units of encoder steps / second / second at the motor.

183 C MAX FREQ The frequency at which the motor will be run when maximum spindle RPM is commanded. Units: 0.01 Hz (two implied decimal places).

184 C MAX ERROR The maximum allowable error (in Hz) between commanded spindle speed and actual speed. If set to zero, it will default to 1/4 of Parameter 183.

185 C FUSE LEVEL See Parameter 10 for description.

186 C DECELERATION Maximum deceleration of axis in encoder steps per second per second.

187 C HIGH GEAR STEPS/REV This name is used when a Vector Drive is installed. This function takes on two meanings depending on how many spindle encoders are used on the machine. If only one encoder is present, it is the number of encoder steps per mechanical revolution of the spindle motor when the transmission is in high gear. (On direct drive machines, the encoder is mounted on the motor, while on others, it is on the spindle or transmission output.) N = (Encoder steps/enc rev)/(Enc pulley ratio X High Gear Ratio) For machines with a spindle and spindle motor encoder, it is the number of spindle motor encoder steps per mechanical revolution of the encoder. Its purpose is to specify the resolution of the spindle motor encoder. This parameter is used in conjunction with parameter 176 bits 25 and 26, which control the ratio between the electrical revolution of the motor to the mechanical revolution of the encoder.
If a vector drive is not installed, this parameter is called: STEPS/REVOLUTION and is not used.

188 C ORIENT GAIN The value is the proportional gain used in the position control loop when performing a spindle orientation.

189 C BASE FREQ This is the rated frequency of the motor.

190 C HI SP CURR LIM At speeds higher than the base frequency, the maximum current that is applied to the motor must be reduced. This is done linearly from base frequency to max frequency. This value is the max current at the max frequency.

191 C MAX CURRENT Sets maximum current allowed from the vector drive to the spindle motor: 4095 = max.

192 C MAG CURRENT This is the magnetization component of the current in the motor, also called the flux or field current.

193 C SPIN ORIENT MARGIN When a spindle orientation is done, if the actual position of the spindle is within this value (plus or minus), the spindle will be considered locked. Otherwise, the spindle will not be locked.

194 SPINDLE STOP FREQ The spindle is considered to be stopped (discrete input SP ST*=0) when the speed drops below this value. Units are encoder steps/millisecond.

195 C START/STOP DELAY This delay is used at the start of motion to magnetize the rotor before acceleration starts. When the motor comes to a stop it remains energized for this amount of time. Units are in milliseconds.

196 C ACCEL LIMIT LOAD This parameter is used when a Vector Drive is installed. This is the % load limit during acceleration. If the load reaches this limit during acceleration the control slows down the acceleration. If a Vector Drive is not installed, this parameter is called C axis EXACT STOP DISTANCE, and is not used.

197 SWITCH FREQUENCY (Unit:Hz.) This is the frequency at which the spindle motor windings are switched. Note that there is a hysteresis band around this point, defined by parameter 198.

198 SWITCH HYSTERESIS (UNIT:Hz) This defines the ± hysteresis band around parameter 197. For example if parameter 197 is 85 Hz, and parameter 198 is 5Hz, the switching will take place at 90Hz when the spindle is speeding up, and at 80 Hz when the spindle is slowing down.

199 PRE-SWITCH DELAY (UNIT: ms) This is the amount of time allowed for the current in the motor to drop before the winding change contactors are switched.

200 POST- SWITCH DELAY (UNIT: ms) This is the amount of time allowed for the contactors to stabilize after a switch is commanded, before current is applied to the motor.

201 X SCREW COMP. COEF. This is the coefficient of heating of the ball screw and is used to shorten the screw length.

205 A SCREW COMP. COEF. This parameter should be set to 0.

206 SPIGOT POSITION Vertical mills only. Maximum number of spigot positions.

207 SPIGOT TIMEOUT (MS) Vertical mills only. Maximum timeout allowed for spigot to traverse one spigot location.

208 SPIN. FAN OFF DELAY Delay for turning the spindle fan off after the spindle has been turned off.

209 COMMON SWITCH 2 Parameter 209 is a collection of general purpose single bit flags used to turn some functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 HS SERIES CNCSet to one for HS series mills; set to zero for all other mills.

1 RESET STOPS TL CHGR Tool changer can be stopped with RESET button.

2 CHAIN TOOL CHANGER On all HS mills with the 60 or 120 pocket chain-style tool changer, it must be set to 1. On all other mills, it must be set to zero.

3 ENABLE CHIP CONVEYR Enables chip conveyor, if machine is so equipped.

4 50% RAPID KEYBOARD When (1) the control will support the 50% rapid traverse key. For controls without a 50% rapid keypad set this bit to (0).

5 FRONT DOOR When enabled the control will look for an additional door switch and will generate an operator message.

6 NO Z HOME IN TL CHG In Horizontal mills only. This bit prevents Z-axis motion to machine zero prior to a tool change.

7 M36 AUTO PAL ROTATE In Horizontal only. When set to (1), an M36 rotates the A-axis after the PART READY button is pressed.

8 AUX AXIS TL CHANGER In Horizontal mills only. When enabled, means the tool changer carousel is driven by an aux. axis.

9 APIGOT KEY INVERT This bit controls the direction the spigot moves when the Coolant Up and Coolant Down buttons are pressed. Changing this bit reverses the direction the spigot moves when the buttons are pressed. It has no effect on the direction the spigot moves when commanded by the M34 and M35 codes.

12 REVERSE CONVEYOR Reverses the direction of the chip conveyor.

13 PRE-ORIENT TAP When this parameter bit is set to 1, a spindle orient command is issued automatically prior to the repeat rigid tap function.

14 UNUSED

15 GREEN BEACON When (1) user relay M25 is used to flash a beacon. If the control is in a reset state, the beacon will be off. If the control is running normally, the beacon will be steadily on. If the control is in a M00, M01, M02, M30 feedhold, or single block state, then the beacon will flash.

16 RED BEACON When (1) user relay M26 is used to flash a beacon. The beacon flashes if the control is experiencing an alarm or emergency stop condition.

17 CNVR DOOR HOLD OVRD When (1) the conveyor will continue to run with the door open. When (0) the conveyor will stop when the door is open, but will resume when the door is closed. For safety it is recommended that the bit be set to (0).

18 DISABLE COOLANT IN If set to 1 low coolant input will not be used.

19 UNUSED

20 REMOTE TOOL RELEASE If set to 1, allows use of remote tool release button on spindle head.

21 FLOPPY ENABLE If set to 1, enables the optional disk drive.

22 TL CHG RECOV KEYPAD If set to 1, enables tool changer restore button on keypad.

23 MCODE RELAY BOARD If set to 1, allows for M-code addressing. This adds the availablility of additional outputs.

24 TSC ENABLE When set to 1, "DSBL CLNT IN" bit is ignored, M24, M54 and M64 are disabled, and TSC will operate. When set to zero, the control functions normally.

25 AUX JOG NACC If the jog handle is moved rapidly the auxiliary axis will not develope extremely large lags.

26 ALIAS M PROGR START Alias M codes during program restart.

27 DISABLE JOG TEST Disables the encoder test for the jog handle.

28 NO ZERO CLAMP During zero return of the pallet changer, the general sequence is 1) lift, 2) home, 3) lower. When this bit is set to 1, only the first two steps are executed. The pallet remains in the unclamp position. This bit was added to prevent damage to the pallet changer prior to Grid Offset and Tool Change Offset (zero return offset for the pallet changer axis) set up.

29 PAL READY BUTTON This parameter accommodates both the APC on the vertical mill the Rotary Pallet Changer on the Horizontal mill. This bit should be set to 1 on 2-pallet APC's to designate a single pallet button configuration. Four pallet APC's have a 2 schedule pallet button and should have this bit set to zero. Note that this bit should be zero on Horizontal Mills as it is intended for future pallet changer software that replaces the macro program.

30 UNUSED

31 SPINDLE NOWAIT When (1), the machine will not wait for the spindle to come up to speed immediately after an M03 or M04 command. Instead, it will check and/or wait for the spindle to come up to speed immediately before the next interpolated motion is initiated. This bit does not affect rigid tapping or the TSC option.

210 X AXIS TOOL CHANGE OFFSET Used on the HS-2RP mill for X axis displacement from the home position to tool change position.
If this parameter contains an incorrect value, a horizontal mill will crash when it does a tool change.

211 Y AXIS TOOL CHANGE OFFSET Used on the HS-2RP mill for Y axis displacement from the home position to tool change position.
If this parameter contains an incorrect value, a horizontal mill will crash when it does a tool change.

212 A TOOL CHANGE OFFSET This parameter sets the distance between the **A**-axis grid offset (Parameter 128) and the spindle home position. The **A**-axis will be limited in movement to the area between the positive value of this parameter and the negative MAX TRAVEL.

213 B TOOL CHANGE OFFSET This parameter sets the distance between the **B**-axis grid offset (Parameter 170) and the spindle home position. The **B**-axis will be limited in movement to the area between the positive value of this parameter and the negative MAX TRAVEL. This parameter must be used on all mills with the 60 or 120 pocket chain-style tool changer, as opposed to parameter 215, CAROUSEL OFFSET, which is used on other side mount tool changers. Note that on a machine with a single mocon board, the Tt axis parameters are automatically copied to the B axis parameters and only the Tt axis parameters can be altered.

214 D:Y CURRENT RATIO % (UNIT: %) This defines the ratio between the two winding configurations. This default winding is Y, and the parameters are set for the Y winding. This number is used to adjust the parameters for the delta winding when the windings are switched.

215 CAROUSEL OFFSET Used on horizontal mills only. Parameter used to align tool 1 of tool changing carousel precisely. Units are encoder steps.

216 CNVYR RELAY DELAY Delay time in 1/50 seconds required on conveyor relays before another action can be commanded. Default is 50.

217 CNVYR IGNORE OC TIM Amount of time in 1/50 seconds before overcurrent is checked after conveyor motor is turned on. Default is 50.

218 CONVYR RETRY REV TIM Amount of time that the conveyor is reversed in 1/50 seconds after overcurrent is sensed. Default is 2000.

219 CONVYR RETRY LIMIT Number of times that the conveyor will cycle through the reverse/forward sequencing when an overcurrent is sensed before the conveyor will shut down. An overcurrent is sensed when chips jam the conveyor. By reversing and then forwarding the conveyor, the chip jam may be broken. Default is 5.

220 CONVYR RETRY TIMEOUT Amount of time in 1/50 seconds between consecutive overcurrents in which the overcurrents is considered another retry. If this amount of time passes between overcurrents, then the retry count is set to (0). Default is 1500, 30 seconds.

221 MAX TIME NO DISPLAY The maximum time (in 1/50 sec.) between screen updates.

222 ROTARY AXIS INCRMNT For Horizontal mills only. This parameter sets the degrees of rotation of the A-axis at an M36 or Pallet Rotate.

223 AIR TC DOOR DELAY For Horizontal mills only. This parameter sets the delay to open the tool changer door (in milliseconds). If the tool changer does not have a pneumatic door, this parameter is set to zero.

224 ROT AXIS ZERO OFSET This parameter shifts the zero point of A for a wheel fixture or tombstone.

225 MAX ROT AXIS ALLOW For Horizontal mills with a wheel fixture only. This parameter sets the maximum rotation (in degrees) allowed before stopping at front door.

226 EDITOR CLIPBOARD This parameter assigns a program number (nnnnn) to the contents of the clipboard (for the advanced editor).

227 DISK DIR NAME When the disk drive is enabled and a directory is read the directory listing is placed into a program as comments. The program is then made the current program so the user can read the contents of the disk drive. This parameter designates where to write the directory listing. Program 08999 is the default value.

228 QUICKCODE FILE This parameter set the program numbers to store in the Quick Code definition program. Usually, this is 9999.

229 X LEAD COMP 10E9 This parameter sets the X-axis lead screw compensation signed parts per billion.

230 Y LEAD COMP 10E9 This parameter sets the Y-axis lead screw compensation signed parts per billion.

231 Z LEAD COMP 10E9 This parameter sets the Z-axis lead screw compensation signed parts per billion.

232 A LEAD COMP 10E9 This parameter sets the A-axis lead screw compensation signed parts per billion.

233 B LEAD COMP 10E9 This parameter sets the B-axis lead screw compensation signed parts per billion.

235 TSC PISTON SEAT With the 50 TSC option, the amount of time given for the piston to seat during system start-up. The default is 500 milliseconds. If machine has a **50 Taper spindle** and the TSC option, this parameter **must be set to 0.**

236 TSC LOW PR FLT After the TSC system has stabilized following start-up, Alarm 151 is generated if coolant pressure falls below 40 psi for the amount of time set in this parameter. The default is 1000 milliseconds.

237 TSC CLNT LINE PURGE The amount of time given for the coolant to purge when the TSC system is shut off. This parameter may be increased by the user to a higher value to help purge coolant from small orifice tooling. The minimum (default) value is 2500 milliseconds.

238 MAX TSC SPINDLE RPM When TSC is enabled and in use, this parameter limits the maximum spindle speed. Default value is 10000 RPM. On 50 taper machines, the maximum spindle speed is 5000 RPM

239 SPNDL ENC STEPS/REV This parameter sets the number of encoder steps per revolution of the spindle encoder.

240 1ST AUX MAX TRAVEL This parameter sets the maximum travel of the first auxiliary (C) axis in the positive direction.

241 2ND AUX MAX TRAVEL This parameter sets the maximum travel of the second auxiliary (U) axis in the positive direction.

242 3RD AUX MAX TRAVEL This parameter sets the maximum travel of the third auxiliary (V) axis in the positive direction.

243 4TH AUX MAX TRAVEL This parameter sets the maximum travel of the fourth auxiliary (W) axis in the positive direction.

244 1ST AUX MIN TRAVEL This parameter sets the maximum travel of the first auxiliary (C) axis in the negative direction.

245 2ND AUX MIN TRAVEL This parameter sets the maximum travel of the second auxiliary (U) axis in the negative direction.

246 3RD AUX MIN TRAVEL This parameter sets the maximum travel of the third auxiliary (V) axis in the negative direction.

247 4TH AUX MIN TRAVEL This parameter sets the maximum travel of the fourth auxiliary (W) axis in the negative direction.

248 SMTC RLY ON / OFF DLY Vertical mills with sidemount tool changers only. It specifies the time needed (in milliseconds) between turning off one relay and turning on the other one, when reversing the carousel.

249 TOOL CLAMP DELAY This parameter provides a delay after the tool has been clamped and before retraction of the tool carousel at the end of a tool change. For most mills, this parameter should be set to zero. Units are milliseconds.

250 TOOL UNCLAMP DELAY This parameter provides a delay after the tool has been unclamped and before the spindle is backed away at the beginning of a tool change. For most mills, this parameter should be set to zero. Units are in milliseconds.

251 A DOOR OPEN ERRTIME This parameter supports the Auto-Door feature. It is used for several things:
1) It specifies the number of 50ths of a second for the motor to run to open the door.
2) The value of this parameter plus one second specifies the number of 50ths of a second for the motor to run to close the door.
3) If, at the end of the door-close time, the door has not yet reached the switch, alarm 238 DOOR FAULT is generated.
If an automatic door is installed, this parameter should be set to 5500 (5.5 seconds) nominally, otherwise it should be set to zero.

252 GEAR MOTOR TIMEOUT This parameter supports the Auto-Door feature. It specifies the length of time (in ms) that is allowed for the door to begin opening. If the door does not move off the door-closed switch within this amount of time, alarm 238 DOOR FAULT will be generated. This parameter should be set to 1000 (1.0 seconds) nominally.

253 SPIGOT FWD POS DLY This parameter is used to specify the length of a delay (units are ms) when moving the coolant spigot forward. This parameter should be set to zero on all machines.

254 TC AIR DOOR CLEARANCE This parameter incorporates the X-axis door clearance for the Mini-horizontal. The mill uses this position during a tool change to avoid hitting the tool changer door, as part of the tool changer door enters the machining area during a tool change.

This parameter also supports the VB-1 Bridge Mill tool carousel air door. The air door is a clamshell shaped door covering the tool carousel, which raises up at one side by air power to allow the spindle to access the tools. In order for it to open and close, there must be sufficient clearance between it and the spindle. This parameter must be set to the correct value (in encoder units), parameter 223 AIR TC DOOR DELAY must set to a non-zero value, parameter 267 ZERO AXIS TC must be set to 1 and parameter 278 TC DR SWITCH must be set to 1. When a tool change is commanded, the following steps are performed:

1) The Y axis is moved to the position specified by parameter 254.
2) The air door is commanded to open.
3) There is a delay specified by parameter 223 to allow the door to open fully.
4) The Y axis is moved to zero and the tool change is performed.
5) The Y axis is moved to the position specified by parameter 254.
6) The air door is commanded to close.
7) There is a delay specified by parameter 223 to allow the door to close fully.

255 CONVEYOR TIMEOUT The number of minutes the conveyor will operate without any motion or keyboard action. After this time, the conveyor will automatically shut off. Note that this parameter value will cause the conveyor to turn off even if the intermittent feature is functioning. Note also that if this parameter is set to zero, the chip conveyor will shut off immediately, i.e., pressing CHIP FWD or CHIP REV will not turn it on.

256 PALLET LOCK INPUT The setting for EC300 must be 26, the EC400 must be 32, and the MDC1 must be 27 or alarm 180 will occur when the spindle is turned on.

257 SPINDL ORIENT OFSET If the machine is equipped with a spindle vector drive (as set in bit 7 of Parameter 278), this bit sets the spindle orientation offset. The offset is the number of encoder steps between the Z pulse and the correct spindle orientation position. It is used to orient the spindle properly anytime it needs to be locked, such as prior to a tool change, or orient spindle command.

258 COLD SPINDLE TEMP The first time Cycle Start is pressed after the machine has been turned on, the control will compare the microprocessor temperature (in degrees Fahrenheit) against the value of this parameter. If the microprocessor is colder, the control will assume that the spindle is too cold or inadequately lubricated to be run safely at high speed and the following message will be displayed:

!!!WARNING!!!
YOUR MACHINE IS COLD, RUN A WARM-UP PROGRAM BEFORE
RUNNING THE SPINDLE AT HIGH SPEED OR DAMAGE MAY RESULT
PRESS 'CANCEL' TO CONTINUE

The user must press CANCEL before continuing. It is recommended that a spindle warm-up program be run immediately. This message will only appear once each time the machine has been turned on. The initial value for this parameter is 70 (degrees F). To disable this feature, change it to zero.

259 COLD SPINDLE DAYS The first time Cycle Start is pressed after the machine has been turned on, the control will compare the number of days that have passed since the machine was turned off against the value of this parameter. If the machine has been off longer, the control will assume that the spindle is too cold or inadequately lubricated to be run safely at high speed and the following message will be displayed:

!!!WARNING!!!
YOUR MACHINE IS COLD, RUN A WARM-UP PROGRAM BEFORE RUNNING
THE SPINDLE AT HIGH SPEED OR DAMAGE MAY RESULT
PRESS 'CANCEL' TO CONTINUE

The user must press CANCEL before continuing. It is recommended that a spindle warm-up program be run immediately. This message will only appear once each time the machine has been turned on. The initial value for this parameter is 3 (days). To disable this feature, change it to 999999.

266 X SWITCHES Parameter 266 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 X LIN SCALE EN Used to enable linear scales for the X axis.

1 X INVRT LN SCL Used to invert the X-axis linear scale.

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 X ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGE OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes.

4 X 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 X NEG COMP DIR Used to negate the direction of thermal compensation.

6 X DELAY AXIS 0 Used with an APL to ensure X axis is zeroed before A axis of APL

7 X MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 X TEMP SENSOR This performs Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. =-28000
351 TEMP PROBE OFFSET =450000

16 SCALE Z HIST For HAAS diagnostic use only.

267 Y SWITCHES Parameter 267 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 Y LIN SCALE EN Used to enable linear scales for the Y axis.

1 Y INVRT LN SCL Used to invert the Y-axis linear scale.

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 Y ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGER OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes.

4 Y 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 Y NEG COMP DIR Used to negate the direction of thermal compensation.

6 Y DELAY AXIS 0 Used with an APL to ensure Y axis is zeroed before A axis of APL.

7 Y MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 Y TEMP SENSOR This performs Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. =-28000
351 TEMP PROBE OFFSET =450000

16 SCALE Z HIST For HAAS diagnostic use only.

268 Z SWITCHES Parameter 268 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 Z LIN SCALE EN Used to enable linear scales for the Z axis.

1 Z INVRT LN SCL Used to invert the Z-axis linear scale

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 Z ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGER OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes.

4 Z 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 Z NEG COMP DIR Used to negate the direction of thermal compensation.

6 Z DELAY AXIS 0 Used with an APL to ensure Z axis is zeroed before A axis of APL

7 Z MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 Z TEMP SENSOR This performs Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. =-28000
351 TEMP PROBE OFFSET =450000

16 SCALE Z HIST For HAAS diagnostic use only.

269 A SWITCHES Parameter 269 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 A LIN SCALE EN Used to enable linear scales for the A axis.

1 A INVRT LN SCL Used to invert the A-axis linear scale.

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 A ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGER OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes.

4 A 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 A NEG COMP DIR Used to negate the direction of thermal compensation.

6 A DELAY AXIS 0 Used with an APL to ensure A axis is zeroed before B axis of APL.

7 A MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 A TEMP SENSOR This performs Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. =-28000
351 TEMP PROBE OFFSET =450000

16 SCALE Z HIST For HAAS diagnostic use only.

270 B SWITCHES Parameter 270 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 B LIN SCALE EN Used to enable linear scales for the B axis.

1 B INVRT LN SCL Used to invert the B-axis linear scale.

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 B ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGER OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes. On all mills with 60 or 120 pocket chain-style tool changer, this bit must be set to 1. It will cause to tool changer offset parameter to be used for tool changes.

4 B 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 B NEG COMP DIR Used to negate the direction of thermal compensation.

6 B DELAY AXIS 0 Used with an APL to ensure B axis is zeroed before A axis of APL.

7 B MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 B TEMP SENSOR This performs Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. =-28000
351 TEMP PROBE OFFSET =450000

16 SCALE Z HIST For HAAS diagnostic use only.

271 C SWITCHES Parameter 271 is a collection of single-bit flags used to turn servo related functions on and off. This parameter is not used when the machine is equipped with a Haas vector drive. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 C LIN SCALE EN Used to enable linear scales for the C axis.

1 C INVRT LN SCL Used to invert the C-axis linear scale.

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 C ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGER OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes.

4 C 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 C NEG COMP DIR Used to negate the direction of thermal compensation.

6 C DELAY AXIS 0 Used with an APL to ensure C axis is zeroed before A axis of APL.

16 SCALE Z HIST For HAAS diagnostic use only.

272 X SCREW COMP T. CONST. This parameter is the thermal compensation time constant, and is the time constant governing the rate of cool down of the screw.

273 Y SCREW COMP T. CONST. This parameter is the thermal compensation time constant, and is the time constant governing the rate of cool down of the screw.

274 Z SCREW COMP T. CONST. This parameter is the thermal compensation time constant, and is the time constant governing the rate of cool down of the screw.

275 A SCREW COMP T. CONST. This parameter should be set to 0.

276 B SCREW COMP T. CONST. This parameter should be set to 0.

278 COMMON SWITCH 3 Parameter 278 is a collection of general purpose single bit flags used to turn some functions on and off. This bit will cause the machine to use discrete outputs 21 and 26 to command the shuttle to move in and out. On mills with the Air Driven Shuttle it must be set to 1. On all other mills it must be set to 0. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 INVERT GEARBOX SIGS This bit allows an alternate gearbox configuration. It inverts the sense of the gearbox inputs. Used for 50 taper option.

1 DPR SERIAL Causes the main serial inputs/outputs to go through the disk video board.

2 CHECK PALLET INPUT If set to 1, the discrete input specified by parameter 256 PALLET LOCK INPUT is checked prior to the execution of a spindle command. If the input was high (i.e. an open circuit), alarm 180 would be generated. The input is also checked while the spindle is turning and will generate the same alarm if it goes high. Thus, the input can now be used to stop a program after the spindle has been commanded to turn (such as by a pressure switch from the user's clamp or fixture).

3 CHK HIDDN MACRO VAR This bit is used on horizontal mills only.

4 DISPLAY ACTUAL RPM When set to 1, displays the actual spindle speed on the Current Commands display page.

5 TSC PURGE ENABLE Enables purge output on TSC option.

6 SINGLE CLAMP SWITCH This parameter enables the control to rely up on a single switch to detect the clamp position of the Side Mount Tool Changer arm. When this bit is set to zero, both the upper and the lower switches are used to detect the arm position. When it is set to one, only the lower switch will be used. This means that the control will not wait until the upper switch is tripped to conclude that the tool is clamped, so subsequent operations can begin immediately. This increases tool change speed.

7 SPINDLE DRIVE LOCK This bit must be set to 1 if machine is equipped with a non-Haas vector spindle drive. This bit must be set to 1 if the machine has a 50 taper spindle or a non-Haas vector drive.

8 UNUSED

9 CONCURENT SPINDLE When set to 1, the spindle will be commanded to start concurrently with other commands in the same block. In the following example, with this bit set to 1, the spindle will start at the same time as the rapid move:

G0 X-1. S7500 M3;

10 HS3 HYDRAULIC TL CH This parameter bit is used with the 38 tool SMTC on the HS-3. When this is set to zero, the mill will behave normally. When it is set to 1, the control will recognize that the toolchanger is a 38-Tool SMTC.

11 HAAS VECTOR DRIVE This bit must be set to 1 if machine is equipped with a HAAS vector spindle drive. When set to 1, voltage to the Haas vector drive is displayed in the diagnostics display as DC BUSS.

12 uP ENCLOSURE TEMP (Microprocessor Enclosure Temperature) When set to 1, the enclosure temperature will be displayed on INPUTS2 screen of the diagnostics display.

13 HAAS REMOTE JOG HDL (Haas Remote Jog Handle) This bit must be set to 1 if the machine is equipped with a Haas 5-Axes Remote Jog Handle.

14 SPIN MOTOR OTEMP NC (Spindle Temperature Sensor Normally Closed) This bit specifies the type (normally open or normally closed) of the spindle temperature sensor. This bit should be set to 1.

15 AIR DRIVE SHUTTLE This bit will cause the machine to use discrete outputs 21 and 26 to command the shuttle to move in and out. On mills with the Air Driven Shuttle it must be set to 1. On all other mills it must be set to 0.

16 GIMBAL SPINDLE Used on 5-axes mills. This bit will cause the machine to check that the Z,A and B axes are at zero before a tool change is started. If one is not, alarm 150 will be generated. On mills with the gimbaled Spindle it must be set to 1. On all other mills it must be set to 0.

17 NO MFIN CHK ON P-UP When this bit is set, it will prevent checking of MFIN at power-up. It should be set for 1 for all machines that have the Haas Automatic Pallet Changer attached, and 0 for all other machines.

18 DEL:Y SWITCH ENABLE (Delta Wye switch enabled). This bit is used for the Vector Drive. The bit enables the switching of spindle motor windings, provided the hardware ENABLE is installed, and the proper parameters are set. If this switch is set, but bit 19 is not, then the winding switching will only be done when the spindle is at rest, depending on the target speed of the spindle.

19 DEL:Y SWITCH ON FLY This bit enables switching on the fly, as the spindle motor is accelerating or decelerating through the switch point. If bit 18 is not set, this switch will be ignored.

20 5 AX TOFS -X This bit is used with the G143 (modal 5 axes tool length compensation) on machines with a Gimbaled Spindle. If it is set to 1, this means that when the corresponding rotary axes is moved, the sign of the X Position must be inverted. Normally, this bit should be set to 0.

21 5 AX TOFS -Y This bit is used with the G143 (modal 5 axes tool length compensation) on machines with a Gimbaled Spindle. If it is set to 1, this means that when the corresponding rotary axes is moved, the sign of the Y Position must be inverted. Normally, this bit should be set to 0.

22 B+C 5 AXES This bit is used with the G142 (modal 5 axes tool length compensation) on machines with a Gimbaled Spindle. The B-axis normally moves the A-axis, but if this is not true, this bit can be set to change which is the inner axis. Normally, this bit should be set to 0.

23 TL CHGR DOOR SWITCH Horizontal tool carousel door configuration. This bit specifies the Horizontal Mill tool carousel door configuration. If it is set to 0, this indicates the configuration where the door is driven open by a timed operation. If it is set to 1, this indicates the configuration where the door is spring-loaded closed and is driven open by the timed operation against the door open switch. In open position, the door switch signal is 0 (low). The switch status is checked before and after commanding the door to open in order to be fail-safe.

For all horizontal mills that have the switch installed, this bit must be set to 1. For all other mills, this bit must be set to 0.

24 HS2 SMTC CAROUSEL

25 HS3 SMTC CAROUSEL

26 S MNT BIT 1 Bits 26, 27, and 28 work together to specify the type of sidemount tool changer that is installed on a vertical mill. The following table shows the bit combinations that must be used:
Bit 26 27 28

0 0 0 No side-mount tool changer installed
1 0 0 Serpentine 1
0 1 0 Serpentine 2
1 1 0 Serpentine 3
0 0 1 Disk 1
1 0 1 Disk 2
0 1 1 Disk 3
1 1 1 Disk 4

27 S MNT BIT 2 Bits 26, 27, and 28 work together to specify the type of sidemount tool changer that is installed on a vertical mill.

28 S MNT BIT 3 Bits 26, 27, and 28 work together to specify the type of sidemount tool changer that is installed on a vertical mill.

29 DOOR SAFETY SW INV This bit supports the CE door interlock that locks when power is turned off. For machines that have the regular door lock that locks when power is applied, this bit must be set to 0. For machines that have the inverted door lock, this bit must be set to 1.

30 SWAP A & C AXES This parameter causes the A and C axes to be swapped internally. This parameter bit should be set to 1 for the bridge mill. All other mills should set this bit to 0.

31 INV SPIND SPD DECEL Inverse Spindle Speed Deceleration. When this parameter is set to 1, the spindle decelerates faster at lower speeds, resulting in a shorter deceleration time.

279 X SCALE GAIN MULT This is used on machines with linear scales. Linear scales are used to continuously correct any errors in the encoder position. The parameter determines the gain of the correction factor, that is, how fast it corrects. This parameter should be set to 40.

280 Y SCALE GAIN MULT See parameter 279 for description

281 Z SCALE GAIN MULT See parameter 279 for description

282 A SCALE GAIN MULT See parameter 279 for description

283 B SCALE GAIN MULT See parameter 279 for description

284 RESERVED

285 X LINEAR SCREW OFFS This parameter is used on machines with linear scales. This parameter accounts for the unused portion of the ball screw between zero and the actual motor. This parameter should be a positive value (400000) unless the NEG COMP DIR bit for the axis is set, in which case this parameter should be a negative value (-400000.)

286 Y LINEAR SCREW OFFS See parameter 285 for description.

287 Z LINEAR SCREW OFFS See parameter 285 for description.

288 A LINEAR SCREW OFFS See parameter 285 for description.

289 B LINEAR SCREW OFFS See parameter 285 for description.

291 A AXIS BRAKE OIL TIME This parameter supports the EC1600 A-axis brake oil sensor. The units are seconds. When this parameter is set to a non-zero number and the sensor indicates a low oil condition for more than that amount of time, the control will cause the red beacon to flash and display the message LOW BK OIL on the screen. If the low oil condition continues alarm 643 LOW BRAKE OIL A-AXIS will be generated when the program ends.

292 AUTO DOOR PAUSE
This parameter supports the Auto-Door feature. It specifies the length of a pause (in 50ths of a second) that occurs during the door close sequence. As the door closes and the switch is activated, the motor is turned off for this amount of time and the door coasts. This allows the door to close smoothly. This parameter should be set to 1 (0.02 seconds) nominally. It works in conjunction with parameter 293.

293 AUTO DOOR BUMP This parameter supports the Auto-Door feature. It specifies the length of time (in 50ths of a second) that the motor should be reactivated after the pause specified by parameter 292. This causes the motor to close the door fully and smoothly. This parameter should be set to 2 (0.04 seconds) nominally.

294 MIN BUSS VOLTAGE This parameter specifies the minimum Haas Vector Drive buss voltage. It should be set to 200 (the units are volts). Alarm 160 will be generated if the voltage falls below this value.

295 SHTL SETTLE TIME Used on mills with an air driven shuttle. This parameter allows settling time for the shuttle after it has moved toward the spindle and before a tool change is performed. It should be set to approximately half a second (500) on all mills with the Air Driven Shuttle. This may very. All other mills can be set to 0 as they are unaffected by it.

296 MAX OVER VOLT TIME Specifies the amount of time (in 50ths of a second) that an overvoltage condition (alarm 119 OVER VOLTAGE) will be tolerated before the automatic shut down process is started.

297 MAX OVERHEAT TIME Specifies the amount of time (in 50ths of a second) that an overheat condition (alarm 122 REGEN OVERHEAT) will be tolerated before the automatic shut down process is started.

298 MAX FEED (DEG/MIN) Used on 5-axes mills. This parameter specifies the maximum rotary feed rate in degrees per minute. Any attempt at cutting faster than this will result in "LIM" being displayed next to the FEED message on the Program Command Check screen.

On mills with a Gimbaled Spindle, this parameter must be set to 300. For all other mills, this bit should be set to 99999.

299 AUTOFEED-STEP-UP This parameter works with the AUTOFEED feature. It specifies the feed rate step-up percentage per second and should initially be set to 10.

300 AUTOFEED STEP-DOWN This parameter works with the AUTOFEED feature. It specifies the feed rate step-down percentage per second and should initially be set to 20.

301 AUTOFEED-MIN-LIMIT This parameter works with the AUTOFEED feature. It specifies the minimum allowable feed rate override percentage that the AUTOFEED feature can use and should initially be set to 1.

302 FEED ACCELERATION This parameter supports the motion control feature. This is the acceleration that applies to feed motion in encoder steps per second squared. For vertical mills, 1/2 of the value of parameter 7 is a good starting point. For horizontal mills, 1000000 is a good value to start with. This parameter can be further updated as necessary.

303 FEED TIME CONSTANT This parameter supports the motion control feature. It is the base 2 exponent of the feed time constant in milliseconds. It should be set to 3.

304 SPIGOT REV POS DLY This parameter is used to specify the length of a delay (units are ms) when moving the coolant spigot in reverse. This parameter should be set to zero on all machines.

305 SERVO PO BRK DLY The SRV PO (Servo Power On) discrete output is used to engage and disengage an axis brake. This parameter is used to specify a time in milliseconds that the control should wait after activating the SRV PO output and turning off power to the servo motors via the MOCON. This parameter also specifies the time to wait after deactivating the SRV PO output and reactivating the servo motors via the MOCON.

306 POCKET UP / DN DELAY This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) for the tool pocket to be raised or lowered. If the pocket does not move to its commanded position within the time allowed by this parameter and by parameter 62, alarm 626 TOOL POCKET SLIDE ERROR is generated. For mills without a side mount tool changer, this parameter should be set to 0.

307 POCK UN / LOCK DELAY This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) to lock or unlock a tool pocket. For mills without a side mount tool changer, this parameter should be set to 0.

308 ARM ROTATE TIME This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) for the arm to rotate to the next position. The positions are, Clamp, Unclamp, and Origin. If the arm does not move to the commanded position within the allowed time, alarm 622 TOOL ARM FAULT is generated. For mills without a side mount tool changer, this parameter should be set to 0.

309 MOTOR COAST TIME This parameter supports the side mount tool changers. It specifies the time allowed for the tool changer to start only. If the arm has not moved after the allowed time, alarm 627 ATC ARM POSITION TIMEOUT is generated. Units are milliseconds.

310 CAM LOCK DELAY This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) to lock the cam by pushing the shot pin in, or to unlock the cam by pulling the shot pin out. If the shot pin has not moved to its commanded position within the allowed time, alarm 625 INVALID TC START CONDITION is generated.

311 ARM BUMP TIME/DEG This parameter supports the side mount tool changers. During tool change recovery, the arm may be moved a small amount by pressing the ATC FWD or ATC REV key. Each press of the key will cause the arm motors to run for the amount of time (in milliseconds) specified by this parameter. For mills without a side mount tool changer, this parameter should be set to 0.

For the high speed tool changer, this parameter specifies the number of thousandths of degrees to bump the arm (i.e., 1000=1 deg.)

On horizontal mills with a side mount tool chager, the arm may be rotated a small amount by pressing the END or PAGE DOWN keys. The shuttle may be moved by pressing the Left Arrow or Right Arrow keys. Each press of the key will cause the motor to run for the amount of time (in milliseconds) specified by this parameter. This parameter is most commonly set to 30.

312 CAROUSEL BUMP TIME This parameter supports the side mount tool changers. During tool change recovery, the carousel may be moved a small amount by pressing the Left Arrow or Right Arrow key. Each press of the key will cause the carousel motors to run for the amount of time (in milliseconds) specified by this parameter. For mills without a side mount tool changer, this parameter should be set to 0.

313 POCKET INCREMENT This is a parameter for the bridge mill. Under normal circumstances it should be set to 1. If it is set to 2, for example, the control will only recognize every other pocket. That is, it will treat the tools and pockets as follows:

Tool 1 is in pocket 1
Tool 2 is in pocket 3
Tool 3 is in pocket 5
Tool 4 is in pocket 7
etc...

If this parameter is set to 3 the control will only recognize every third pocket and so on. **It is the operator's responsibility to ensure that the total number of pockets in the tool changer is evenly divisible by this parameter value.** If not, the control will pick the wrong pocket after the carousel has exceeded a full revolution.

314 FEED DELTA V This parameter supports the motion control feature. It is the maximum change in velocity in encoder steps per millisecond.

315 COMMON SWITCH 4

0 ALIS M GRPHC When this bit is set to 0, all user defined M codes (such as M50 normally used to do a pallet change on a horizontal mill) will be ignored when a program is run in graphics mode. If it is necessary to have graphics recognize such M codes, this bit should be set to 1.

1 GANTRY

2 NO X MOVE NEXT TOOL This parameter only affects horizontal mills, and is intended for use primarily on the HS-3. If this bit is set to zero, it will have no effect. If it is set to one, the X-axis will not move following a NEXT TOOL button press. The reason for this is because after pressing NEXT TOOL on an HS-1 or HS-2, the spindle, which is mounted on the X-axis, is moved closer to the operator so the next tool can be manually installed. On an HS-3, the X-axis is on the table and there is no advantage to moving it. Setting this bit to one will save time.

3 EXTRA-LARGE TOOLS This parameter enables the user to specify that large tools are considered to be extra large, and allow the Tool Pocket table to get set up as shown below. This parameter bit should be set to 1 on all mills with the 50 Taper Side Mount Tool Changer. It will enable the control to recognize tools that occupy three pockets.
An example of a tool pocket table with extra large tools:

1 –
2 L
3 –
4 –
5 L
6 –

Note that when this parameter bit is set to 1, the following tool pocket configuration is not allowed (see alarm 422).

–
L
–
L
–

4 HIGH SPD MACHINING This parameter bit enables the High Speed Machining feature. This parameter requires an unlock code in order to set the bit to 1. This option requires the Floating Point Co-Processor and Floating Point software. If this option is turned on when non-floating point software is installed the High Speed option will have no effect.

5 FAEMAT SPINDLE This bit controls the tool clamp and unclamp sequence for different spindles. This bit should be set to 1 when the mill has a Faemat spindle installed. Otherwise the bit should be set to 0. This improvement is intended primarily for the VB-1 bridge mill.

6 MANUAL TOOL CHANGER This parameter must be set to 1 when a TM-1 has no tool changer and zero when it has a tool changer. When it is set to 1, an M06 will stop the program and display a message requesting the operator to change tools manually.

7 RESET STOPS PAL CHG This parameter enables the RESET button to stop a pallet change. It is intended for use with the future hard-coded pallet changer macro program. It should be set to zero.

8 MINI POWER SUPPLY When parameter 315 bit 8 MINI MILL is set to 1, the Over Voltage discrete input will be displayed as P.S. Fault.
When it is set to 1:

(a) The DC BUSS voltage that is normally displayed on the diagnostics screen for a Vector Drive machine will not be displayed.

(b) The conditions that would normally generate alarm 119 OVER VOLTAGE and alarm 160 LOW VOLTAGE will instead generate alarm 292 320V POWER SUPPLY FAULT and this alarm will be added to the alarm history only after a 1 second delay to prevent false 292 alarms being added to the alarm history at the moment power is turned off. This parameter bit must be set to 1 on all Mini Mills.

9 DOOR OPEN SWITCH The bit allows the software to work with an optional door-open switch. This bit should be set to 1 on all machines fitted with the second door switch. If this bit is set to 1, the control will look for a second door switch when the door is opened automatically to the fully open position. If the switch is not found, alarm 238 DOOR FAULT will be generated. If this bit is set to zero, the control behaves as before.

10 PALLET HARDCODE This bit supports the hard-coded APC pallet changer function. It must be set to 1 when an APC is present that is wired for two APC door switches. On all other machines, it must be set to 0.

11 M50 CLOSES DOOR The MDC-1 pallet changer station auto door closes before an M50 pallet rotate and opens afterward provided that this parameter bit is set to 1. If the bit is set to zero, a flashing message directing the operator to close the pallet changer door (manually or by pushing the PART READY button) will be displayed and the pallet change will not occur until the door is closed. Note that the door will not close automatically if the Pallet Schedule Table is used to schedule a pallet.

12 MANUAL JOG TRM/TRL This parameter bit enables the manual jog feature for the Tool Room Mill's handwheels.

13 SAFTY SWITCH When set to zero, the control behaves as normal. When it is set to 1, the Toolroom Mill's safety switch must be pressed by the operator for controlled motion to start or continue.

14 FOURTH AXIS This parameter bit prevents unauthorized use of the 4th (A) axis. It can only be set to 1 with a magic code. When it is set to zero, it prevents the user from altering setting 30 and prevents the user from zeroing the parameter 43 DISABLED bit. When this parameter bit is changed to zero, setting 30 will be returned to OFF and the parameter 43 DISABLED bit will be set to 1.

15 FIFTH AXIS This parameter bit prevents unauthorized use of the 5th (B) axis. It can only be set to 1 with a magic code. When it is set to zero, it revents the user from altering setting 78 and prevents the user from zeroing the parameter 151 DISABLED bit. When this parameter bit is changed to zero, setting 78 will be returned to OFF and the parameter 151 DISABLED bit will be set to 1. Note that when parameter 209 HORIZONTAL is set to 1, setting 78 is unavailable and not displayed because the B axis is used for the tool changer.

16 TOOL CAGE DOOR Supports the machines fitted with the side-mount tool changer cage door. When a machine has a cage door, this parameter must be set to 1. On all other machines, it must be set to zero.

17 VIBRATION SENSOR This parameter enables the vibration sensor. When it is set to 1, the output from the sensor will be converted to Gs and displayed on the Current Commands Tool Load screen. When this parameter is set to zero, NO SENSOR will be displayed instead.

18 HIGH Z TOOL CHANGER Setting this parameter to 1 and commanding either a G28 move of all the axes, or a pressing Second Home will cause the Z axis to move to the maximum position prior to moving to machine zero. When this parameter is set to zero, the Z axis will move directly to machine zero. Previously, the Z axis would move directly to machine zero regardless of this parameter bit. This enhancement was made primarily for the Gantry Router mills.

19 PAL LOAD AUTODOOR This bit tells the control that the pallet changer has an automatic door, as opposed to the operator Auto Door feature. This is so that an MDC can have either an Auto Door or an automatic pallet changer door.

20 MAP 4TH AXIS This bit enables the Rotary Index button at the load station and prevents movement of the rotary outside of the work area (i.e., rotary mounted on the outside pallet position.)

21 INV PAL DOOR SWITCH This parameter bit must be set to 1 on the MDC1 and zero on all other machines. This bit indicates the polarity of the pallet changer door closed switch.

22 PAL RECIEVER SWITCH This parameter supports the APC pallet receiver position switch. When the switch is present, the bit must be set to 1, otherwise it must be set to zero.

23 RAPID -> HS FEED This bit enables straight line rapid moves. Normally, during a rapid move of two or more axes, the axis with the shorter distance will finish first. When this parameter is set to 1, the control will treat rapid moves as high-speed feeds, that is, all axes will complete their motion at the same time.

25 POWER DICONN RELAY When it is set to zero, the machine behaves as before. When it is set to 1, and parameter 57 SAFETY CIRC is set to 1, and the door is opened, I GAIN on all axes will be cleared. When the door is closed and power to the servos is restored, the I GAIN values will be restored. This is intended to be used in conjunction with special hardware by customers who require the servo power to be cut when the door is opened.

26 STATUS RELAYS This parameter bit supports the Machine Data Collection enhancement. The default value for all machines is zero.

27 UNUSED

28 ADVANCED TOOL MGMT. This feature allows the user to specify groups of tools. When the life of a tool (based on feed time, total time, usage, number of holes, tool load, or vibration) has expired, the control will automatically use another tool from the same group. When all the tools from a group are used up, the control will alarm.

29 RND5 TRM/TRL

30 RND5 HANDWHEEL

31 INTUITIVE PROG SYS When set to 1, the Intuitive Programming System is activated.

316 APC PAL. CLAMP TIME
This is the time required to clamp the APC pallet to the receiver. It should be set to 4000 on all pallet changing machines except the the EC-300 and MDC, which should be set to 1000. Units are milliseconds.

317 APC UNCLAMP TIME This is the time required to unclamp the APC pallet from the receiver. It should be set to 4000 on all pallet changing machines except the the EC-300 and MDC, which should be set to 1000. Units are milliseconds.

318 APC PAL. CHAIN TIME This is the time required to cycle the chain. It should be set to 8000. Units are milliseconds.

319 APC DOOR CLOSE TIME This is the time required to close the door. It should be set to 6000. Units are milliseconds.

320 RP DRAWBAR DOWN This is the time required for the drawbar to move down. Units are milliseconds.

321 RP DRAWBAR UP TIME This is the time required for the drawbar to move up. Units are milliseconds.

327 X SCALES PER INCH This parameter is used on machines equipped with linear scales. This parameter should be set to 25,400 on mills fitted with linear scales. On all other mills, they should be set to zero.

328 Y SCALES PER INCH This parameter is used on machines equipped with linear scales. This parameter should be set to 25,400 on mills fitted with linear scales. On all other mills, they should be set to zero.

329 Z SCALES PER INCH This parameter is used on machines equipped with linear scales. This parameter should be set to 25,400 on mills fitted with linear scales. On all other mills, they should be set to zero.

330 A SCALES PER INCH This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.

331 B SCALES PER INCH This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.

333 X SCALES PER REV This parameter is used on machines equipped with linear scales. This parameter should be set to 50,000 on mills fitted with linear scales. On all other mills, they should be set to zero.

334 Y SCALES PER REV This parameter is used on machines equipped with linear scales. This parameter should be set to 50,000 on mills fitted with linear scales. On all other mills, they should be set to zero.

335 Z SCALES PER REV This parameter is used on machines equipped with linear scales. This parameter should be set to 50,000 on mills fitted with linear scales. On all other mills, they should be set to zero.

336 A SCALES PER REV This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.

337 B SCALES PER REV This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.

339 X SPINDLE THERM COEF. This parameter supports the Spindle Head Thermal Compensation feature, and should be set to 0.

340 Y SPINDLE THERM COEF. See parameter 339 for description.

341 Z SPINDLE THERM COEF. See parameter 339 for description.

342 A SPINDLE THERM COEF. See parameter 339 for description.

343 B SPINDLE THERM COEF. See parameter 339 for description.

345 X SPINDLE THERM TIME.CONST. This parameter supports the Spindle Head Thermal Compensation feature, and should be set to 0.

346 Y SPINDLE THERM TIME.CONST. See parameter 345 for description.

347 Z SPINDLE THERM TIME.CONST. See parameter 345 for description.

348 A SPINDLE THERM TIME.CONST. See parameter 345 for description.

349 B SPINDLE THERM TIME.CONST. See parameter 345 for description.

351 THRML SENSOR OFFSET This is a parameter used for Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut.

352 RELAY BANK SELECT This parameter allows the user to change which bank of relays is to be used (Parameter 209 bit 23 MCD RLY BRD assumes that relay bank one is to be used). It may be set to a number from 0 to 3 (inclusive). M codes M21 through M28 will be switched to the selected bank. This parameter requires a revision "S" I/O board. If a previous board is installed (without the additional banks of relays), this parameter should be set to zero.

Bank #	Relay Location	Description
0	I/O PCB	Internal machine functions
1	I/O PCB	User relay outputs (some may be used for internal functions)
2	1st M-code PCB	8M option. 8 additional user outputs.
3	2nd M-code PCB	Typically used for built in options such as, side mount tool
	2nd M-code PCB	changer, etc.

430 W RATIO (STEPS/UNIT) For the EC300 and MDC1, this parameter is set to 57344. This parameter controls the rotation of the pallet. When a pallet change is performed, the pallet will rotate 180 degrees. It is essential that this parameter is checked after a software upgrade.

586 MAX DOOR OPN SP RPM This parameter specifies the maximum allowable spindle RPM after the door has been opened manually or commanded open by an M80.

588 X ENC. SCALE FACTOR This axis parameter work in place of the axis parameters called SCALE/X LO and SCALE/X HI. If SCALE FACT/X is set to 1, the scale ratio is determined by SCALE/X LO and SCALE/X HI as follows:

HI	LO	
0	0	3
0	1	5
1	0	7
1	1	9

If, however, SCALE FACT/X is set to zero, the value of ENC. SCALE FACTOR will be used for the scale ratio instead. Note that any value outside the range of 1 to 100 will be ignored and the scale ratio will remain unaffected. Note also that currently, these parameters are intended for use only on rotary axes (A and B).

589 Y ENC. SCALE FACTOR See parameter 588 for description

590 Z ENC. SCALE FACTOR See parameter 588 for description

591 A ENC. SCALE FACTOR See parameter 588 for description

592 B ENC. SCALE FACTOR See parameter 588 for description

593 Sp ENC. SCALE FACTOR See parameter 588 for description

594 U ENC. SCALE FACTOR See parameter 588 for description

595 V ENC. SCALE FACTOR See parameter 588 for description

596 W ENC. SCALE FACTOR See parameter 588 for description

600 PEAK SPIN. PWR (KW) This parameter supports the spindle kilowatt (KW) load display which appears on the current commands page, next to the spindle load percentage. This parameter should be set to the peak power output in KW for the spindle motor.

601 TOOL CHANGE DELAY On a mill where the operator needs to be warned that a running program is about to do a tool change (no enclosure) it will beep and delay for the duration specified by parameter 601.
If parameter 601 is set to zero, there will be no beep or delay. If the operator changes tools by pressing buttons on any kind of tool changer, there will be no beep or delay.
If the machine has a manual tool changer and an M06 is commanded from a running program, there will be no beep or delay because the control will stop and prompt the operator to manually insert the tool.

605 Pallet Changer Type This parameter defines the type of pallet changer on the machine. Also see Parameter 606

606 Number of Pallets This parameter specifies the number of pallets present in the installed pallet changer. Also see Parameter 605.

Pallet Changer	Parameter 605	Parameter 606
APC (Pallet Ready button)	0	2
APC (Schedule Pallet Buttons)	2	2
Rotary Pallet Changer (HS 1/2)	1	2
Quad APC	2	4
MDC-1 / EC300	3	2
EC400	4	2
2 Pallet APC	2	2

612 Spigot Type This parameter supports the programmable coolant spigot. Type 0 uses the peaks of the spigot fan for positioning. Type 1 uses the peaks and valleys of the spigot fan for positioning. All other values are treated the same as type 0. Note that if parameter 253 SPIGOT FWD POS DLY and parameter 304 SPIGOT REV POS DLY are non-zero, type 1 processing uses those values. Otherwise, the type 1 processing calculates the delay value for positioning from parameters 613 and 614.

613 Spigot FWD MTR DLY This parameter supports the programmable coolant spigot. It specifies the delay time in ms from the moment the spigot motor is turned off to the moment the spigot is stopped in the forward direction.

614 Spigot REV MTR DLY This parameter supports the programmable coolant spigot. It specifies the delay time in ms from the moment the spigot motor is turned off to the moment the spigot is stopped in the reverse direction.

619 Pre Gear Change Dly This parameter specifies the delay time (in milliseconds) after the spindle has been commanded to stop and before the solenoid for the gear change is commanded to start. It should be set to 100 on all machines.

620 X-Axis Plus Travel Limit Note that only parameters 623 and 624 for the A and B axes are intended to be used, and only on the Trunnion Mills (VF5TR and VF6TR) where it is necessary to place the home switch in the middle of the travel range (in order to keep the table flat when at the home position) and limit movement to +/-120 degrees. The PLUS TRAVEL LIMIT parameter is used to store the number of encoder steps that a rotary can take in the plus direction from its current home position. The control then takes into account these updated travel limits for jog and feed conditions. For example, if the steps/unit on the A axis is 4000 and the PLUS TRAVEL LIMIT is set to 20000 then the control will allow the A rotary to go up to +5 degrees before stopping. (This assumes that the encoder scale factor is set to zero). The same applies for the B axis. This feature will enable the home switch to be moved to any desired location so that a rotary can make the proper orientation during zero return. Note that parameter 591 and 592 AB ENC. SCALE FACTOR will be applicable in determining the limits. So if this parameter is set to 3, then in the above example the rotary will be allowed to go up to +15 degrees due to encoder scaling. Similar results will be achieved when the SCALE FACT/X bit is set to 1 (based on SCALE/X LO and SCALE/X HI bits =0). To deactivate this feature on any axis, the PLUS TRAVEL LIMIT should be set to zero.

621 Y-Axis Plus Travel Limit See Parameter 620

622 Z-Axis Plus Travel Limit See Parameter 620

623 A-Axis Plus Travel Limit See Parameter 620

624 B-Axis Plus Travel Limit See Parameter 620

629 Sp-Axis Plus Travel Limit See Parameter 620

626 U-Axis Plus Travel Limit See Parameter 620

627 V-Axis Plus Travel Limit See Parameter 620

628 W-Axis Plus Travel Limit See Parameter 620

630 Tt-Axis Plus Travel Limit See Parameter 620

644 X-Axis Indexer Increment Note that only parameters 647 and 648 for the A and B axes are intended to be used, and only on Horizontal Mills fitted with a Rotary Indexer. The Rotary Indexer is a device that holds a part to be machined and rotates in one-degree increments. It can rotate only in rapid motion (G00), it cannot rotate in a feed motion (G01). It can be jogged by pressing a jog button, or with a jog handle. Before it can be rotated, air is applied to lift the indexer from its clamped position. The message, A UNCLMP (for example) will appear at the bottom of the screen, and remain as long as the rotary indexer is in the up position. When the commanded position is reached, the indexer will automatically move forward or backward to the closest proper locking angle, then settle into its clamped position. The locking angle is computed from the INDEXER INCREMENT parameter which is in units of one-thousandth of a degree. For example, if the A axis INDEXER INCREMENT parameter is set to 1000 (1.0 degrees) and the A axis is jogged to 25.5 degrees, when the operator leaves jog mode, the indexer will automatically settle and clamp itself at 26.0 degrees. If the parameter contains a 1 (one-thousandth of a degree) or less, the rotary indexer feature is turned off and a regular rotary platform is assumed.

645 Y Axis Indexer Increment See Parameter 644

646 Z Axis Indexer Increment See Parameter 644

647 A Axis Indexer Increment See Parameter 644

648 B Axis Indexer Increment See Parameter 644

650 U Axis Indexer Increment See Parameter 644

651 V Axis Indexer Increment See Parameter 644

652 W Axis Indexer Increment See Parameter 644

653 Sp Axis Indexer Increment See Parameter 644

654 Tt Axis Indexer Increment See Parameter 644

659 Indexer Down Timeout Supports the indexer rotary table. It specifies the amount of time (in ms) allowed for seeking the indexer Down-switch. If the switch is not detected within the allowed time, alarm 960 INDEXER SWITCH NOT FOUND IN TIME is generated. When this parameter is set to zero, the feature is bypassed. Note that parameter 69 AIR BRAKE DELAY is used as the allowed time for seeking the Up-switch. If the switch is not detected within the allowed time, alarm 925 A INDEXER IS NOT FULLY IN THE UP POSITION is generated.

680 – 689 LEAD COMPENS SHIFT
These parameters specify the amount of shift needed for proper indexing into the Lead Screw Compensation table. Note that these parameters are very similar to Param 58. The difference is that these parameters hold a non-zero value, they take precedence over the general parameter 58. For example:
Param 58 [LEAD COMPENS SHIFT] = 14 (General Parameter)
Param 683 [A LEAD COMPENS SHIFT] = 12 (axis Parameter A)
Param 684 [B LEAD COMPENS SHIFT] = 0 (axis Parameter B)
In the above example, the A axis will take its lead screw shift value from Parameter 683 since it is a non-zero value, but the B axis will get its shift value from Parameter 58 (NOT from Parameter 684). Determining the appropriate value for lead screw compensation: Example: Assume Steps Per Unit on A is 2800 (Parameter 47)
a) Take steps per unit and multiply by 360 (unscaled).
2800 x 360 = 1008000
b) Apply Enc. scale factor (if present). For example with a scale factor set to 3, we have: (1008000/3) = 336000
c) Determine the smallest number 'n' that will hold the inequality:
336000/(2^n) < 256 => 336000/(2^11) < 256 ; so n = 11
d) Therefore, set Par 683 to 11

671 Indexer Down Settle Supports the indexer rotary table. It specifies the amount of time (in ms) the machine is allowed to settle after detecting the indexer Down-switch. If the parameter is zero, the feature is backward compatible.

704 SMTC2 UNCLAMP POS This parameter supports the high speed tool changer. It specifies the absolute position in degrees *1000 which the TT axis will stop at in order to unclamp the tool.

705 SMTC2 CLAMP POS This parameter supports the high speed tool changer. It specifies the absolute position in degrees *1000 which the TT axis will stop at in order to clamp the tool.

708 Pallet Changer Axis Specifies the mocon channel of the MDC-1 and EC-300 pallet changer. It enables both the servo axis pallet changer and the Super SMTC tool changer to operate on the same machine. On an MDC-1 with a single mocon board, this parameter must be set to 4. On an MDC-1 or EC-300 with two mocon boards, this parameter must be set to 8. On all other machines, this parameter must be set to 0. Note also that when this parameter is set to 4, the B axis parameters are used to control the pallet changer and the message "USE Tt PARAMS" will not be displayed. When this parameter is set to 8, the W axis parameters are used to control the pallet changer.

709 SMTC DR Output Rely Specifies the output relay that should be activated for the tool changer door. Set to 39 for the EC300. Set to 1 for the EC400. Set to 26 for the HS series mills. Set to zero for all other mills without a tool changer door.

710 Tool Changer Type Specifies which type of tool changer is installed on the machine. Note that if this parameter is set to zero, the control will automatically reset it based upon the parameters which previously specified the tool changer type. The following types are recognized:

1 Generic Geneva or umbrella type - This is the default.

2 Horizontal type using W axis

3 Horizontal type using B axis

4 Horizontal type using TT axis

5 Generic Vertical Side Mount Tool Changer (VSMTC)

6 Super2 VSMTC, using TT axis

7 Chain Type

8 Mori Side Mount Tool Changer

9 Manual Tool Changer

711 Pocket Up Settle This parameter supports the vertical mill side mount tool changer. It specifies the amount of time, in 50ths of a second, that the carousel is to wait after a tool change before it is allowed to move. It should be set to 20 on all mills.

715 Color Message Used to change the color of the text messages displayed at the bottom of an LCD monitor. Any value from 0 to 255 can be used. The following are some suggestions:

Black: 0	Brown: 3, 4, 11, 12, 19, 20
Red: 5, 6, 13, 143	Orange: 7, 15, 23
Yellow: 30, 31, 39, 55, 63	Pink: 95, 103, 111, 119, 159, 167, 175, 183
Purple: 67, 75, 77, 83, 140, 141, 198, 215	Blue: 64, 88, 210, 248
Green: 24, 40, 56, 104, 120	

716 Color CMD Position Used to change the color of the positions text displayed on the Current Commands page on an LCD monitor. See color values listed for parameter 715.

717 Color CMD G-Code Used to change the color of the active G and M code text displayed on the Current Commands page on an LCD monitor. See color values listed for parameter 715.

718 Color CMD Axes Load Used to change the color of the axis load text displayed on the Current Commands page on an LCD monitor. See color values listed for parameter 715.

719 Color CMD Bold Text Used to change the color of the large feed and speed text displayed on the Current Commands page on an LCD monitor. See color values listed for parameter 715.

720 Coor Override Used to change the color of the spindle and axis override text displayed on the Current Commands page on an LCD monitor. See color values listed for parameter 715.

721 'RUNNING' RELAY Supports the Machine Data Collection feature which specifies an output relay that will be turned on when the machine is in RUNNING mode. Note that this only works when it is set to 32 or larger and specifies an actual relay, and when parameter 315 bit 26 STATUS RELYS is set to zero. Note also that if SINGLE BLOCK is activated while the machine is running, the relay may not turn off at the end of the current block.

727 APC CHAIN MIN TIME Defines the time to wait BEFORE some switch fault checks are to begin. It should be set to 3000 on all APC mills and zero on all others. The units are milliseconds.

730 PWR FAULT THRESHOLD
731 PWR FAULT MAX TIME
Parameter 730 and 731 support the optional Power Failure Detect Module. Parameter 730 PWR FAULT THRESHOLD units are an analog to digital value. Parameter 731 PWR FAULT MAX TIME units are millisecond/20. If the Power Failure Detection Module is not installed, parameters 730 and 731 should both be set to zero.

733 APC AIR BLAST RELAY
Defines the output relay that turns on the air blast on the EC-300 and MDC-500. Set to 39 for the Mill Drill Center and EC-300, or zero for all other mills

734 INPUT MASK (Used for the Office Mills)

0 TOOL CHANGER IN	16 SPARE
1 TOOL CHANGER OUT	17 SPARE
2 TOOL #1 IN POSITION	18 SPARE
3 LOW TSC PRESSURE	19 SPARE
4 TOOL IN POSITION	20 LOW TRANS OIL PRESS
5 SPINDLE HIGH GEAR	21 APC DOOR
6 SPINDLE LOW GEAR	22 APC PIN CLEAR #1
7 EMERGENCY STOP	23 APC PIN CLEAR #2
8 DOOR/SAFETY SWITCH	24 TOOL UNCLAMP REMOTE
9 M-CODE FINISH	25 SPARE
10 OVERVOLTAGE	26 APC PALLET #2 HOME
11 LOW AIR PRESSURE	27 APC PALLET #1 HOME
12 LOW LUBE PRESSURE	28 GROUND FAULT
13 REGEN. OVERHEAT	29 G31 BLOCK SKIP
14 DRAWBAR OPEN	30 SPIGOT POSITION
15 DRAWBAR CLOSED	31 CONVEYR OVERCURRENT

Ball Screw Compensation

Separate ball screw compensation is provided for each of the **X**, **Y**, and **Z** axes. The operator-entered compensation values are spaced at 0.5 inch intervals within the machine coordinate system. The compensation values are entered in inches with a resolution of 0.0001 inch. The operator entered values are used to interpolate into a table of 256 entries. The spacing between two entries in the table of 256 is defined by Parameter 58. The entered values are limited to +/-127 encoder steps; so the limit in inches is dependent on Parameters 5, 19, and 33.

Note that the first entry corresponds to machine position zero and subsequent entries are for increasingly negative positions in the machine coordinate system. The user should not ever need to adjust the ball screw compensation tables.

Electronic Thermal Compensation

When ballscrews rotate they generate heat. Heat causes the ballscrews to expand. In constant duty cycles, the resultant ball screw growth can lead to cutting errors on the next morning start up. The Haas ETC algorithm can accurately model this heating and cooling effect and electronically expand and contract the screw to give near glass scale accuracy and consistency.

This compensation is based on a model of the lead screw which calculates heating based on the distance traveled and the torque applied to the motor. This compensation does not correct for thermal growth due to changes in ambient temperature or due to part expansion.

Electronic thermal compensation works by estimating the heating of the screw based on the total amount of travel over its length and including the amount of torque applied to the screw. This heat is then turned into a thermal coefficient of expansion and the position of the axis is multiplied by the coefficient to get a correction amount.

If the machine is turned off when there is some compensation applied (due to motion and heating of screw), when the machine is turned back on, the compensation will be adjusted by the clock indicated elapsed time.

Spindle Head Thermal Compensation

This feature integrates spindle speed over time and builds a model of thermal growth. As the model shows the spindle head warming up, the control adjusts the Z axes to compensate for thermal growth.

MAINTENANCE

General Requirements

Operating Temperature Range: 41°F to 104°F (5 to 40°C)
Storage Temperature Range: -4°F to 158°F (-20 to 70°C)
Ambient Humidity: 20% – 95% relative humidity, non-condensing
Altitude: 0-7000 ft.

Electricity Requirements

All Machines Require:

AC input power is three phase Delta or Wye power, except that the power source must be grounded (e.g. leg or center leg for delta, neutral for Wye)
Frequency range of 47-66 Hz
Line voltage that does not fluctuate more than ± 10%
Harmonic distortion not to exceed 10% of the total RMS voltage

20-15 HP System (Standard VF and 10K, EC300, EC400)

	195-260V Voltage Requirements	354-488V High-Voltage Requirements
Power Supply [1]	50 AMP	25 AMP
Haas Circuit Breaker	40 AMP	20 AMP
If service run from elec. panel is less than 100' use:	8 GA. WIRE	12 GA. WIRE
If service run from elec. panel is more than 100' use:	6 GA. WIRE	10 GA. WIRE

40-30 HP System (50 Taper, 40 Taper HT 10K, VF Super Speed, EC-300, EC-400 12K)

	195-260V Voltage Requirements	354-488V High-Voltage Requirements[2]
Power Supply[1]	100 AMP	50 AMP
Haas Circuit Breaker	80 AMP	40 AMP
If service run from elec.panel is less than 100' use:	4 GA. WIRE	8 GA. WIRE
If service run from elec. panel is more than 100' use:	2 GA. WIRE	6 GA. WIRE

40-30 HP System (VS 1/3, HS 3-7 incl R models)

	195-260V Voltage Requirements
Power Supply	125 AMP
Haas Circuit Breaker	100 AMP
If service run from ele.panel is less than 100' use:	2 GA. WIRE
If service run from ele. panel is more than 100' use:	0 GA. WIRE

WARNING!
A separate earth ground wire of the same conductor size as the input power is required to be connected to the chassis of the machine. This ground wire is required for operator safety and for proper operation. This ground must be supplied from the main plant ground at the service entrance, and should be routed in the same conduit as the input power to the machine. A local cold water pipe or ground rod adjacent to the machine cannot be used for this purpose.

Input power to the machine must be grounded. For wye power, the neutral must be grounded. For delta power, a central leg ground or one leg ground should be used. The machine will not function properly on ungrounded power. (This is not a factor with the External 480V Option.)

The rated horsepower of the machine may not be achieved if the imbalance of the incoming voltage is beyond an acceptable limit. The machine may function properly, yet may not deliver the advertised power. This is noticed more often when using phase converters. A phase converter should only be used if all other methods cannot be used.

The maximum leg-to-leg or leg-to-ground voltage should not exceed 260 volts, or 504 volts for high-voltage machines with the Internal High Voltage Option.

[1] The current requirements shown in the table reflect the circuit breaker size internal to the machine. This breaker has an extremely slow trip time. It may be necessary to size the external service breaker up by 20-25%, as indicated by “power supply”, for proper operation.

[2] The high-voltage requirements shown reflect the Internal 400V configuration which is standard on European machines. Domestic and all other users must use the External 480V option.

Air Requirements

The mill requires a minimum of 100 psi at the input to the pressure regulator on the back of the machine. A volume of 4 scfm (9scfm for EC and HS mills) is also necessary. This should be supplied by at least a two-horsepower compressor, with a minimum 20-gallon tank, that turns on when the pressure drops to 100 psi.

NOTE: Add 2 scfm to the above minimum air requirements if the operator will be using the air nozzle during pneumatic operations.

Machine Type	Main Air Regulator	Input Airline Hose Size
EC-300	85 psi	1/2” I.D.
EC-400	85psi	1/2” I.D.
EC-1600	85psi	1/2” I.D.
HS 3/4/6/7 incl R models	85psi.	1/2” I.D.
VF-1 - VF-11 (40Taper)	85psi	3/8” I.D.
VF-5 - VF-11 (50 Taper)	85psi	1/2” I.D.
VR Series	85psi	1/2” I.D.
VS 1/3	85psi	1/2” I.D.

The recommended method of attaching the air hose is to the barb fitting at the back of the machine with a hose clamp. If a quick coupler is desired, use a 1/2" coupler.

NOTE: Excessive oil and water in the air supply will cause the machine to malfunction. The air filter/regulator has an automatic bowl dump that should be empty before starting the machine. This must be checked for proper operation monthly. Also, excessive contaminants in the air line may clog the dump valve and cause oil and/or water to pass into the machine.

NOTE: Auxiliary air connections should be made on the unregulated side of the air filter/regulator.

WARNING!

When the machine is operating and the pressure gauge (on the machine regulator) drops by more than 10 psi during tool changes or pallet changes, insufficient air is being supplied to the machine.

MAINTENANCE SCHEDULE

The following is a list of required regular maintenance for the machining center. Listed are the frequency of service, capacities, and type of fluids required. These required specifications must be followed in order to keep your machine in good working order and protect your warranty.

Interval	Maintenance Performed
Daily	• Check coolant level each eight-hour shift (especially during heavy TSC usage). • Check way lube lubrication tank level. • Clean chips from way covers and bottom pan. • Clean chips from tool changer. • Wipe spindle taper with a clean cloth rag and apply light oil.
Weekly	• Check Through the Spindle Coolant (TSC) filters. Clean or replace element if needed. • Check for proper operation of auto drain on filter regulator. • On machines with the TSC option, clean the chip basket on the coolant tank. Remove the tank cover and remove any sediment inside the tank. Disconnect the coolant pump from the cabinet and **power off** the machine before working on the coolant tank. **Do this MONTHLY for machines without the TSC option.** • Check air gauge/regulator for 85 psi. Check the spindle air pressure regulator for 17 psi. For 15K-spindle machines, check spindle air pressure regulator for 20 psi. • For machines with the TSC option, place a dab of grease on the V-flange of tools. **Do this MONTHLY for machines without the TSC option.** • Clean exterior surfaces with mild cleaner. **DO NOT** use solvents. • Check the hydraulic counterbalance pressure according to the machine's specifications.
Monthly	• Check oil level in gear box. **For 40 taper spindles:** Remove inspection cover beneath spindle head. Add oil slowly from top until oil begins dripping from overflow tube at bottom of sump tank. **For 50 taper spindles:** Check oil level in sight glass. Add from side of gearbox if necessary. • Inspect way covers for proper operation and lubricate with light oil, if necessary. • Place a dab of grease on the outside edge of the guide rails of the tool changer and run through all tools. • **EC-400** Clean the locating pads on the A-axis and the load station. This requires removing the pallet
Six Months	• Replace coolant and thoroughly clean the coolant tank. • Check all hoses and lubrication lines for cracking. • Check the rotary A-axis. If necessary add oil (Mobil SHC-630). The correct oil level is halfway on the sight glass.
Annually	• Replace the gearbox oil. Drain the oil from the bottom of the gearbox. Remove inspection cover beneath spindle head. Add oil slowly from top until oil begins dripping from overflow tube at bottom of sump tank. **For 50 taper spindles**, add oil from the side of the transmission. • Check oil filter and clean out residue at bottom of filter. • Check SMTC oil level in sight glass, (see Side Mount Tool Changer Oil Level in this section).
2 years	• Replace air filter on control box every 2 years. • **EC-400** Replace the Rotary A-axis oil

Periodic Maintenance

A periodic maintenance page is found on the Current Commands screens titled "Scheduled Maintenance" and accessed by pressing Page Up or Page Down to activate and deactivate a series of checks.

An item on the list can be selected by pressing the up and down arrow keys. The selected item is then activated or deactivated by pressing Origin. If an item is active, the remaining hours will be displayed, a deactivated item will display, "—" instead.

The maintenance item time is adjusted by using the left and right arrows. Pressing the Origin key will reinstate the default time.

Items are tracked either by the time accumulated while power is on (ON-TIME) or by cycle-start time (CS-TIME). When the time reaches zero the message "Maintenance Due" is displayed at the bottom of the screen (a negative number of hours indicates the hours past due).

This message is not an alarm and does not interfere with machine operation in any way. After the necessary maintenance has been performed, the operator can select that item on the "Scheduled Maintenance" screen, press the Origin button to deactivate it, then press Origin again to reactivate it with the default number of hours remaining.

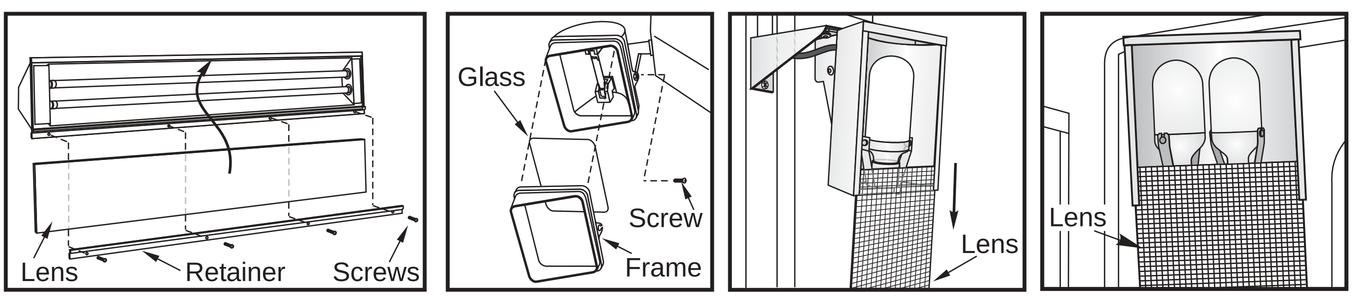
Windows / Guarding

Polycarbonate windows and guarding can be weakened by exposure to cutting liquids and chemicals that contain amines. It is possible to loose up to 10% of the remaining strength annually. If degradation is suspected, window replacement should occur at no more than a two year interval.

Windows and guarding should be replaced if damaged or severely scratched - Replace damaged windows immediately

Worklight

There are threetype of worklights for the Haas mills. Turn off power to the machine at the main breaker before doing any work on the mill.



Chip Auger

During normal operation, most chips are discharged from the machine at the discharge tube. However, very small chips may flow through the drain and collect in the coolant tank strainer. To prevent drain blockage, clean this strainer regularly. Should the drain become clogged and cause coolant to collect in the pan, stop the machine, loosen the chips blocking the drain, and allow the coolant to drain. Empty the coolant tank strainer, then resume operation.

Spindle Air Pressure

Verify Spindle air pressure using the gauge located behind the air regulator panel. VF, VR and VS mills should be set to 17 psi. EC-series and HS Series should be set to 25psi. Adjust if necessary.

15K Spindle

The air pressure for the 15K Spindle is 20 psi. The 15K Spindle requires higher pressure to slightly reduce the amount of oil and speed the delivery of the oil to the bearings.

TSC Maintenance

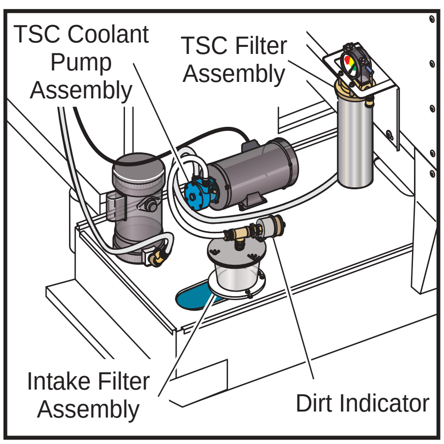
The TSC pump is a precision gear pump and will wear out faster and lose pressure if abrasive particles are present in the coolant.

• Check the dirt indicator on the 100-micron mesh filter with the TSC system running and no tool in the spindle. Change the element when the indicator reaches the zred zone.

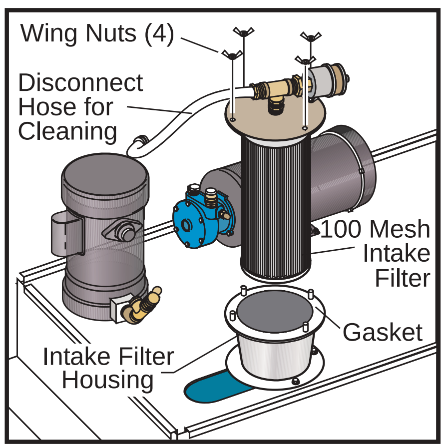
• Clean the pump intake filter when indicator is in the red zone. Reset indicator with button. All intake filters can be cleaned with a wire brush.

• After changing or cleaning filter elements, run TSC system with no tool in spindle for at least one minute to prime system.

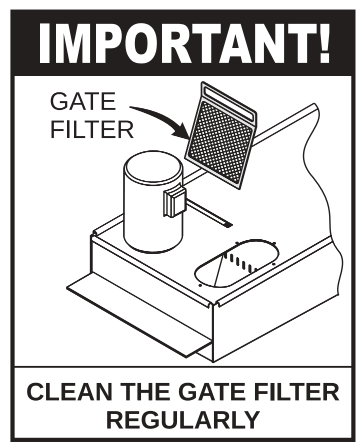
• Coolant will be used more quickly when the TSC system is in use. Make sure to keep the coolant level up and to check the level more frequently (check after every eight hour shift). **Premature wear of the pump can result from running with a low coolant level in the tank**.



TSC Coolant Pump Assembly



Cleaning the Intake Filter



Gate Filter

Warnings

Use of coolants with extremely low lubricity can damage the TSC coolant tip and pump.

Shortened pump life, reduction of pressure and increased maintenance are normal and to be expected in abrasive environments and are not covered by warranty. A special filter, in addition to the standard filter should be used; contact Haas for recommendations.

Machining of ceramics and the like voids all warranty claims for wear and is done entirely at customer's risk. Increased maintenance schedules are absolutely required with abrasive swarf. The coolant must be changed more often and the tank thoroughly cleaned of sediment on the bottom. An auxiliary coolant filter is recommended.

When machining castings, sand from the casting process and the abrasive properties of cast aluminum and cast iron will shorten pump life unless a special filter is used in addition to the 100 mesh suction filter. Contact Haas for recommendations.

Lubrication Chart

System	Lubricant	Quantity
Vertical Mills		
Way lube and pneumatics	Mobile Vactra #2	2-2.5 qts
Transmission	Mobil DTE 25	40Taper 34 oz 50 Taper 51oz
A and B axis (VR-Series)	Mobile SHC 630	A-axis 5qts B-axis 4qts
EC-Series		
Way lube and pneumatics	Mobile Vactra #2	2-2.5 qts
Transmission	Mobil DTE 25	34oz
Rotary Table	Mobil SHC-630	Cover sight glass
HS 3/4/6/7 incl R		
Way lube and pneumatics	Mobile Vactra #2	2-2.5 qts
Transmission	Mobil DTE 25	34oz
Rotary Table	Mobil SHC-630	Cover sight glass

Coolant and Coolant Tank

Machine coolant must be water-soluble, synthetic oil based or synthetic based coolant/lubricant. **Using mineral cutting oils will damage rubber components throughout the machine**.

Do not use pure water as a coolant; machine components will rust. Do not use flammable liquids as coolant.

If the mill is equipped with Through-the-Spindle Coolant (TSC) do not use coolants with extremely low lubricity; these types of coolant can damage the TSC Coolant tip and pump.

The coolant tank must be thoroghly cleaned periodically, especially for mills equipped with TSC.

Coolant Overview

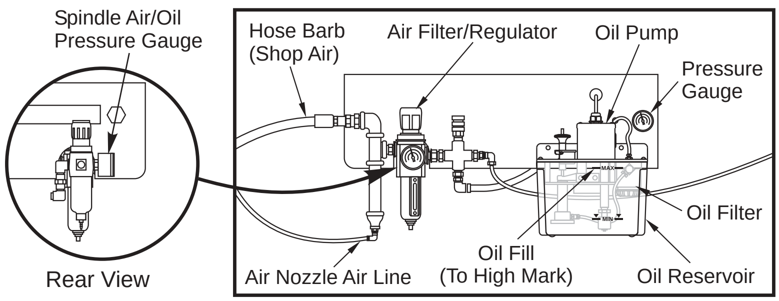
As the machine runs the water will evaporate which will change the concentration of the coolant. Coolant is also carried out with the parts.

A proper coolant mixture is between 6% and 7%. To top-off coolant only more coolant or deionized water should be used. Be sure that the concentration is still within the range. A refractometer can be used to check the concentration.

Coolant should be replaced at regular intervals. A schedule should be set and held to. This will avoid a build up of machine oil. It will also ensure that coolant with the proper concentration and lubricity will be replaced.

Lubrication System

All machine lubrication is supplied by the external lubrication system. Current lube level is visible in the reservoir; Add oil as necessary to maintain proper oil level. **Warning!** Do not add lube above the "high" line marked on the reservoir. Do not allow the lube level to go below the "low" line marked on the reservoir as machine damage could result.



External Lubrication System

Lube Oil Filter

The way lube oil filter element is a 25-micron porous metal filter (94-3059). It is recommended that the filter should be replaced annually or every 2000 hours of machine operation. The filter element is housed in the filter body, which is located **in** the oil pump reservoir (internal filters).

To change the filter element follow these steps:

1. Remove the screws that hold the oil reservoir to the pump body, carefully lower the reservoir and set aside.

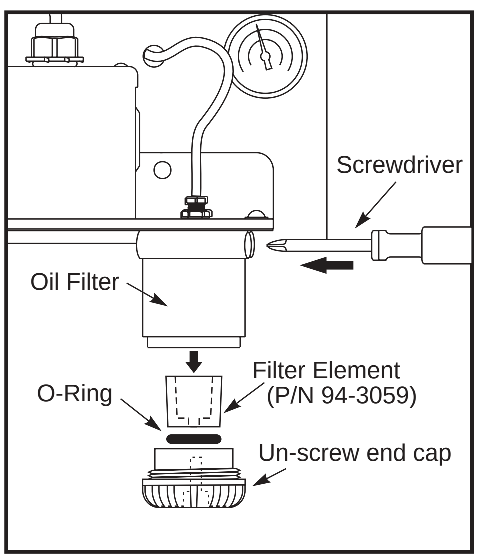
2. Use a strap wrench, pipe wrench or adjustable pliers to unscrew the end cap (see the figure). **Caution:** Use a screwdriver or similar tool to stop the filter from turning while the end cap is removed.

3. Remove the oil filter element from the filter body once the end cap is removed.

4. Clean the inside of the filter housing and the filter end cap as required.

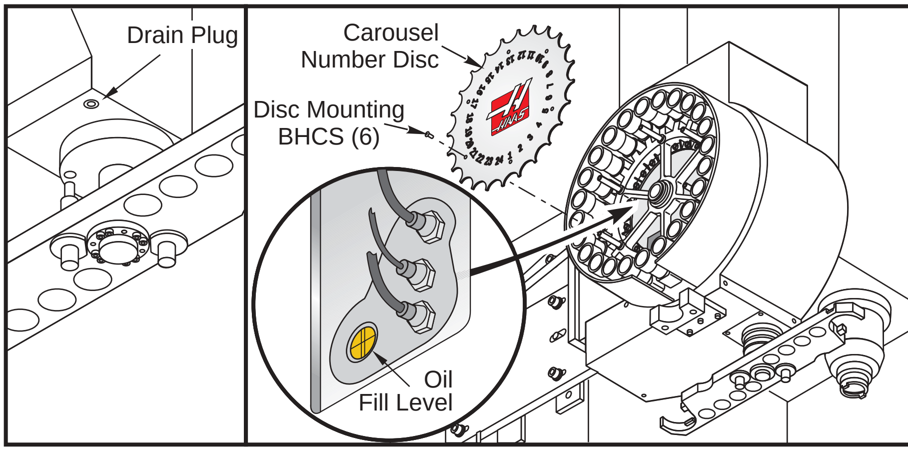
5. Install the new oil filter element (p/n 94-3059), O-ring and the end cap. Use the same tools that were used to remove the filter end cap, to tighten it - Do Not Over Tighten.

6. Replace the oil reservoir; ensure the gasket seats properly between the reservoir and the top flange.

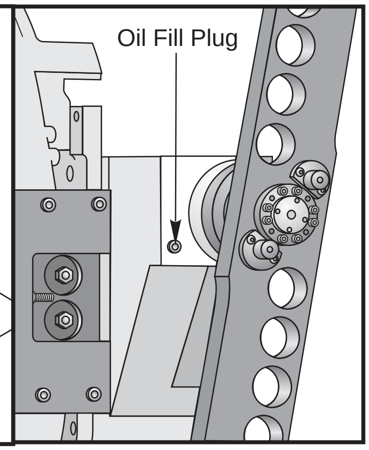


Side Mount Tool Changer Gearbox Oil

Checking the oil level



Vertical Mills



EC-Series Mills

Vertical Mills: View the Oil level sight glass in the location shown. The proper level is half way on the sight glass. If more oil is needed, fill the gear box to the proper level at the oil fill/breather where shown.

EC-Series: Remove the plug and feel for oil with your finger. If no oil is felt, add oil until the oil starts to come out of the oil. Replace plug.

SMTC Oil Types

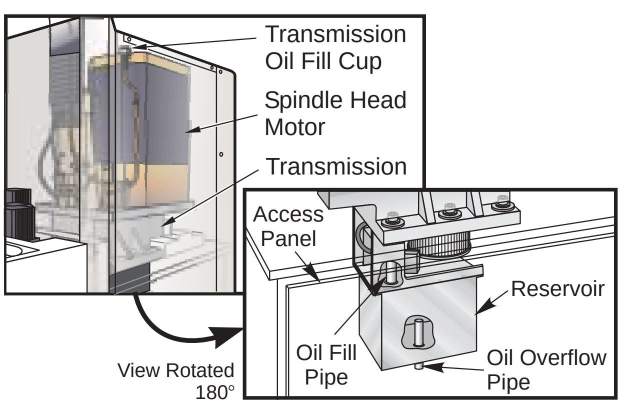
Mobilgear 632 or equivalent, for standard tool changers
Mobil SHC 630 or equivalent, for high speed tool changers

Transmission

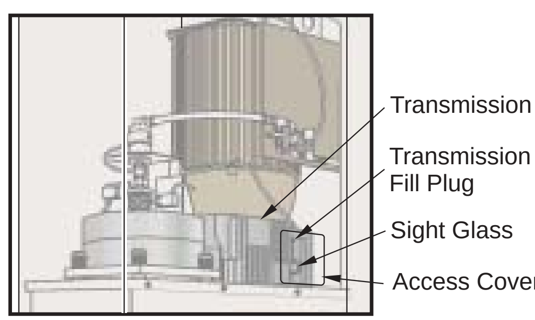
Vertical Mill 40Taper Transmission Oil Replacement

There is no visible indicator for the level of transmission oil in the VF 1-6/40T models.

To add transmission oil, remove the access panel located directly behind the spindle head. This will expose the Transmission Oil Overflow Pipe. Place a container on the table, beneath this outlet. Manually jog the Z axis to its full -Z travel. Power down the machine. Locate the transmission oil fill cup, accessed from the top of the motor housing. There is a cut-out provided in the top of the motor housing sheetmetal for filling. Slowly pour in Mobil DTE 25 oil until oil starts to come out of the overflow pipe; this overflow indicates the reservoir is full. Close the transmission oil fill cup, wipe off the overflow pipe and replace the access cover. Consider any overflow oil to be used and dispose of properly.



VF 1-6 40 Taper



VF 6 through 11 50T

Vertical Mill 50 Taper Oil Level Check

The VF 6 through 11 50T machines provide a means to check the transmission oil level. The transmission oil level sight glass is located behind an access panel secured to the right side of the spindle housing (as viewed from the front; see figure below). To visually check the oil level, remove the 6 BHCS securing the access panel to the spindle housing sheetmetal. Remove the access panel. The transmission oil level sight glass will be visible. The oil level should reach the middle of the sight glass.

If additional oil is necessary, remove the fill port plug located just to the left of the sight glass. Add Mobil DTE 25 oil until the proper level is reached. Replace the fill port bolt and tighten. Securely reattach the access panel.

Oil Change

1. Remove the sheet metal from the spindle head.

2. Remove the encoder and the encoder mounting plate.

3. Remove the oil drain plug. When the oil drains, check the magnet for metal particles.

4. Replace the oil drain plug and fill the gear case with 1¼ liters of Mobil DTE 25 gear oil at the fill cup on top.

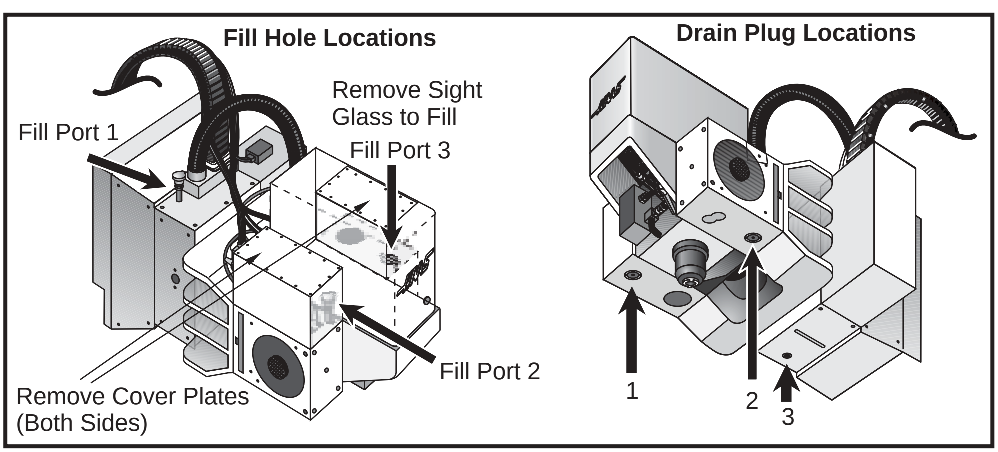
5. Replace the oil overflow plug, put a small amount of thread sealant on the threads. (Do not use loctite) install encoder and insure that the spindle orientation is correct.

6. Install the sheet metal and run a spindle warm up and check for leaks.

VR-Series

The following items must be performed in addition to the regular maintenance items.

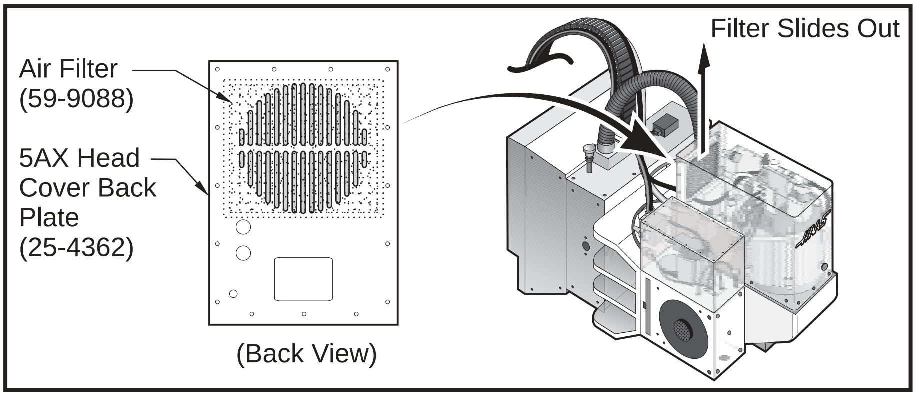
Interval	Maintenance Performed
Monthly	• Grease all pivot points on the tool changer assembly. • Check the oil in the three (3) areas of the head. The A-axis covers need to be removed to access the filler cap and the sight glass. The B-axis filler is on the ouside of the casting. Add Mobil SHC-630 to the fill port at the top of the casting.
Annually	• Replace the oil in the three (3) areas of the head: For the areas on either side of the spindle head (A-axis), remove the drain plug (4 BHCS) and drain the oil. **Note:** Remove the plug closest to the front on the left side of the head, and the plug towards the rear of the right side of the head. Fill the two areas with Mobil SHC-630 as described in the "Monthly" section above. **B-Axis** For the area at the rear of the spindle head, remove the 1/4" NPT pipeplug with an allen wrench and drain the oil. **Note:** The plug is near the center of this rear area. Fill with Mobil SHC-630 as described in the "Monthly" section above.



VR-Series Air Filter

The VR mills are equipped with an air filter (P/N 59-9088) for the motor housing. The recommended replacement interval is monthly, or sooner depending on your machining envrionment.

The air filter is located on the rear of the head cover. To remove the air filter, simply pull up on the filter; the filter will slide upward out of its bracket. To replace the filter, slide in the new air filter, oriented properly to filter air into the motor housing. Filter air-flow direction is determined by a sticker on the replacement filter.



VR-11 Air Filter Location

VR-Series Air Spring Counterballence Replacement

The counterbalance air spring and rod ends should be replaced every two (2) years.

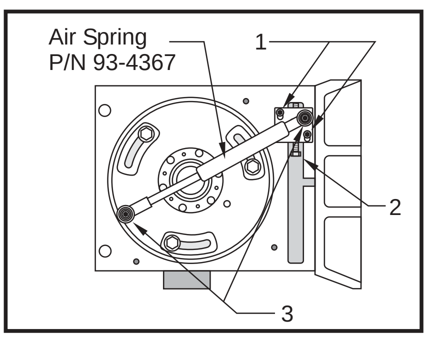
1. Verify that the Axis is at 0 degrees befrore beginning. Press E-stop before doing any disassembly.

2. Remove sheet metal cover and loosen the two 3/8-16 SHCS (1).

3. Back out the 1/4-20 SHCS (2), and tighten the two 3/8-16 SHCS (1) this will keep the preload cam secure while the next step is accomplished.

4. Remove 3/8-16 SHCS that mount Air Spring and Rod Ends (3).

5. Tighten the rod ends onto the Air Spring and secure the Air Spring using the two 3/8-16 SHCS removed in step 4.

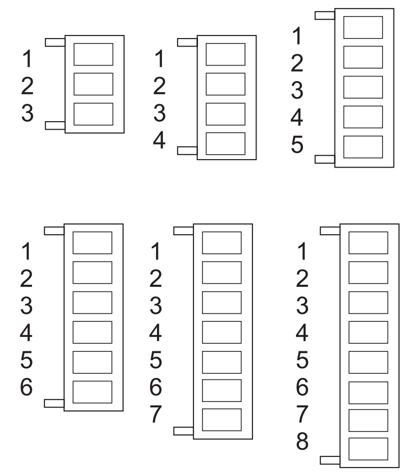


6. Slightly loosen the 3/8-16 SHCS (1). Screw in the 1/4-20 SHCS to force preload cam counterbalance down (This will push the air spring inward). Tighten this adjusting bolt until the slots in the cam have contacted the tops of the mounting bolts. Tightening the two 3/8-16 SHCS (1), these will hold the preload cam in place.

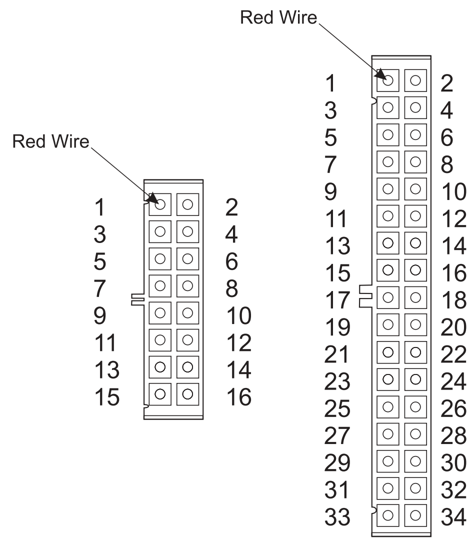
7. Replace the sheet metal, reset the E-stop and clear the alarms.

8. PCBs, CABLE LOCATIONS AND BOARD DIAGRAMS

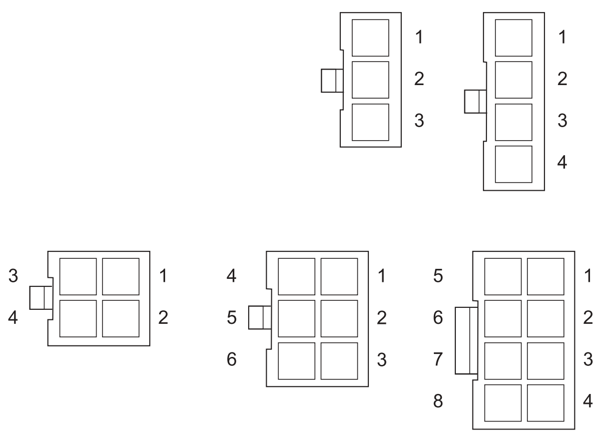
Shown below are three types of commonly used cable connectors. **They are shown as seen when plugged into the pc board.** These diagrams are to aid in locating the pins for trouble shooting.



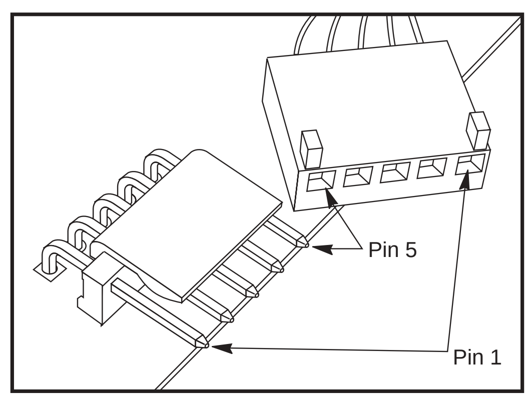
Friction Lock



Ribbon Cables



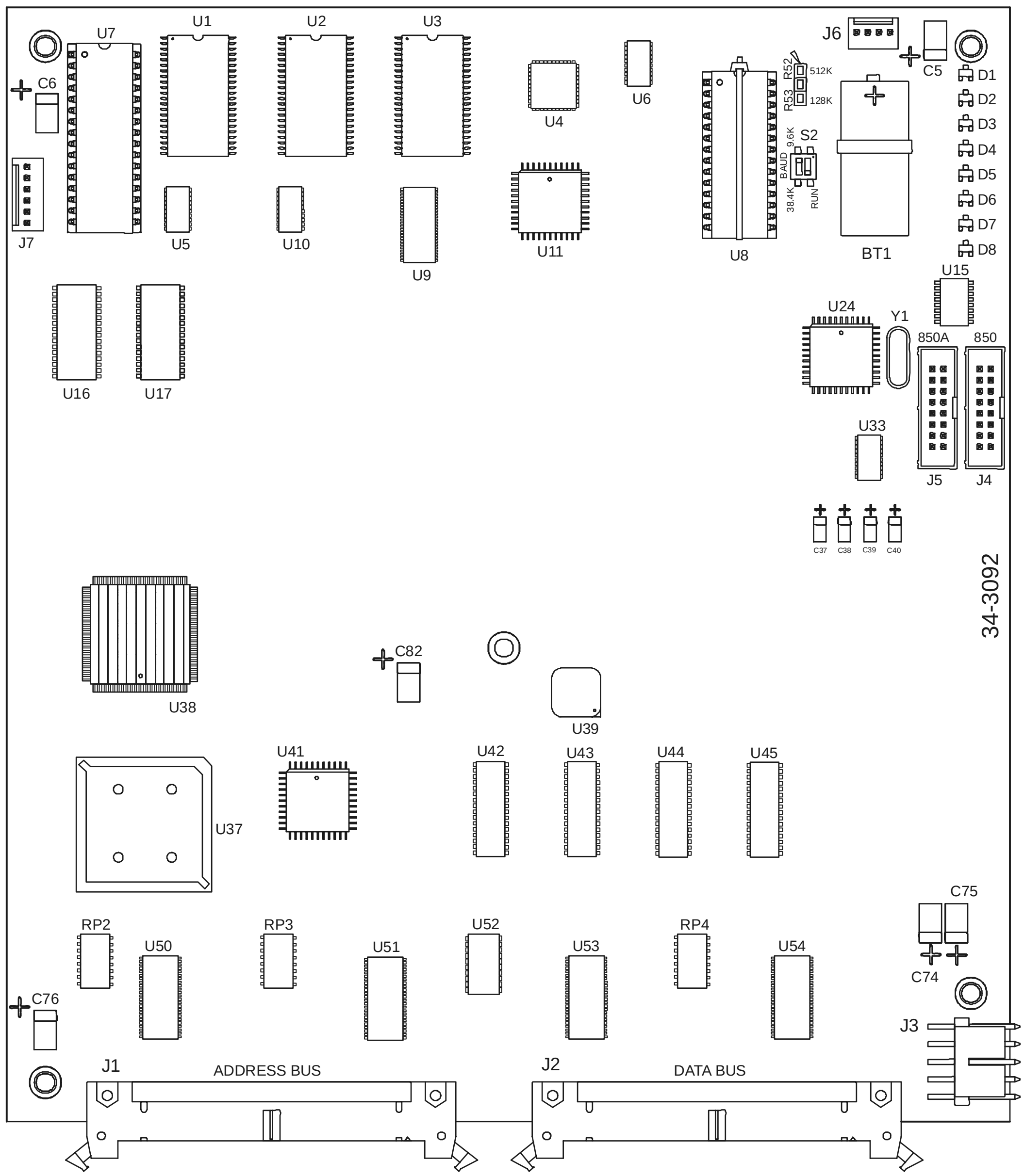
Mini Fit



Connection example

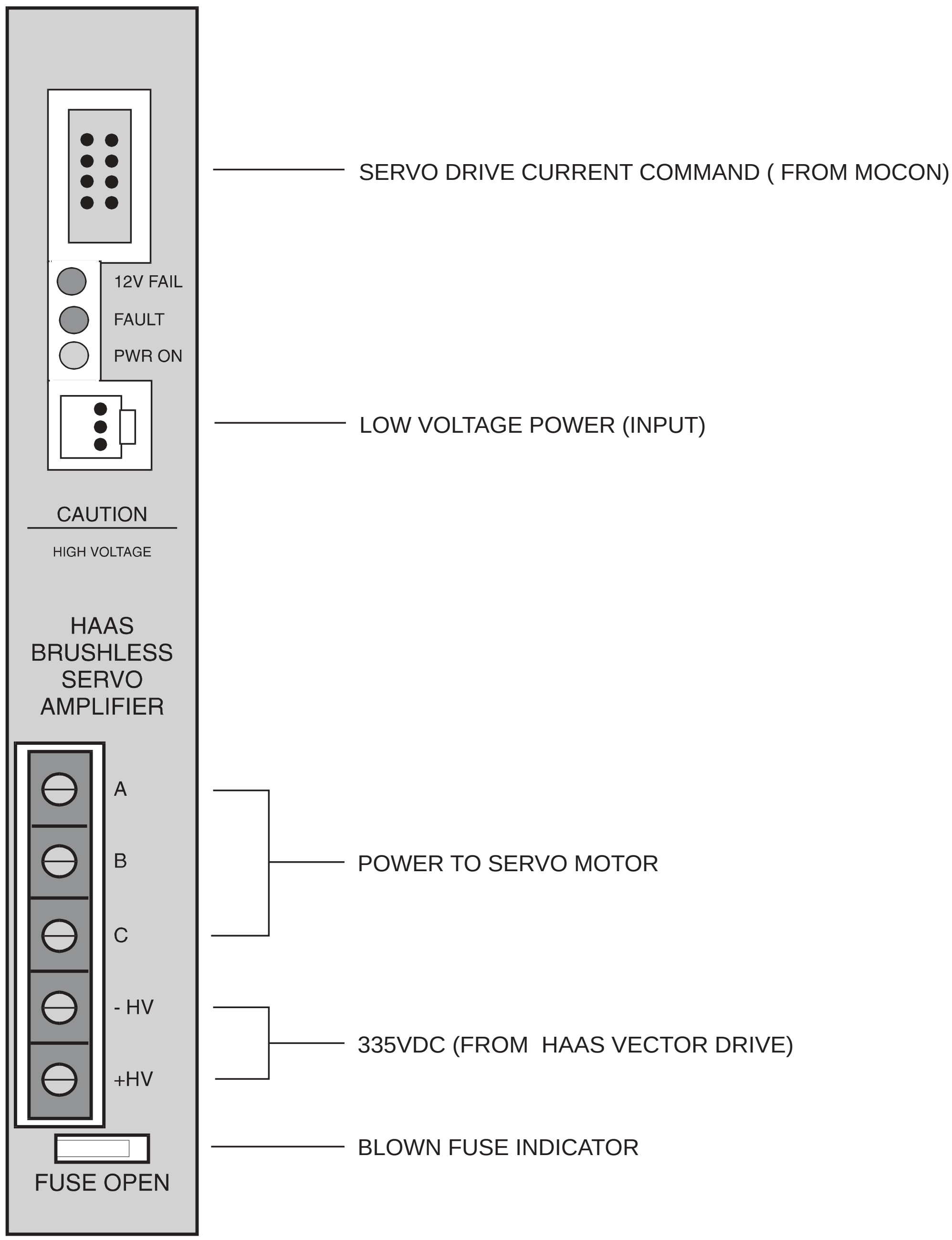
Note:The numbering sequence is the same regardless of the number of pins.

MICRO PROCESSOR PCB



PROC. PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨	LOCATION	PLUG #
J1 ADDRESS		ADDRESS BUSS		VIDEO-MOCON-MOTIF	____
J2 DATA		DATA BUSS		VIDEO-MOCON-MOTIF	____
J3	860	LOW VOLTAGE		<FROM>POWER SUPPLY PCB	____
J4 PORT 1	850	SERIAL PORT #1		KEYBOARD INT.	____
J5 PORT 2	850A	SERIAL PORT #2 AUX PORT		AUX SERIAL PORT	____

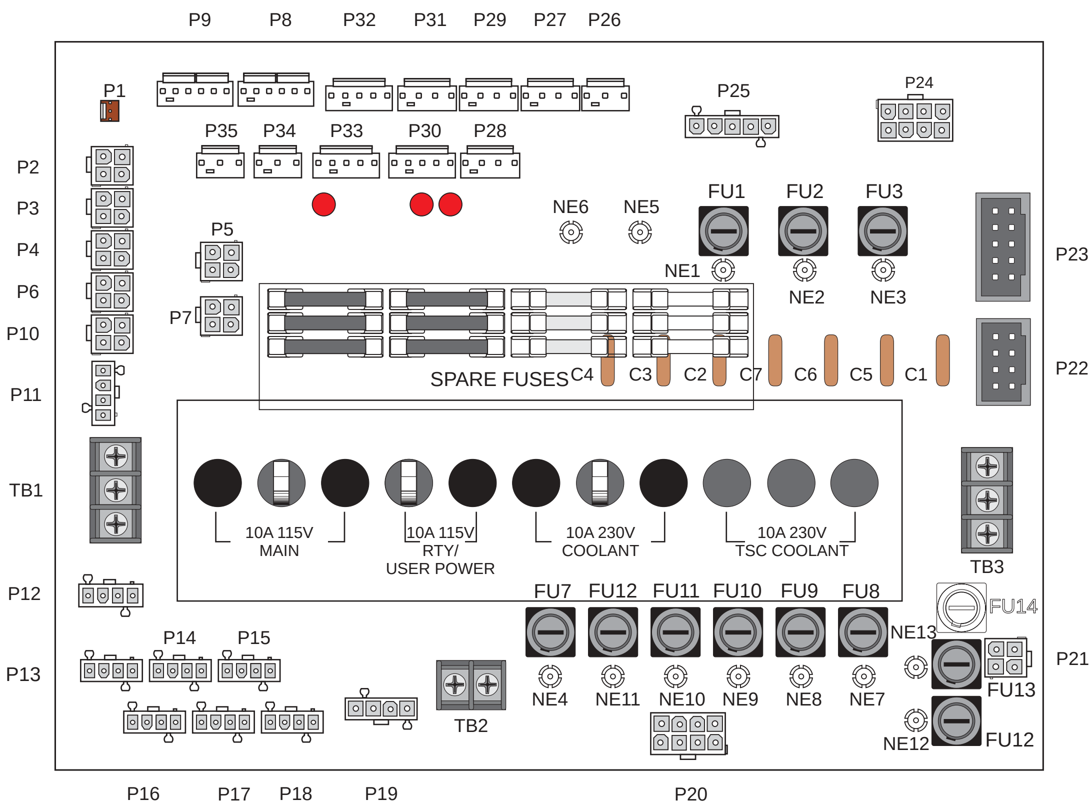
BRUSHLESS SERVO AMPLIFIER



BRUSHLESS SERVO AMPLIFIER CABLE CONNECTIONS

MOCON PLUG #	CABLE #	SIGNAL NAME ⇨ TO ⇨	LOCATION	PLUG #
X AXIS AMP				
P	570	LOW VOLTAGE	L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE	X SERVO MOTOR	——
P	610	X DRIVE SIGNAL	MOCON PCB	P2
TB -HV +HV	——	335VDC	SPINDLE DRIVE	——
Y AXIS AMP				
P	580	LOW VOLTAGE	L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE	Y SERVO MOTOR	——
P	620	Y DRIVE SIGNAL	MOCON PCB	P3
TB -HV +HV	——	335VDC	SPINDLE DRIVE	——
Z AXIS AMP				
P	590	LOW VOLTAGE	L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE	Z SERVO MOTOR	——
P	630	Z DRIVE SIGNAL	MOCON PCB	P4
TB -HV +HV	——	335VDC	SPINDLE DRIVE	——
A AXIS AMP				
P	600	LOW VOLTAGE	L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE	A SERVO MOTOR	——
P	640	A DRIVE SIGNAL	MOCON PCB	P5
TB -HV +HV	——	335VDC	SPINDLE DRIVE	——

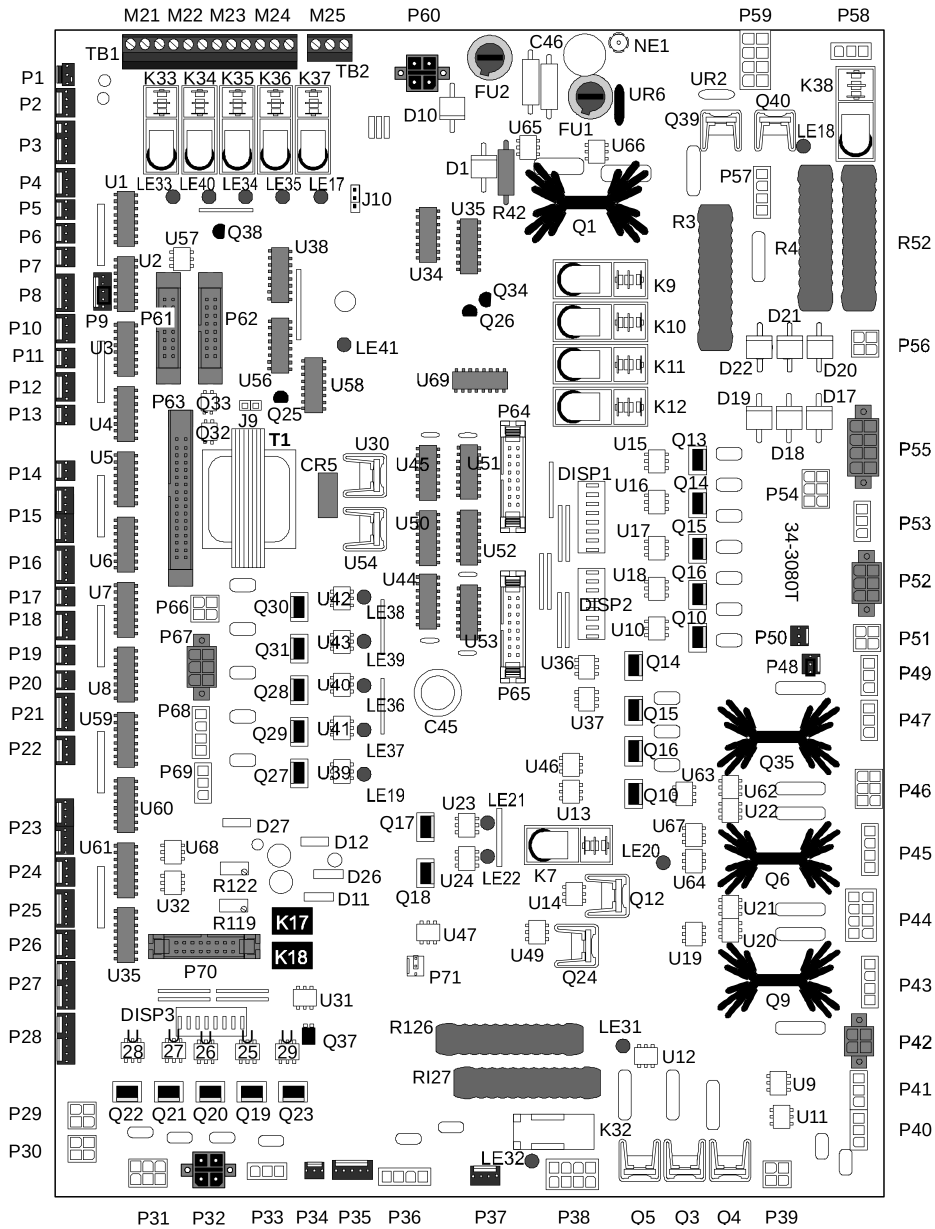
POWER PCB



P9
P8
P32
P31
P29
P27
P26
P1
P25
P24
P35
P34
P33
P30
P28
P2
P3
P4
P6
P10
P11
P5
P7
NE6
NE5
FU1
FU2
FU3
NE1
NE2
NE3
P23
P22
SPARE FUSES
C4
C3
C2
C7
C6
C5
C1
TB1
10A 115V
MAIN
10A 115V
RTY/
USER POWER
10A 230V
COOLANT
10A 230V
TSC COOLANT
TB3
P12
FU7
FU12
FU11
FU10
FU9
FU8
FU14
NE13
P21
P13
P14
P15
FU13
NE4
NE11
NE10
NE9
NE8
NE7
TB2
NE12
FU12
P16
P17
P18
P19
P20

POWER PCB
CABLE CONNECTIONS

PLUG #	CABLE #	SIGNAL NAME ⇨ TO ⇨	LOCATION	PLUG#
P1		+12VDC	CNC Unit Fan	
P2	90B	115VAC	Low Voltage Power Supply	
P3	90B	115VAC	Probe PS	
P4	90B	115VAC	Work Light	
P5	90B	115VAC	Switch Door Fan	
P6	90B	115VAC	Servo Fan	
P7	90B	115VAC	Delta-Wye	
P8	860	+12/-12/+5 VDC In	From Low Voltage Power Supply	
P9	860	+12/-12/+5 VDC In	From Low Voltage Power Supply	
P10	90B	115VAC	Door Fan	
P11	90B	115VAC	Monitor	
P12	90C	115VAC	Regen Fan	
P13	90C	115VAC	SMTC PCB	P4
P14	90C	115VAC	spare	
P15	90C	115VAC	spare	
P16	90C	115VAC	spare	
P17	90C	115VAC	Trans PCB	P2
P18	90C	115VAC	spare	
P19	90	3PH 115VAC	IO PCB	P56
P20	930	230V CLNT/TSC	IO PCB	P44
P21	160	Chip Conv. 230V 3PH	IO PCB	P39
P23	170	Auto Off/Contactor	Contactor K1/IO PCB	P42
P22	740	On/Off	Front Panel	
P24		Prim/Sec	To T5	
P25	71, 72, 73	Overvolt Protection	From Contactor K1	
P26	860	+12VDC	SKBIF	
P27	860	+12/+5 VDC	IO PCB	P60
P28	860	+12/+5 VDC	Motif PCB	P15
P29	860	+12/+5 VDC	Processor PCB	J3
P30	860	+12/-12/+5 VDC	spare	
P31	860	+12/+5 VDC	Video PCB	P1
P32	860	+12/-12/+5 VDC	Mocon 1 PCB	P15
P33	860	+12/-12/+5 VDC	Mocon 2 PCB	P15
P34	860	+12 VDC	SMTC PCB	P2
P35	860	+12 VDC	MCD Relay PCB	P2
TB1	94, 95, 96	115VAC	From Transformer	
TB2	90A	115 VAC Out	Barfeeder / T/C PCBA	P8
TB3	77, 78, 79	3PH 230V In	From Transformer	



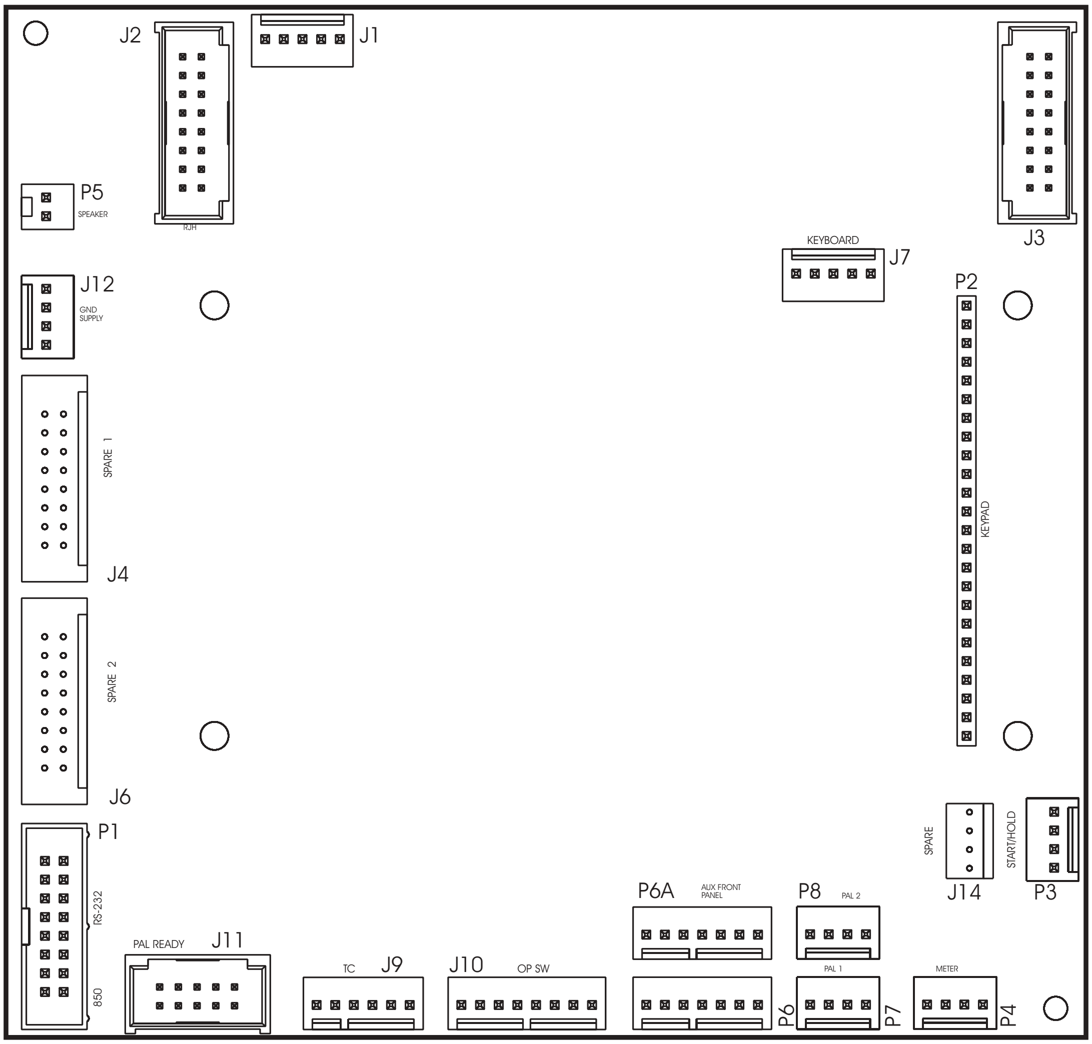
I/O PCB CABLE CONNECTIONS

I/O PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1	140B		Chip Conveyor VB1/Gantry	
P2	820B		TC in/SMTC Pkt down	
P3	820		TC out/SMTC pkt up/Tool #1/TC mark	
P4	900		Low TSC press	
P5	770		E-Stop Front Panel	
P6	770A		E-Stop Sw B	
P7	770B		E-Stop SW C	
P8	1050		Door Open A	
P9	1050A		Door Open B	
P10	100		M-Fin	
P11	970		VD Over Volt	VD J1
P12	950		Low Air/Low Oil/VB low chill pressure	
P13	960		Low Lube	
P14	830		Regen Overheat	
P15	890		SPDB Open/Closed	
P16	780		2nd VD OV/contactor On / counterbalance	

I/O PCB CABLE CONNECTIONS

I/O PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P17	410		APC Door Open , VB Clamshell	
P18	790		APC Pin Clear - door open/closed	
P19	190		Remote Unclamp SW / Low phase	
P20	190A		Not Used	
P21	240		Spare APC Pallet Home / Grnd fault/ pal up,dwn	
P22	1070		Skip	M22
P23	420		APC #2 pin clr / pal home	
P24	440		Auto Door Open / Spare	
P25	450		APC #2 door open	
P26	460		APC #2 door closed	
P27	470		SMTC mtr stop / SMTC origin/ /smtc cl uncl	
P28	480		Spare APC door closed/Open / APC pal clamped	
P29	1040A		CE DoorLK	
P30	1040		CE Door LK	
P31	230		5th Axis Brake	
P32	250		APC Door open, VR Shut In	
P33	270		TSC Purge	
P34	260		APC Pal Ready Lt	
P35	200		Spigot CW/CCW	
P36	280		Beacon	
P37	140A		Chip Conv Enable	
P38	140		Chip Conv Reverse	
P39	160		Chip Conv Power Input	PSUP P21
P40	300		250V Oil Pump/Luber	
P41	300A		SP Fan/Oil Pump	
P42	170		Auto Off	PSUP P23
P43	940		Coolant Output	
P44	930		250V TSC/Cool Input Power	PSUP P20
P45	940A		TSC Coolant	TSC Cool. Out.
P46	390		4th Axis Brake	
P47	350		Axis Brake	Trans P6
P48	120		Coolant Over Temp	
P49	350A		Hyd En	Trans P4
P50	130		TSC Over Temp	
P51	430		APC Pallet Clamp	
P52	710		APC #1 pal ready #1,2	
P53	880C		Wye-Delta Switch	
P54	880B		High/Low Gear	
P55	880A		Tool unclamp precharge	
P56	90		115V IOPCB Input Pwr(AC)	PSUP P19
P57			TC Jumper or SMTC Resistor	
P58	810A		T.C. in/smtc ATC fwd / APC chn drv en/rev	
P59	810		T.C. CW/ SMTC CRSL CW	
P60	860A		+5/+12V Logic Pwr (IOPCB)	PSUP P27
P61	540		Outputs Cable 24-55	MOCON P14
P62	540A		Outputs Cbl For MCD Relay	MCD Relay P1
P63	550		Inputs Cable	MOCON P10
P64	520		Outputs Cable 8-15	MOCON P12
P65	510		Outputs Cable 0-7	MOCON P11
P66	M27		Air Blast	
P67	M28		APC Beeper	
P68	310		Auto Door open	
P69	220		Pocket Up/Down,VR Shuttle Out, VB Clamshell	
P70	530		Outputs Cable 16-23	MOCON P13
TB1	M21-24		Probe, M-Fin, User Spare	
TB2	M25		User Spare	

SERIAL KEYBOARD INTERFACE PCB WITH HANDLE JOG

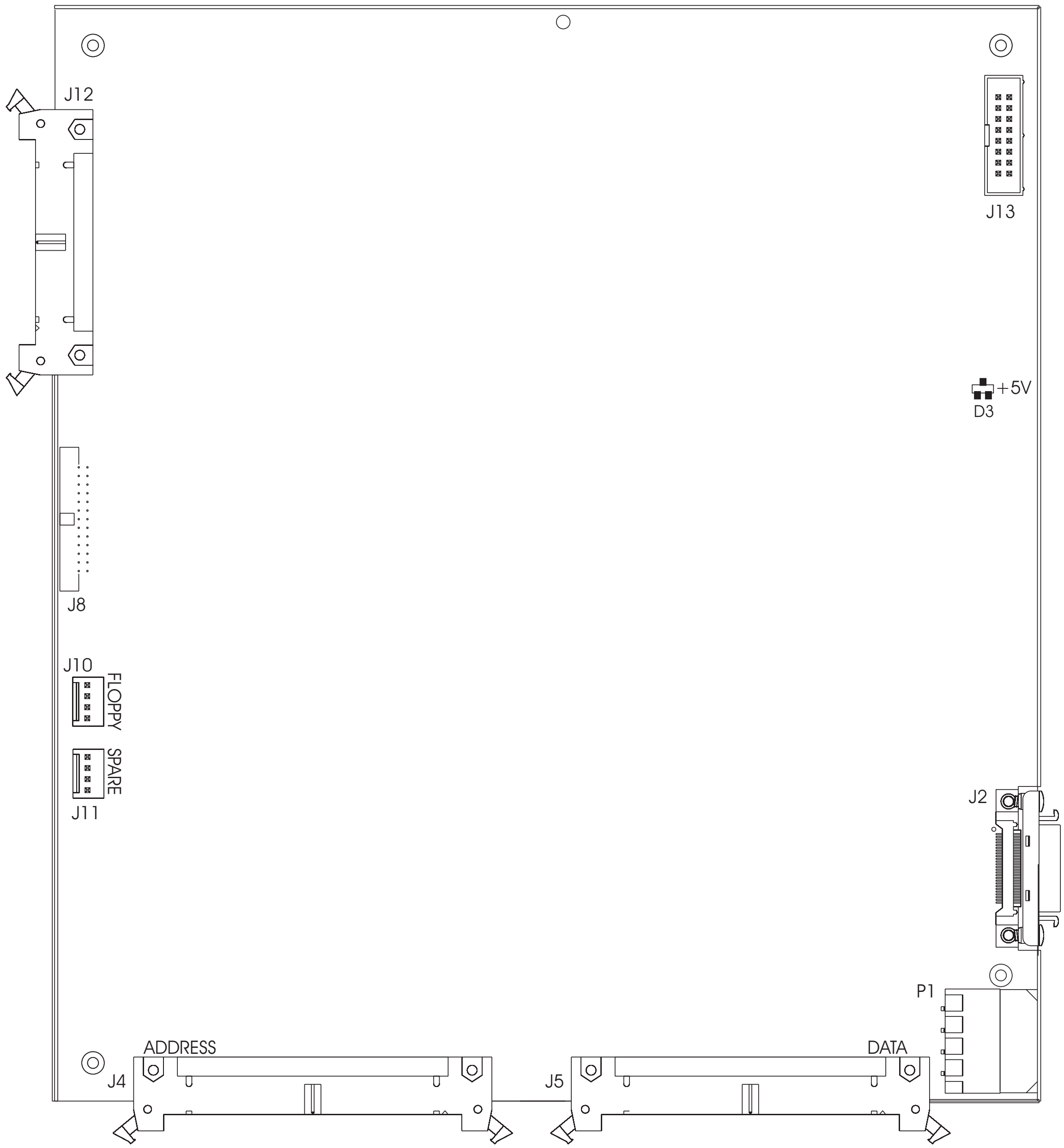


SERIAL KEYBOARD INTERFACE PCB WITH HANDLE JOG CABLE CONNECTIONS

PLUG#	CABLE#	⇨ TO ⇨	LOCATION	PLUG#
P1	700B		PROCESSOR	850
P2	——-		KEYPAD	——-
P3	700A		CYCLE START/ HOLD SWITCHES	——-
P4	730		SP LOAD METER	——-
P5	——-			——-
P6	——-		AUX FPANEL	——-
J1	——-			——-
J2	——-		REMOTE JOG HANDLE	——-
J3	750		MOCON	P18
J5	——-		(MIKRON ONLY)	——-
J7	——-		EXTERNAL KEYBOARD	——-
J12	860C		FT. PANEL FAN	——-

* See "Keyboard Diagnostic" section of this manual for Troubleshooting information.

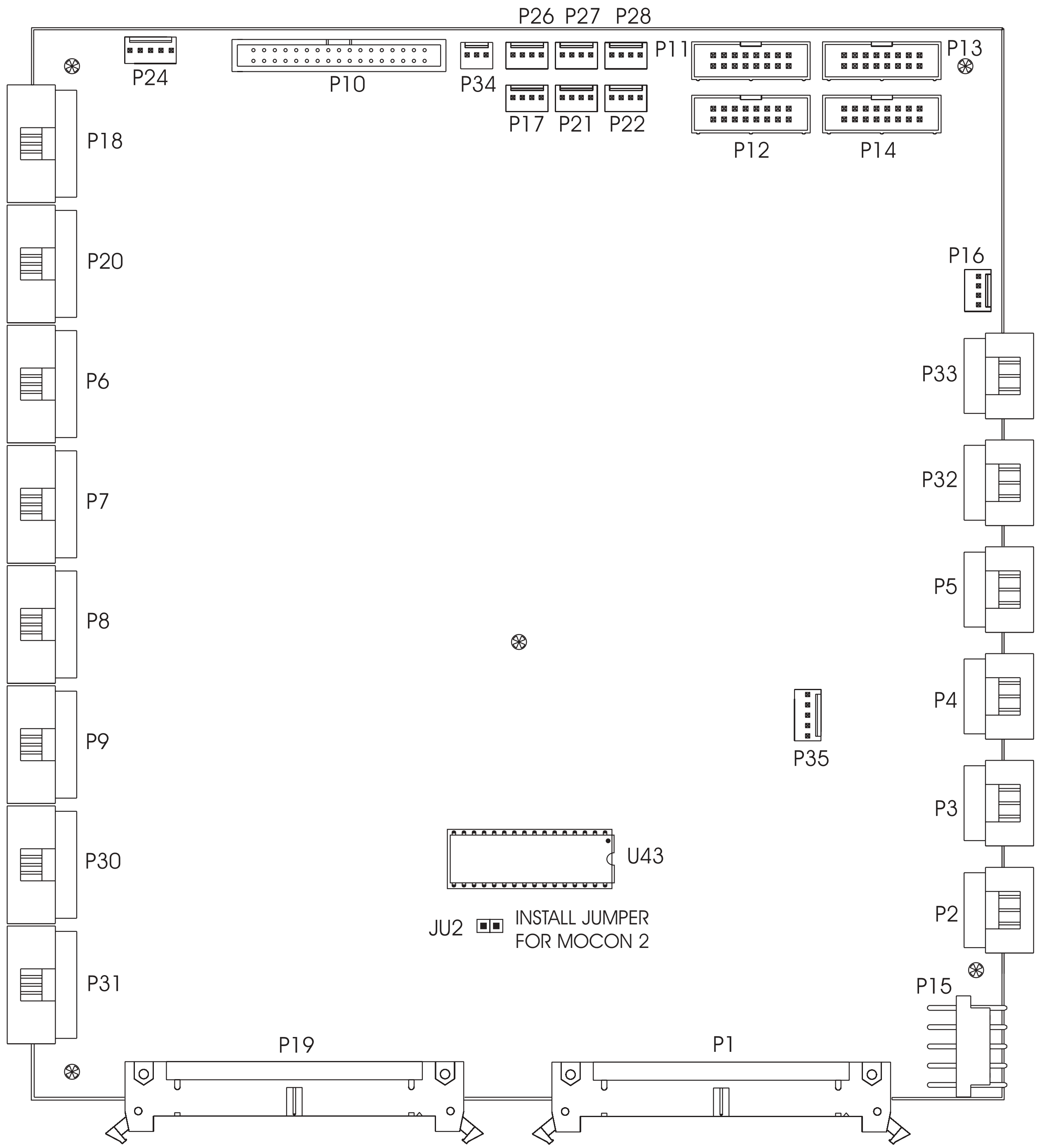
VIDEO & KEYBOARD PCB W/ FLOPPY DRIVE



VIDEO PLUG #	CABLE #	SIGNAL NAME ⇨	TO ⇨	LOCATION	PLUG #
P1	860	LOW VOLTAGE		POWER SUPPLY PCB	——
J2	____	VIDEO SIGNAL		LCD	____
J4	____	ADDRESS BUSS		MICRO PROC.PCB	____
J5	____	DATA BUSS		MOTIF PCB	____
J10	____	FLOPPY DR. POWER		FLOPPY DRIVE	____
J11	____	SPARE		N/A	N/A
J12	____	FLOPPY DR. SIGNAL		FLOPPY DRIVE	____
J13	850	SERIAL DATA		N/A	J1

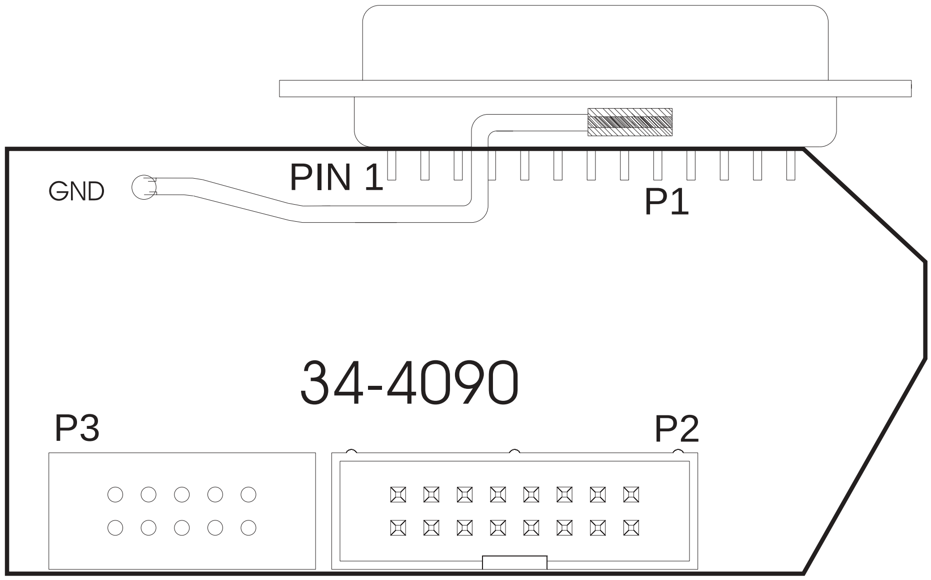
* Not used with Serial Keyboard Interface

MOCON PCB


P26 P27 P28
P11
P13
P24
P10
P34
P17 P21 P22
P12
P14
P18
P20
P16
P6
P33
P7
P32
P5
P8
P4
P9
P35
P3
P30
U43
P2
JU2
INSTALL JUMPER
FOR MOCON 2
P31
P15
P19
P1

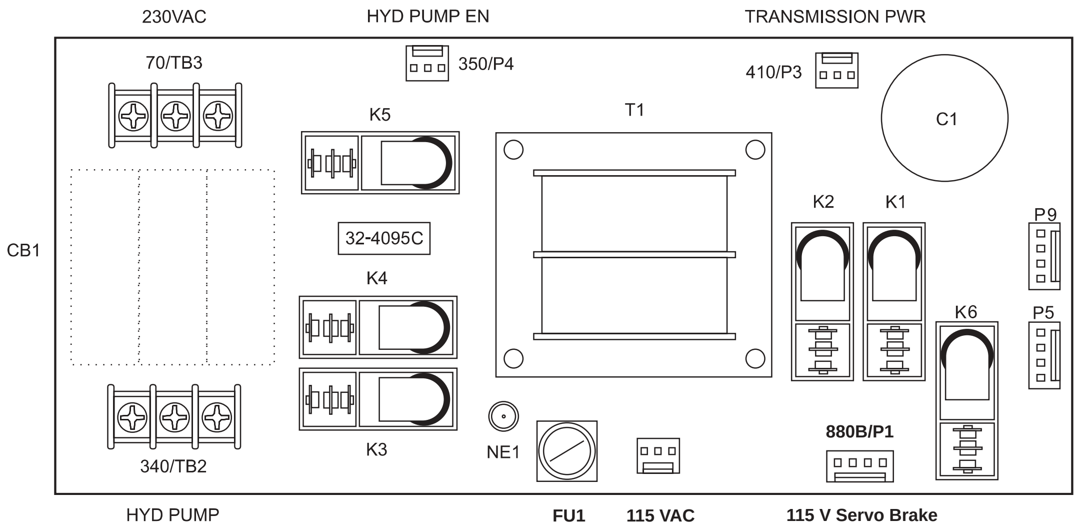
MOCON PCB
CABLE CONNECTIONS

MOCON PLUG #	CABLE #	SIGNAL NAME ⇨ TO ⇨	LOCATION	PLUG #
P1	——	DATA BUSS	VIDEO PCB	——
			MICRO PROC. PCB	——
P2	610	X DRIVE SIGNAL	X SERVO DRIVE AMP.	P
P3	620	Y DRIVE SIGNAL	Y SERVO DRIVE AMP.	P
P4	630	Z DRIVE SIGNAL	Z SERVO DRIVE AMP.	P
P5	640	A DRIVE SIGNAL	A SERVO DRIVE AMP.	P
P32	640B	B DRIVE SIGNAL	B SERVO DRIVE AMP.	P
P6	660	X ENCODER INPUT	X ENCODER	——
P7	670	Y ENCODER INPUT	Y ENCODER	——
P8	680	Z ENCODER INPUT	Z ENCODER	——
P9	690	A ENCODER INPUT	A ENCODER	——
P30	690B	B ENCODER INPUT	B ENCODER	——
P10	550	MOTIF INPUTS/		
		I/O OUTPUTS	I/O PCB	P63
P11	510	I/O RELAYS 1-8 I/O	I/O PCB	P65
P12	520	I/O RELAYS 9-16	I/O PCB	P64
P13	530	I/O RELAYS 17-24	I/O PCB	P70
P14	540	I/O RELAYS 25-32	I/O PCB	P61
P15	860	LOW VOLTAGE	POWER SUPPLY PCB	——
P16	720	SP. LOAD METER	LOAD METER	——
P17	980	VOLTAGE MONITOR	N/A	N/A
P18	750	JOG ENCODER INPUT	JOG HANDLE	——
P19		ADDRESS BUSS	VIDEO PCB	——
			MICRO PROC. PCB	——
P20	1000	SP. ENCODER INPUT	SPINDLE ENCODER	——
P21		X-AXIS TEMP SENSOR		
P22	730B	SP. DRIVE LOAD	SPINDLE DRIVE	——
P24	990	HOME SENSORS	X, Y & Z LIMIT	——
P26		Y-AXIS TEMP SENSOR		
P27		Z-AXIS TEMP SENSOR		
P31	690C	C-AXIS ENCODER INPUT	SPINDLE MOTOR (lathe)	
P33	640C	VCTR DR CUR. CMD.	VECTOR DRIVE	J3



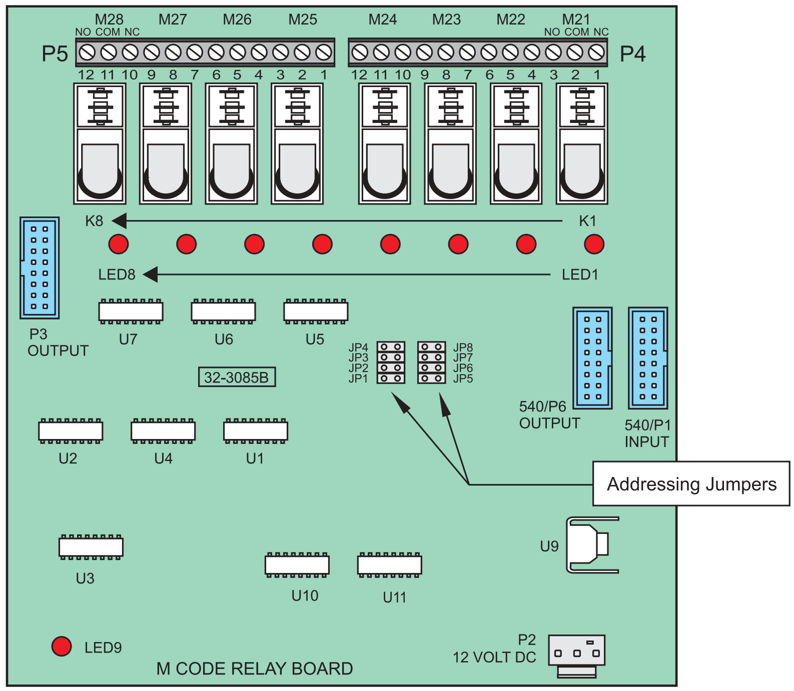
RS-232 PORT #1 PCB
CABLE CONNECTIONS

PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1 INTERNAL EXTERNAL	850		VIDEO & KEYBOARD	J13



50T TRANSMISSION P.S. / HYDRAULIC C.B. PCB CABLE CONNECTIONS

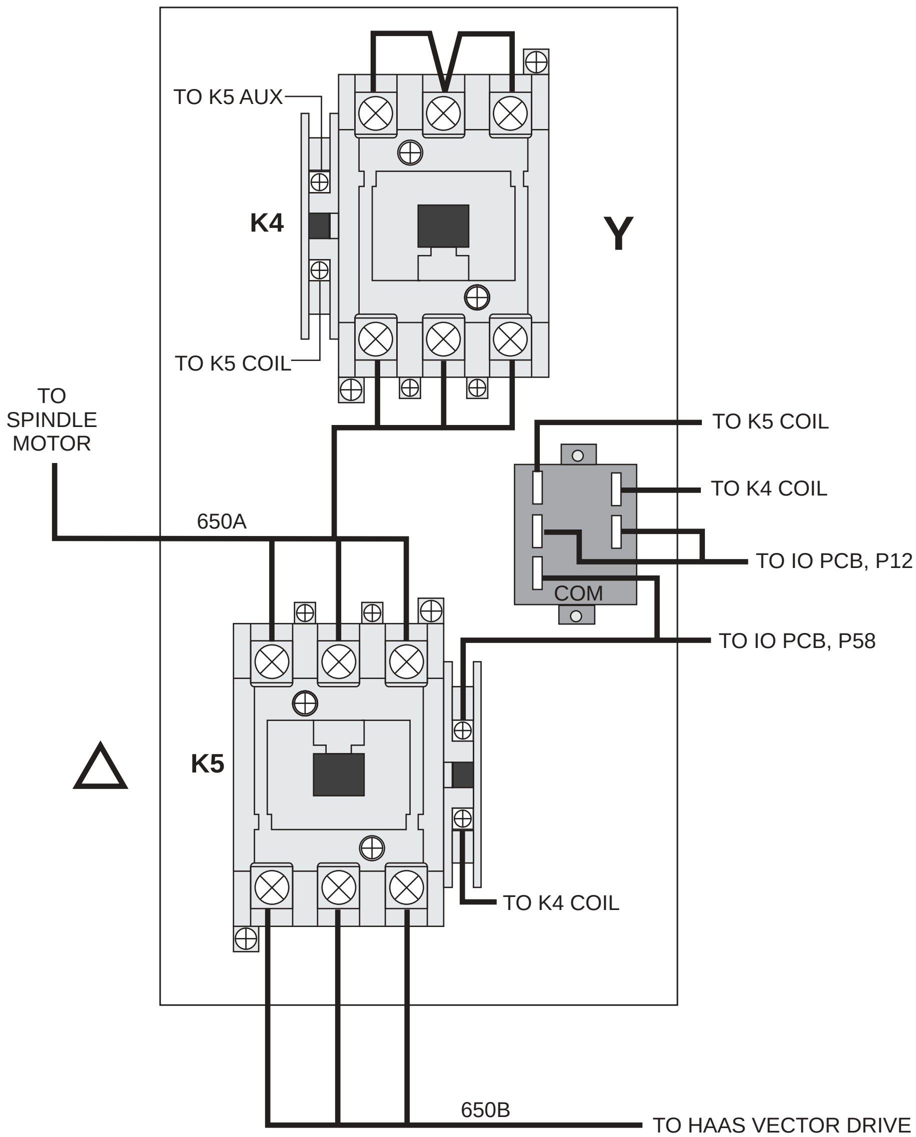
PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1	880B		IO PCB	P12
P2	90		POWER PCB	P8
P3	410		GEAR BOX	
P4	350		IO PCB	P54
TB2	340		HYDRAULIC MTR	
TB3	70		MAIN TRANSFORMER (VECTOR DRIVE UNIT)	



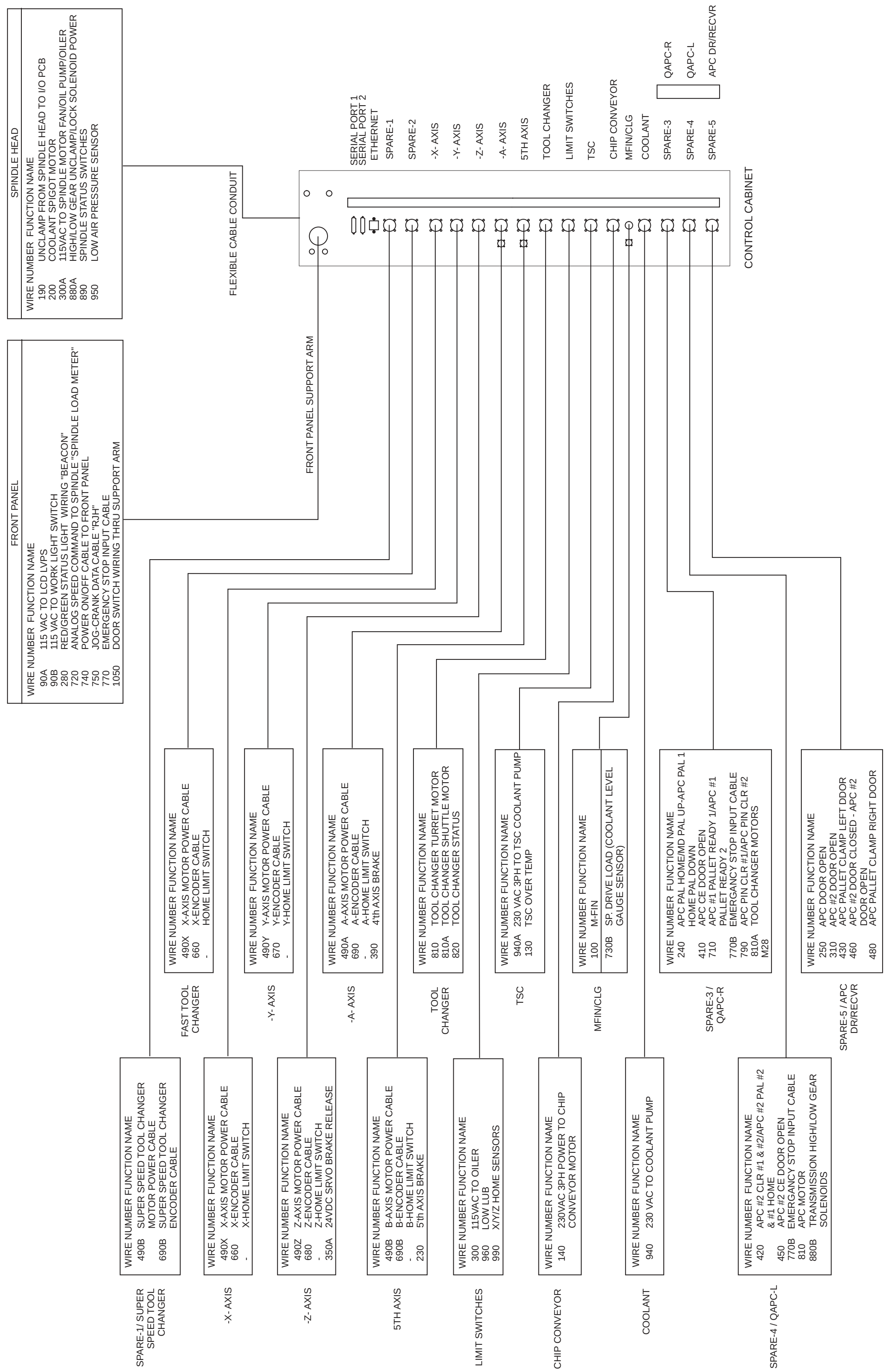
M CODE RELAY BOARD
CABLE CONNECTIONS

PLUG #	CABLE #	SIGNAL NAME ⇨ TO ⇨	LOCATION	PLUG #
P1	540	MOCON INPUT	IO PCB`	P62
P2	860A	12VD TO M-CODE PCBA	PSUP	P31
P3	540A	IOPCB OUTPUT		
P4	M21	M-FUNCTION		
	M22	PROBE OPTION		
	M24	spare		
P5	M25	spare		
	M26	spare		
	M27	spare		
P6	540B	M CODE OUTPUT	2nd MCD	P1

Y-DELTA SWITCH ASSEMBLY
P/N 32-5851B (40T 10HP)
P/N 32-5864A (SUPER SPEED AND 50T)



CABLE LOCATION DIAGRAM



9. CABLE LIST

WIRE/ TERMINAL NUMBER	FUNCTION NAME:
	INCOMING POWER 195-260 VAC (353-488 VAC OPTIONAL)
L1	INCOMING 195-260VAC, PHASE 1, TO CB1-1
L2	INCOMING 195-260VAC, PHASE 2, TO CB1-2
L3	INCOMING 195-260VAC, PHASE 3, TO CB1-3
71	PROTECTED 195-260 VAC FROM MAIN CB1-4 TO K1-1
72	PROTECTED 195-260 VAC FROM MAIN CB1-5 TO K1-2
73	PROTECTED 195-260 VAC FROM MAIN CB1-6 TO K1-3
74	195-260 VAC FROM K1-4 TO XFORMER T1
75	195-260 VAC FROM K1-5 TO XFORMER T1
76	195-260 VAC FROM K1-6 TO XFORMER T1
77	230VAC PHASE 1 , FROM XFORMER T1 TO VECTOR / CHIP CONV
78	230VAC PHASE 2 , FROM XFORMER T1 TO VECTOR / CHIP CONV
79	230VAC PHASE 3 , FROM XFORMER T1 TO VECTOR / CHIP CONV
90	115 VAC FROM TB2 (CB2 OUTPUT) TO IOPCB P33
91	STEPPED-DOWN 115 VAC (FROM XFRMER T1) #18
92	STEPPED-DOWN 115 VAC (FROM XFRMER T1) #18
93	STEPPED-DOWN 115 VAC (FROM XFRMER T1) #18
94	SHIELD DRAIN
—	115 VAC FROM XFORMER T1 TO TB1
94	STEPPED-DOWN 115 VAC (FROM XFORMER T1)
95	STEPPED-DOWN 115 VAC (FROM XFORMER T1)
96	STEPPED-DOWN 115 VAC (FROM XFORMER T1)
90A	115 VAC TO CRT
91A	LEG 1 #16
92A	LEG 2 #16
93A	SHIELD DRAIN
90B	115 VAC TO HEAT EXCHANGER
91B	LEG 1 #16
92B	LEG 2 #16
93B	SHIELD DRAIN

90C	115 VAC TO CB4
91C	LEG 1 #16
92C	LEG 2 #16
93C	SHIELD DRAIN

100 M-FIN

101	SIGNAL #20
102	COMMON #20
101	SIGNAL #20
102	COMMON #20
103	SHIELD DRAIN

120	TSC OVER TEMP THERMAL SENSOR
121	THERMAL SENSOR SIGNAL
122	THERMAL SENSOR RETURN
123	SHIELD

140	230VAC 3PH POWER TO CHIP CONVEYOR MOTOR
141	PHASE A 230VAC
142	PHASE B 230VAC
143	PHASE C 230VAC
144	STARTING WINDING 230VAC
145	STARTING WINDING 230VAC
146	SHIELD DRAIN

160	3PH 230VAC TO CHIP CONVEYOR CONTROLLER
161	PHASE A 230VAC
162	PHASE B 230VAC
163	PHASE C 230VAC
164	SHIELD DRAIN

170 AUTO OFF FUNCTION

171	UNSWITCHED LEG 1 #20
172	SWITCHED LEG 2 #20
173	SHIELD DRAIN

180 COOLANT SPIGOT DETENT SWITCH

181	SIGNAL
182	COMMON
183	SHIELD DRAIN

190 UNCLAMP FROM SPINDLE HEAD TO IOASM

191	INPUT 25
192	DIGITAL RETURN

200 COOLANT SPIGOT MOTOR (12VDC)

201	MOTOR +
202	MOTOR -

210	DATA CABLE TO 3" FLOPPY DISK DRIVE

220	SERVO BRAKE 115VAC
221	115VAC COMMON
222	115VAC SWITCHED
223	SHIELD DRAIN
230	5'th AXIS BRAKE
240	(OPTION) APC PAL 2 HOME/MD PAL UP - APC PAL 1 HOME/MD PAL DOWN
250	(OPTION) VR SHUT IN / APC DOOR OPEN/ MD NIAGRA COOLANT ON
260	K210 CABLING FOR EC
270	K111 CABLING FOR EC
280	RED/GREEN STATUS LIGHT WIRING
281	RED LAMP 115VAC
282	GREEN LAMP 115VAC
283	COMMON 115VAC
284	SHIELD DRAIN
300	115VAC TO SPINDLE MOTOR FAN/OIL PUMP/OILER
301	LEG 1 115VAC PROTECTED #18
302	LEG 2 115VAC PROTECTED #18
303	SHIELD DRAIN
310	APC #2 DOOR OPEN
350	SERVO BRAKE RELEASE 115VAC
351	LEG 1 COMMON
352	LEG 2 SWITCHED
353	SHIELD DRAIN
360-389	RESERVED
390	115VAC TO 4'TH AXIS BRAKE (LATHE PART DOOR)
391	LEG 1 COMMON
392	LEG 2 SWITCHED
393	SHIELD DRAIN
410	VB CLAMSHELL / APC CE DOOR OPEN
420	APC #2 PIN CLR #1 / APC #2 PIN CLR #2 / APC #2 PAL #2 HOME / APC #2 PAL #1 HOME
430	APC PALLET CLAMP MD PAL UP
440	AUTO DOOR OPEN
450	APC #2 CE DOOR OPEN
460	APC #2 DOOR CLOSED - APC #2 DOOR OPEN
470	SMTC MOTOR STOP
480-483	RESERVED

490	ALL BRUSHLESS AXIS SERVO MOTOR DRIVE POWER CABLE
491	A PHASE
492	B PHASE
493	C PHASE
494	GROUND
490A	A AXIS MOTOR POWER
490B	B AXIS MOTOR POWER
490X	X AXIS MOTOR POWER
490Y	Y AXIS MOTOR POWER
490Z	Z AXIS MOTOR POWER
500	OVERTEMP SENSOR FROM SPINDLE MOTOR
501	OVERTEMP WIRE 1 #20
502	OVERTEMP WIRE 2 #20
503	SHIELD DRAIN
510	RELAY CARD 1 DRIVE CABLE - 16 WIRE RIBBON #24
520	RELAY CARD 2 DRIVE CABLE - 16 WIRE RIBBON #24
530	RELAY CARD 3 DRIVE CABLE - 16 WIRE RIBBON #24
540	RELAY CARD 4 DRIVE CABLE - 16 WIRE RIBBON #24
550	INPUTS CARD CABLE 34 WIRE RIBBON #24
610	X AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD
610-1	+A CHANNEL
610-2	ANALOG GROUND
610-3	+B CHANNEL
610-4	ANALOG GROUND
610-5	ENABLE
610-6	LOGIC GROUND
610-7	FAULT
610-8	LOGIC GROUND
610-9	NOT USED
610-10	SHIELD/ANALOG GROUND
620	Y AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD (SAME AS 610-1 THRU 610-10)
630	Z AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD (SAME AS 610-1 THRU 610-10)
640A	A AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD (SAME AS 610-1 THRU 610-10)

640B	B AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD (SAME AS 610-1 THRU 610-10)
640C	C AXIS HAAS VECTOR CURRENT COMMAND CABLE TO MOTOR CONTROLLER BD. (SAME AS 610-1 THRU 610-10)
650	THREE PHASE POWER TO SPINDLE MOTOR
651	LEG 1 OF 230VAC
652	LEG 2
653	LEG 3
654	SHIELD DRAIN
650A	THREE PHASE POWER TO SPINDLE MOTOR
651A	LEG 1 OF 230VAC
652A	LEG 2
653A	LEG 3
654A	SHIELD DRAIN
650B	THREE PHASE POWER TO SPINDLE MOTOR
651B	LEG 1 OF 230VAC
652B	LEG 2
653B	LEG 3
654B	SHIELD DRAIN
660	X-ENCODER CABLE
660-1	LOGIC RETURN (D GROUND)
660-2	ENCODER A CHANNEL
660-3	ENCODER B CHANNEL
660-4	+5 VDC
660-5	ENCODER Z CHANNEL (OR C)
660-6	HOME/LIMIT SW
660-7	OVERHEAT SWITCH
660-8	ENCODER A*
660-9	ENCODER B*
660-10	ENCODER Z* (OR C*)
660-11	X HALL A (NOT USED)
660-12	X HALL B (NOT USED)
660-13	X HALL C (NOT USED)
660-14	X HALL D (NOT USED)
660-15	SHIELD DRAIN
660-16	(NOT USED)
670	Y-AXIS ENCODER CABLE (SAME AS 660-1 THRU 660-16)
680	Z-AXIS ENCODER CABLE (SAME AS 660-1 THRU 660-16)
690	A-AXIS ENCODER CABLE (SAME AS 660-1 THRU 660-16)

690B	B-AXIS ENCODER CABLE (SAME AS 660-1 THRU 660-16)
690C	C-AXIS ENCODER CABLE (SAME AS 660-1 THRU 660-16)
700	KEYBOARD CABLE - 34 WIRE RIBBON WITH IDC (FROM VIDEO P4 TO KBIF P1)
710	APC #1 PALLET READY 1 / APC #1 PALLET READY 2
711	FORWARD COMMAND
712	REVERSE COMMAND
713	RESET COMMAND
714	COMMON
715	SHIELD DRAIN
720	ANALOG SPEED COMMAND TO SPINDLE (BRUSH SYSTEMS)
721	0 TO +10 VOLTS SPEED COMMAND (SPINDLE DRIVE CN1-1) #24
722	SPEED COMMAND REFERENCE (A GROUND) (CN1-17) #24
723	SHIELD DRAIN
730	POWER METER FROM SPINDLE DRIVE TO KBIF (BRUSH SYSTEMS)
731	METER + #24
732	METER - #24
723	SHILD DRAIN
730A	POWER METER FROM KBIF TO METER (BRUSH SYSTEMS)
733	METER + AFTER TRIM POT #24
734	METER - AFTER TRIM POT #24
734	METER - AFTER TRIM POT #24
730B	ANALOG SIGNAL FROM SPINDLE DRIVE LOAD MONITOR (BRUSH SYSTEMS)
731	SIGNAL 0.5V
732	GROUND
740	POWER ON/OFF CABLE TO FRONT PANEL
741	POWER ON SWITCH LEG 1 (24 VAC) #24
742	POWER ON SWITCH LEG 2 #24 N.O.
743	POWER OFF SWITCH LEG 1 (24 VAC) #24
744	POWER OFF SWITCH LEG 2 #24 N.C.
745	SHIELD DRAIN
750	JOG-CRANK DATA CABLE (REM JOG SIDE CONNECTION) (ALL #28)

750-1	LOGIC RETURN (D GROUND) 0VDC
750-2	ENCODER A CHANNEL
750-3	ENCODER B CHANNEL
750-4	+5 VDC
750-5	N/C
750-6	X-AXIS
750-7	Y-AXIS
750-8	N/C
750-9	N/C
750-10	N/C
750-11	Z-AXIS
750-12	A-AXIS
750-13	X 10
750-14	X 1
750-15	SHIELD DRAIN
750-16	N/C

750-2	CYCLE START
750-4	D GROUND
750-6	FEED HOLD

760	MONITOR VIDEO DATA CABLE

770	EMERGENCY STOP INPUT CABLE
771	SIGNAL (INPUT 8) #20
772	RETURN (D GROUND) (65) #20
772	RETURN (D GROUND) (65) #20

770A	SECOND E-STOP INPUT FOR HORIZONTAL

770B	THIRD E-STOP INPUT FOR APC (REMOTE CONTROL PANEL)

780	STATUS CABLE FROM SPINDLE DRIVE (BRUSH SYSTEMS)
781	+12 VDC (SPINDLE DRIVE CN1-25) #24
782	FAULT (INPUT 18 TO CN1-24) #24
783	AT SPEED (INPUT 20 TO CN1-23) #24
784	STOPPED (INPUT 19 TO CN1-22) #24
785	SHIELD DRAIN

790	APC PIN CLR #1 / MD OP DOOR OPEN - APC PIN CLR #2 / MD OP DOOR CLOSED
791	SPARE 1
792	SPARE 2
793	COMMON

810	TOOL CHANGER MOTORS #20
811	TURRET MOTOR + (IO P30-2 TO P6-J) #14
812	TURRET MOTOR - (IO P30-1 TO P6-I) #14
812	SHIELD DRAIN
810A	TOOL CHANGER MOTORS #20
813	SHUTTLE MOTOR #14
814	SHUTTLE MOTOR #14
812	SHIELD DRAIN
820	TOOL CHANGER STATUS
821	LOGIC RETURN #24
822	GENEVA MARK (INPUT 5 TO P6-G) #24 (LATHE PART DOOR)
823	TOOL #1 (INPUT 3 TO P6-E) #24
824	SHUTTLE IN (INPUT 1 TO P6-C) #24 (LATHE TURRET CLAMPED)
825	SHUTTLE OUT (INPUT 2 TO P6-D) #24 (LATHE TURRET UNCLAMPED)
826	SHUTTLE IN (INPUT 1 TO P6-C) #24 (LATHE TURRET CLAMPED)
827	SHIELD DRAIN
830	OVERHEAT THERMOSTAT
831	OVERHEAT SIGNAL (INPUT 14) #20
832	OVERHEAT RETURN (D GROUND) (65) #20
833	SHIELD DRAIN
840	CIRCUIT BREAKER FOR 160 VDC
841	LEG 1 (TO 81) #14
842	LEG 2 #14
843	SHIELD DRAIN
850	SERIAL PORT #1 TO SERIAL KEYBOARD INTERFACE CABLE
850A	SERIAL PORT #2 INTERFACE CABLE - AUXILIARY PORT TO ROTARY CONTROLLER
860	+12V/+5V/Gnd POWER CABLES - 6 WIRE (all #18)
861	+12 VOLTS
862	-12 VOLTS FROM LOW V SUPPLY TO 68020 PCB
863	+5 VOLTS
864	-5 VOLTS
865	LOGIC POWER RETURN (D GROUND)
866	POWER GOOD SIGNAL FROM SUPPLY
860A	12 VOLT POWER TO IOPCB - SHIELD +2
861	+12 VOLTS
862	LOGIC POWER RETURN (D GROUND)
860B	+5 POWER TO 3" FLOPPY DRIVE
860C	+5,+12,-12 POWER TO 68030

870	115VAC TO OILER - (2 + SHIELD)
871	115VAC LEG 1 #18
872	115VAC LEG 2 #18
873	SHIELD DRAIN

880A	HIGH/LOW GEAR UNCLAMP/LOCK SOLENOID POWER - SHIELD +6
881	115 VAC SOLENOID COMMON (IO P12-5) #18
882	HIGH GEAR SOLENOID (IO P12-4) #18
883	LOW GEAR SOLENOID (IO P12-3) #18
884	TOOL UNCLAMP SOLENOID (IO P12-2) #18
885	SPINDLE LOCK SOLENOID (IO P12-1) #18
886	PRE-CHARGE SOLENOID #18 (IO P12-7)
887	SHIELD DRAIN

880B	TRANSMISSION HIGH/LOW GEAR SOLENOIDS FOR LATHE
881	115 VAC SOLENOID COMMON (IO P12-5) #18
882	HIGH GEAR SOLENOID (IO P12-4) #18
883	LOW GEAR SOLENOID (IO P12-3) #18
884	SHIELD DRAIN

890	SPINDLE STATUS SWITCHES
891	SIGNAL RETURN (D GROUND) #24
892	HIGH GEAR #24
893	LOW GEAR #24
894	TOOL UNCLAMPED #24
895	TOOL CLAMPED #24
896	SPINDLE LOCKED #24
897	SHIELD DRAIN

900	LOW COOLANT STATUS
901	LOW COOLANT SIGNAL #20
902	LOW COOLANT RETURN (D GROUND) #20
903	SHIELD DRAIN

910	115 VAC CIRCUIT BREAKER TO SOLENOIDS
911	LEG 1 #18
912	LEG 2 #18
913	SHIELD DRAIN

910A	115VAC FROM CB4 ON MAIN POWER DIST.
910B	115VAC TO SERVO FAN
910C	115VAC TO DELTA/WYE COIL
910D	115VAC TO WORK LIGHT

920	REGENERATIVE LOAD RESISTOR FOR SERVO
921	LEG 1 #18
922	LEG 2 #18
923	SHIELD DRAIN

930	FUSED 230 VAC FOR COOLANT PUMP
931	LEG 1 #14
932	LEG 2 #14
933	SHIELD DRAIN
940	230 VAC TO COOLANT PUMP
941	LEG 1 (P7-A) #14
942	LEG 2 (P7-F) #14
943	SHIELD DRAIN
950	LOW AIR PRESSURE SENSOR
951	LOW AIR SIGNAL (INPUT 12) #20
952	LOW AIR/OIL RETURN (D GROUND) (65) #20
953	LOW OIL PRESSURE SWITCH FOR VERTICAL TRANSMISSION #20
954	SHIELD DRAIN
950A	LOW HYDRAULIC PRESSURE SWITCH FOR LATHE
952	LOW HYDRAULIC RETURN (D GROUND) #20
953	LOW HYD PRESSURE SWITCH FOR VERTICAL TRANSMISSION #20
954	SHIELD DRAIN
960	LOW LUB/DOOR OPEN SENSORS
961	LOW LUB SIGNAL #24
962	LOW LUB RETURN (D GROUND) (65) #24
963	DOOR OPEN SIGNAL (INPUT 9) #24 (OBSOLETE OPTION)
964	DOOR OPEN RETURN (D GROUND) (65) #24 (OBSOLETE OPTION)
965	SHIELD DRAIN
970	LOW VOLTAGE SENSOR
971	LOW VOL SIGNAL #24
972	LOW VOL RETURN (D GROUND) #24
973	SHIELD DRAIN
980	VOLTAGE MONITOR
981	VOLTAGE MONITOR 0 TO #24
982	VOLTAGE MON RET #24
983	VOLTAGE MON RET #24
990	HOME SENSORS
991	X HOME SWITCH #24
992	Y HOME SWITCH #24 (LATHE TAIL STOCK)
993	Z HOME SWITCH #24
994	HOME SWITCH RETURN #24
995	SHIELD DRAIN

1000 SPINDLE ENCODER CABLE (LATHE TAIL STOCK)(BRUSH SYSTEMS)
1001 LOGIC RETURN (D GROUND) #24
1002 ENCODER A CHANNEL #24
1003 ENCODER B CHANNEL #24
1004 +5 VDC #24
1005 ENCODER Z CHANNEL #24
1006 SHIELD DRAIN

1020 SPINDLE TEMPERATURE SENSOR CABLE
1021 SIGNAL
1022 ANALOG RETURN
1023 +5 VOLTS TO SENSOR
1024 SHIELD GROUND

1030 SPINDLE LOAD RESISTOR
1031 REGEN LOAD RESISTOR FOR SPINDLE DRIVE (B1) #18
1032 REGEN LOAD RESISTOR FOR SPINDLE DRIVE (B2) #18
1033 SHIELD DRAIN

1040 Y160 (MIKRON DOOR LOCK OR HORIZONTAL PART READY LAMP)

1041 SWITCHED RELAY CONTACT
1042 SWITCHED RELAY CONTACT

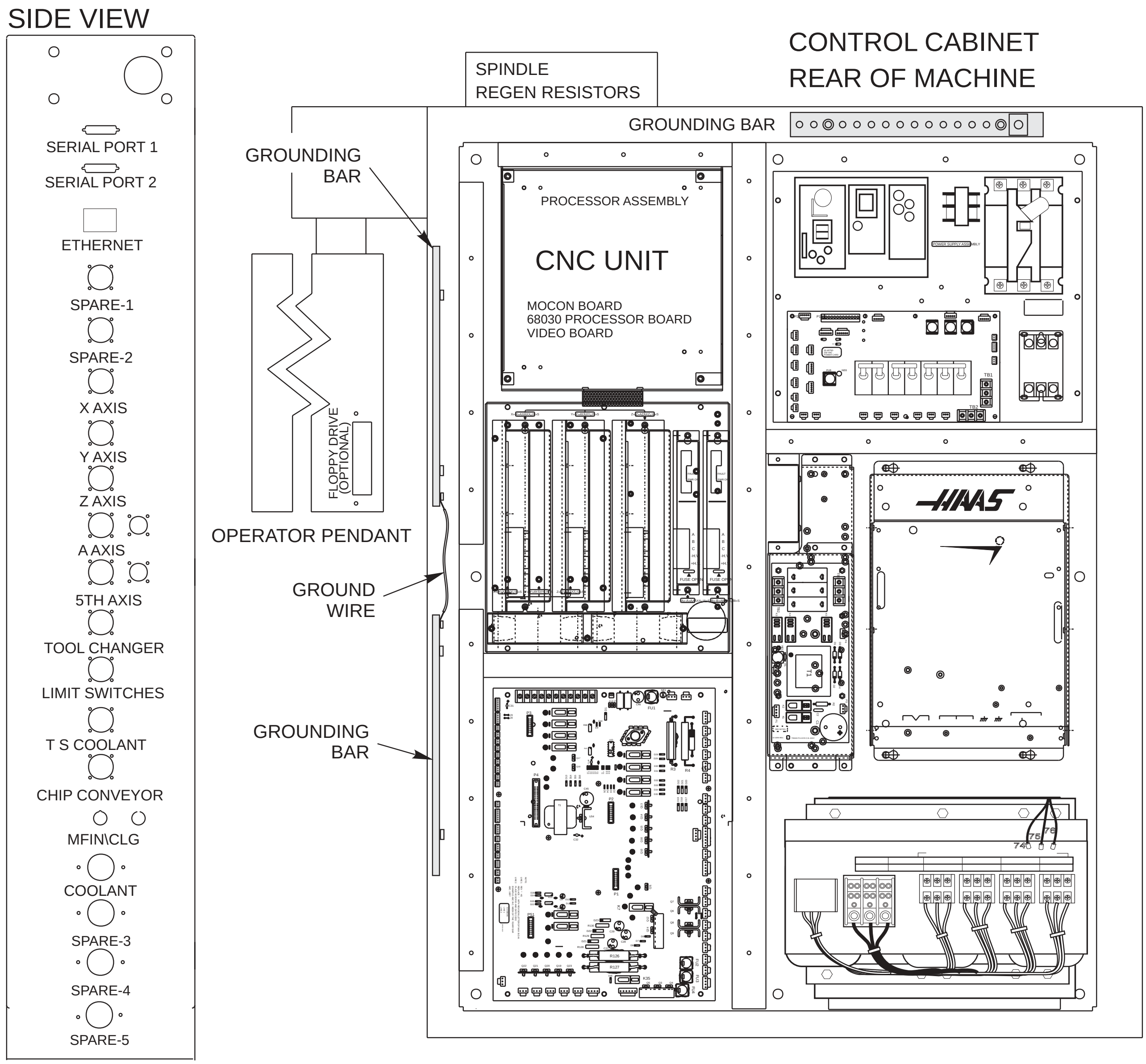
1050 DOOR SWITCH WIRING THRU SUPPORT ARM

1051 DOOR OPEN SIGNAL (INPUT 9) #24
1052 DOOR OPEN RETURN (D GROUND) (65) #24
1053 SHIELD DRAIN

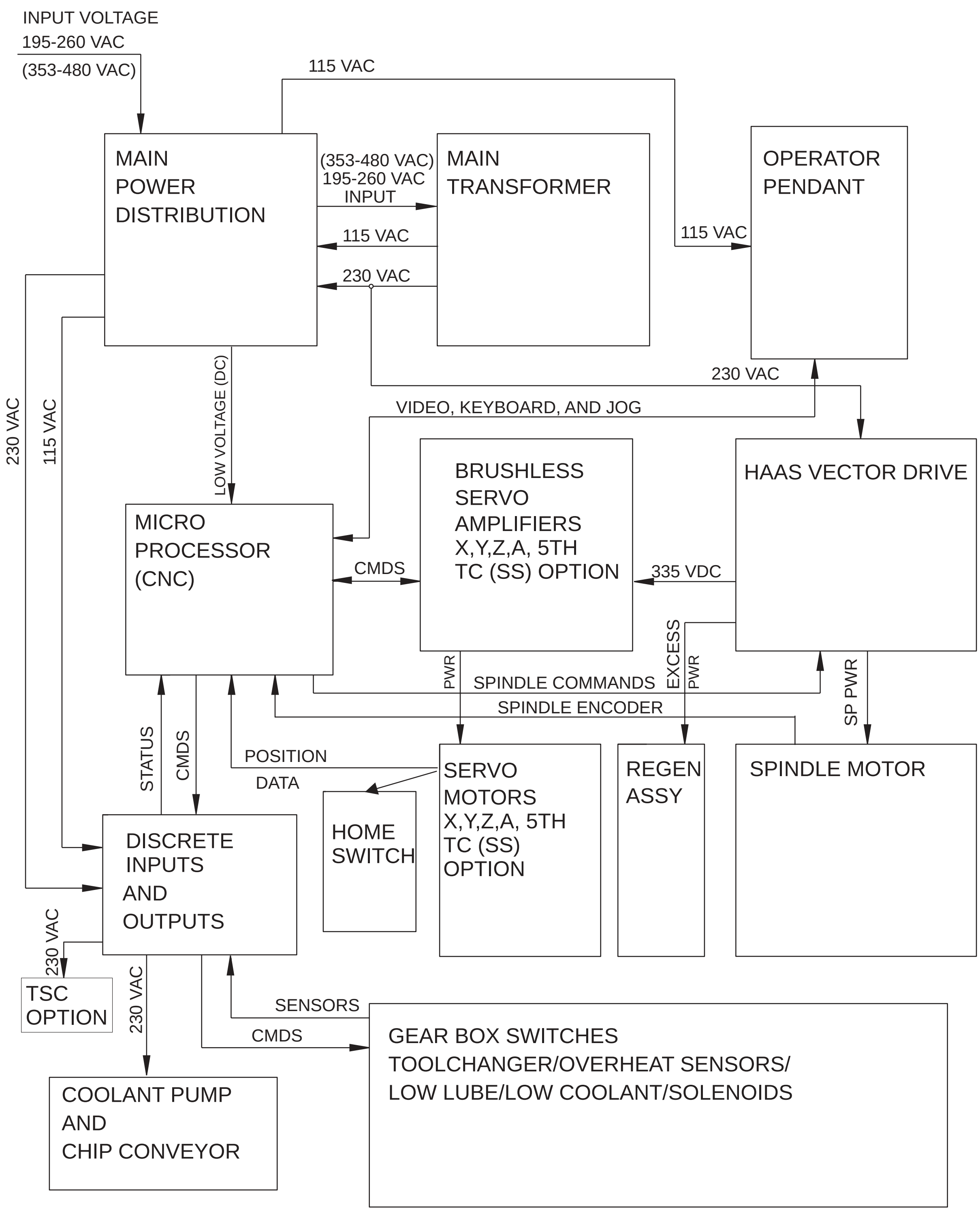
1060 GROUND FAULT DETECTION SENSE INPUT
1061 + INPUT FROM SENSE RESISTOR
1062 - INPUT FROM SENSE RESISTOR

1070 SKIP INPUT FROM SENSOR
1071 LOGIC COMMON
1072 SKIP SIGNAL
1073 SHIELD DRAIN

ELECTRICAL WIRING DIAGRAMS

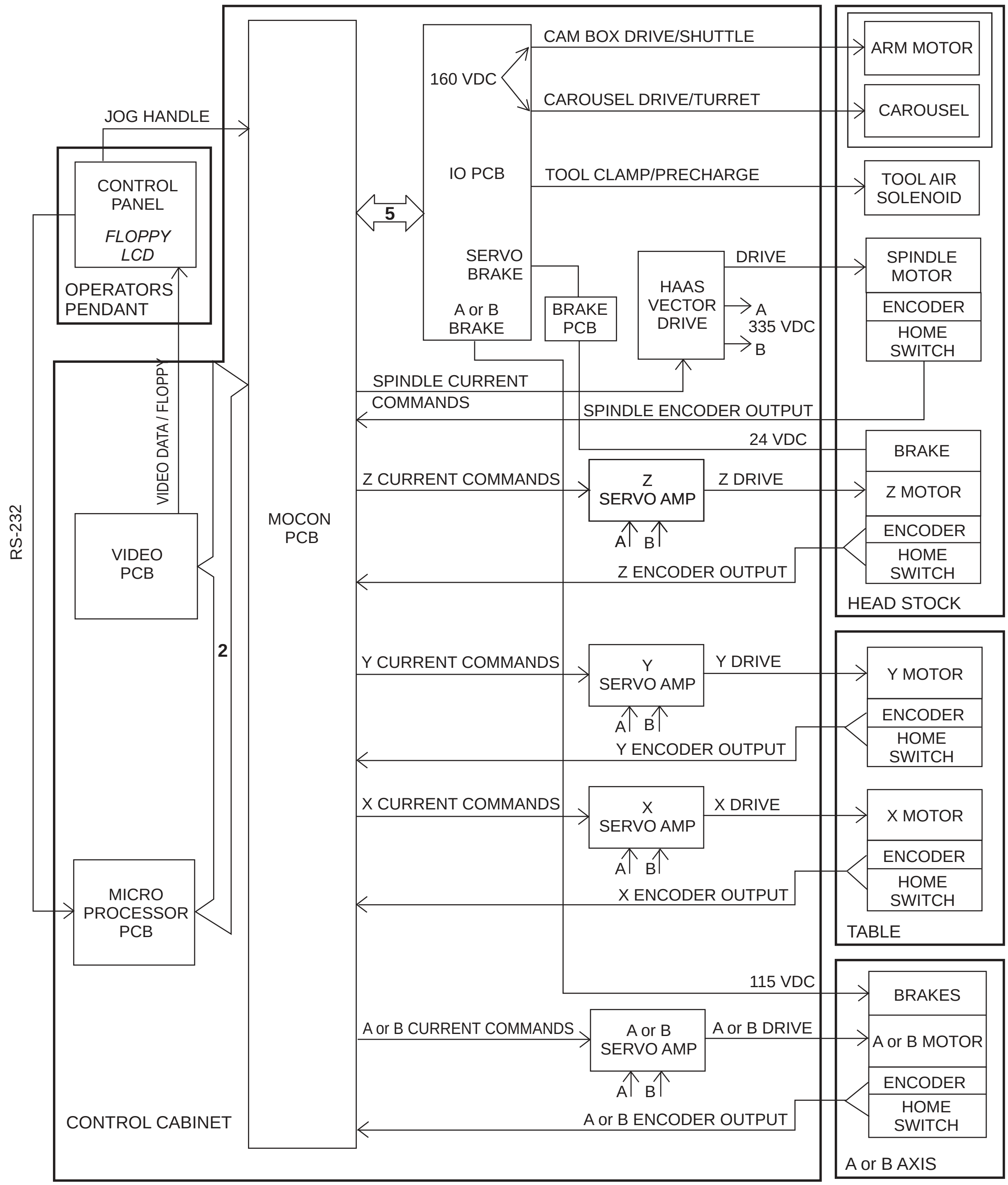


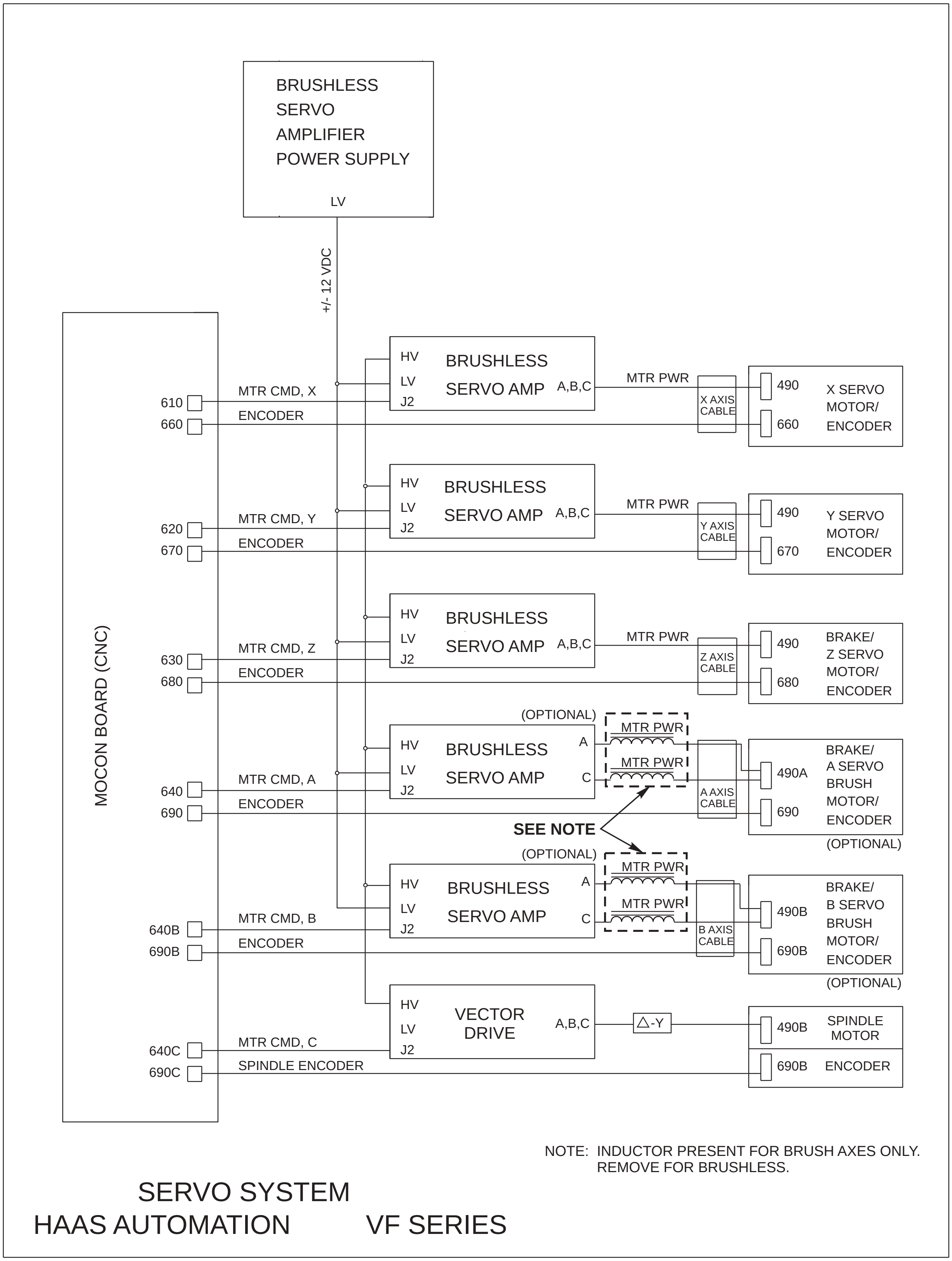
CONTROL LAYOUT DIAGRAM

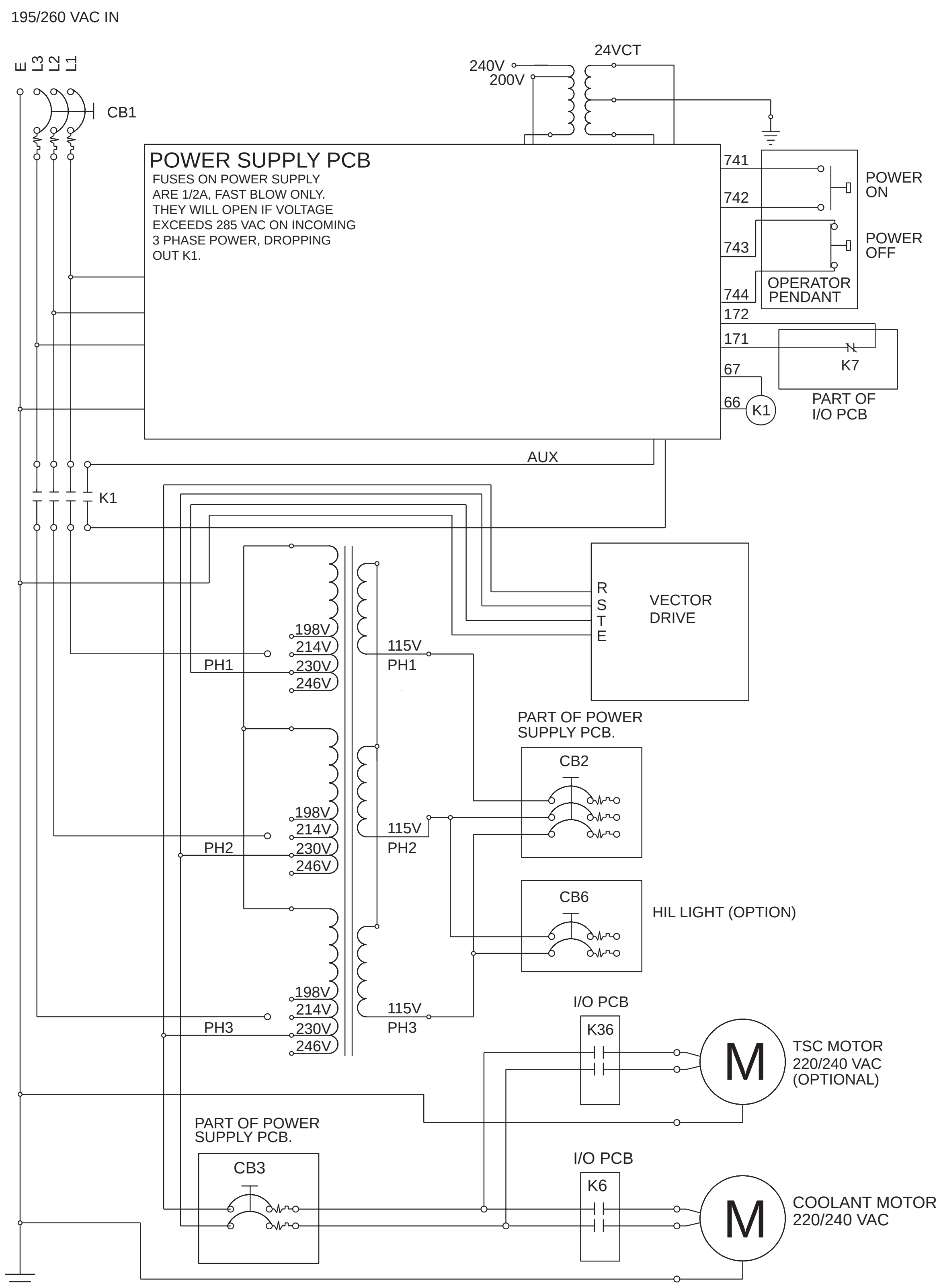


SYSTEM BLOCK DIAGRAM - LOW VOLTAGE (HIGH VOLTAGE)

VERTICAL MILLS

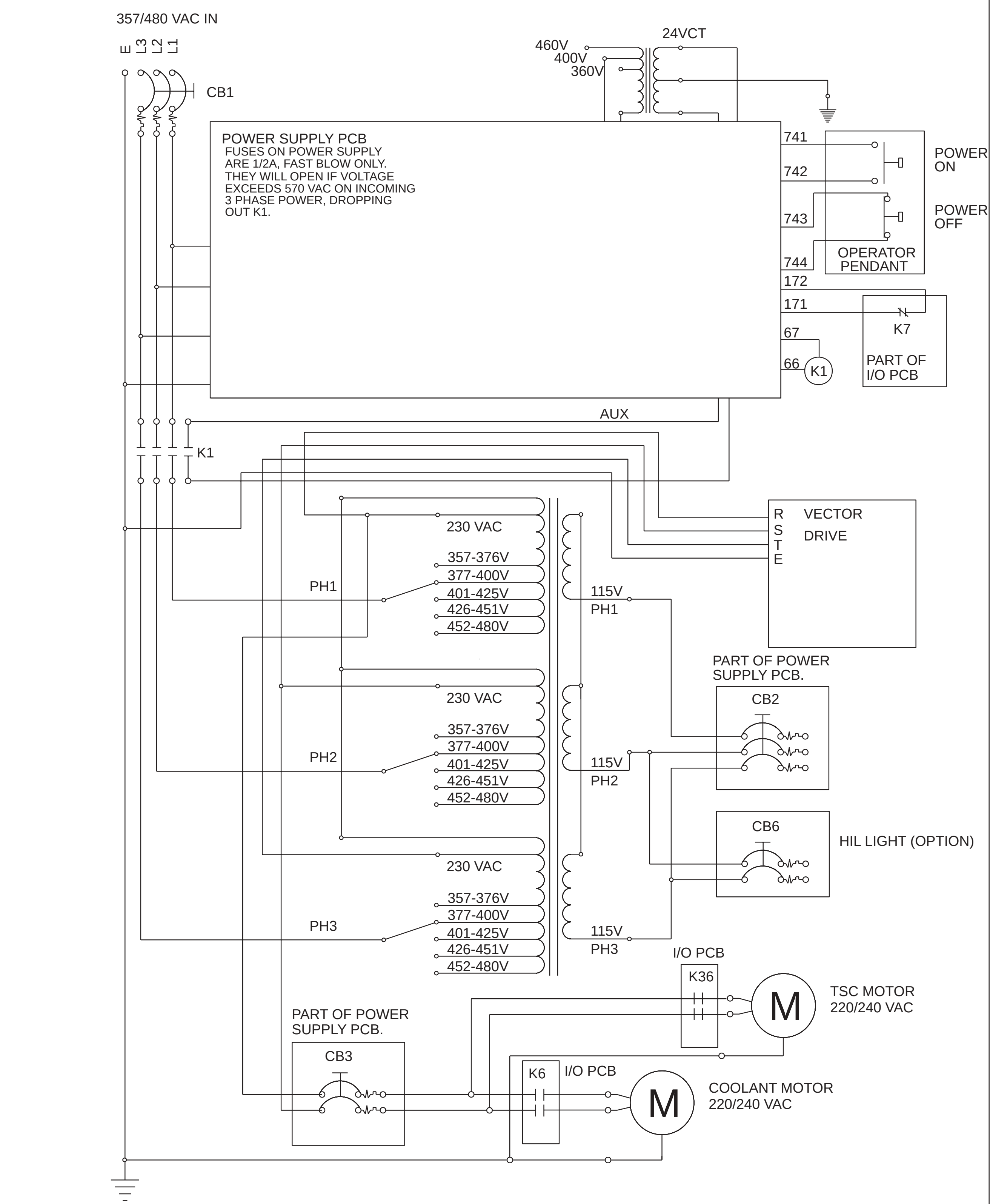



BRUSHLESS
SERVO
AMPLIFIER
POWER SUPPLY
LV
+/- 12 VDC
MOCON BOARD (CNC)
610
660
620
670
630
680
640
690
640B
690B
640C
690C
MTR CMD, X
ENCODER
MTR CMD, Y
ENCODER
MTR CMD, Z
ENCODER
MTR CMD, A
ENCODER
MTR CMD, B
ENCODER
MTR CMD, C
SPINDLE ENCODER
HV
LV
J2
BRUSHLESS
SERVO AMP
A,B,C
MTR PWR
X AXIS
CABLE
490
660
X SERVO
MOTOR/
ENCODER
Y AXIS
CABLE
490
670
Y SERVO
MOTOR/
ENCODER
Z AXIS
CABLE
490
680
BRAKE/
Z SERVO
MOTOR/
ENCODER
(OPTIONAL)
A
C
MTR PWR
A AXIS
CABLE
490A
690
BRAKE/
A SERVO
BRUSH
MOTOR/
ENCODER
(OPTIONAL)
SEE NOTE
(OPTIONAL)
B AXIS
CABLE
490B
690B
BRAKE/
B SERVO
BRUSH
MOTOR/
ENCODER
(OPTIONAL)
VECTOR
DRIVE
△-Y
490B
SPINDLE
MOTOR
690B
ENCODER
NOTE: INDUCTOR PRESENT FOR BRUSH AXES ONLY.
REMOVE FOR BRUSHLESS.
SERVO SYSTEM
HAAS AUTOMATION
VF SERIES

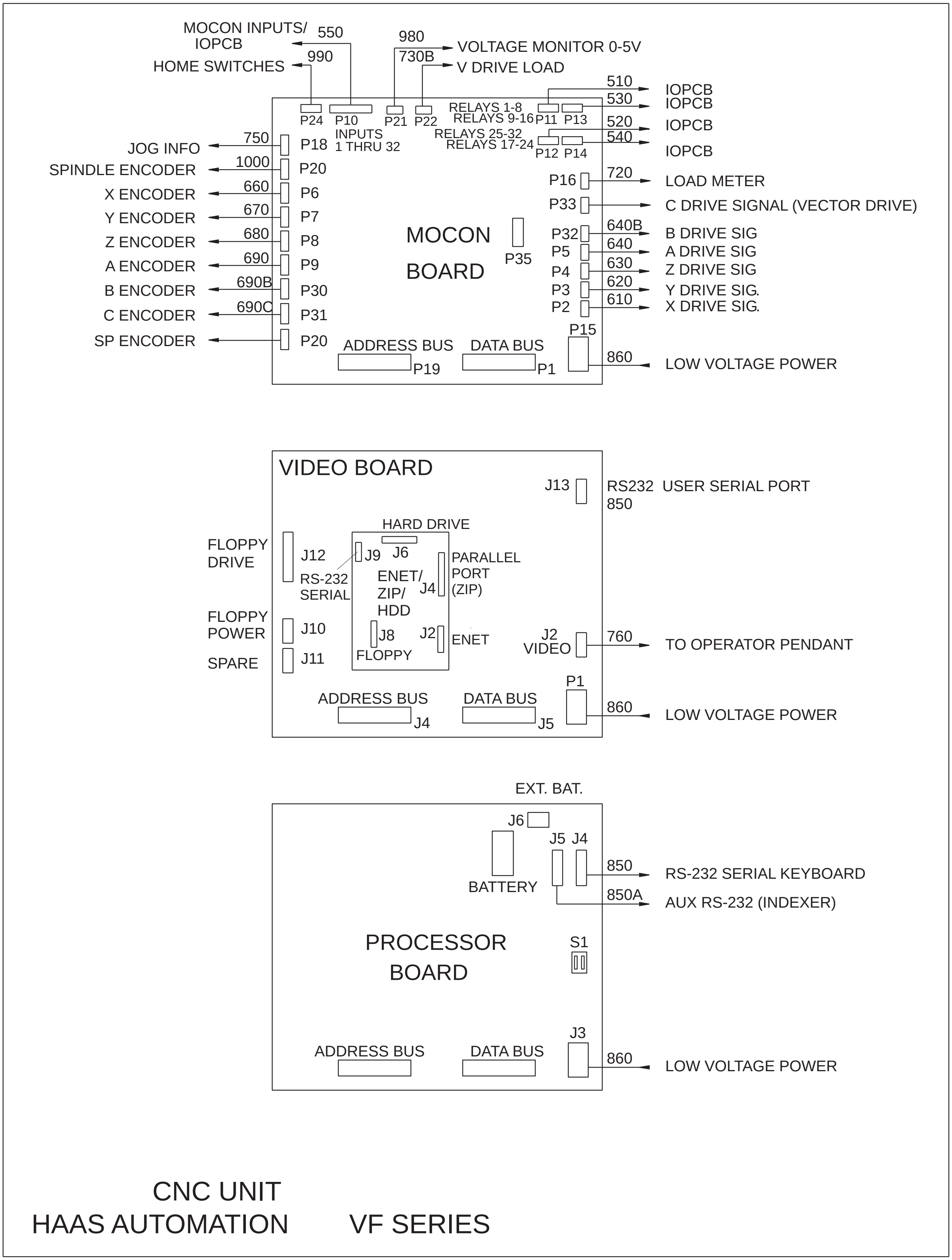


MAIN TRANSFORMER - LOW VOLTAGE

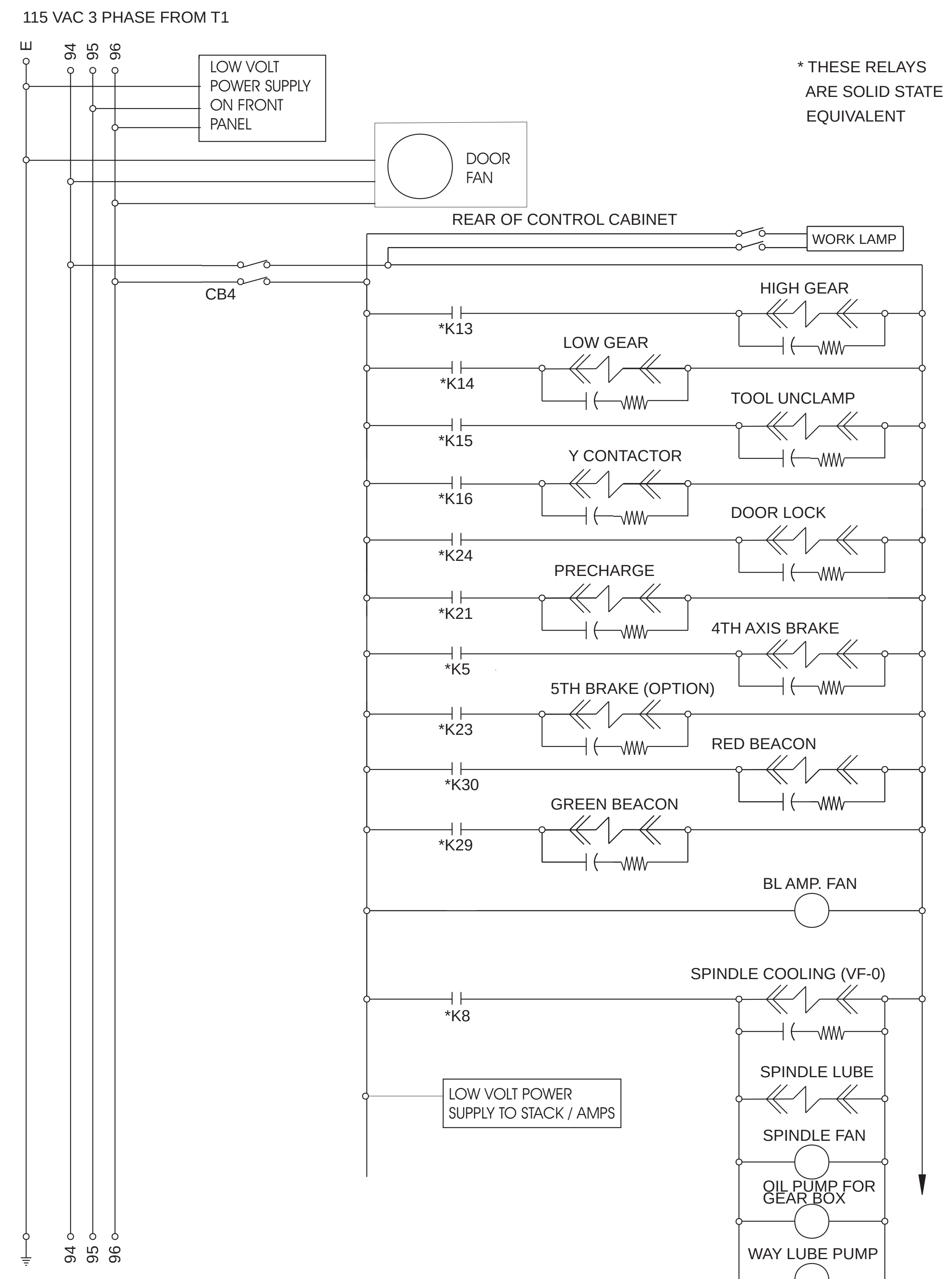
HAAS AUTOMATION VF SERIES



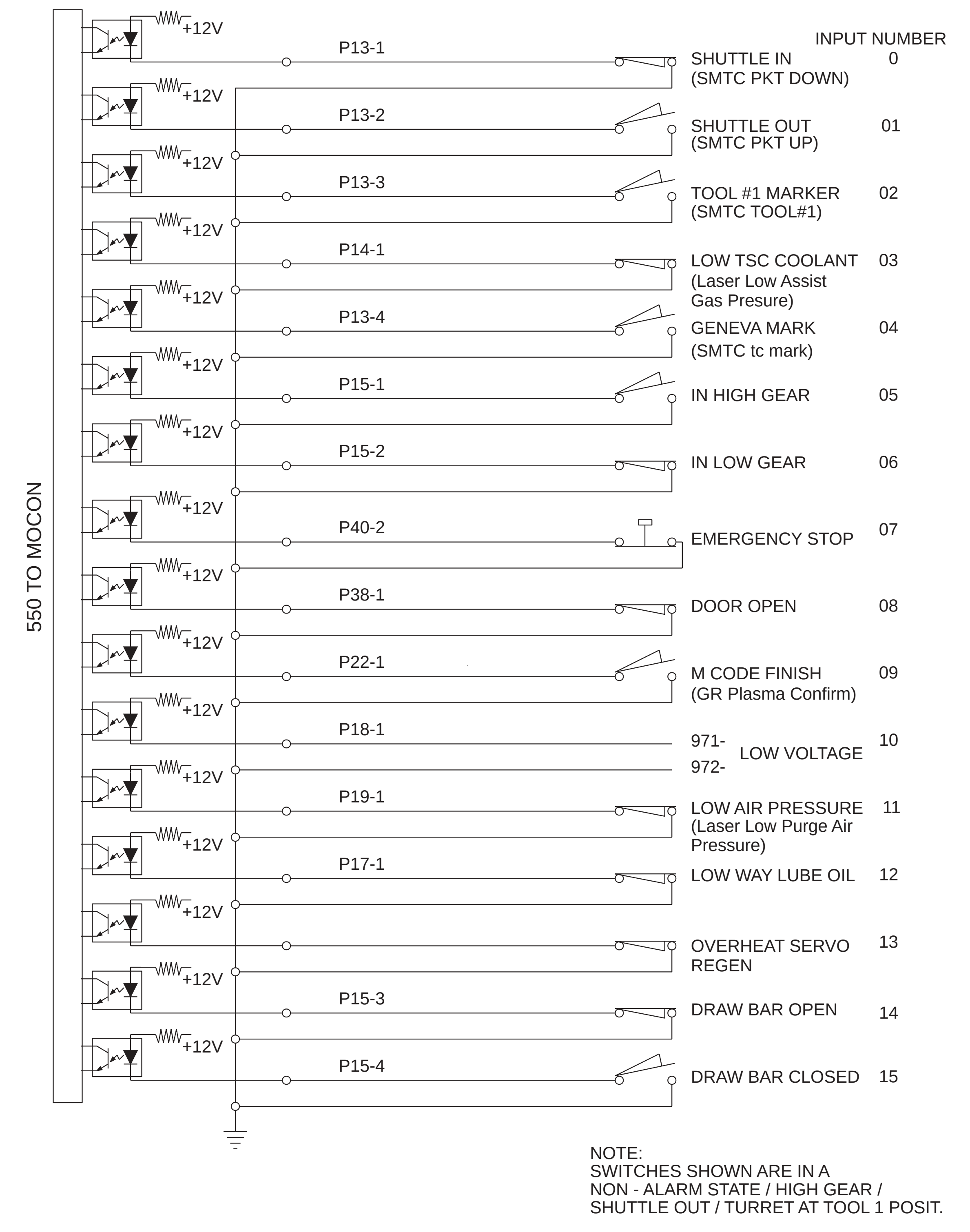
MAIN TRANSFORMER - HIGH VOLTAGE
HAAS AUTOMATION VF SERIES



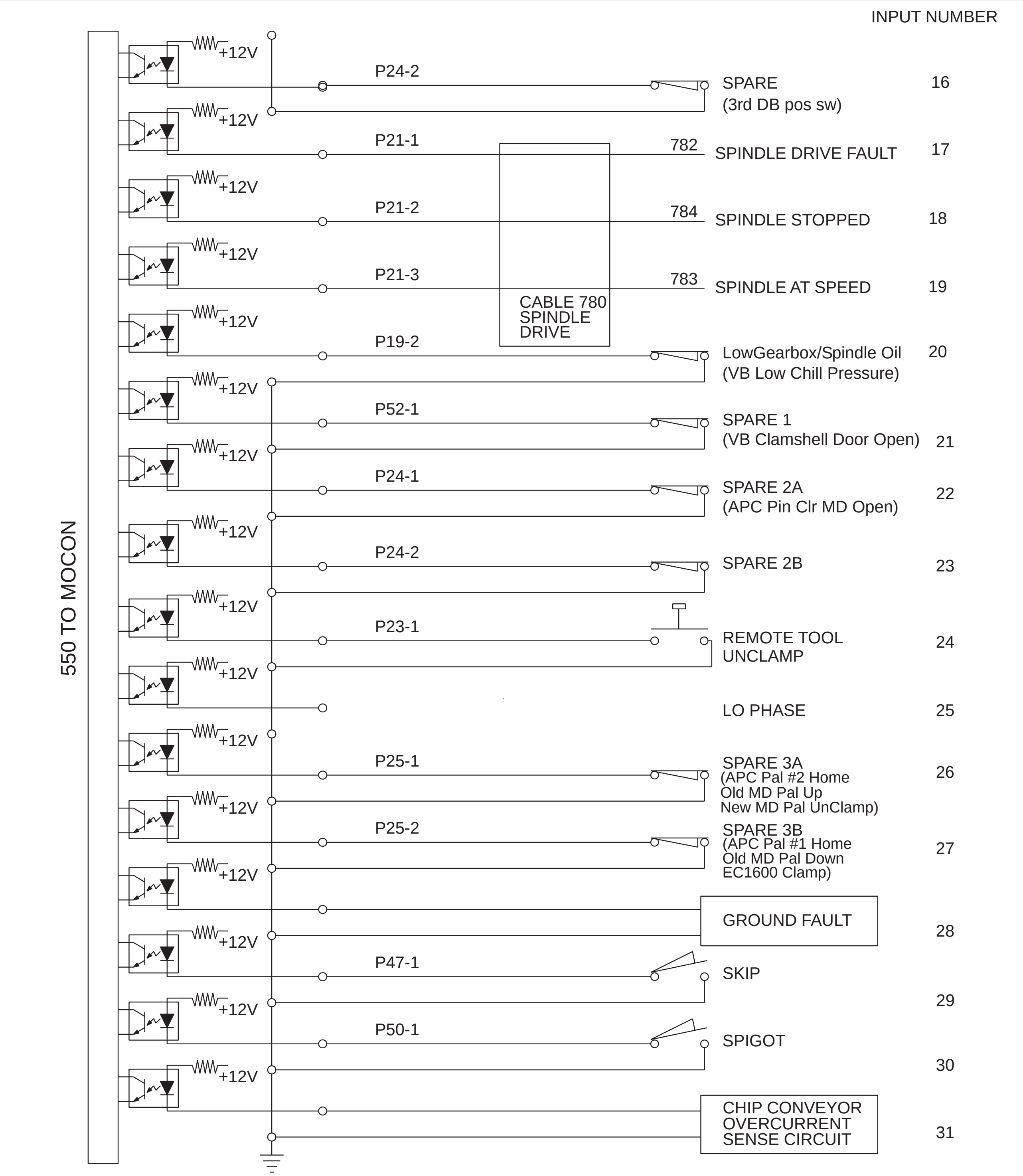
MOCON INPUTS/
IOPCB
HOME SWITCHES
550
990
980
730B
VOLTAGE MONITOR 0-5V
V DRIVE LOAD
510
530
520
540
IOPCB
IOPCB
IOPCB
IOPCB
P24
P10
P21
P22
RELAYS 1-8
RELAYS 9-16
RELAYS 25-32
RELAYS 17-24
P11
P13
P12
P14
INPUTS
1 THRU 32
JOG INFO
SPINDLE ENCODER
X ENCODER
Y ENCODER
Z ENCODER
A ENCODER
B ENCODER
C ENCODER
SP ENCODER
750
1000
660
670
680
690
690B
690C
P18
P20
P6
P7
P8
P9
P30
P31
P20
MOCON
BOARD
P35
P16
P33
P32
P5
P4
P3
P2
P15
720
640B
640
630
620
610
860
LOAD METER
C DRIVE SIGNAL (VECTOR DRIVE)
B DRIVE SIG
A DRIVE SIG
Z DRIVE SIG
Y DRIVE SIG.
X DRIVE SIG.
ADDRESS BUS
DATA BUS
P19
P1
LOW VOLTAGE POWER
VIDEO BOARD
J13
RS232 USER SERIAL PORT
850
HARD DRIVE
FLOPPY
DRIVE
J12
J9
J6
RS-232
SERIAL
ENET/
ZIP/
HDD
J4
PARALLEL
PORT
(ZIP)
FLOPPY
POWER
J10
J8
J2
ENET
J2
VIDEO
760
TO OPERATOR PENDANT
SPARE
J11
FLOPPY
ADDRESS BUS
DATA BUS
P1
J4
J5
860
LOW VOLTAGE POWER
EXT. BAT.
J6
J5
J4
BATTERY
850
RS-232 SERIAL KEYBOARD
850A
AUX RS-232 (INDEXER)
PROCESSOR
BOARD
S1
J3
ADDRESS BUS
DATA BUS
860
LOW VOLTAGE POWER
CNC UNIT
HAAS AUTOMATION
VF SERIES



115 VAC CIRCUITS
HAAS AUTOMATION VF SERIES

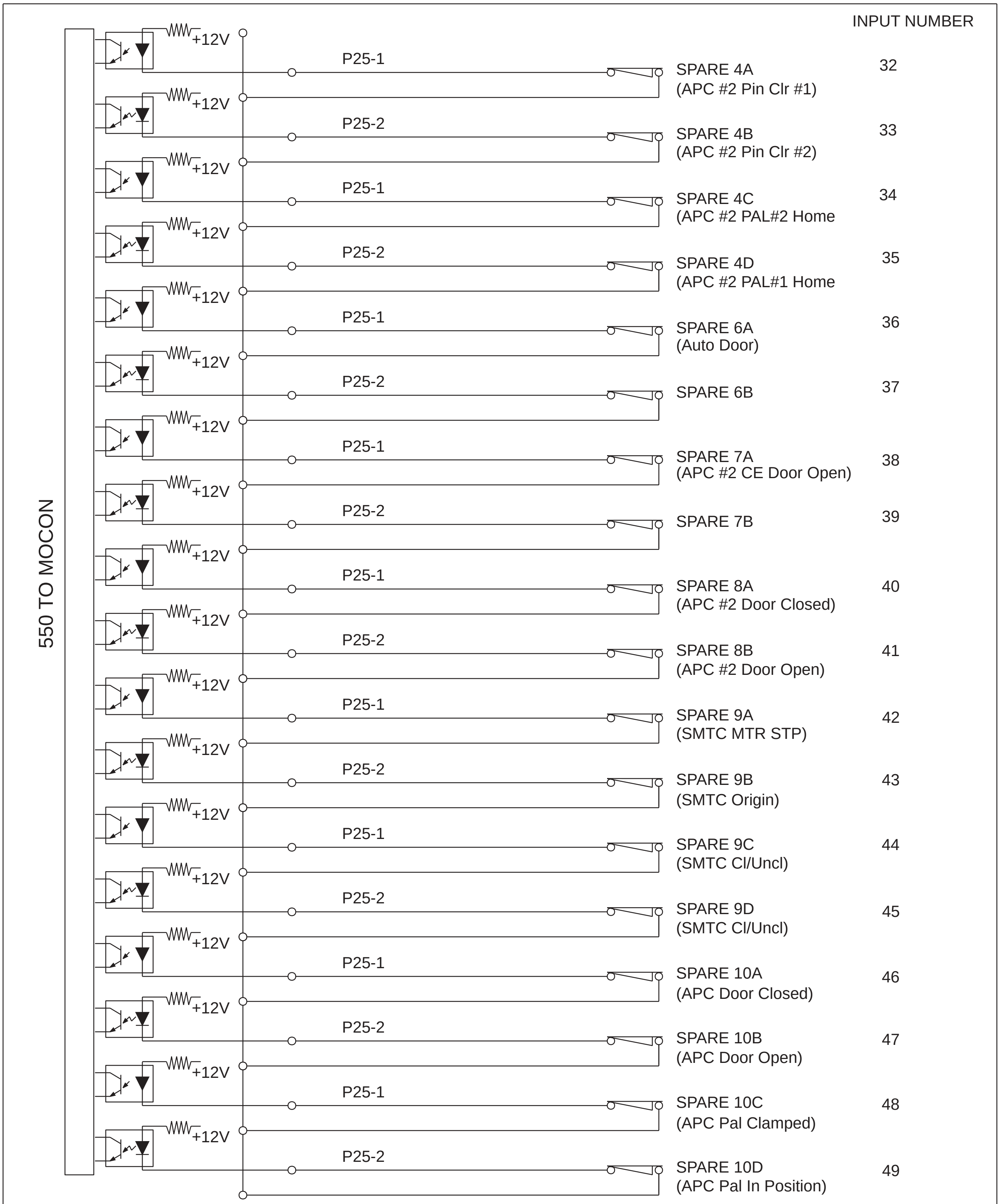


DISCRETE INPUTS 0 THROUGH 15
HAAS AUTOMATION VF SERIES



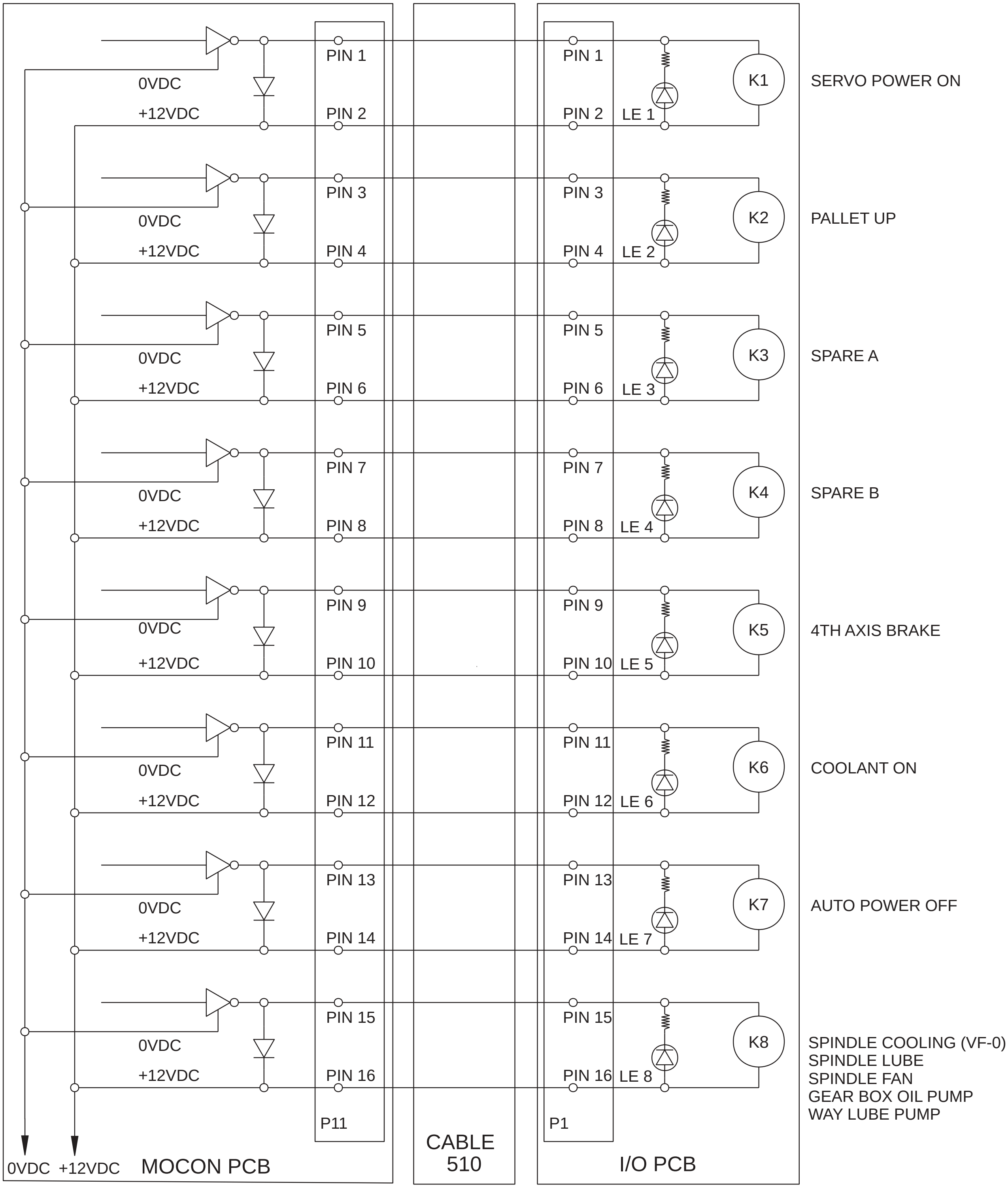
DISCRETE INPUTS 16 THROUGH 31
HAAS AUTOMATION VF SERIES

NOTE:
SWITCHES SHOWN ARE IN A
NON - ALARM STATE / HIGH GEAR /
SHUTTLE OUT / TURRET AT TOOL 1 POSIT.

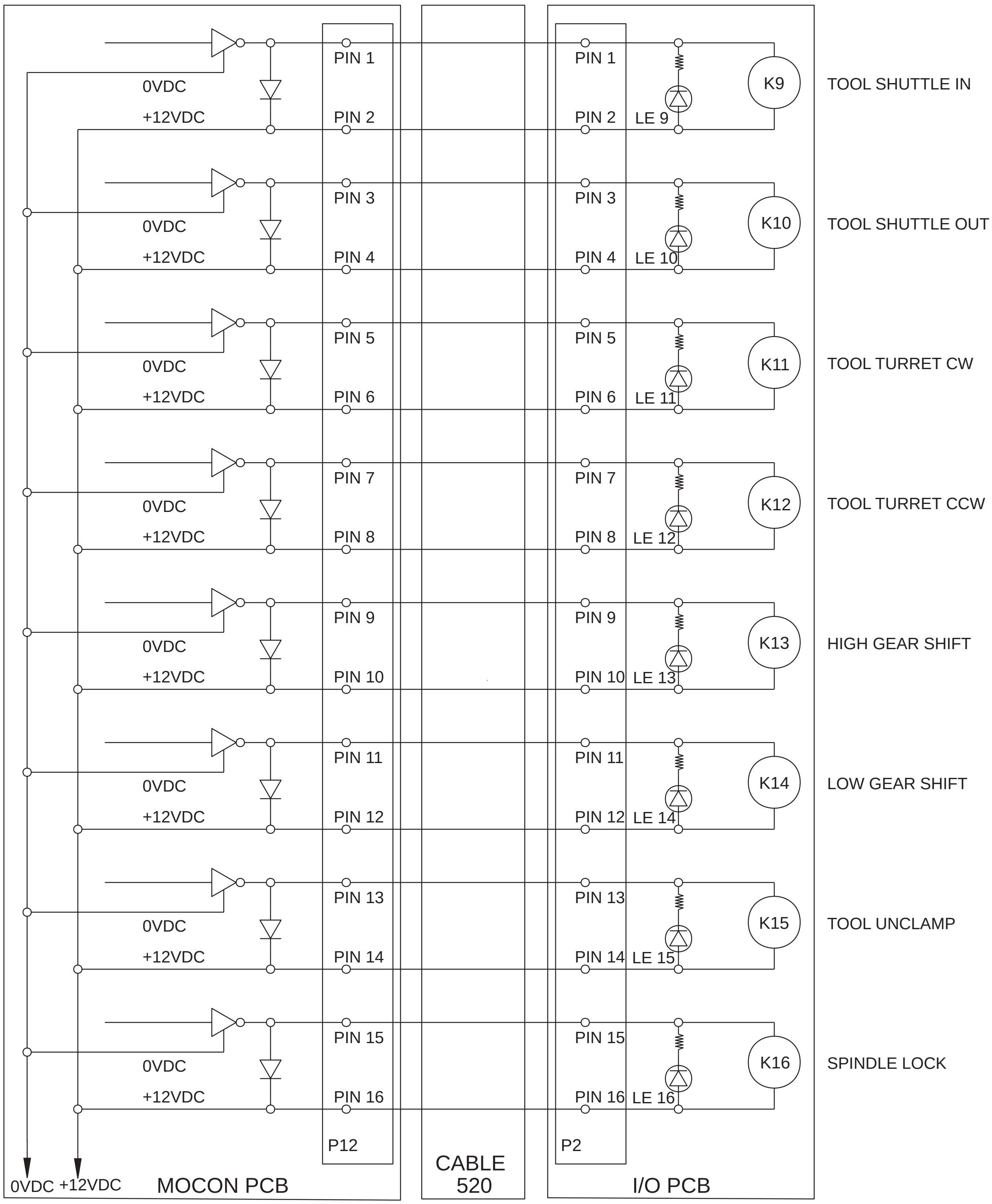


DISCRETE INPUTS 32 THROUGH 49
HAAS AUTOMATION VF SERIES

NOTE:
SWITCHES SHOWN ARE IN A NON - ALARM STATE / HIGH GEAR / SHUTTLE OUT / TURRET AT TOOL 1 POSIT.

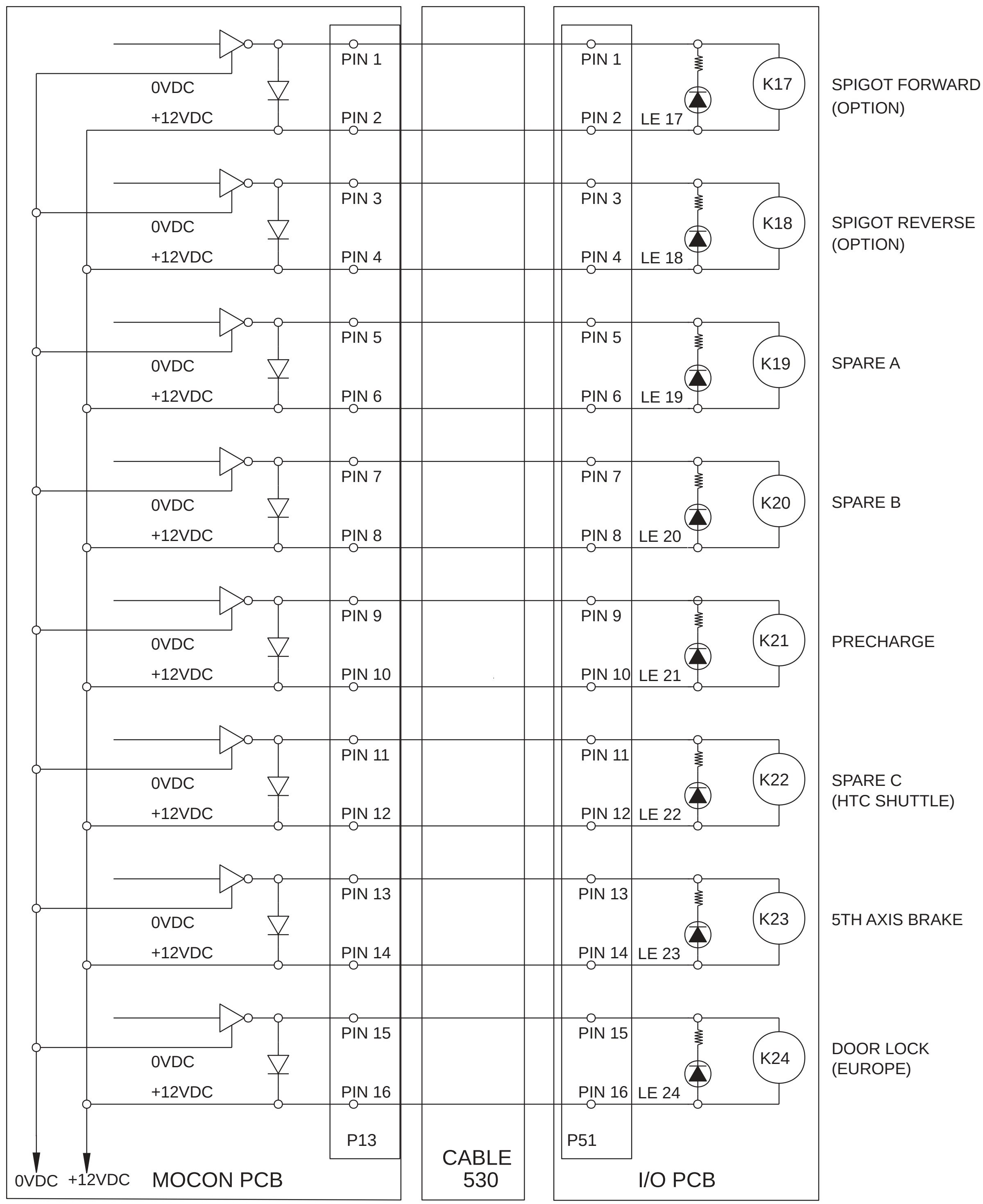


RELAY COIL DRIVERS, K1 THROUGH K8
HAAS AUTOMATION VF SERIES

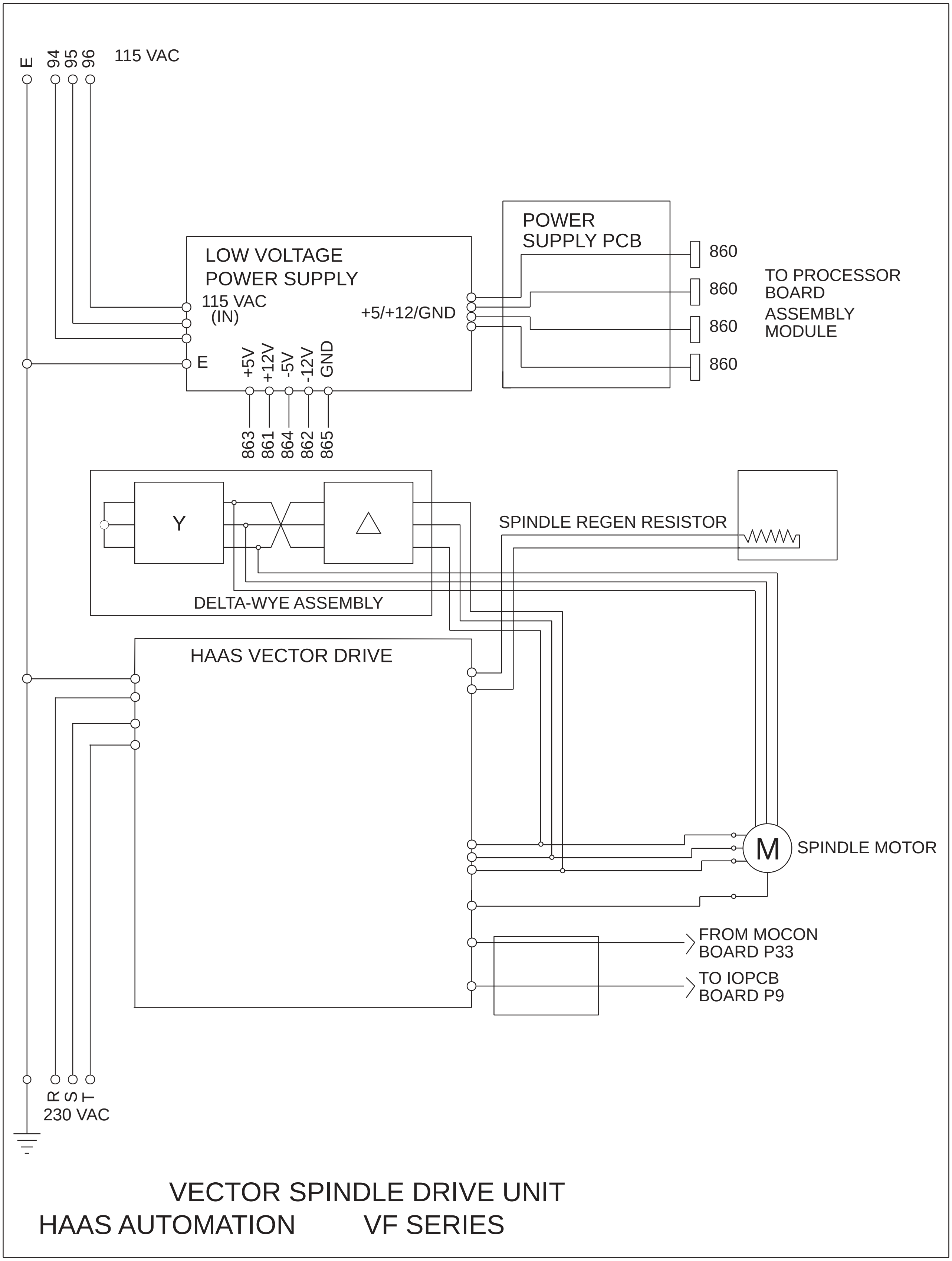


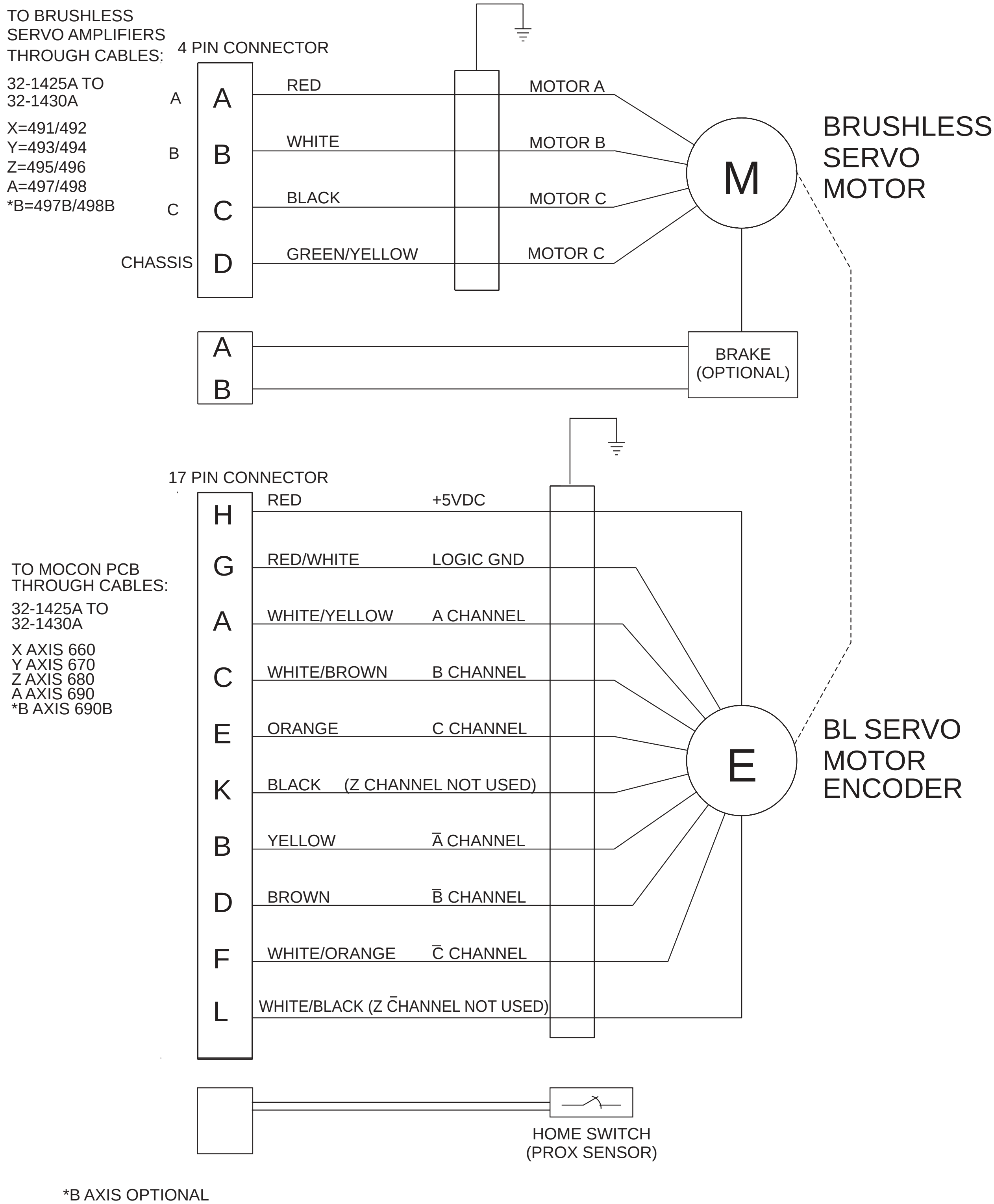
RELAY COIL DRIVERS, K9 THROUGH K16

HAAS AUTOMATION VF SERIES

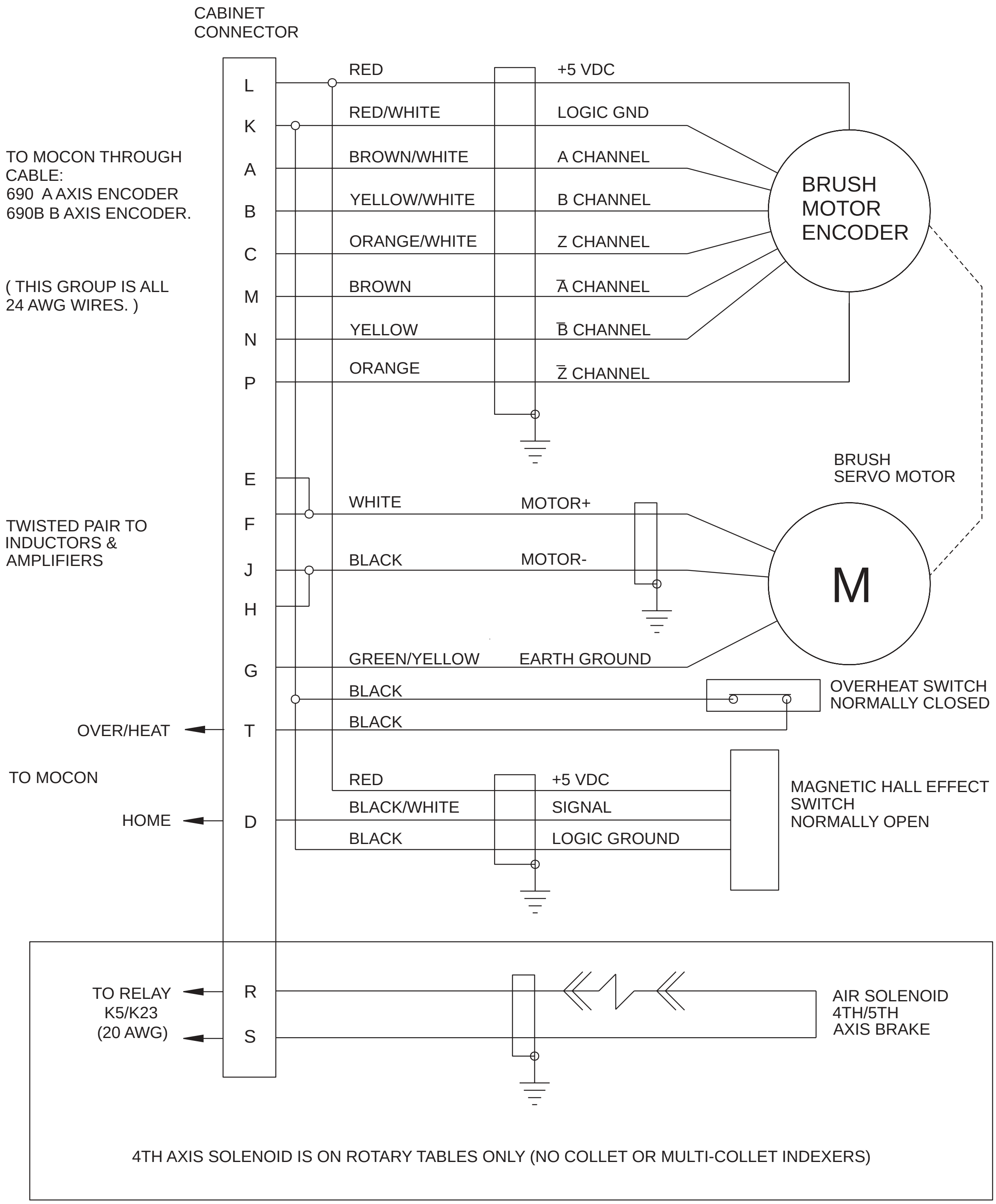


RELAY COIL DRIVERS, K17 THROUGH K24
HAAS AUTOMATION VF SERIES


E
94
95
96
115 VAC
LOW VOLTAGE
POWER SUPPLY
115 VAC
(IN)
+5/+12/GND
E
+5V
+12V
-5V
-12V
GND
863
861
864
862
865
POWER
SUPPLY PCB
860
860
860
860
TO PROCESSOR
BOARD
ASSEMBLY
MODULE
Y
SPINDLE REGEN RESISTOR
DELTA-WYE ASSEMBLY
HAAS VECTOR DRIVE
M
SPINDLE MOTOR
FROM MOCON
BOARD P33
TO IOPCB
BOARD P9
R
S
T
230 VAC
VECTOR SPINDLE DRIVE UNIT
HAAS AUTOMATION
VF SERIES

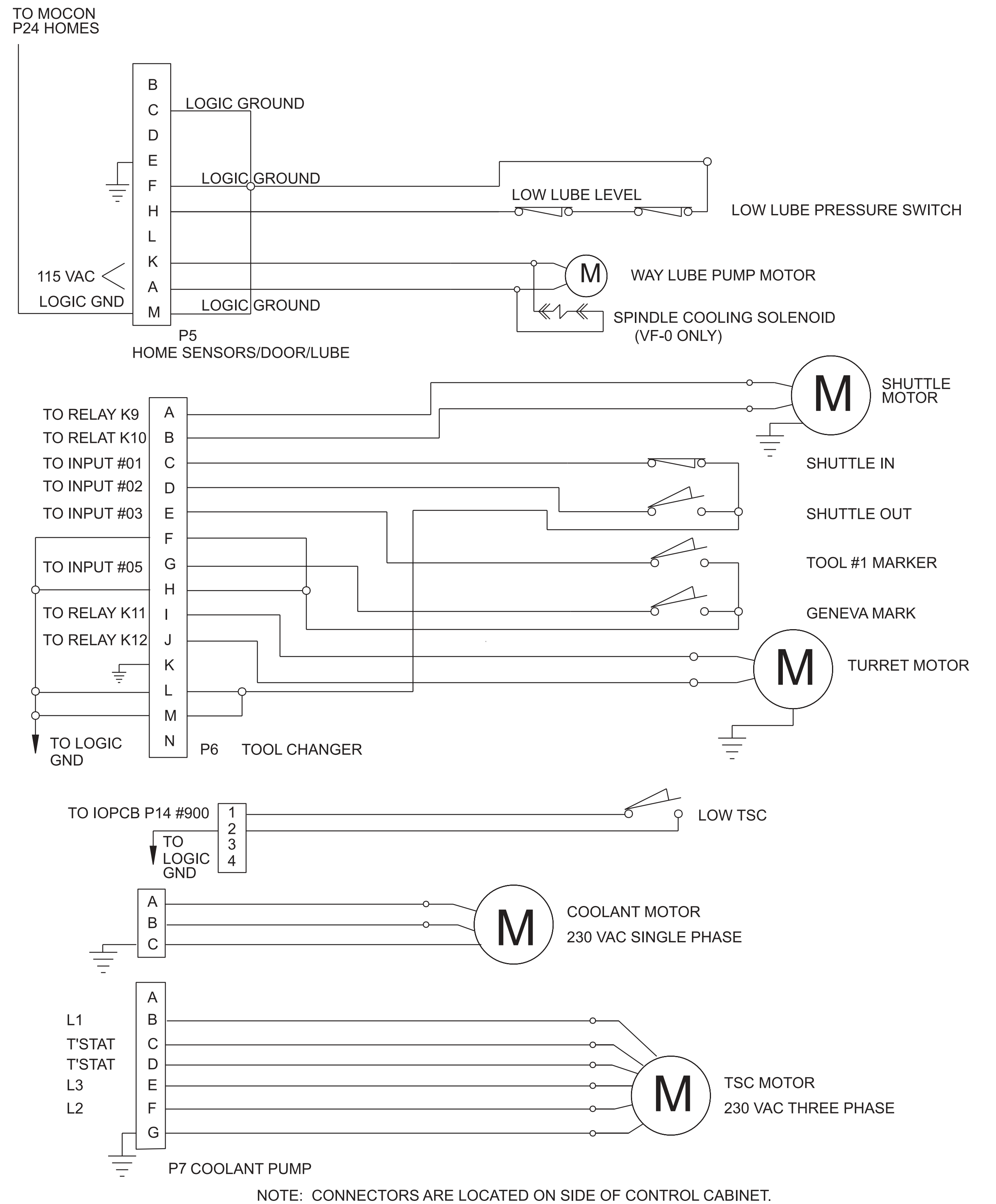


X/Y/Z AXIS BRUSHLESS MOTOR & ENCODER
HAAS AUTOMATION VF SERIES

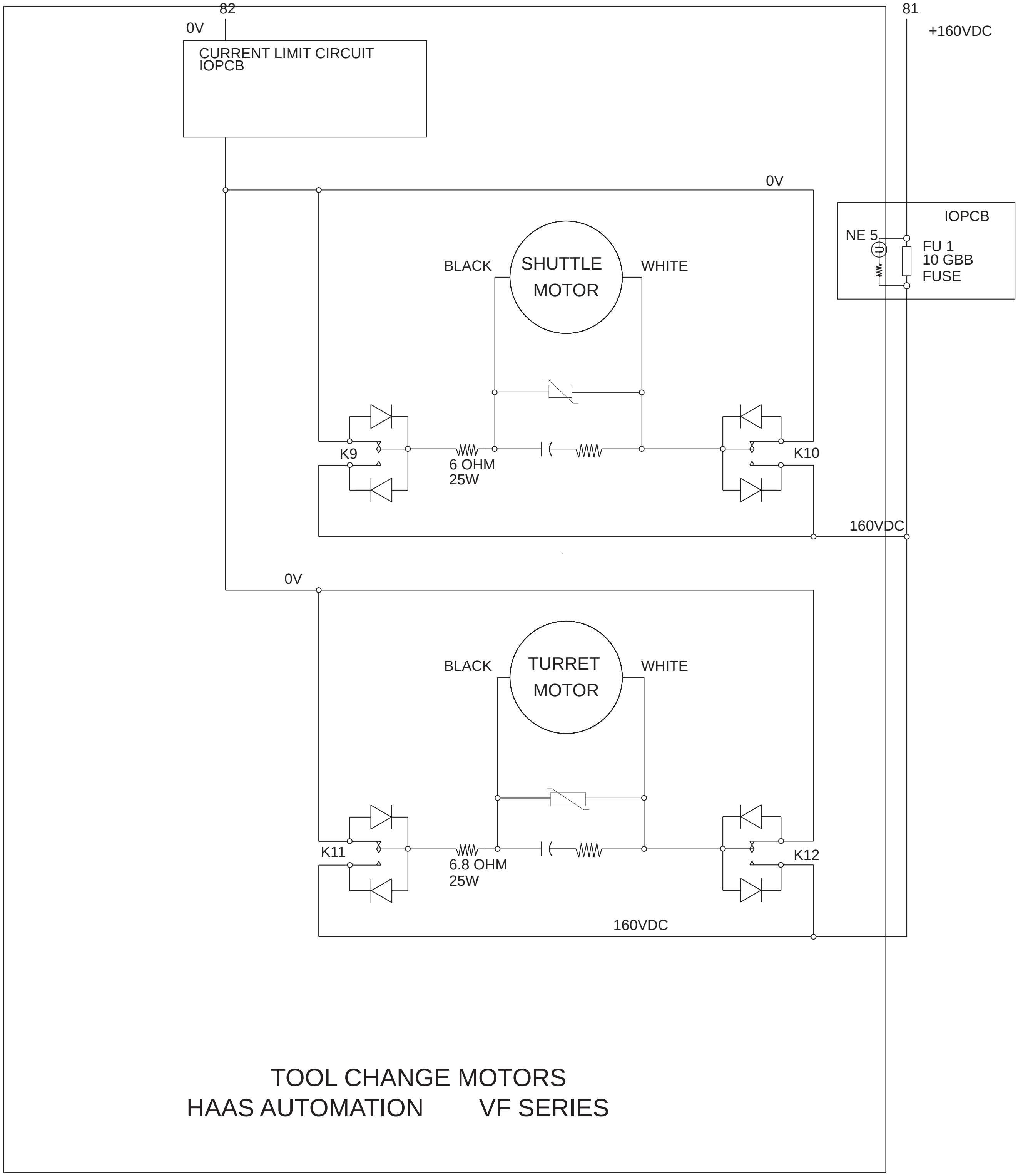


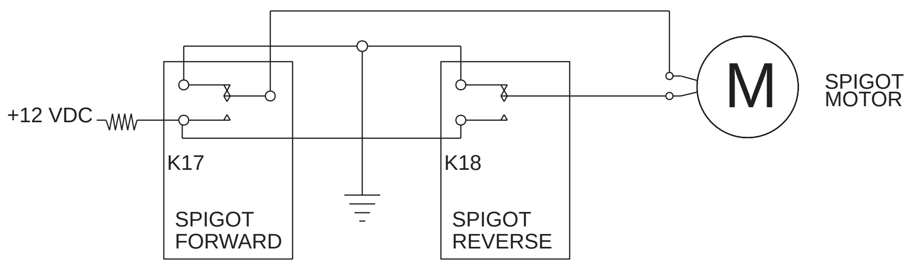
A/B AXIS (BRUSH MOTORS)

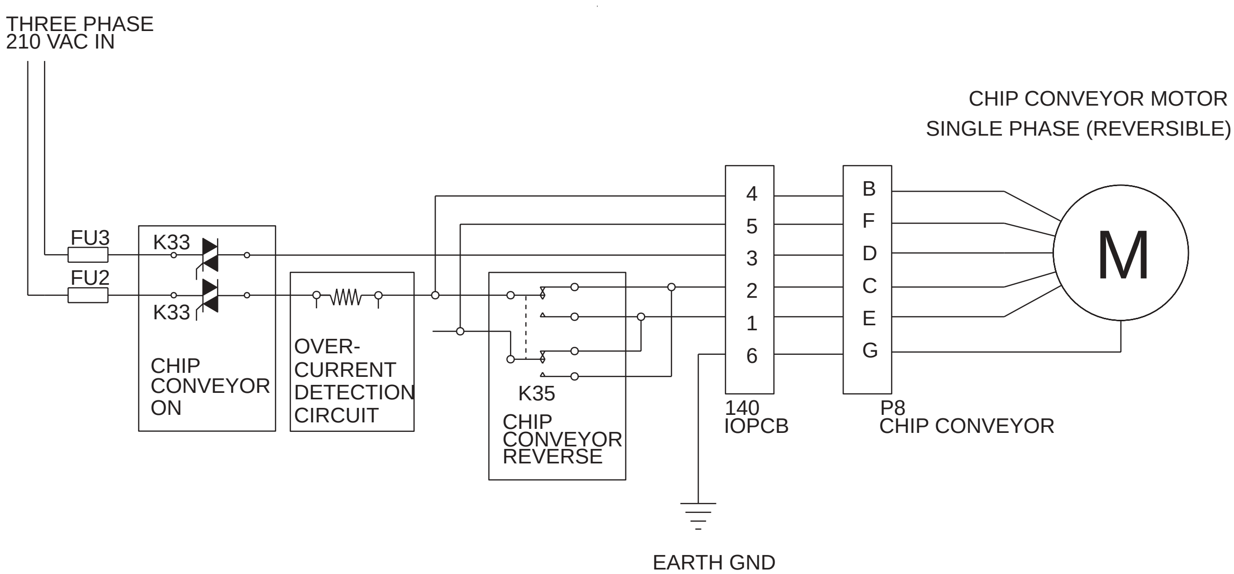
HAAS AUTOMATION VF SERIES



CABINET CONNECTORS
HAAS AUTOMATION VF SERIES

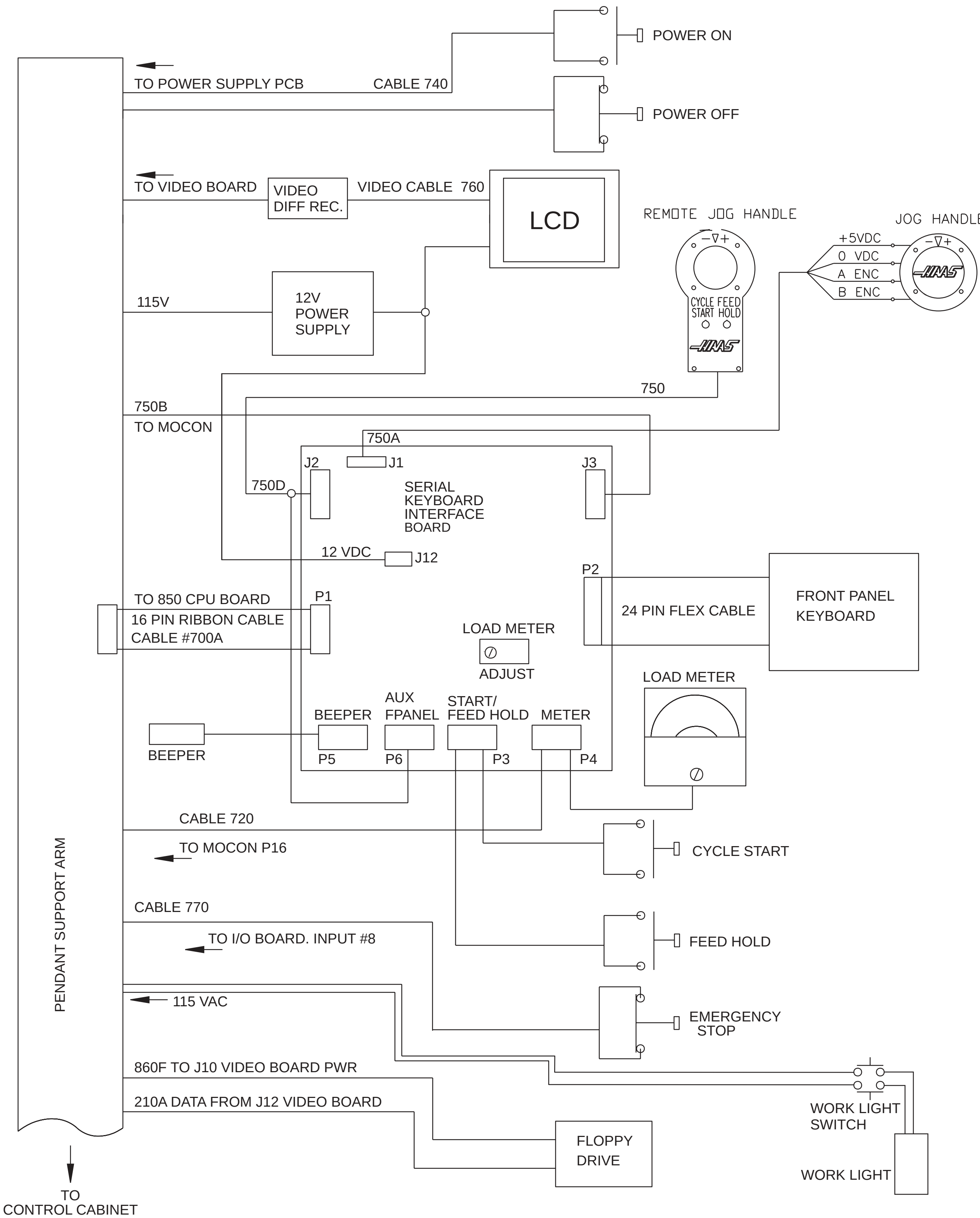

82
0V
CURRENT LIMIT CIRCUIT
IOPCB
81
+160VDC
0V
IOPCB
NE 5
FU 1
10 GBB
FUSE
BLACK
SHUTTLE
MOTOR
WHITE
K9
6 OHM
25W
K10
160VDC
0V
BLACK
TURRET
MOTOR
WHITE
K11
6.8 OHM
25W
K12
160VDC
TOOL CHANGE MOTORS
HAAS AUTOMATION
VF SERIES





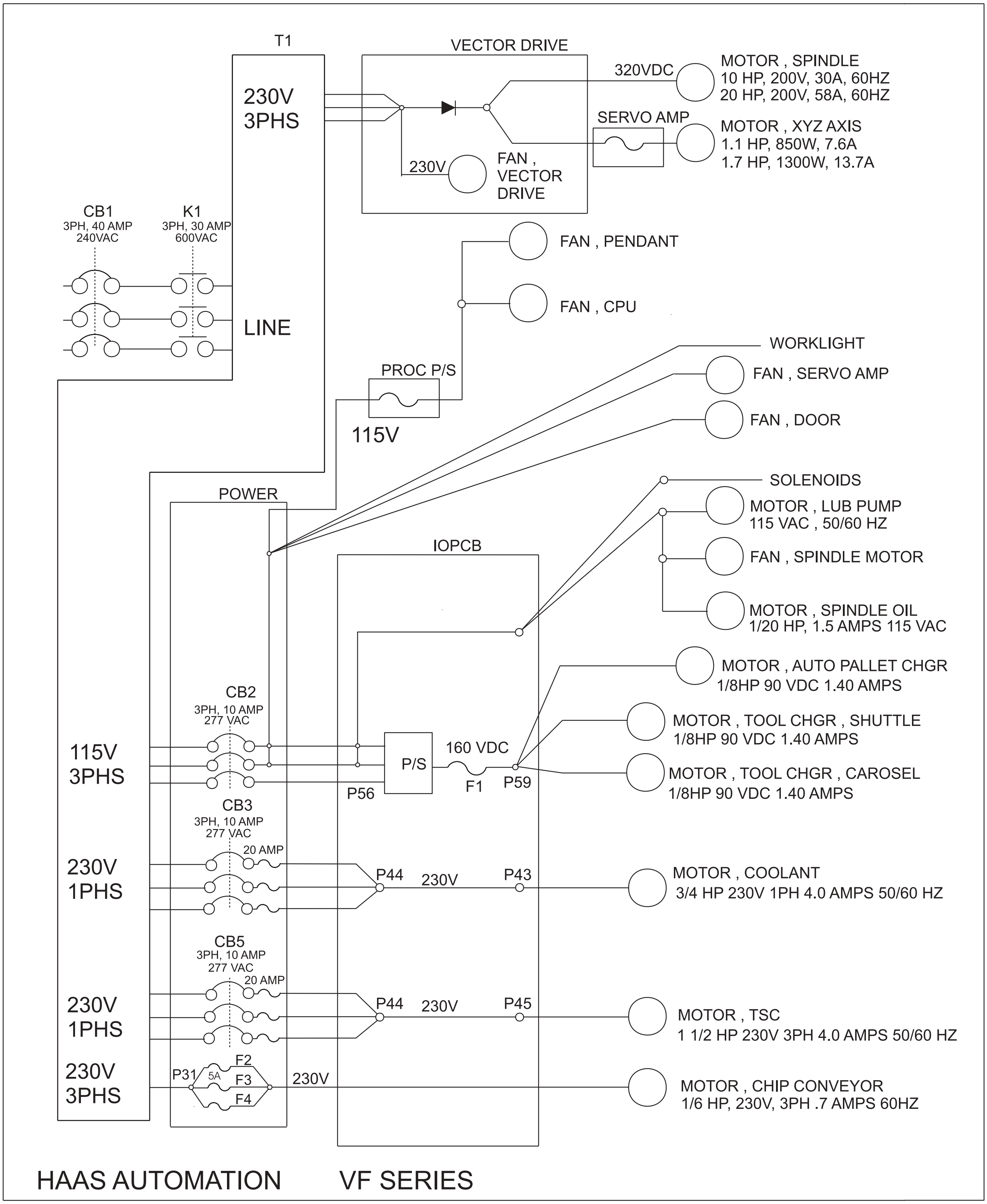
CHIP CONVEYOR AND SPIGOT MOTORS

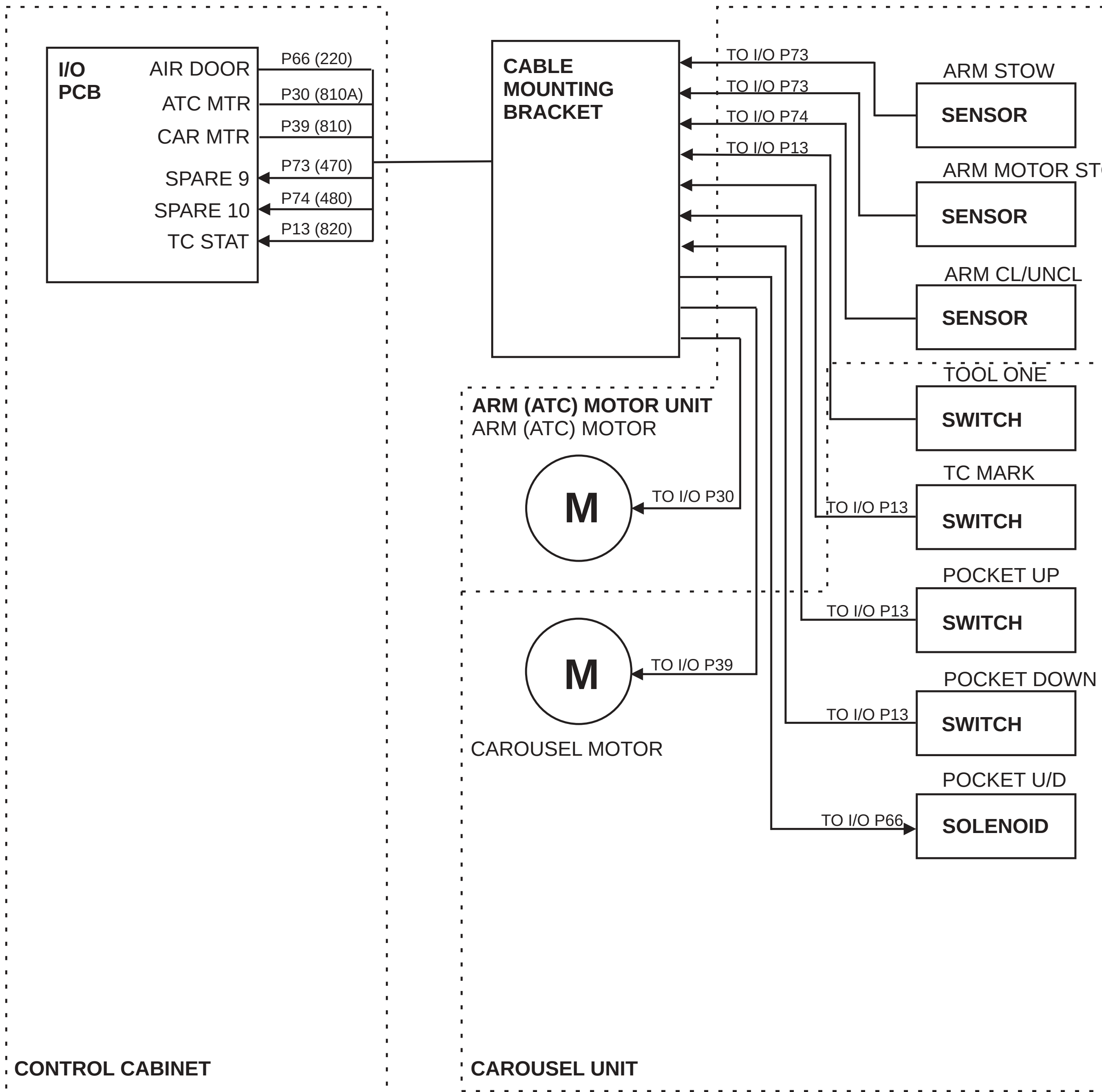
HAAS AUTOMATION VF SERIES



OPERATOR PENDANT

HAAS AUTOMATION VF SERIES

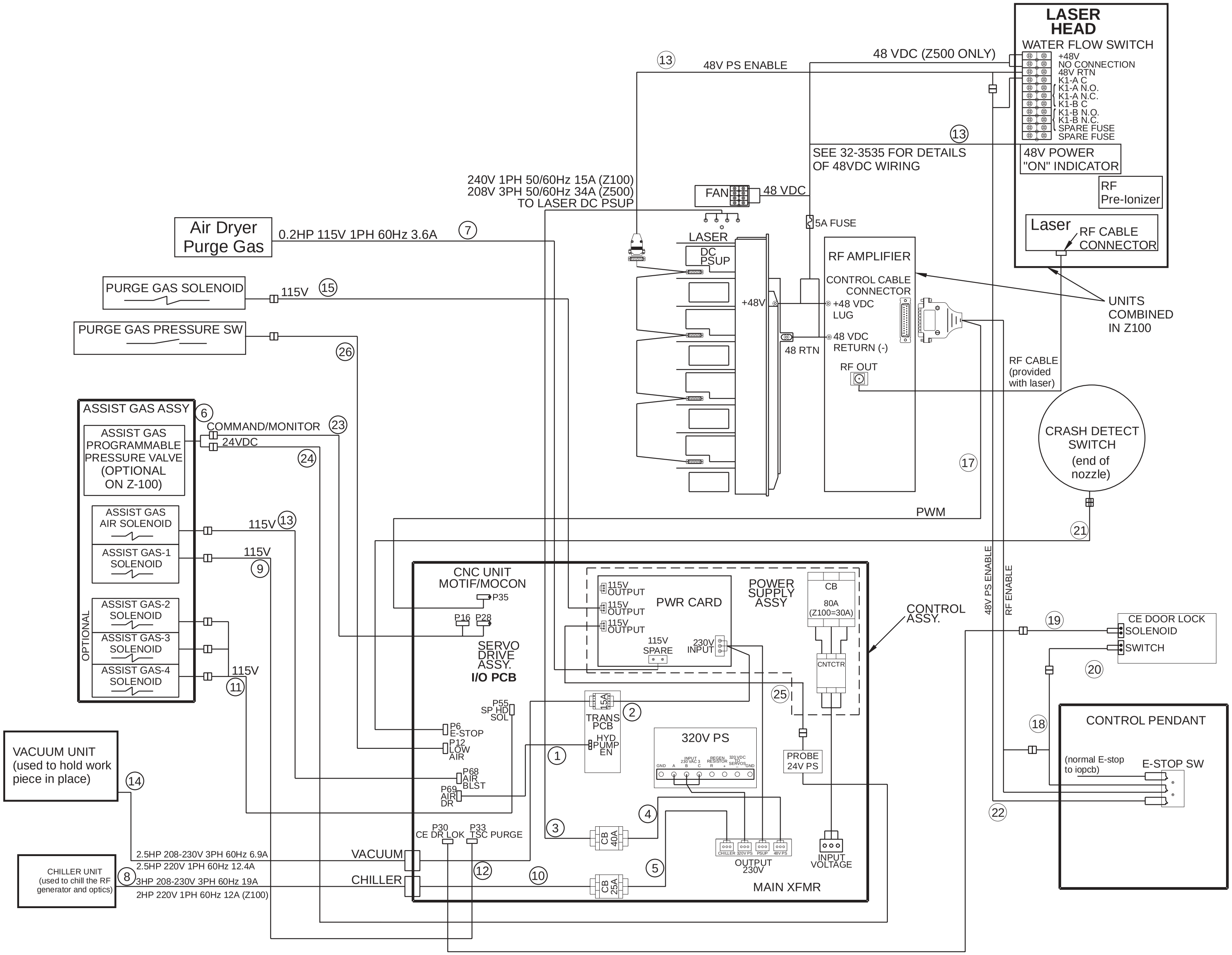

T1
230V
3PHS
VECTOR DRIVE
320VDC
MOTOR , SPINDLE
10 HP, 200V, 30A, 60HZ
20 HP, 200V, 58A, 60HZ
SERVO AMP
MOTOR , XYZ AXIS
1.1 HP, 850W, 7.6A
1.7 HP, 1300W, 13.7A
230V
FAN , VECTOR DRIVE
CB1
3PH, 40 AMP
240VAC
K1
3PH, 30 AMP
600VAC
LINE
FAN , PENDANT
FAN , CPU
WORKLIGHT
FAN , SERVO AMP
FAN , DOOR
PROC P/S
115V
POWER
SOLENOIDS
MOTOR , LUB PUMP
115 VAC , 50/60 HZ
FAN , SPINDLE MOTOR
IOPCB
MOTOR , SPINDLE OIL
1/20 HP, 1.5 AMPS 115 VAC
MOTOR , AUTO PALLET CHGR
1/8HP 90 VDC 1.40 AMPS
CB2
3PH, 10 AMP
277 VAC
115V
3PHS
P/S
160 VDC
F1
P56
P59
MOTOR , TOOL CHGR , SHUTTLE
1/8HP 90 VDC 1.40 AMPS
MOTOR , TOOL CHGR , CAROSEL
1/8HP 90 VDC 1.40 AMPS
CB3
3PH, 10 AMP
277 VAC
20 AMP
230V
1PHS
P44
230V
P43
MOTOR , COOLANT
3/4 HP 230V 1PH 4.0 AMPS 50/60 HZ
CB5
3PH, 10 AMP
277 VAC
20 AMP
230V
1PHS
P44
230V
P45
MOTOR , TSC
1 1/2 HP 230V 3PH 4.0 AMPS 50/60 HZ
230V
3PHS
P31
5A
F2
F3
F4
230V
MOTOR , CHIP CONVEYOR
1/6 HP, 230V, 3PH .7 AMPS 60HZ
HAAS AUTOMATION
VF SERIES



40/50 TAPER SIDE MOUNT TOOL CHANGER

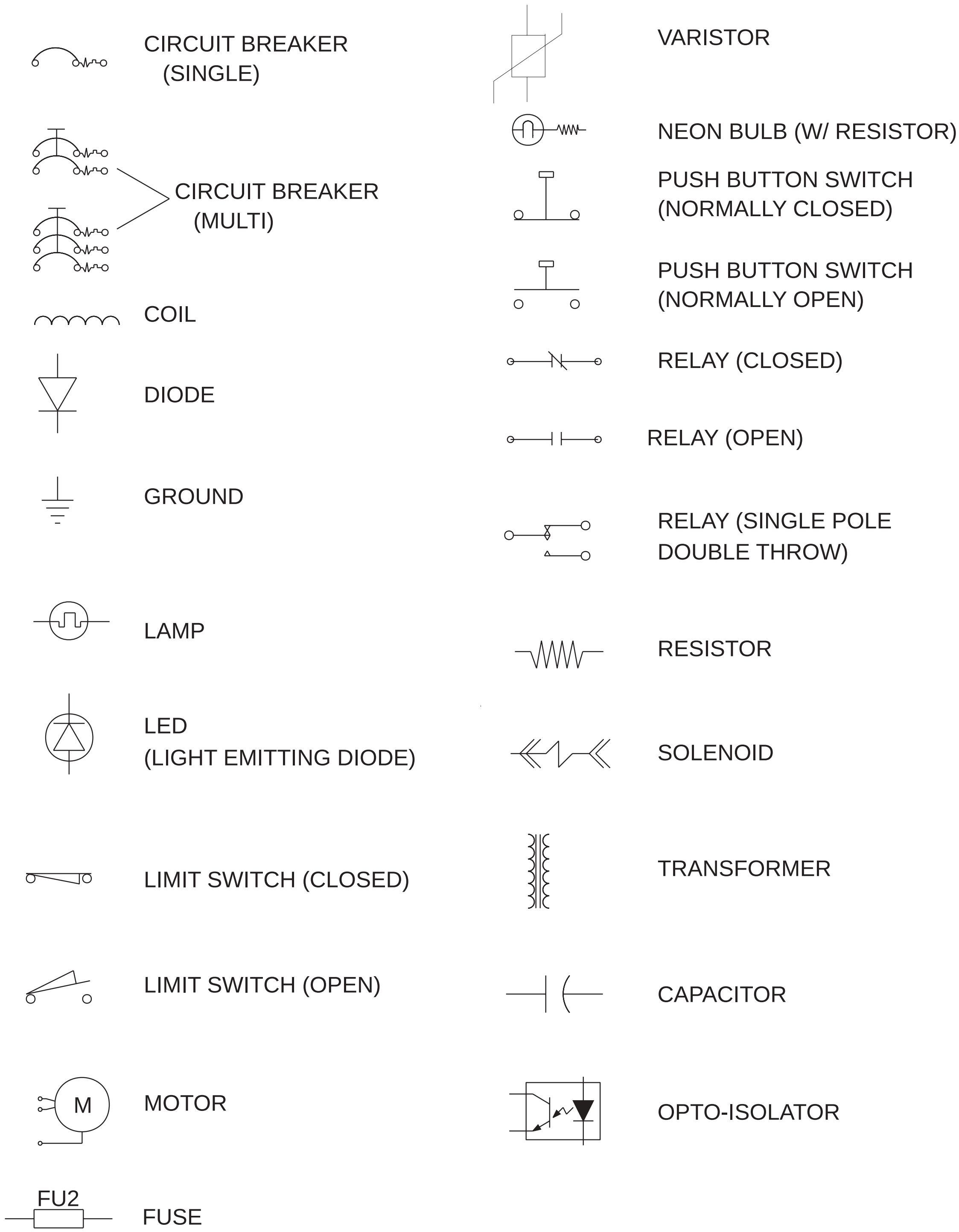
1/2001 HAAS AUTOMATION VF SERIES

LASER MACHINES



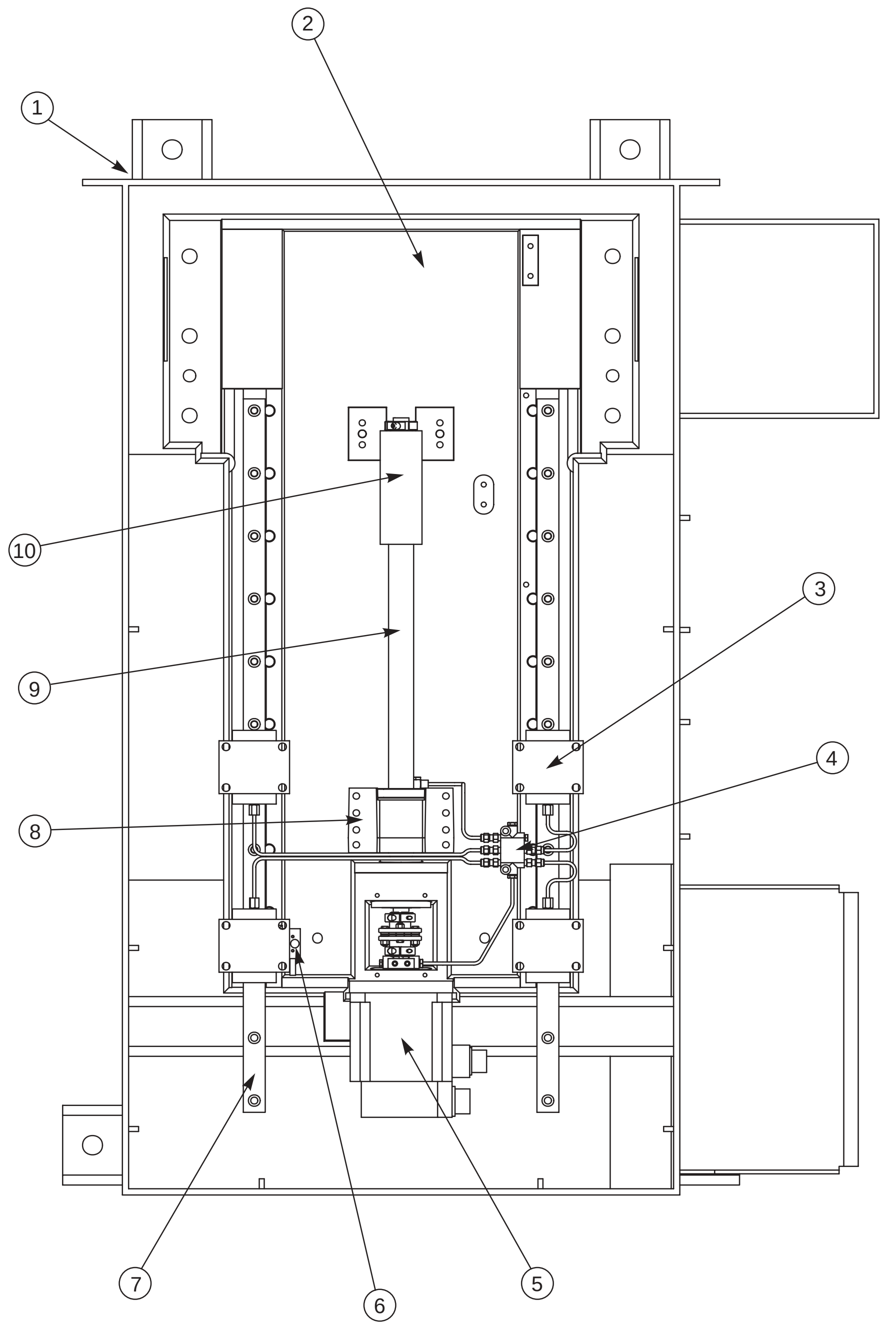
ITEM #	CABLE P/N	CABLE P/N
1	33-3x00	CBL VACUUM ENABLE ASSY Z2
2	33-3x01	CBL 230V 3PH PWR PS-VAC BRK
3	33-3x02	CBL 230VAC 3PH PWR TO DC PSUP Z-2
4	33-3x03	CBL 230V XFRM TO DC PS BRKR Z-2
5	33-3x04	CBL 230V XFRM TO CHILLER BRKR Z-2
6	32-3x05	CBL CNTRLD PRES VLV ASSY
7	33-3x07	CBL90A 115V TO AIR DRYER
8	32-3x08	CBL 230V 3PH TO CHILLER ASSY
9	33-3x08	CBL270 115V SOL ASSIST GAS-1
10	32-3x09	CBL77-78 230V CHILLER RECPTCL
11	33-3x09	CBL880A 115V SOL ASSIST GAS-2,3,4
12	32-3x10A	CBL341-343 230V VACUUM RCPTCL
13	33-3x10	CBLM27 115V SOL ASSIST GAS AIR
14	32-3x11A	CBL 230V 3PH VACUUM ASSY
15	33-3x11	CBL90C PURGE GAS SOL
16	33-3x13	DC PSUP EN CBL
17	33-3x14	CBL610 MODULATION INPUT SIGNAL Z-2
18	33-3x15	RF ENABLE EXT. CBL
19	33-3x19	CBL1040 INTLK SOL PWR
20	33-3x20	CBL INTRLK SW
21	33-3x32	CBL CRASH DETECTOR EXT
22	33-3x34	CBL LASER DC PSUP EN-ESTOP
23	33-3x39	CBL ASSIST GAS CNTLD VALVE CNTL SIG
24	32-9122	CBL ASSIST GAS CNTLD VALVE 24V
25	33-1910A	CBL90 115V TO PROBE PS
26	33-3525	CBL950 PURGE GAS PRES SW
27	33-3x23	48V LED ASSY

NOTE: -35xx FOR Z-500, -39xx FOR Z-100



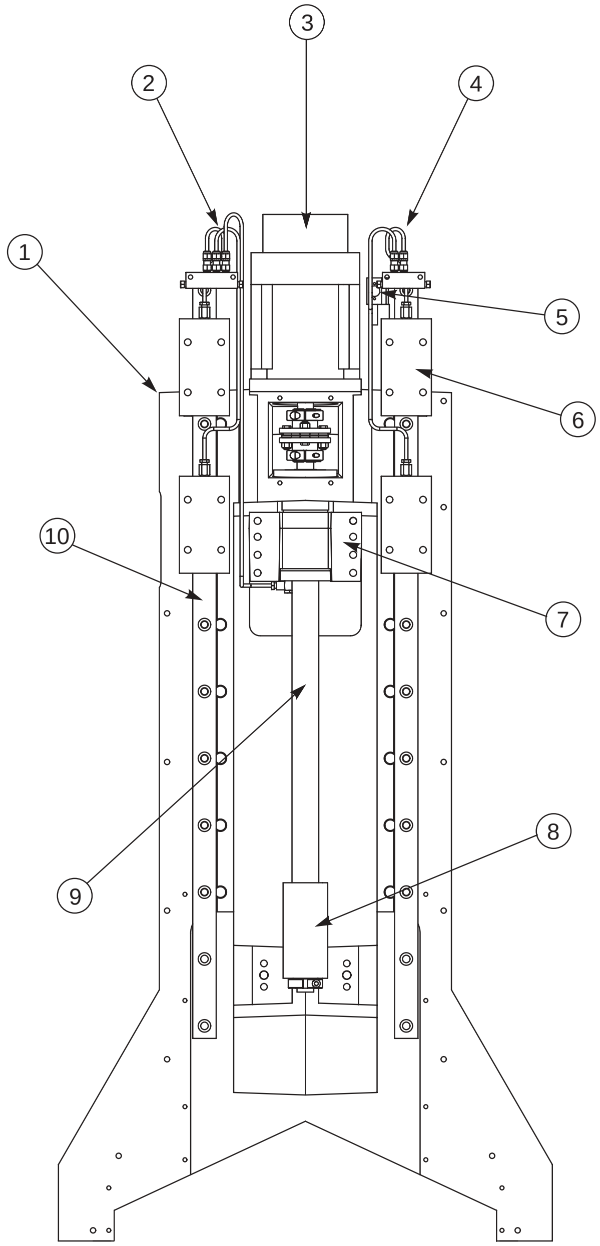
ELECTRICAL SYMBOLS
HAAS AUTOMATION VF SERIES

ASSEMBLY DRAWINGS



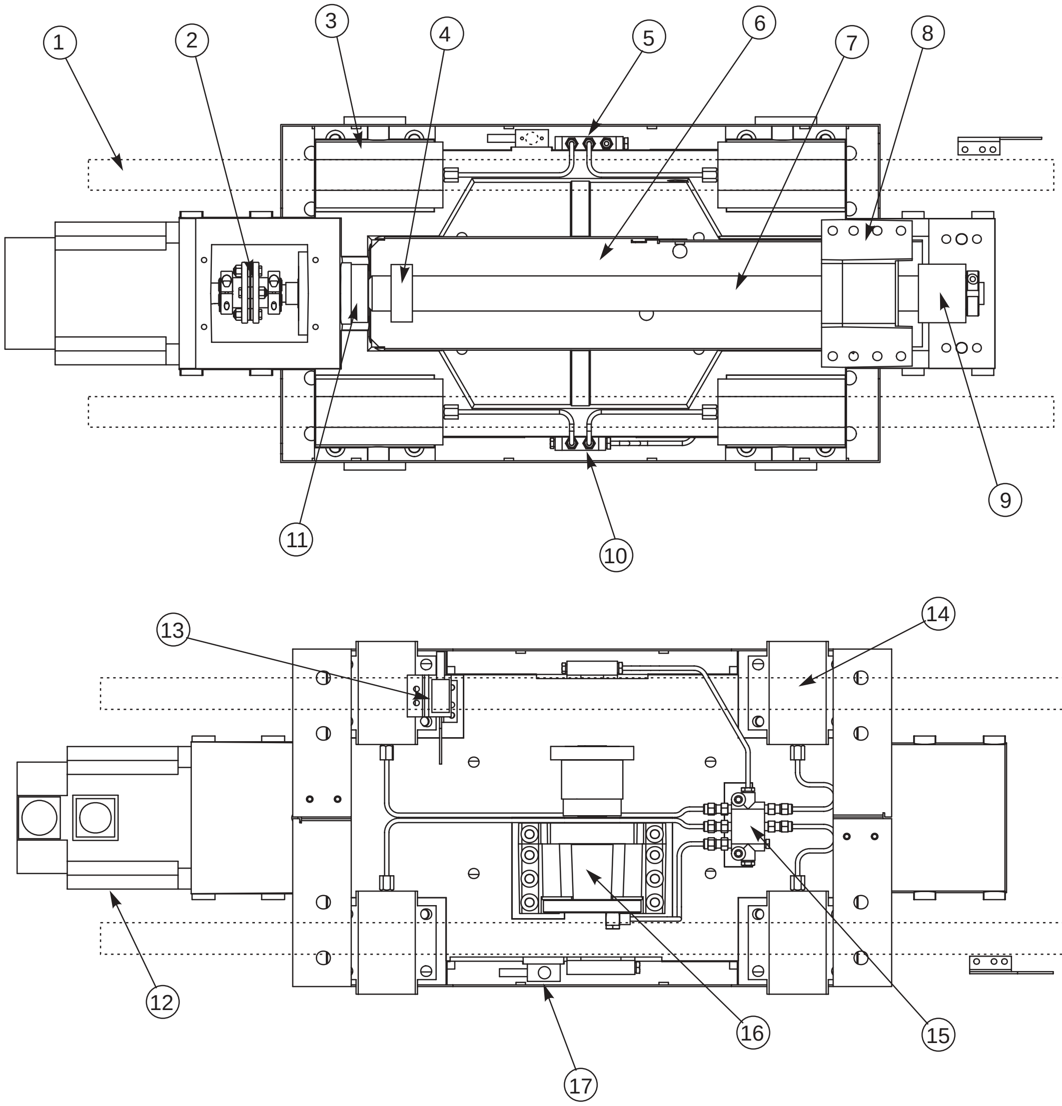
1. 20-3005C Base
2. 20-3000 Casting
3. 50-0011 Y-axis runner block
4. 30-1752 Lube line assy
5. 62-0014 Y-axis motor
6. 32-2131 Limit switch
7. 50-3007 Linear Guide
8. 20-7008F Nut housing
9. 24-3006 Ballscrew
10. 20-3018 Bumper Y-axis

Mini-Mill Base



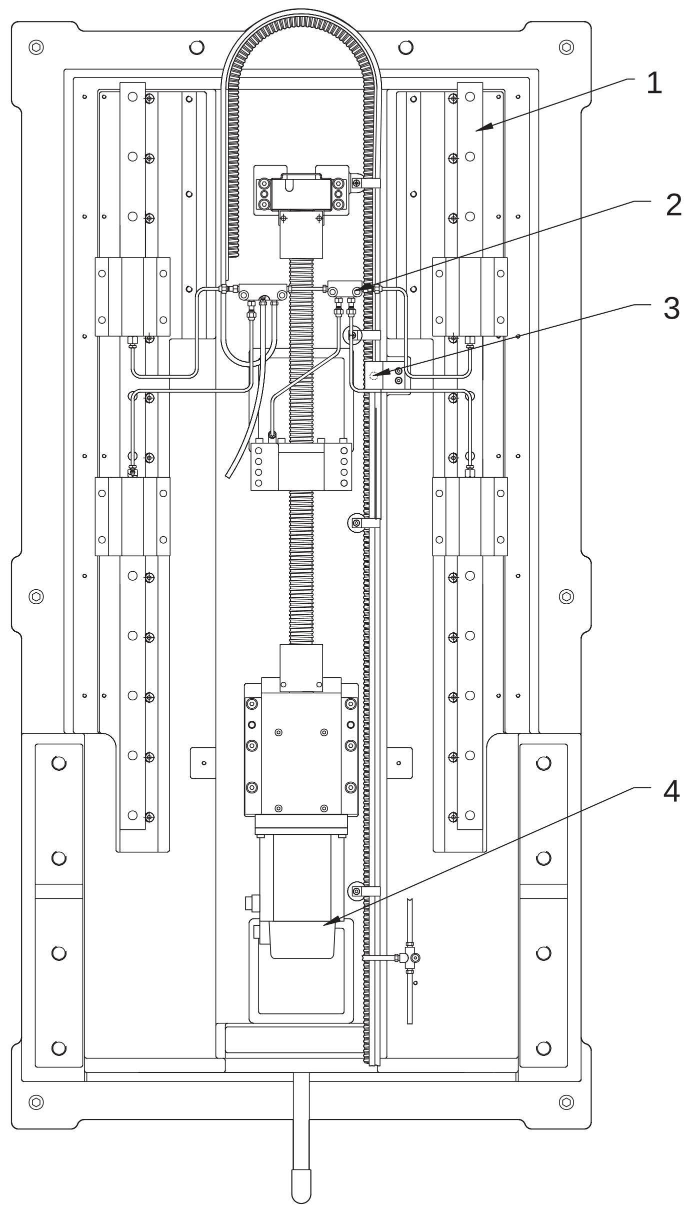
1. 20-3001 Column casting
2. 30-3048 Oil line assembly
3. 62-0009 Z-axis motor
4. 30-3049 Oil line assembly
5. 32-2130 Limit Switch
6. 50-0010 Runner block
7. 20-7008F Nut housing
8. 20-3019 Bumper Z-axis
9. 25-7273 Ballscrew assembly
10. 50-3007 Linear guide

Mini-Mill Column



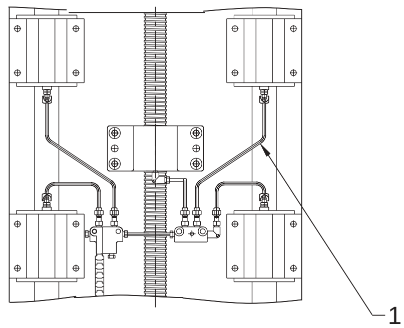
1. 50-3007 Linear guide
2. 30-1220 Coupling assembly
3. 50-0010 Runner block
4. 20-0505 Floating bumper
5. 30-1751 Lube line assembly
6. 25-0659 Carrier tray
7. 24-3006A Ballscrew
8. 20-7008F Nut Housing
9. 20-3017 Bumper, X-axis
10. 30-1750 Lube line assembly
11. 30-0154 Motor bearing assembly
12. 62-0014A X-axis motor
13. 32-2131 Limit switch
14. 50-0011 Runner block
15. 30-1752 Lube line assembly
16. 20-7008F Nut housing
17. 32-2130 Limit switch

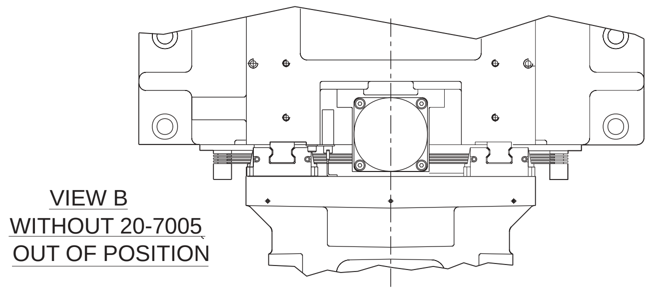
Mini- Mill Saddle

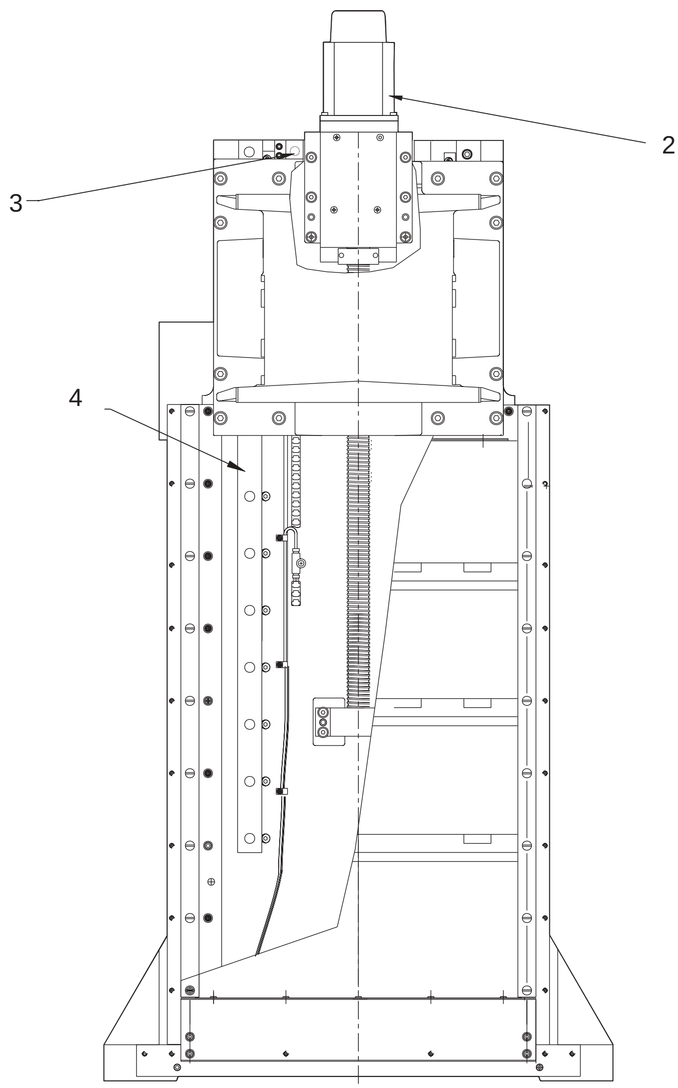


1. 50-3300 Linear guide
2. 30-0171 Oil line assembly
3. 32-2030 Switch assembly
4. 62-0014 Motor (except XRT)

VF-1 Base

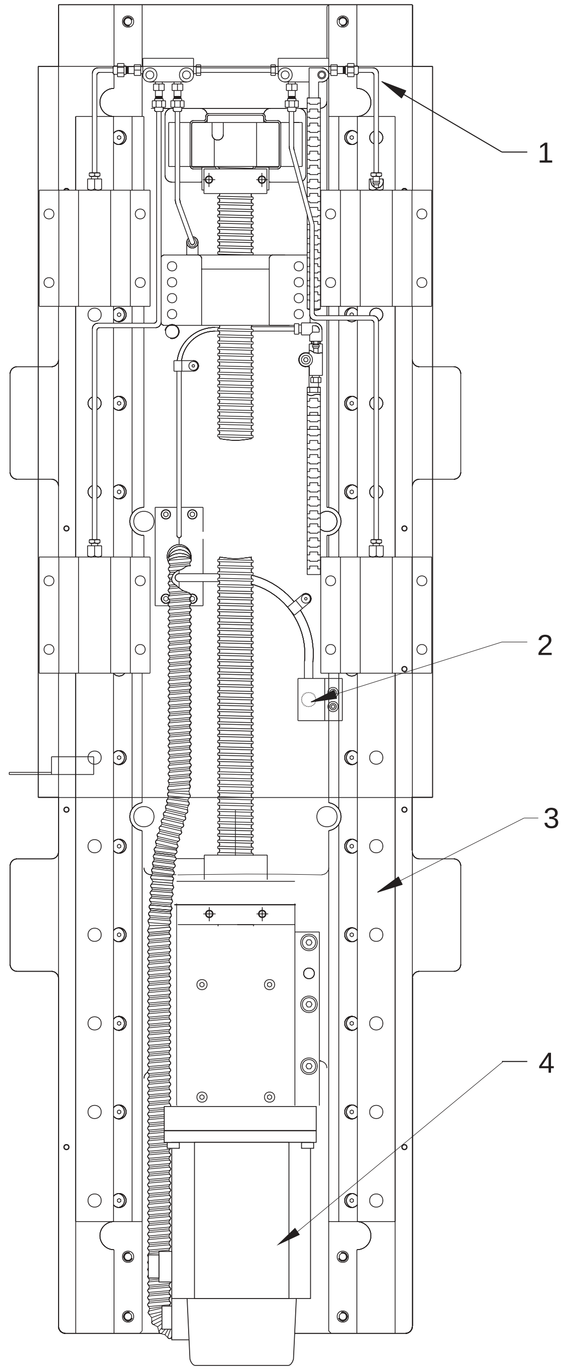






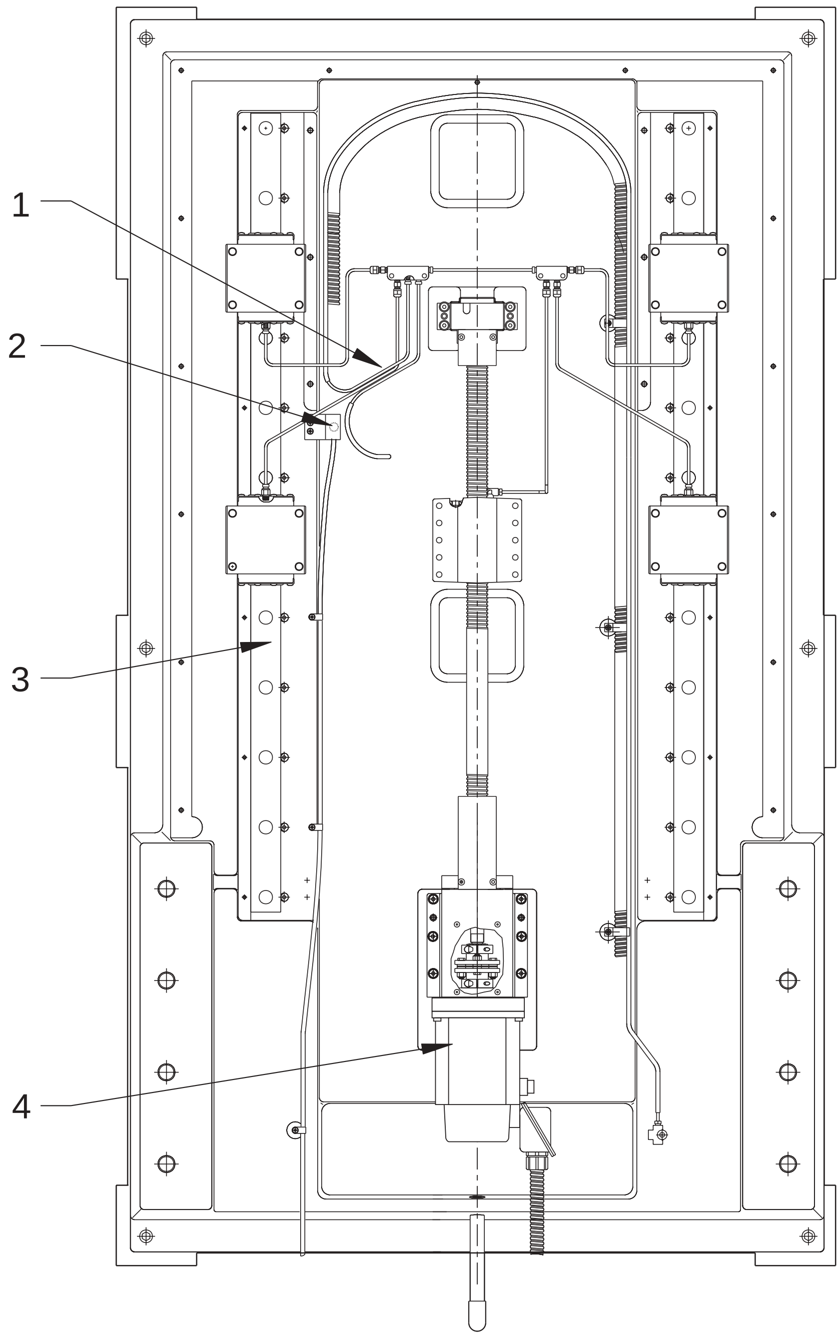
1. 30-0170 Oil line assembly
2. 62-0009 Motor (except XRT)
3. 32-2040 Switch assembly
4. 50-3300 Linear guide

VF-1 Column



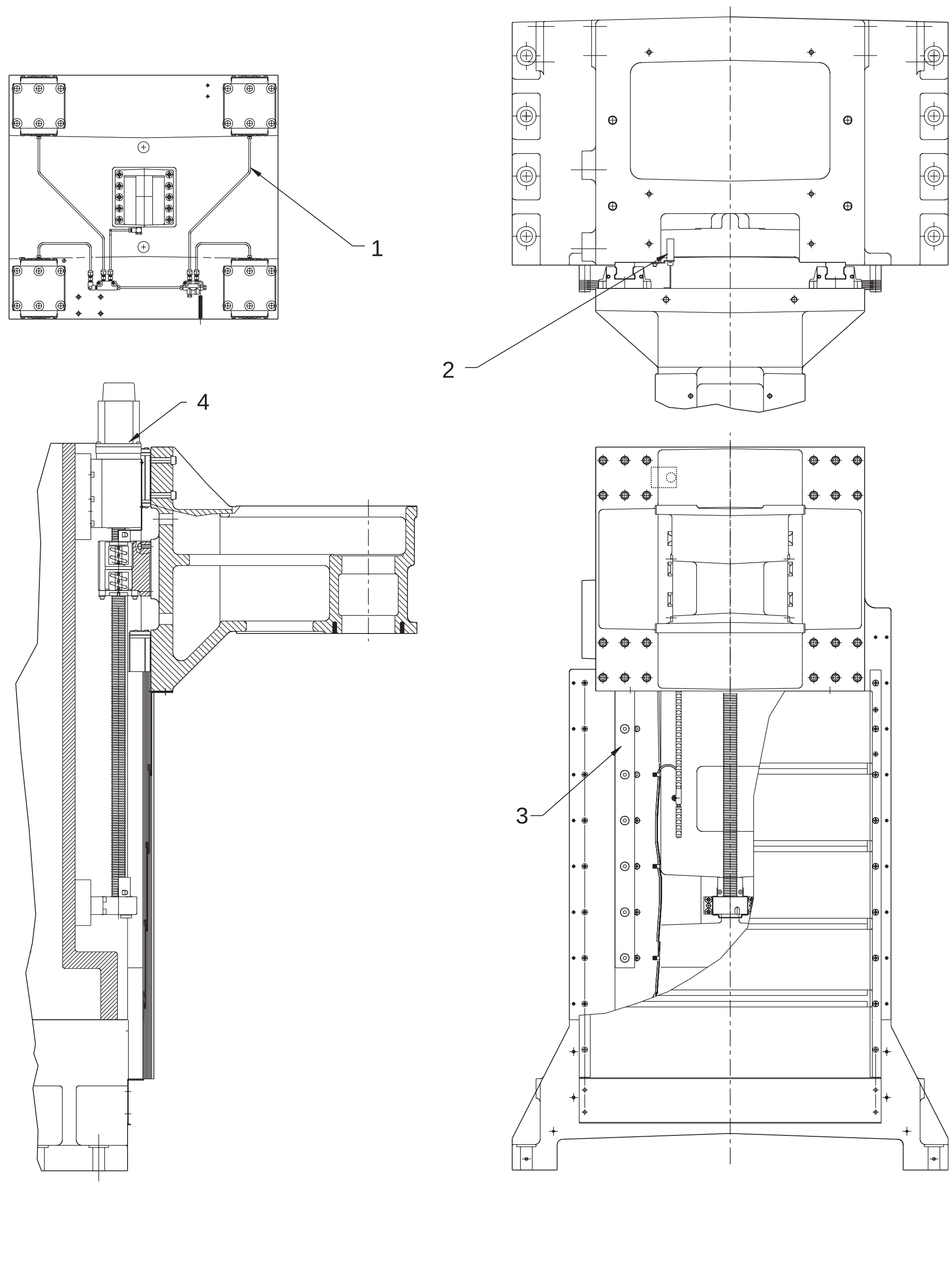
1. 30-0173 Oil line assembly
2. 32-2050 Switch
3. 50-3300 Linear guide
4. 62-0014 Motor (except XRT)

VF-1 Saddle



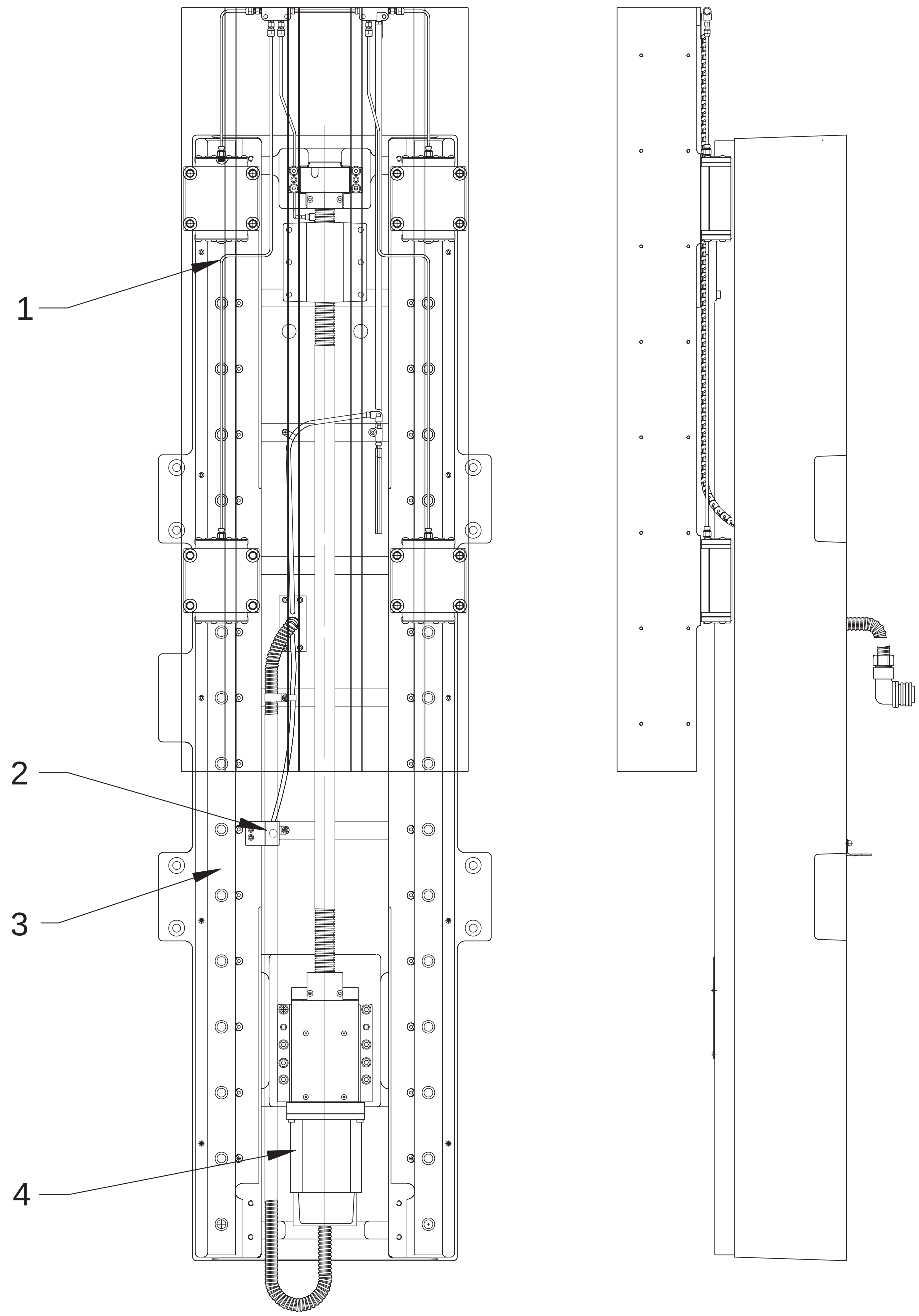
1. 30-0221 Oil line assembly
2. 32-2031 Switch assembly
3. 50-9011 Linear guide
4. 62-0014 Motor assembly (except XRT)

VF-3 Base



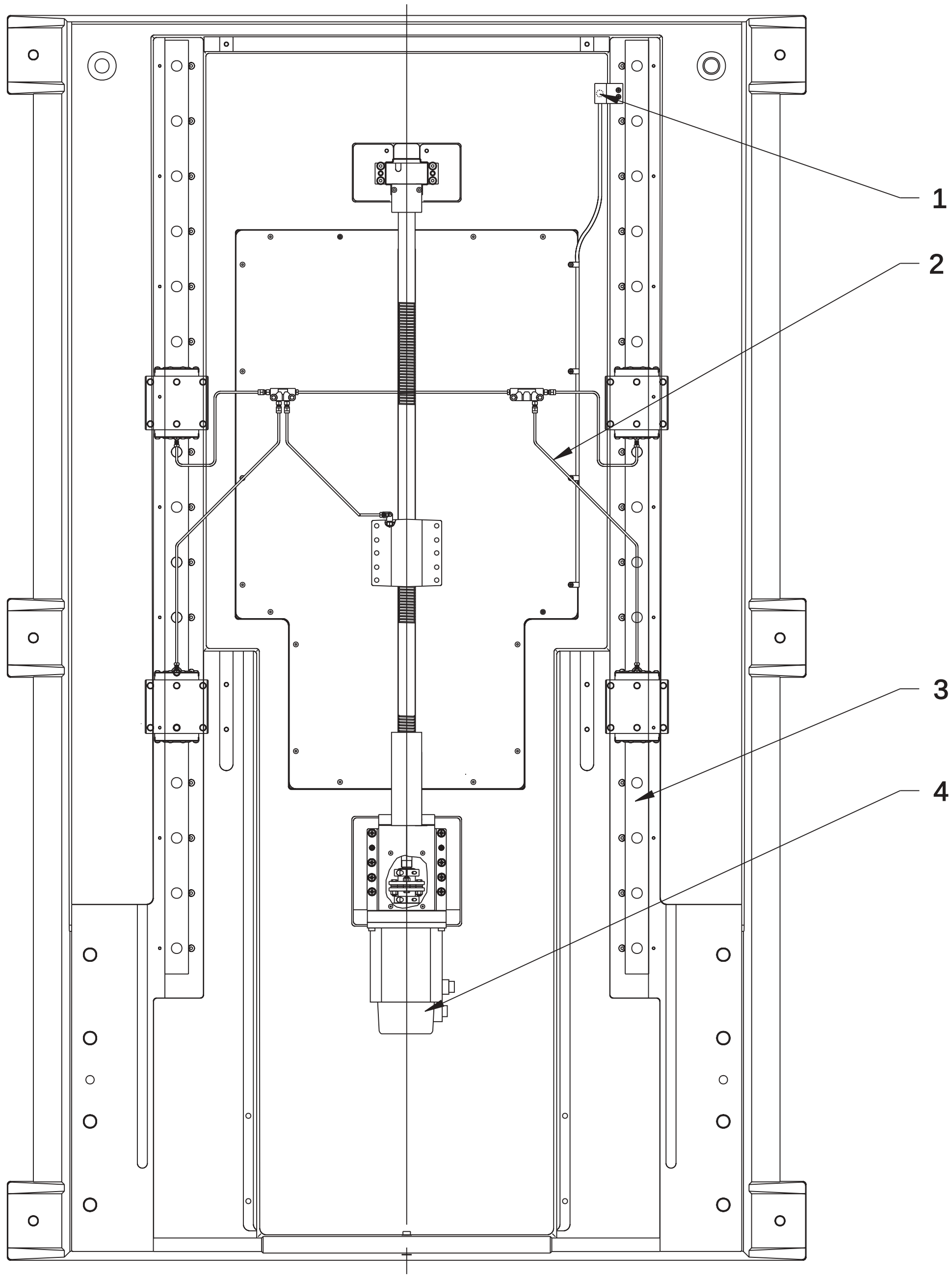
1. 30-0687 Oil line assembly
2. 32-2041 Switch assembly
3. 50-9011 Linear guide
4. 62-0014 Motor (except XRT)

VF-3 Column



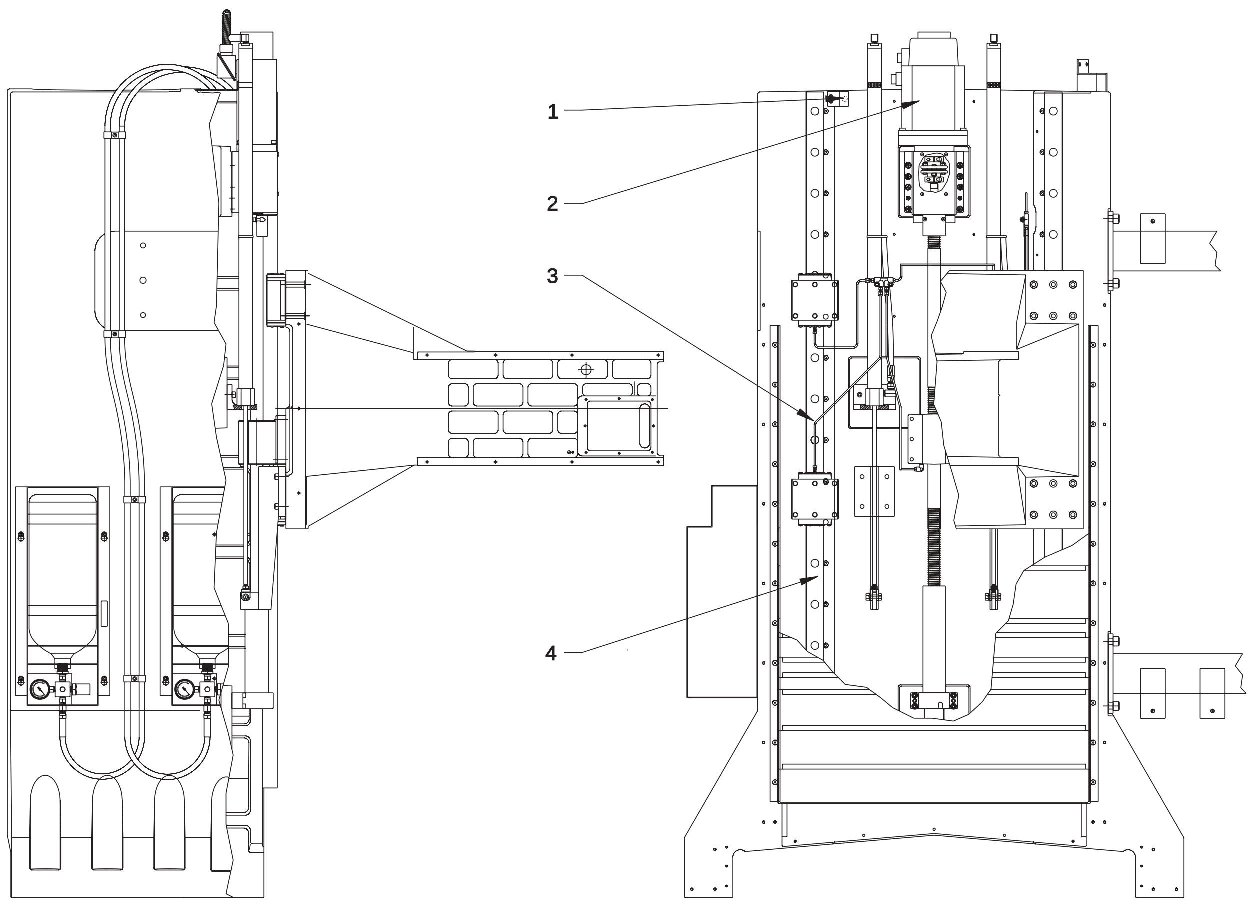
1. 30-0223 Oil line assembly
2. 32-2050 Switch assembly
3. 50-9010 Linear guide
4. 62-0014 Motor (except XRT)

VF-3 Saddle



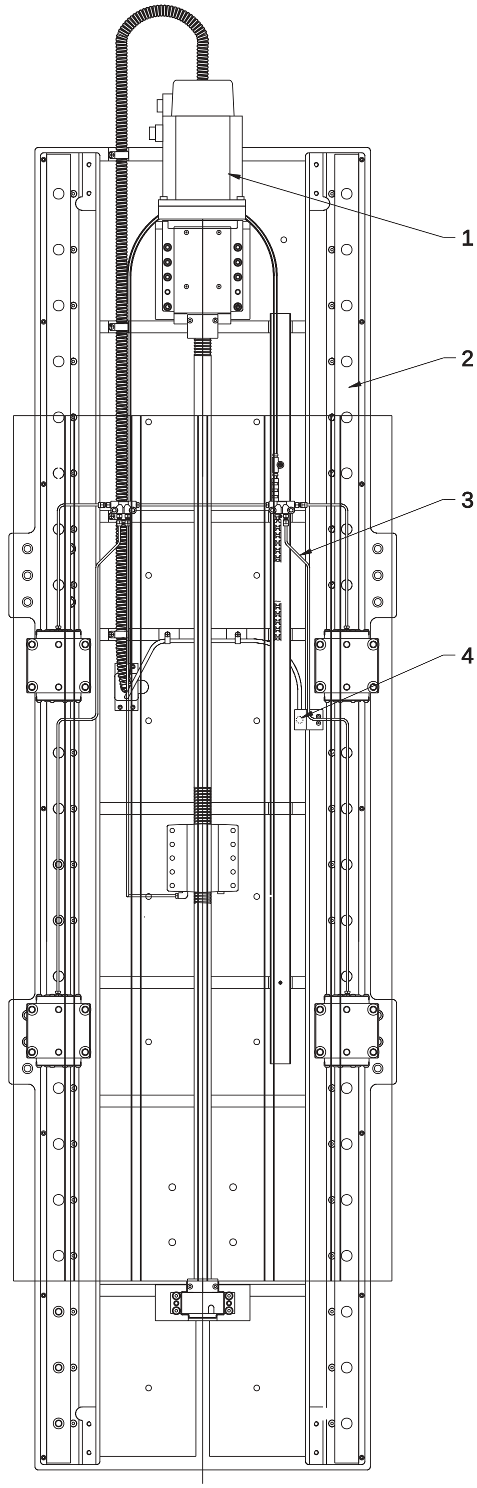
1. 32-5056 Limit switch assembly
2. 30-0221 Oil line assembly
3. 50-9010 Linear guide
4. 62-0014 Motor (except XRT)

VF-6 Base



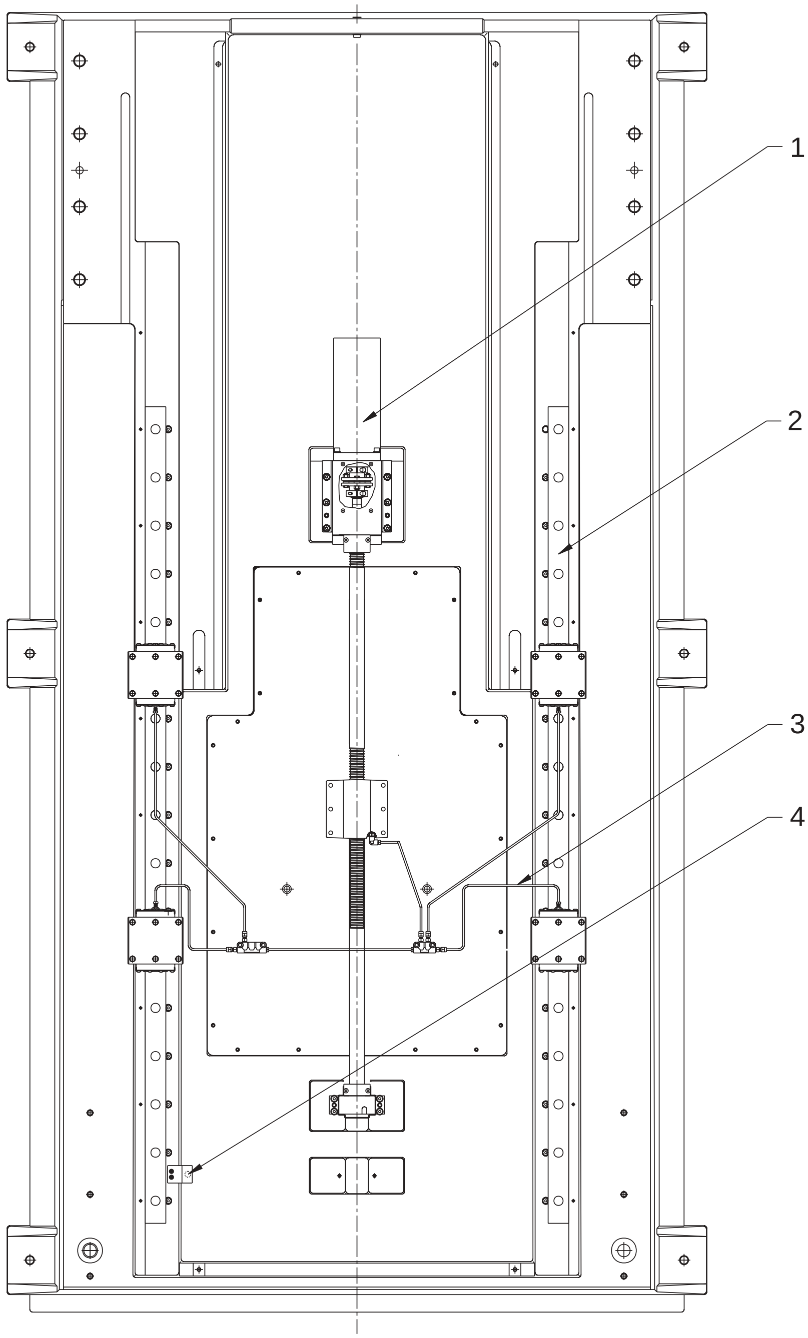
1. 32-2050 Limit switch assembly
2. 62-0014 Motor (except XRT)
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide

VF-6 Column



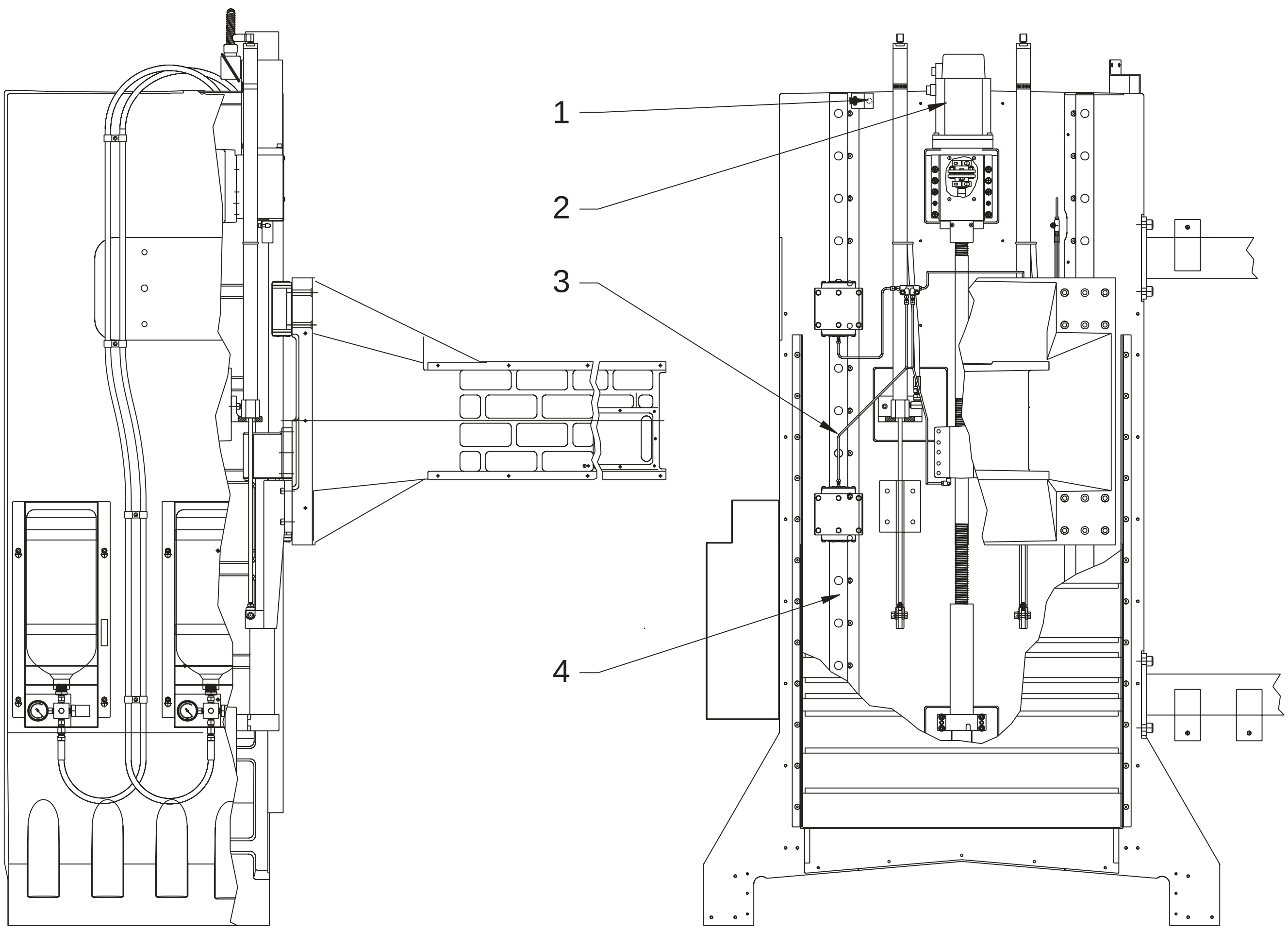
1. 62-0014 Motor (except XRT)
2. 50-9806 Linear guide
3. 30-0463 Oil line assembly
4. 32-2051 Limit switch assembly

VF-6 Saddle



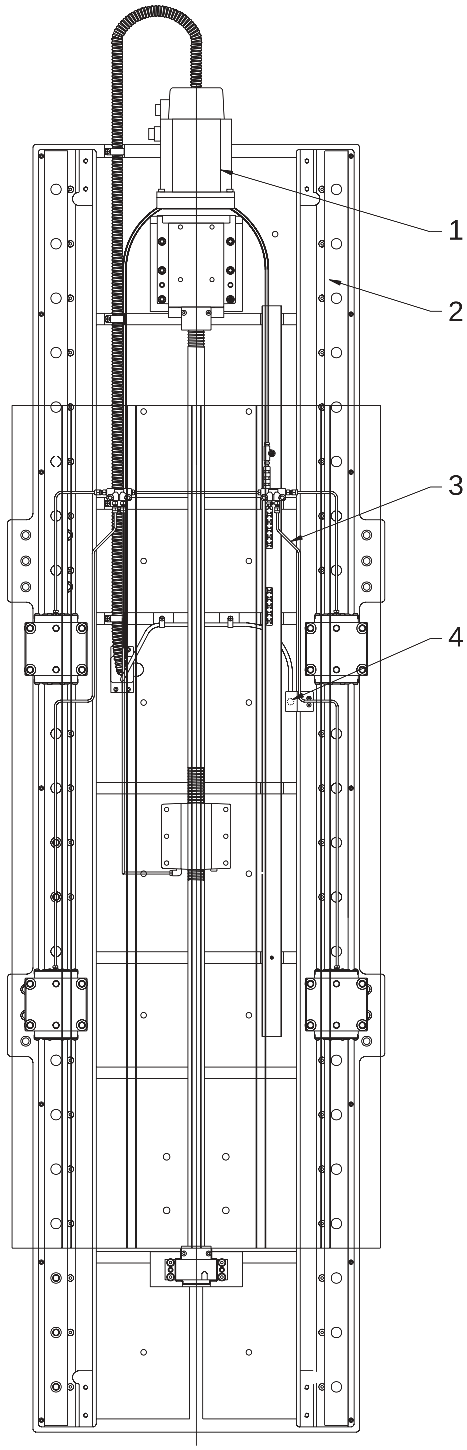
1. 62-0014 Motor (except XRT)
2. 50-9010 Linear guide
3. 30-0461 Oil line assembly
4. 32-5056 Limit switch assembly

VF-8 Base



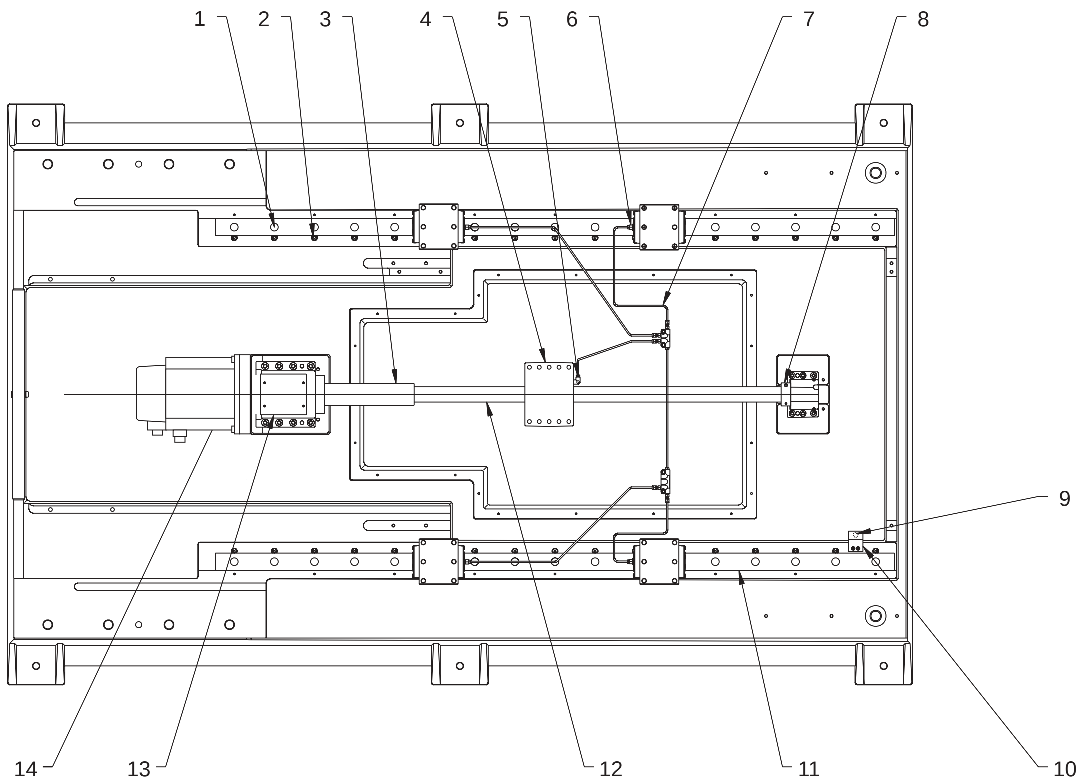
1. 32-2050 Limit switch assembly
2. 62-0014 Motor (except XRT)
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide

VF-8 Column



1. 62-0014 Motor (except XRT)
2. 50-9806 Linear guide
3. 30-0463 Oil line assembly
4. 32-2051 Limit switch assembly

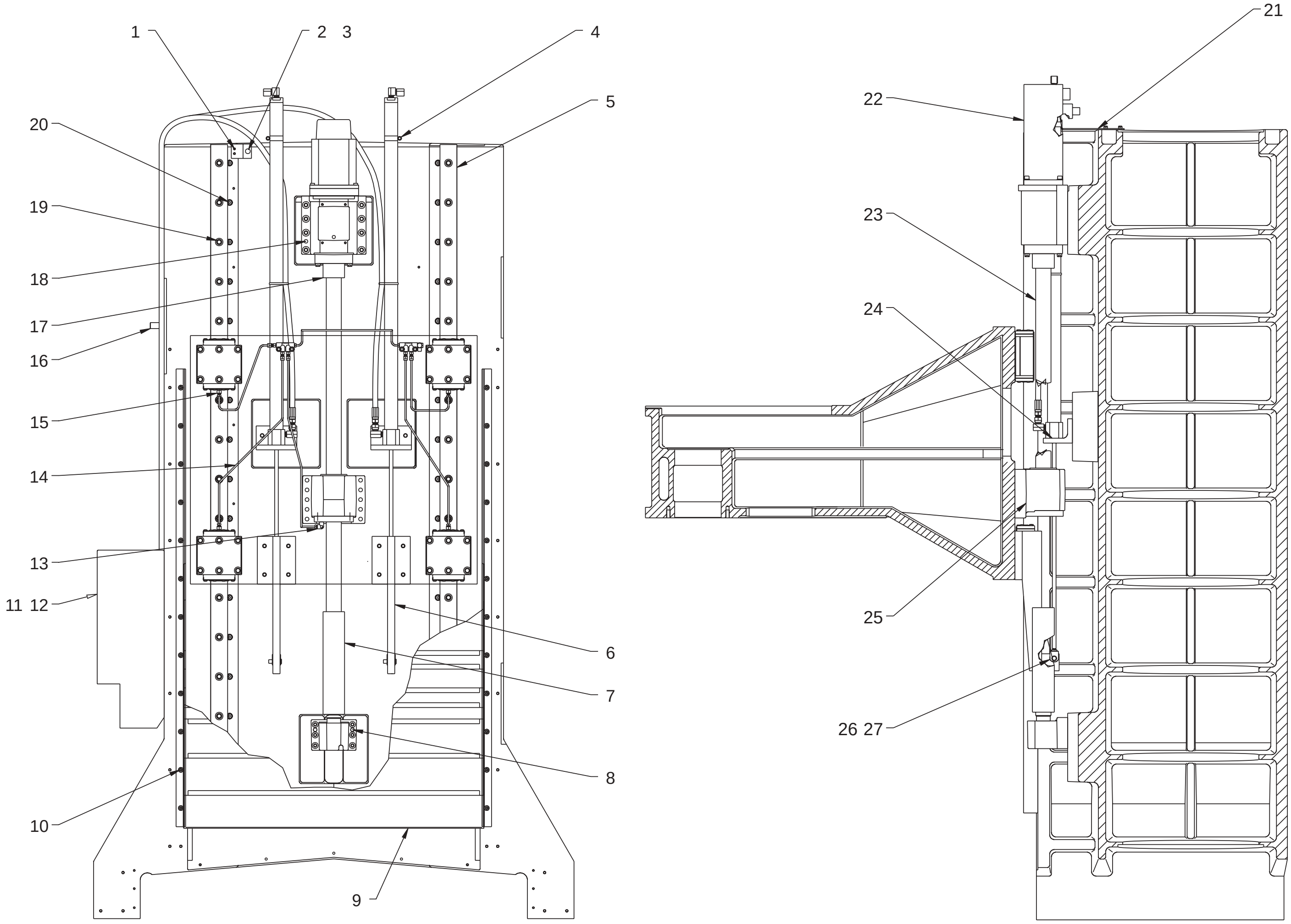
VF-8 Saddle



1. 59-6655 Rubber plug guide rail
2. 22-7458 Cam, linear guide
3. 20-9218 Y-axis bumper, motor end
4. 20-0150 Nut housing
5. 58-3031 Banjo elbow 5/16 female x M6 male
6. 58-1560 Adaptor 1/8m (NSK and THK Linear guides) 59-0001 (Star linear guides)
7. 30-0461 Oil line assembly
8. 20-0156 Bumper for 40 and 50 mm ballscrews
9. 32-5056 Limit switch assembly
10. 25-7268 Bracket mounting Y-axis
11. 50-9010 Linear guide
12. 24-9960 40mm ballscrew (except XRT)
13. 25-9203 Cover plate motor mount
14. 62-0014 servo motor (40 taper) 62-0016 servo motor (50 taper)*

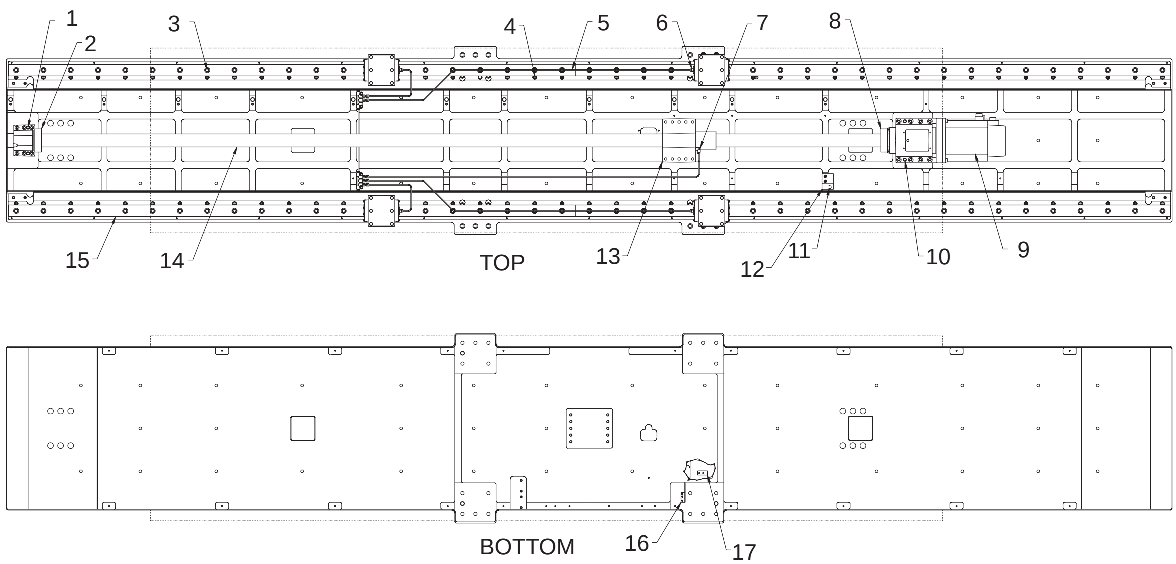
*Except XRT

VF-10 Base



1. 25-7267 Bracket mounting Y-axis
2. 25-9929 Stabilizer bracket hyd. cyl.
3. 32-2050 Limit switch Z-axis
4. 59-4002 Hose clamp 13/16 x 1 3/4
5. 50-9010 Linear guide
6. 22-9826A Counterweight head bracket
7. 20-9217 Z-axis bumper, support end
8. 48-0045 Dowel pin 3/8 x 1 1/2 pull
9. 25-9813 Z-axis waycover
10. 40-2021 FHCS 1/4-20 x 3
11. 25-7560B Tank cover
12. 30-1420 (40 taper) 30-1421 (50 taper) Counterbalance tank assembly
13. 58-3031 Banjo elbow 5/16 F x M6 M
14. 30-0464 Oil line assembly
15. 58-1560 Linear guide adaptor 1/8m (NSK and THK) 59-0001 (Star)
16. 48-1699 Dowel pin 5/8 x 2 1/4
17. 20-9216 Z-axis bumper, motor end
18. 48-10045 Dowel pin 3/8 x 1 1/2
19. 59-6655 Rubber plug
20. 22-7458 Cam
21. 25-9929 Stabilizer bracket
22. 20-0365 Clevis counter balance
23. 48-0017 Clevis pin 3/8 dia. x 1 1/4 and 49-0026 Cotter pin 1/8 x 1 1/4
24. 20-0150 Nut housing
25. 22-9927 Bracket cylinder counter
26. 24-9960 40mm ballscrew (except XRT)
27. 62-0014 Motor (except XRT)

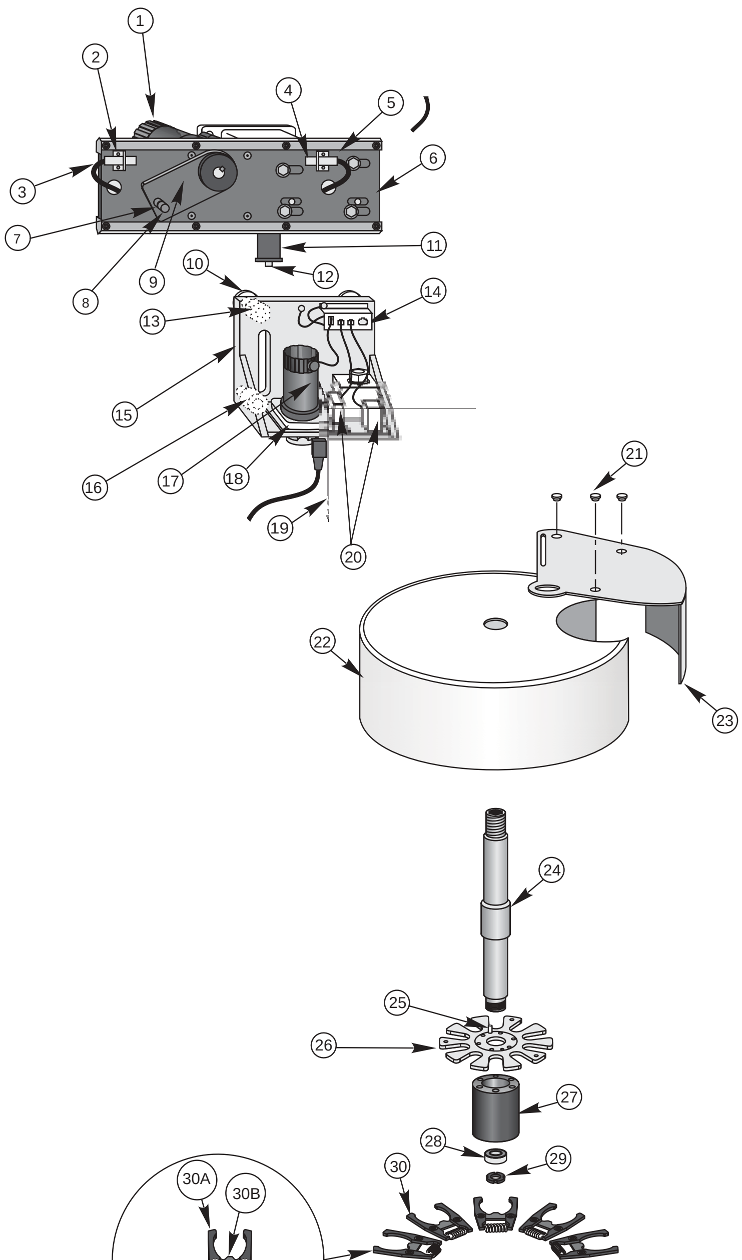
VF-10 Column

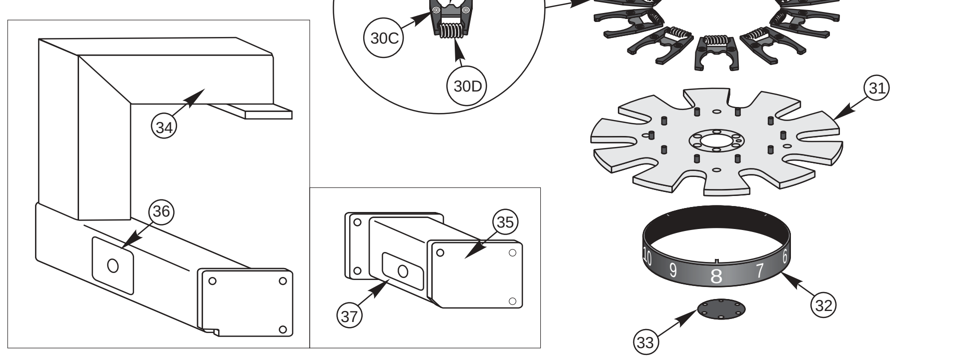


1. 20-0152 Bearing housing 40mm and 50mm ballscrew
2. 20-0156 Bumper
3. 59-6655 rubber plug
4. 22-7458 Cam, linear guide
5. 30-0534 Oil line assembly
6. 58-1560 Linear guide adaptor 1/8m (NSK and THK) 59-0001 (Star)
7. 58-3031 Banjo elbow 5/16 F x M6 M
8. 20-0156 Bumper 40 and 50mm ballscrews
9. 62-0016 Moptor (except XRT)
10. 48-0045 Dowel pin 3/8 x 1 1/2 pull
11. 32-2055 X-axis limit switch
12. 25-9219 Bracket, limit switch
13. 20-0150 Nut housing
14. 24-0002C Ballscrew 50mm (except XRT)
15. 50-0001 Linear guide
16. 25-7459 Bracket trip table
27. 25-9220 Bracket, trip X-axis

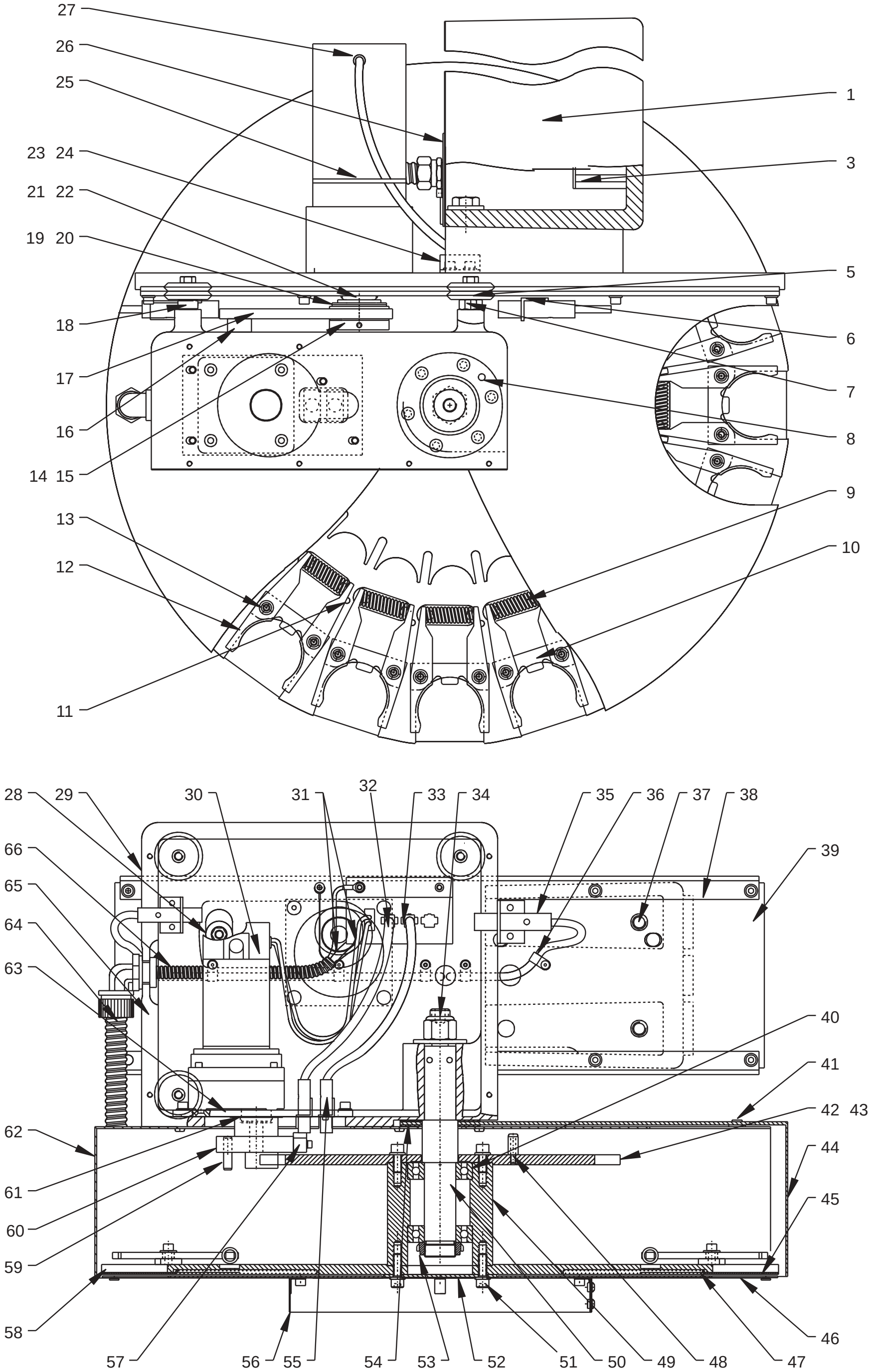
VF-10 Saddle

1	32-1875	Motor Assembly
2	22-7263	Block Switch Mounting
3	32-2010	Limit Switch
4	32-2000	Limit Switch
5	25-4146	Cover T/C Switch
6	20-0682	Tool Holding Plate
7	22-7034	Spacer Cam Follower
8	54-0010	Cam Follower T/C
9	30-7200A	Actuating Arm
10	54-0030	Guide Wheel
11	25-0466	Door Opener Bracket
12	22-2065	Locating Pin
13	54-0020	Bushing Guide Wheel
14	25-7162	Connector Bracket
15	20-1354A	T/C Carriage
16	54-0040	Standard Bushing Gd Wheel
17	30-1679	Turret Motor Assembly
18	20-0680A	Plate Motor Mtg 10 pkt
19	25-0634	T/C Cover
20	32-1999	Limit Switch
21	22-7163	Rider Trap Door
22	25-0633	T/C Shroud
23	25-0636A	Trap Door
24	20-0681	Vertical Axle
25	22-7255A	Tool #1 Standoff
26	20-0678	Geneva Star
27	20-0679	Bearing Housing
28	51-2022	Bearing Radial
29	51-2041	Bearing Locknut BH-05
30	A 22-9574A	CT Extractor
	B 22-7067F	Extractor Key
	C 22-9256	Extractor Bushing
	D 24-9257	Extractor Spring
31	20-0670	Carousel
32	25-0638	Number Ring
33	25-0635	Bearing Cover
34	20-1118A	(TRM)
35	20-1263	(MM)
36	25-4030	(TRM)
37	25-9912	(MM)





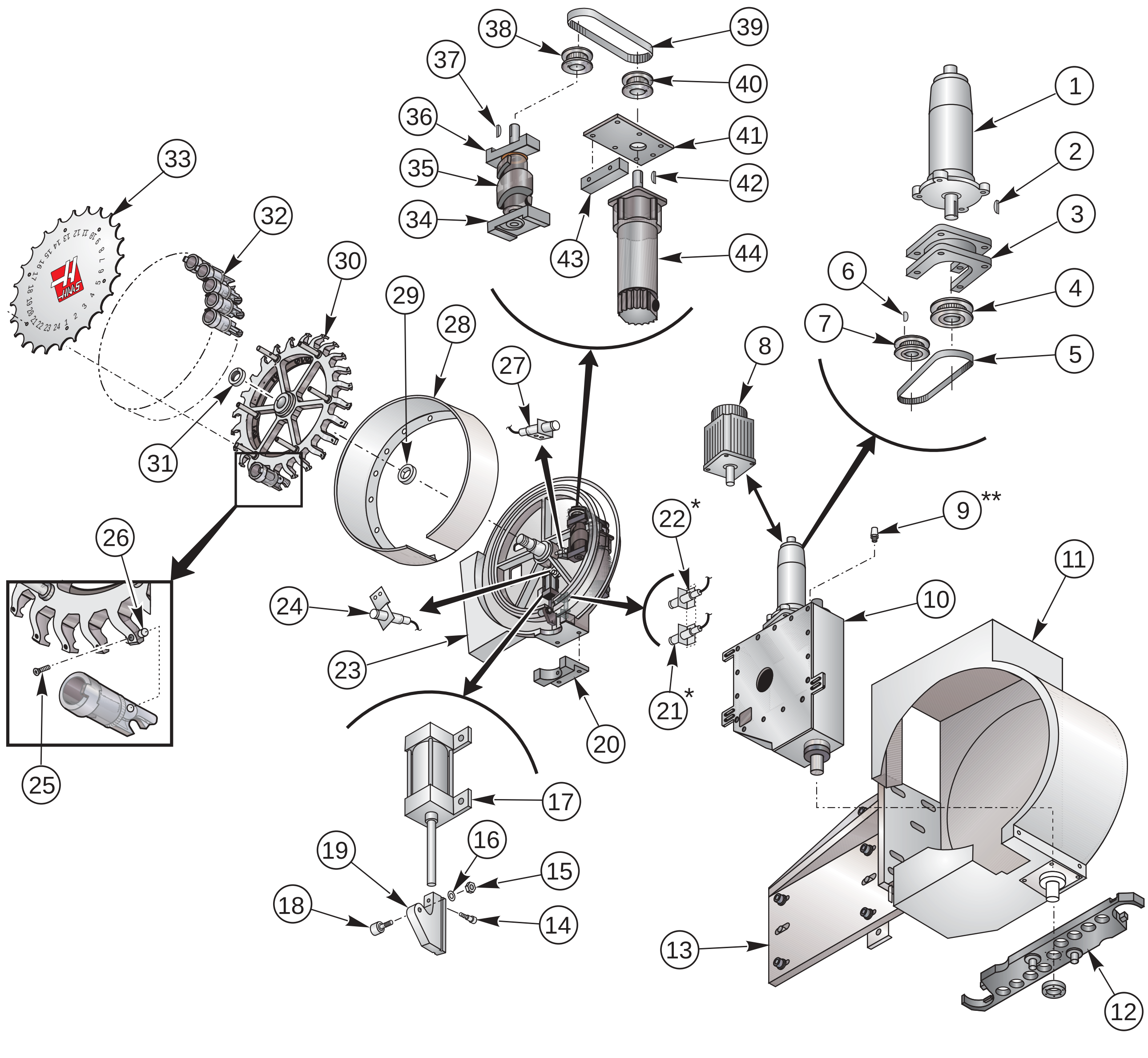
10 Pocket Tool Changer



20 Pocket Tool Changer

1. 20-7029B Holding arm
2. 57-7379 Tool holding arm gasket
3. 79-1000 Wire channel 1in. x 2in.
4. 79-1001 Cover wire channel 1"
5. 54-0030 Guide wheel
6. 22-7263 Block switch mounting
7. 54-0020 Bushing guide wheel
8. 48-0019 Dowel pin 1/4 x 5/8
9. 24-9257 Spring, extractor
10. 22-7067F Key extractor spring
11. 48-0002 Roll pin 7/32 x 7/8
12. 22-9574A CT extractor spring load
    22-7166A BT Extractor
13. 22-9256 Bushing extractor
14. 20-7476 Hub slip clutch
15. 48-0005 Dowel pin 3/16 x 3/8
16. 22-7034 Spacer, cam follower
17. 20-7475 Arm slip clutch
18. 54-0040 Standard bushing guide wheel
19. 22-9256 Bushing extractor
20. 45-2020 Washer 1 1/4 nylon
21. 51-6000 Bearing locknut NT-05
22. 55-0010 Spring washer B2500-080
23. 22-2065 Locating pin
24. 25-7168 Bracket, door opener
25. 70-0050 PLT4S-M cable ties
26. 25-9253 Conduit mounting plate
27. 32-1800 Shuttle motor assembly
28. 54-0010 Cam follower T/C
29. 20-7030E Tool carriage
30. 32-1900A Turret motor assembly
31. 32-7011A Molded T/C cable assembly (VF 0-5)
    32-7012B Molded T/C cable Assembly (VF 6-11)
32. 75-15721 MLX 2 pin M 7.11 LSW/Earmolex
33. 25-7162 Connector bracket
34. 46-1705 Nut 3/4-10 nylon lock
35. 32-2010 Limit switch shuttle In/Out 24"
36. 63-1031 Cable clamp 1/4
37. 48-1750 Dowel pin 1/2 x 1 1/2
38. 22-7106 V track
39. 20-7033 F hold plate
40. 51-0010 Bearing deep groove
41. 22-7163 Rider trap door
42. 20-9336 20 pocket geneva star
43. 48-0020 Dowel pin 1/4 x 1
44. 25-7238C Tool trap door
45. 25-7249 Sliding panel
46. 25-7250B Sliding panel cover
47. 24-2010A Compression Spring
48. 22-7255A Tool #1 standoff
49. 20-7038A bearing housing
50. 20-7035G Vertical axle
51. 54-0040 Standard bushing guide wheel
52. 25-7036Cap, tool changer
53. 51-0012 Bearing locknut BH-06
54. 26-7239 Spacer ring
55. 32-2000 Limit switch 4 wire 12"
56. 25-7570 Number ring
57. N/A
58. 20-7352B 20 tool carousel
    20-1524 20 Tool carousel BT
59. 51-0001 Bearing 3/4 cam follower
60. 20-9332 Driver geneva 2 pin
61. N/A
62. 25-7237C 20 pocket T/C cover
63. 20-7236A Motor mounting plate
64. 32-7618 TL Carriage cable 40T (VF 6-11)
65. 57-7378 Tool Carriage gasket (VF6-10)
66. 78-1996 Split flex tubing 1/2 I.D.

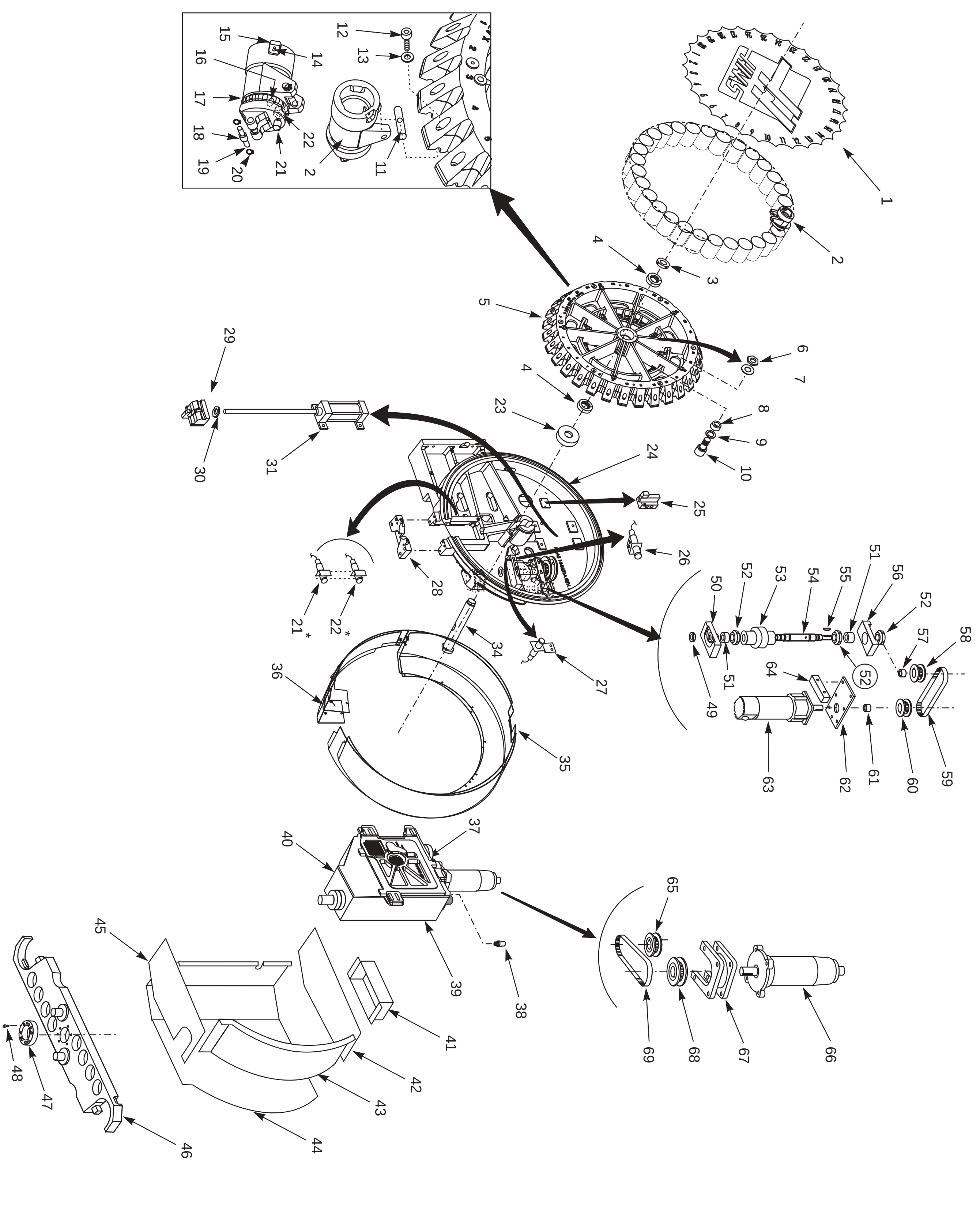
20 Pocket Tool Changer



Side Mount Tool Changer Assembly

* Back Side
** Hose, on Horizontal Applications
1. Cam Box Motor
2. Key
3. Cam Box Motor Mount
4. Cam Box Pulley
5. Drive Belt
6. Key
7. Pulley
8. Cam Box Motor (High Speed)
9. Oil Fill/Breather
10. Cam Box Assembly
11. ATC Enclosure
12. Double Arm Assembly
13. ATC Mount
14. Shoulder Bolt
15. Hex Nut
16. Lockwasher
17. Air Cylinder
18. Slide Roller
19. Tool Pocket Slide
20. Pocket Stop
21. Proximity Switch (pocket Up)*
22. Proximity Switch (Pocket Down)*
23. Carousel Housing
24. Proximity Switch (Tool One)
25. Pocket Retaining Screw
26. Tool Pocket Shaft
27. Proximity Switch (Tool Mark)
28. Carousel Shroud
29. Bearing
30. Carousel
31. Bearing Nut
32. Tool Pockets
33. Carousel Number Disc
34. Bottom Cam Support
35. Carousel Cam
36. Top Cam Support
37. Key
38. Pulley
39. Timing Belt
40. Pulley
41. Motor Mounting Plate
42. Key
43. Motor Mounting Block
44. Carousel Motor

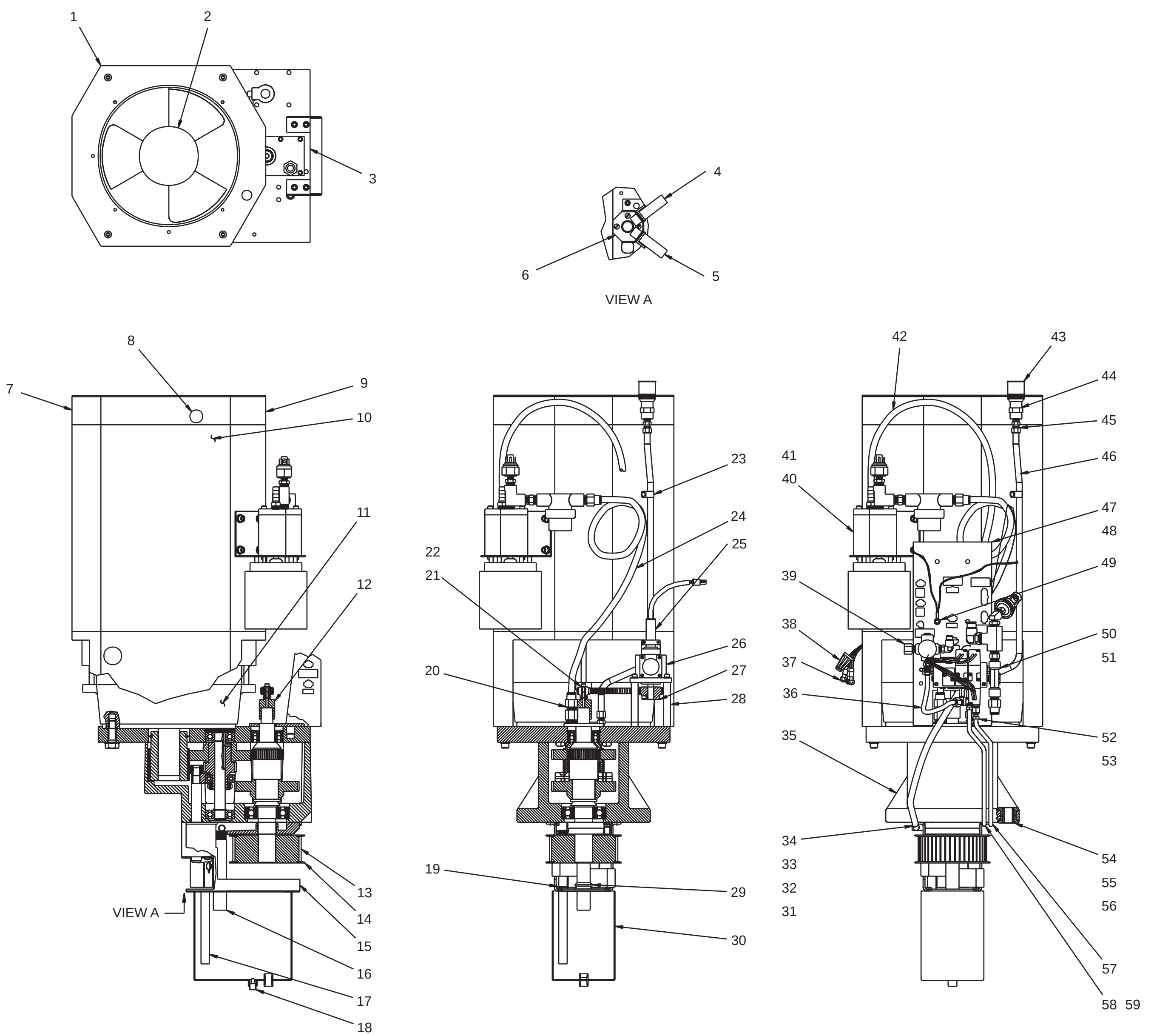
Side Mount Tool Changer Assembly



50 Taper Side Mount Tool Changer Assembly

1. 25-0284A Carousel Cover
2. 20-0490B Tool Pocket 50T
3. 51-2043 Bearing Lock Nut
4. 51-0020 Bearing
5. 20-0438 Carousel 50T
6. 46-1663 Jam Nut
7. 45-0068 Flat Washer
8. 20-1239A Tapered Bushing
9. 45-0070 Washer
10. 51-0045 Cam Follower
11. 20-0385 Pocket Roller Shaft
12. 56-0020 Retaining Clip
13. 40-1715 SHCS
14. 45-1739 Washer
15. 40-1919 Screw
16. 20-0384 Arm Key
17. 29-0382 Pocket Plunger
18. 59-0114 Spring
19. 20-0383 Tool Pocket Rollers
20. 20-0386Tool Pocket Shaft
21. 51-0051 Cam Follower
22. 46-1810 Nut
23. 20-0392 Press Fit Washer
24. 20-0621A ATC Housing
25. 32-0039 Solenoid Assy.
26. 32-2295 Prox Switch
27. 32-2253 Prox Switch
28. 20-0390 Pocket Slide
29. 20-0393 Pocket Stop
30. ¾ 16 Jam Nut
31. 59-0116 Air Cylinder
32. 32-2252 Prox Switch
33. 32-2251 Prox Switch
34. 20-0387A T/C Shaft
35. 25-0286B Shroud
36. 25-0291B Corner Shroud
37. 20-0456A Cam Box Cover
38. 58-3069 Muffler
39. 20-0455B Cam Box Case
40. 30-1150 Cam Box Assy.
41. 25-0288A Motor Cover
42. 25-0287A Top Plate
43. 25-0290A Front Cover
44. 25-0289A Right Cover
45. 25-0292A Bottom Cover
46. 20-0388A Double Arm Assy.
47. 20-0240 Arm Hub
48. 40-1610 (8X) SHCS ¼-20-1"
49. 51-2012 Bearing Lock Nut
50. 20-0268 Carousel Cam Bottom Support
51. 51-2025 Bearing
52. 51-2041 Bearing Lock Nut
53. 20-0439 Carousel Cam
54. 20-0231 Carousel Shaft
55. 22-2629 Key Stub
56. 20-0268 20-7239 Carocam Support
57. 54-0039 Bushing
58. 54-0044 Pulley
59. 54-0045 Belt
60. 54-0043 Pulley
61. 54-0017 Bushing
62. 20-0272A Motor Mount Plate
63. 32-1875 Motor Assy.
64. 20-0273 Motor Mount Block
65. 54-0043 Pulley
66. 32-1880B Motor Assy.
67. 20-0772 Motor Mounting Base
68. 54-0037 Pulley
69. 54-0036 Belt

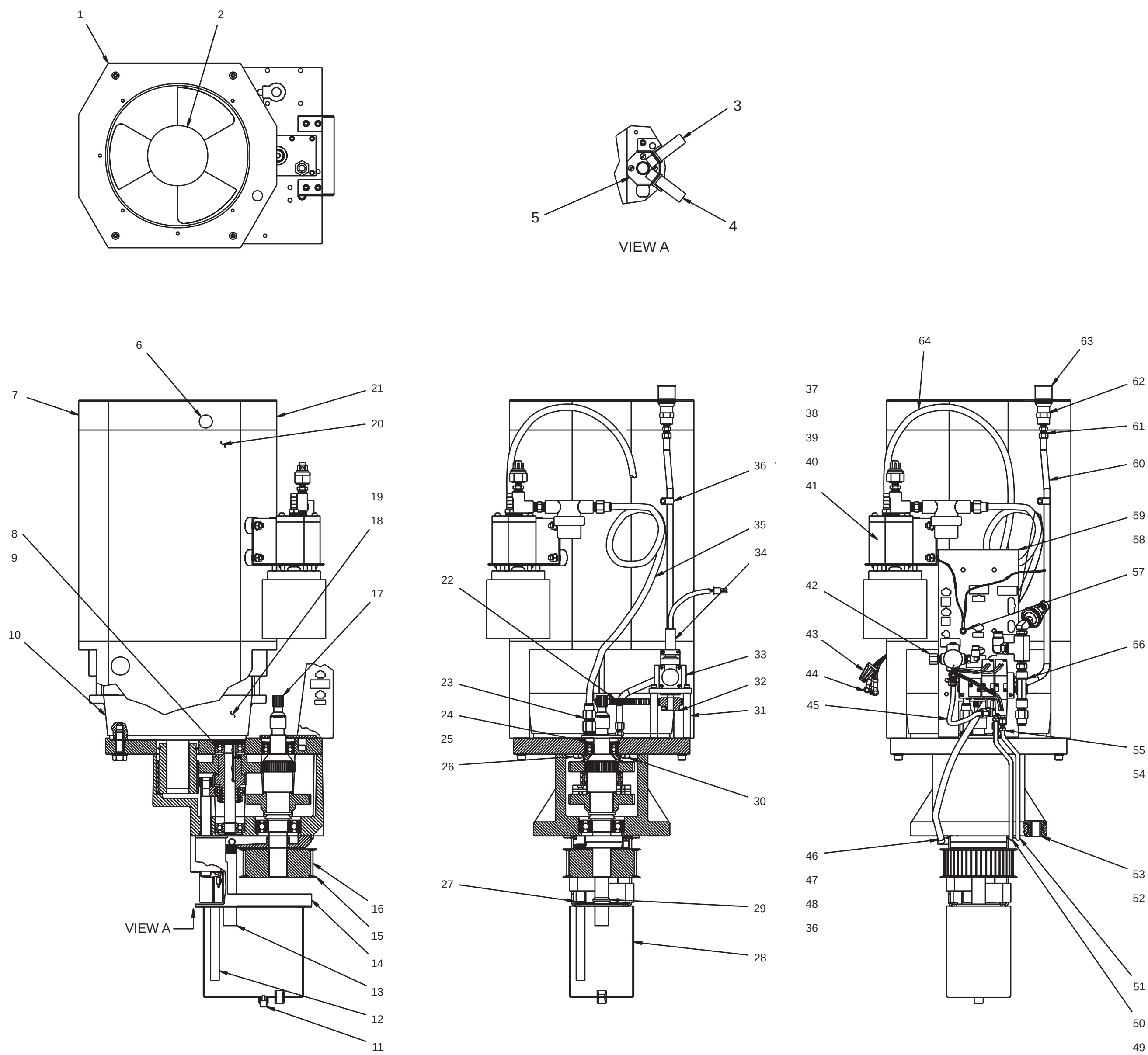
50 Taper Side Mount Tool Changer Assembly



VF 1-11 Gearbox Assembly 15 HP

1. 25-0108 Fan bracket motor shroud
2. 36-3035 Spindle fan assembly
3. 59-7130 Protective strip
4. 32-2011 30" limit switch
5. 32-2010 24" limit switch
6. 25-7264 Switch mounting bracket
7. 29-0022 Shroud caution decal
8. 59-1482 Nylon finish plug, 13/16
9. 25-01074 Motor shroud
10. 20-0064 Adaptor encoder pulley
11. 62-3010 Spindle motor, 10HP
12. 59-0046 Soundcoat shroud RT/LT
13. N/A
14. N/A
15. 25-7433 Sump bracket
16. 22-7445A drain tube dry sump
17. 22-7446 Pick up tube dry sump
18. 58-2745 Magnetic oil plug
19. 57-0001 Oil seal
20. 58-3657 1/4 female 1/8 male adaptor
21. 54-2125 Drive belt HTD 300-3M-09
22. 54-1013 Drive sprocket .250 RTAP
23. 59-2040 Cable clamp 7/16
24. 58-2001 Polyu hose 1/2OD x 3/8ID
25. 32-1455D RTAP encoder cable
26. 60-1810 Shaft encoder 2000 line
27. 54-7127 Drive sprocket .375 RTAP
28. 22-7260 Encoder standoff
29. 57-0002 Oil seal
30. 25-7434 Sump tank
31. 63-1031 Cable clamp 1/4
32. 59-4006 Hose crimp, 35/64
33. 59-2040 Cable clamp, 7/16
34. 58-3616 3/8 90 deg. elbow 1/4 NPT
35. N/A
36. 58-7377 Air reg/solenoid tube
37. 76-2420 Crimp ring, 12-10 10 stud
38. 77-8011 Wire nut, ideal #30-076
39. 30-3270A Precharge regulator assy
40. N/A
41. 59-0027 Hose clamp 1/2 hose
42. 58-2020 3/8OD natural tubing
43. 22-7487 Oil fill cap modified
44. 58-2065 Coupling, 1/4NPT
45. 58-2070 1/4NPT male to 3/8 comp
46. 58-9114B Trans fill tube
47. 25-7336 Solenoid mounting bracket
48. 33-3200 Solenoid bracket cable assembly
49. 33-5088 Ground strap spindle motor shroud
50. 30-3146 Air solenoid assy mac TP
51. N/A
52. 58-2100 Sleeve lube assembly
53. 58-2110 Sleeve nuts lube assembly
54. 22-7520A Isolater trans
55. 22-7521A Spacer trans
56. N/A
57. 58-7636 High gear tube VF-3
58. 58-7635 Low gear tube VF-3
59. 63-0001 Nylon cable clamp 1/2

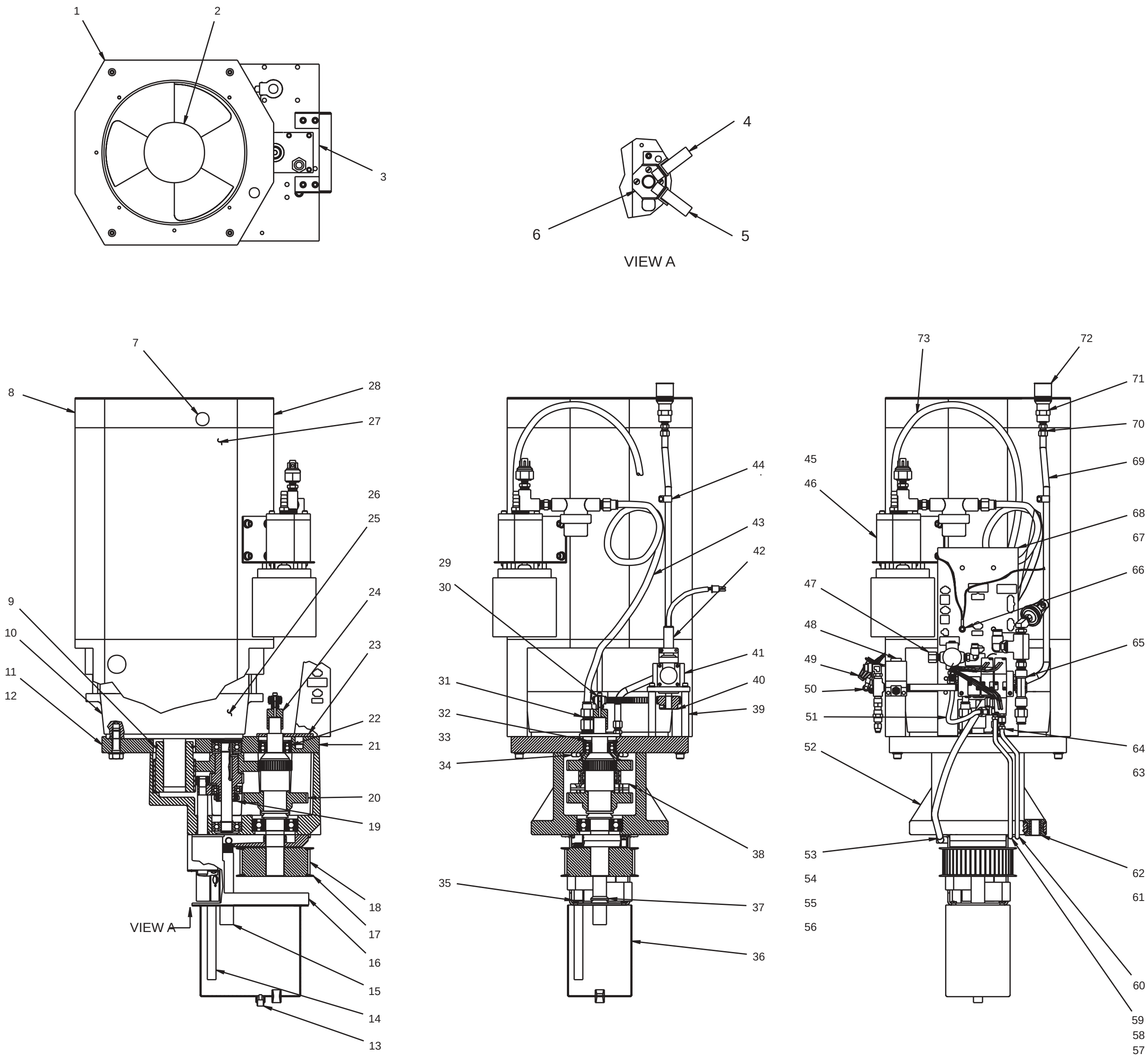
VF 1-11 Gearbox Assembly 15 HP



VF 1-11 Gearbox Assembly HT10K

1. 25-0108 Fan bracket motor shroud
2. 36-3035 Spindle fan assembly
3. 32-2011 Switch assembly (30" cable length)
4. 32-2010 24" limit switch
5. 25-7264 Switch mounting bracket
6. 59-1482 Nylon finish plug, 13/16
7. 29-0022 Shroud caution decal
8. 55-0035 Spring washer, BS-204
9. 56-2087 Snap ring, N5000-206
10. 29-7399 Transmission motor label
11. 58-2745 Magnetic oil plug
12. 22-7446 Pick up tube dry sump
13. 22-7445A Drain tube dry sump
14. 25-7433 Sump bracket
15. 22-7376 Sprocket flange
16. 20-7374 1 1/8 sprocket
17. 20-0125 Drive sprocket encoder
18. 57-7573A Trans motor gasket
19. 36-3078 10K 10HP motor kit
20. 59-0046 Sound coat shroud RT/LT
21. 25-0107 Motor shroud
22. 54-2125 Drive belt HTD 300-3M-09
23. 58-3657 1/4 female 1/8 male adaptor
24. 55-0036 Spring washer, BS-205
25. 56-0070 Snap ring, N5000-187
26. 58-7357 Top plate tube-A
27. 57-0001 Oil seal
28. 25-7434 Sump tank
29. 57-0002 Oil seal
30. 58-7358A Top plate tube-B
31. 22-7260 Encoder standoff
32. 54-7127 Drive sprocket .375 RTAP
33. 60-1810 Shaft encoder 2000 line
34. 32-1455D RTAP encoder cable
35. 58-2001 Polyu hose 1/2OD x 3/8ID
36. 59-2040 Cablt clamp, 7/16
37. 59-0027 Hose clamp 1/2 hose
38. 57-0049 Rubber stud bumper
39. 46-1625 Nut hex blk ox 1/4-20
40. 45-1800 Washer split lock 1/4 med
41. 30-3260B oil gear pump assembly
42. 30-3270A Precharge regulator assembly
43. 77-8011 Wire nut, ideal #30-076
44. 76-2420 Crimp ring, 12-10 10 stud
45. 58-7377 Air reg/solenoid tube
46. 58-3616 3/8 90 deg elbow 1/4 NPT
47. 59-4006 Hose crimp, 35/64
48. 63-1031 Cable clamp 1/4

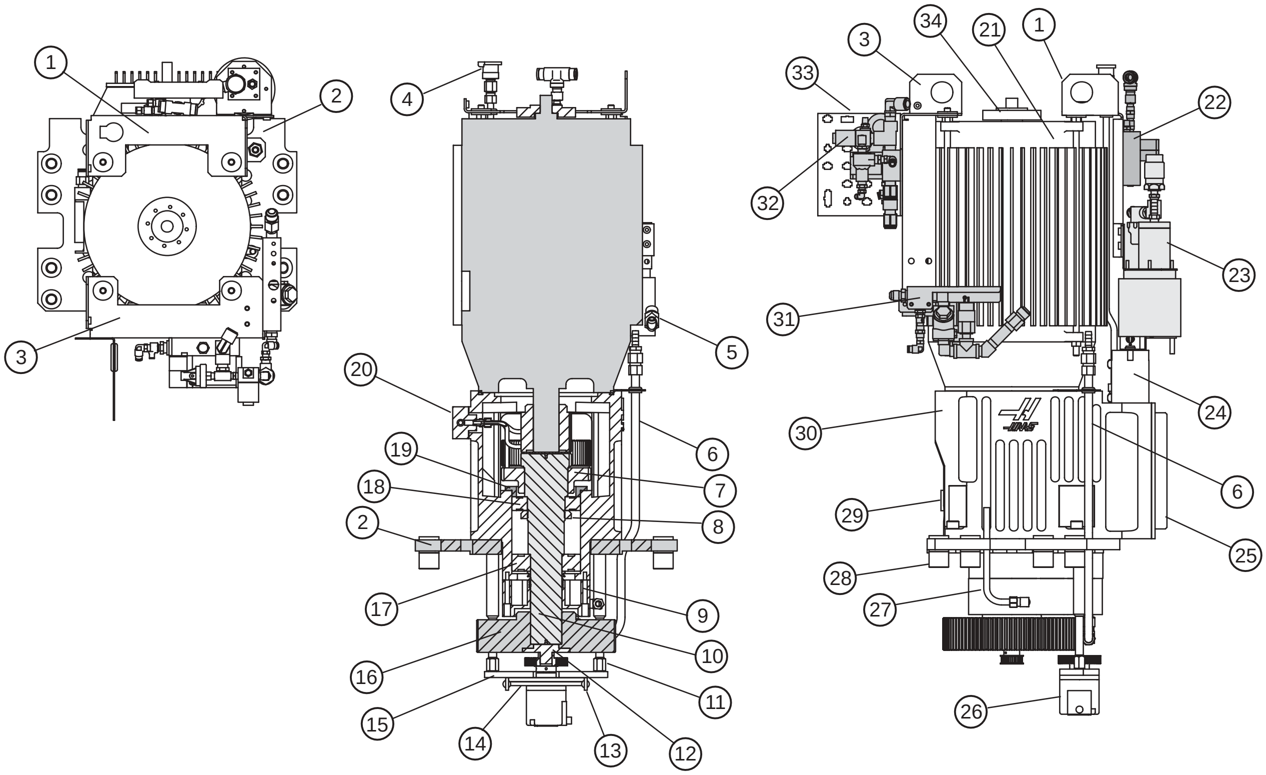
VF 1-11 Gearbox Assembly HT10K



VF 1-11 Gearbox Assembly HT10K TSC

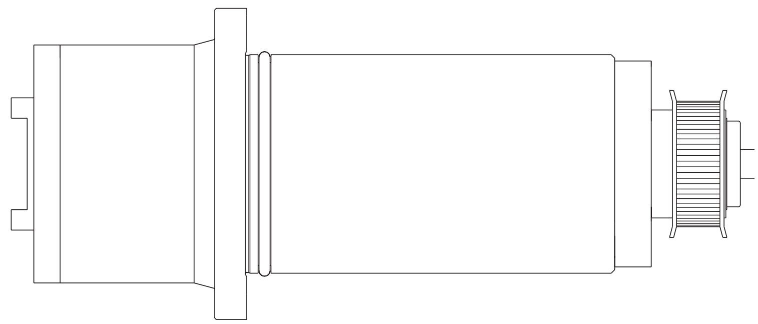
1. 25-0108 Fan bracket motor shroud
2. 36-3035 Spindle fan assembly
3. 59-7130 Protective strip
4. 32-2011 Switch (30" cable lenght)
5. 32-2010 24" limit switch
6. 25-7264 Switch mounting bracket
7. 59-1482 Nylon finish plug 13/16
8. 29-0022 Shroud caution decal
9. 57-0006 O-ring 2-328 buna
10. 29-7399 Transmission motor label
11. 29-9128 Label, transmission
12. 48-0020 Pin, dowel 1/4 x 1
13. 58-2745 Magnetic oil plug
14. 22-7446 Pick up tube dry sump
15. 22-7445A Drain tube dry sump
16. 25-7433 Sump bracket
17. 22-7376 Sprocket flange
18. 20-7374 1 1/8 Sprocket
19. N/A
20. N/A
21. N/A
22. N/A
23. 20-7435 Oil plate
24. 20-0064 Adaptor encoder pulley
25. 57-7573A Trans motor gasket
26. 36-3078 10K 10HP motor kit
27. 59-0046 Soundcoat shroud RT/LT
28. 25-0107 Motor shroud
29. 54-1013 Drive sprocket .250 RTAP
30. 54-2125 Drive belt HTD 300-3M-09
31. 58-3657 1/4 female 1/8 male adaptor
32. 55-0036 Spring washer, BS-205
33. 56-0070 Snap ring N5000-187
34. 58-7357 Top plate tube-A
35. 57-0001 Oil seal
36. 25-7434 Sump tank
37. 57-0002 Oil seal
38. N/A
39. 22-7260 Encoder standoff
40. 54-7127 Drive sprocket .375 RTAP
41. 60-1810 Shaft encoder 2000 line
42. 32-1455D RTAP encoder cable
43. 58-2001 Polyu hose 1/2OD x 3/8 ID
44. 59-2040 Cable clamp 7/16
45. 59-0027 Hose clamp 1/2 hose
46. 30-3260B Oil gear pump asssembly
47. 30-3270A Precharge regulator assembly
48. 30-3276 Purge solenoid valve assembly
49. 77-8001 Wire nut, ideal #30-076
50. 76-2420 Crimp ring, 12-10 10 stud
51. 58-7377 Air reg solenoid tube
52. N/A
53. 58-3616 3/8 90 deg. elbow 1/4NPT
54. 59-4006 Hose crimp, 35/64
55. 59-2040 Cable clamp 7/16
56. 63-1031 Cable clamp 1/4
57. 63-0001 Nylon cable clamp 1/2
58. 58-7635 Low gear tube VF-3
59. N/A
60. 58-7636 High gear tube vf-3
61. 22-7521A Spacer trans
62. 22-7520A Isolater trans
63. 58-2110 Sleeve nuts lube assembly
64. 58-2100 Sleeve lube assembly
65. 30-3146 Air solenoid assy mac tp
66. 33-5008 Ground strap spindle motor shroud
67. 33-3200 Solenoid bracket cable assembly
68. 25-7336 Solenoid mounting bracket
69. 58-9114B Trans fill tube
70. 58-2070 1/4NPT male to 3/8 comp
71. 58-2065 Coupling, 1/4NPT
72. 22-7487 Oil fill cap modified
73. 58-2020 3/8OD natural tubing

VF 1-11 Gearbox Assembly HT10K TSC



1. 25-4420 Oil Pump Bracket
2. 20-1452 Transmission Plate
3. 25-4419 Solenoid Bracket
4. 22-7487 Oil Fill Cap
5. 30-3275 TSC Check Valve
6. 58-0609 Oil Pickup Tube
7. 20-1440 Out put Gear
8. 51-0089 Bearing Locknut
9. 20-1459 Oil Pan
10. 35-0017 Output Shaft
11. 20-2965 Encoder Stand Off
12. 20-1454 Encoder Pulley
13. 25-6298 Encoder Spring Clamp
14. 25-6299 Encoder Spring Plate
15. 20-2964 Encoder Spring Mounting Plate
16. 20-1455 Pulley
17. 51-0088 Deep groove Bearing
18. 51-0087 Bearing
19. 20-2393 Bearing Ring
20. 20-1458 Oil Manifold
21. 62-4010 Spindle Motor
22. 30-3644 Shift Valve
23. 30-3260 Oil Pump Assembly
24. 20-1448 Cylinder Shifter
25. 20-1782 Housing Cover Plate
26. 32-1457 Rtap Encoder
27. Dipstick
28. 20-1396 Transmission Spacer Plug
29. Oil Sight Level
30. 20-1526 Housing Gearbox
31. 30-3275 Check Valve Assembly
32. 30-3642 TRP TSC Solenoid Assembly
33. 25-4421 Spindle Connector Bracket
34. 20-1147 X-Axis Support Bumper

50 Taper Gearbox Assembly

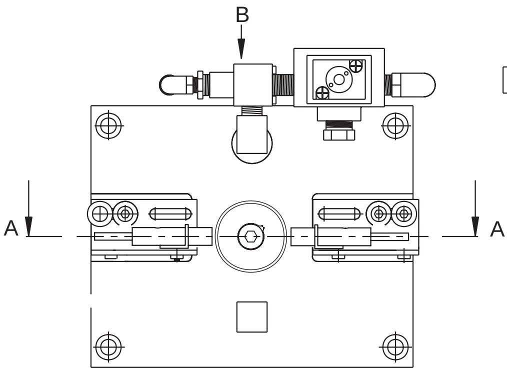


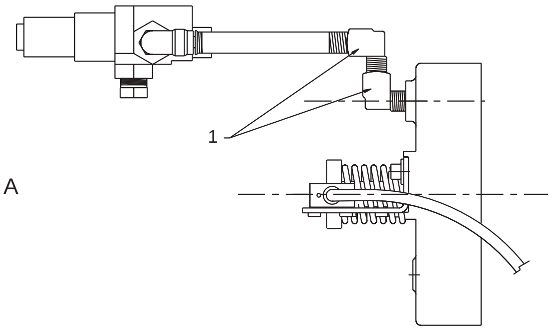
SPINDLES
30-0319A 7.5 Spindle Assembly
30-2132 10K Spindle Assembly
30-1360 15K Spindle Assembly
30-1468 15K spindle assembly VF5-11

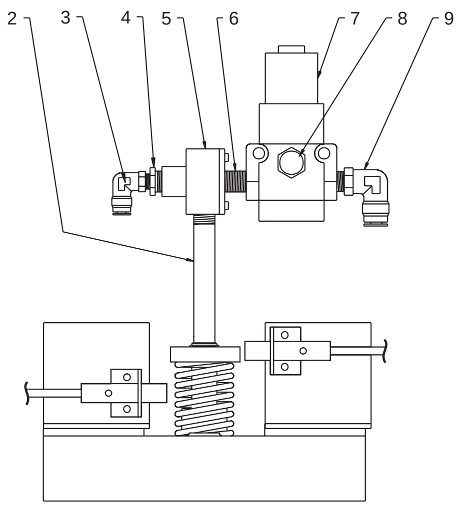
30-0449 50 Taper Spindle Assembly

DRAWBAR
30-3410E 7.5k spindle with or without TSC
30-0067 50 Taper

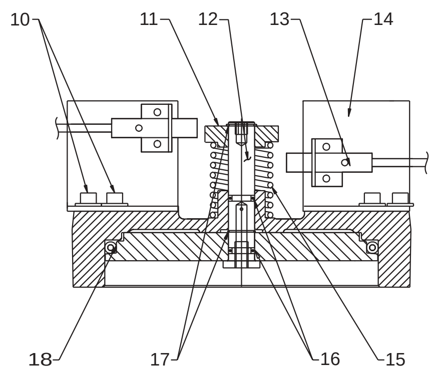
Spindle Assemblies







VIEW B
OUT OF POSITION



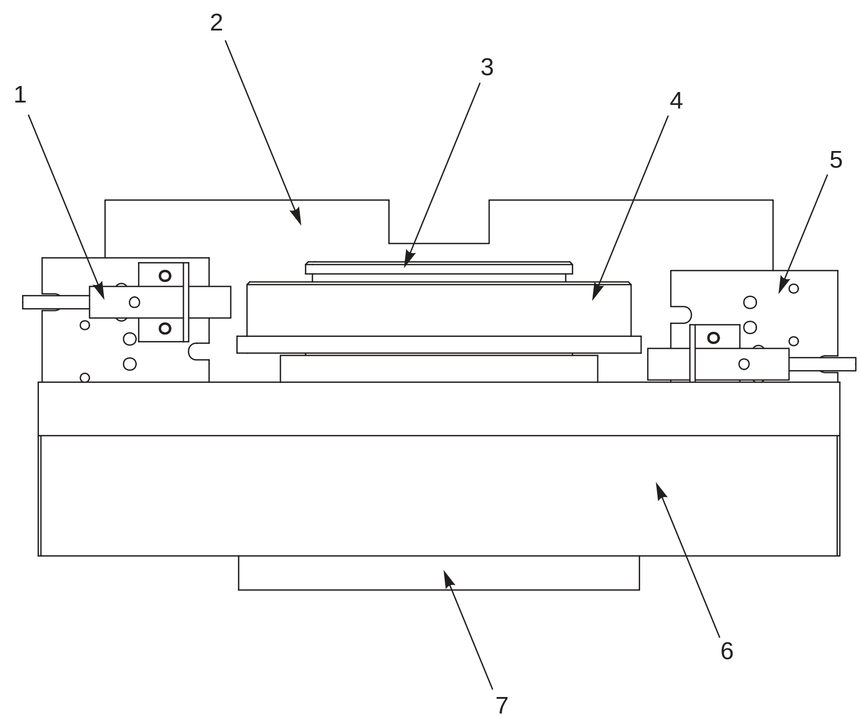
SECTION A-A
OUT OF POSITION

1. 58-3613 1/4 Street elbow
2. 58-3050 Elbow 1/4 bylon tubing
3. 58-3670 1/4NPT M 1/8F reducer
4. 58-3727A 1/4NPT x 4 nipple brass
5. 59-2832B Quick exhaust 1/4
6. 58-2165 Fitting close nipple 1/4
7. 32-5620 TRP solenoid valve assembly
8. 58-2265 Air muffler 3/8 flat
9. 58-3685 1/4NPT M 3/8 tube swivel elbow
10. N/A
11. 22-4045 Spring retainer TRP 30 degree
12. N/A
13. 32-2010 Limit sw shuttle in/out 24"
14. 25-4050C Switch mounting bracket
15. 59-2760 Comp spring/large wire
16. 57-0040 O-ring 2-111 Buna
17. 56-0040 Retaining ring N5100-62
18. 57-0018 O-ring 2-446 buna

40 Taper Complete Assembly Non -TSC 30-3201A
Mini Mill TRP Assembly 30-1668

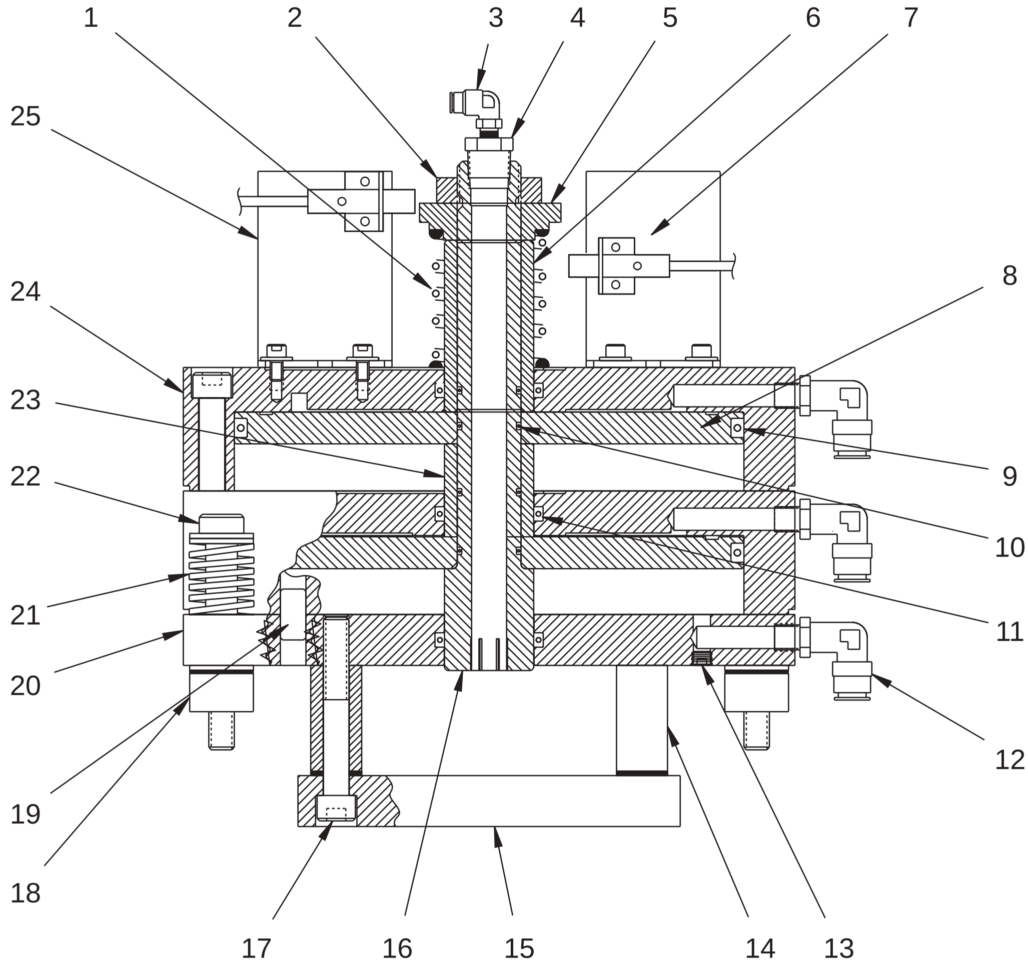
TRP base XHC 30-3207
TRP base 30-3205

Tool Release Piston Assembly



1. 32-2201 Proximity Switch
2. 20-1692A TRP Piston, In-line
3. 20-1691 TRP Shaft
4. 20-1696A TRP Spring Reatin, In-line
5. 25-4648A Bracket Switch Mounting
6. 20-1693A TRP Cylinder In-ine
7. 20-1690C Striker Plate

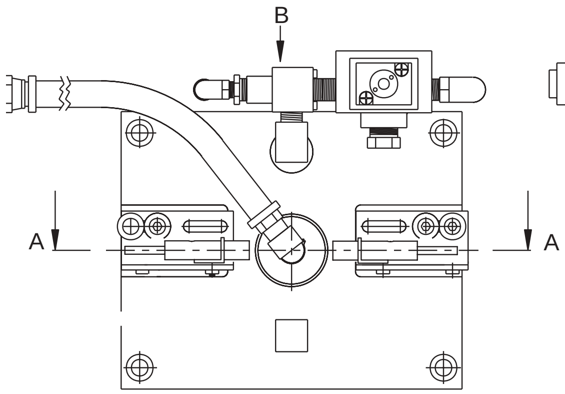
In Line Spindle Tool Release Piston

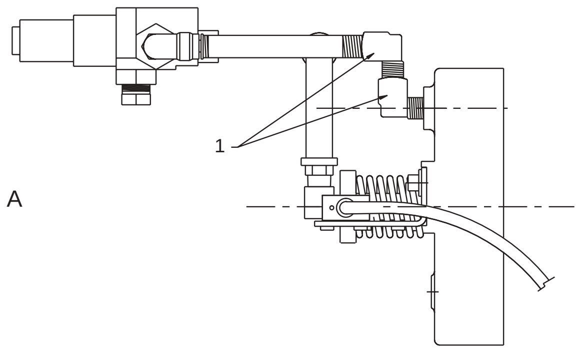


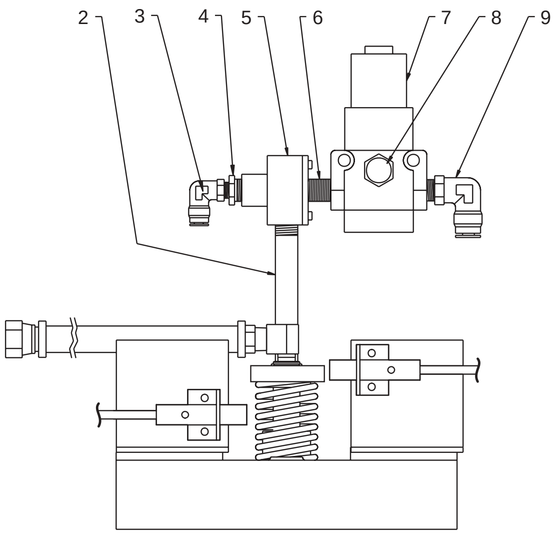
1. 59-0049 Spring compression
2. 52-0003 Shaft clamp
3. 58-3050 Elbow 1/4 nylon tubing
4. 58-3631 Reducer bushing 1/2M-1.8F
5. 20-0016B Switch plate
6. 20-0021 Spacer upper TRP 50T
7. 32-2013 Limit switch shuttle assembly
8. 20-0019A Piston TRP 50T
9. 57-0092 O-ring 2-448 Viton
10. 57-0027 O-ring 2-121 Buna
11. 57-0095 O-ring 2-327 Viton
12. 58-1695 Elbow 1/4MPT
13. 58-1627 1/8-27 pipe plug
14. 20-0013 Spacer fork spindle
15. 20-0015 Fork lift Spindle
16. 20-0018A Shaft TRP 50T
17. N/A
18. 22-0014 Spacer .62ID x 1.25OD.857
19. 48-1662 Dowel pin 1/2 x 1
20. 20-0017A Sub plate TRP 50T
21. 59-0016 Spring compression
22. 49-0003 Shoulder bolt 5/8 x 3 1/2
23. 20-0020A Spacer lower TRP 50T
24. 20-0022A Housing air cylinder
25. 25-0009 Switch mounting bracket

50 Taper complete assembly 30-3202A

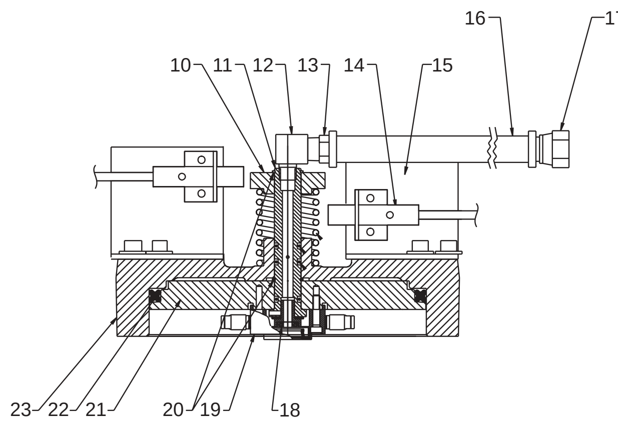
50 Taper Tool Release Piston







VIEW B
OUT OF POSITION

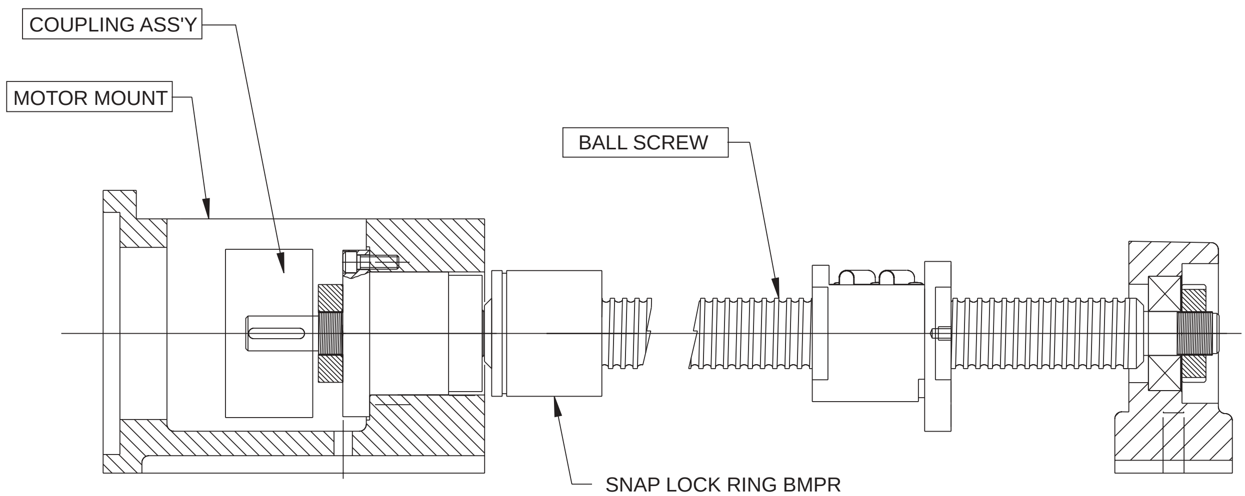


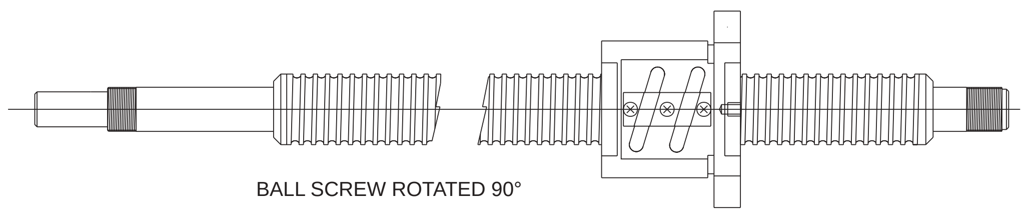
SECTION A-A
OUT OF POSITION

93-30-3206 Complete assembly

1. 58-3618 1/4 Street elbow 90 deg.
2. 58-3727A 1/4NPT x 4 nipple brass
3. 58-3050 Elbow 1/4 nylon tubing
4. 58-3670 1/4NPT M 1/8 F reducer
5. 59-2760 Compr spring/large wire
6. 58-2165 Fitting close nipple 1/4
7. 32-5620 TRP solenoid valve assembly
8. 58-2265 Air muffler 3/8 flat
9. 58-3685 1/4NPT M 3/8 tube swivel elbow
10. 22-7045A Spring retainer TRP 30 degree
11. 20-7626A Shaft TRP hex
12. 58-3614 1/4F 1/8M street elbow
13. 58-0028 Hose barb 3/8 PL-1/4 MP
14. 32-2010 Limit switch shuttle in/out 24"
15. 25-7050C Switch mount tool release
16. 58-2046 Hose 3/8ID pushlock 300psi.
17. 58-0032 Hose barb 3/8 PL 3/8 SAE F
18. 20-7640 Tool Release Bolt, 3/8-LH
19. 30-3298 Seal Housing Assembly
20. 56-0040 Retaining ring N5100-62
21. 20-7630A TRP rectangle TSC
22. 57-2156 Quad-ring Q4-440 buna
23. 20-7007A Cylinder housing

TSCHP Tool Release Piston Assembly





BALL SCREW ROTATED 90°

	Mini-mill	VF 0-1	VF 2	VF 3	VF 4-5	VF-5XT
Base	24-3006	30-0157	30-0157	30-0196	30-0196	30-0196
Saddle	24-3006	30-0157	30-0194	30-0195	30-0197	30-2152
Column	24-3006	30-0157	30-0157	30-0196	30-0196	30-0196

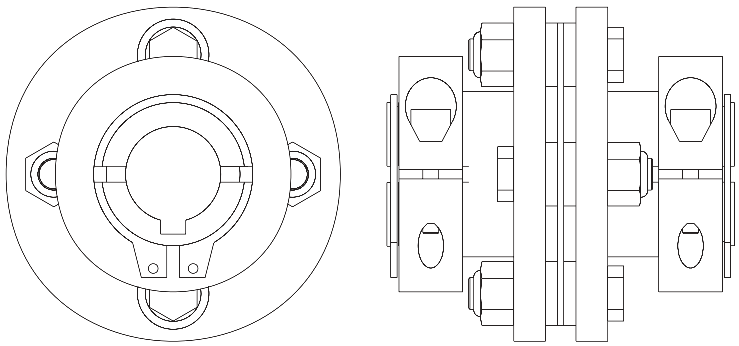
	VF-6/8	VF-7/9	VF-10/11
Base	30-0474	30-0474	30-0474
Saddle	30-0470	30-0473	30-0516
Column	30-0474	30-0474	30-0474

50 Taper

	VF5	VF-5XT	VF-6/8	VF-7/9	VF-10/11
Base	30-0202	30-0202	30-0895	30-0895	30-0895
Saddle	30-0198	30-2152	30-0896	30-0897	30-0516
Column	30-0202	30-0202	30-0895	30-0895	30-0895

*Except XRT

Ball Screw Assembly

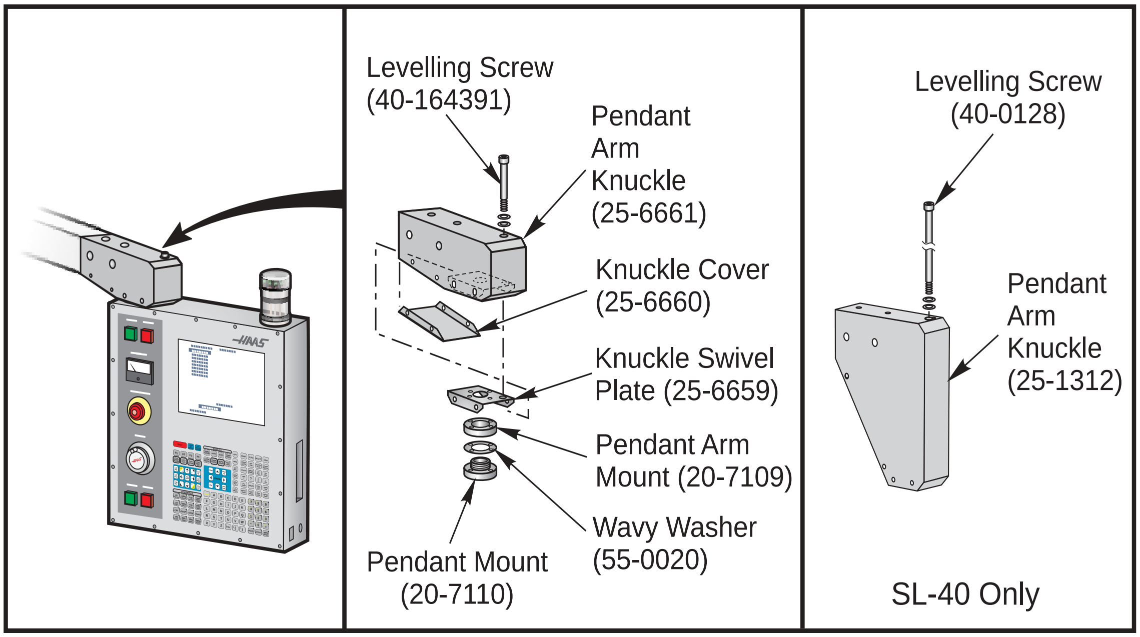


	VF 0-5 & Mini-Mill		VF-5XT	VF 6/8	VF 7/9	VF10/11
Base	30-0211 (30-1220A)		30-1215	30-1219	30-1219	30-1219
Saddle	30-0211 (30-1220A)		30-1219	30-1225A	30-0516	
Column	30-0211 (30-1220A)		30-1219	30-1219	30-1219	

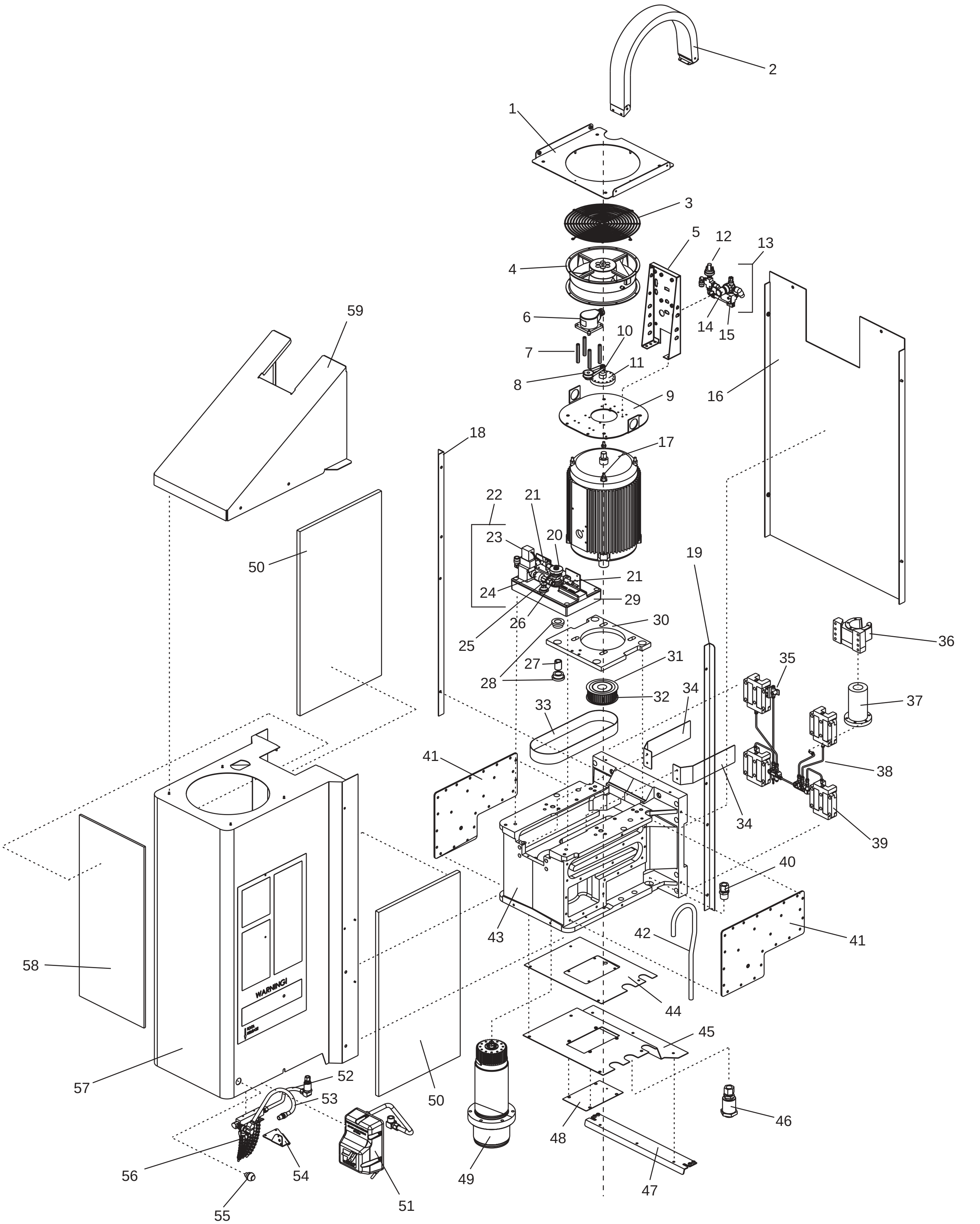
50 Taper

	VF5	VF-5XT	VF-6/8	VF-7/9	VF-10/11
Base	30-1215	30-1215	30-1215	30-1215	30-1215
Saddle	30-1215	30-1215	30-1215	30-1225A	30-1225D
Column	30-1215	30-1215	30-1215	30-1215	30-1215

Coupling Assembly



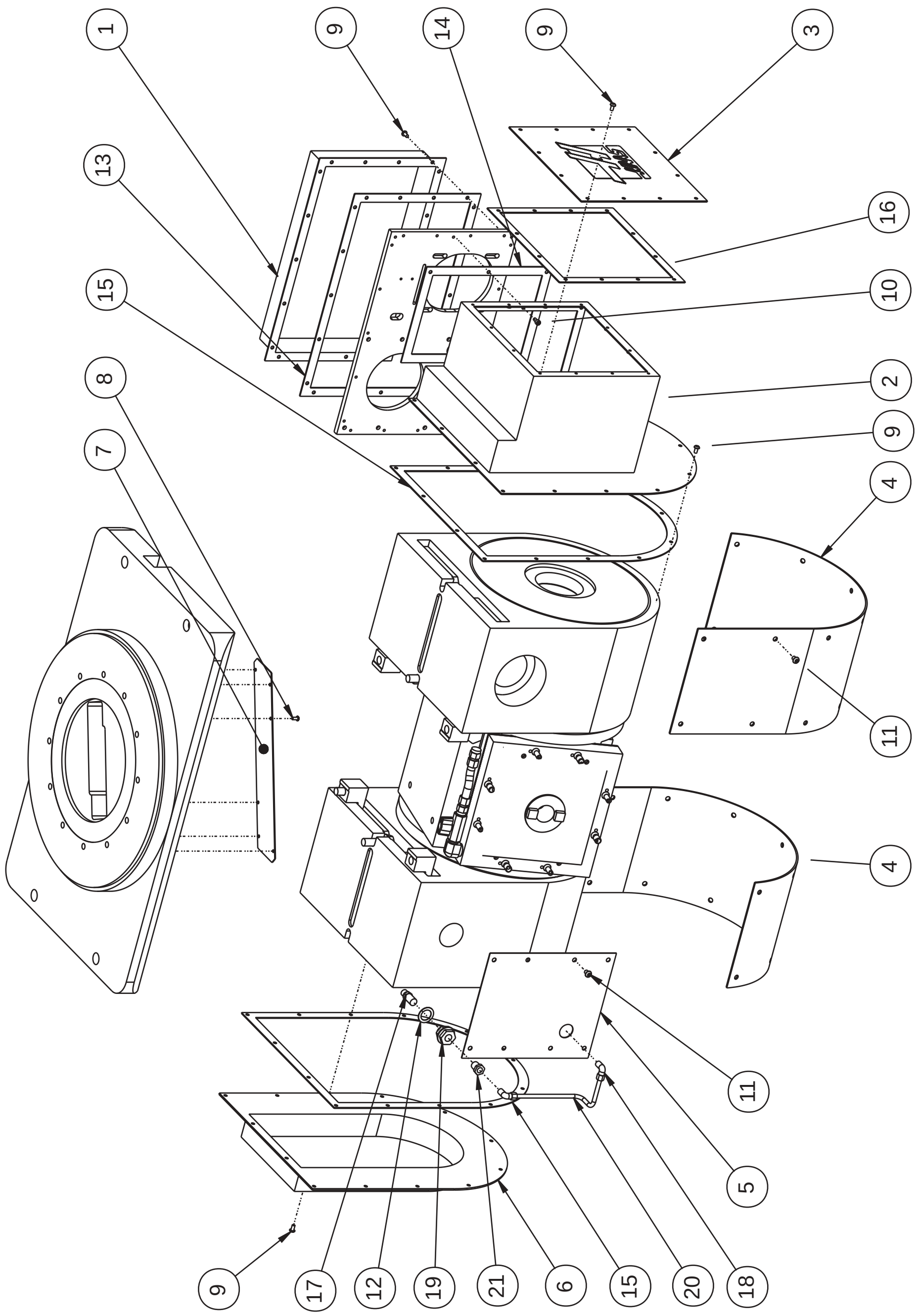
Pendant Leveling Assembly



Mill Drill Spindle Head Assembly

1 25-6804 Fan racket
2 59-0091 Cable carrier
3 59-0144 Fan guard
4 36-3035 Fan Assembly
5 25-7336 Solenoid bracket
6 60-1815 Encoder
7 22-7260 Encoder stand-off
8 54-7127 Drive sprocket
9 25-9667 Encoder mounting plate
10 54-2121 Drive belt
11 20-0276 Drive sprocket
12 53-3001 Pressure switch
13 30-3156 Air solenoid
14 58-2736 Air regulator
15 59-2780 Solenoid
16 25-7440 Rear sound shield
17 62-3016 Spindle motor
18 25-5748 Left chip shield
19 25-5747 Right chip shield
20 20-1656 Spring retainer
21 32-2010 Limit switch
22 32-5620 Solenoid valve assembly
23 30-3201 TRP assembly
24 59-2832 Quick exhaust
25 59-2760 Compression spring
26 20-7626 TRP shaft
27 22-7520 Isolator
28 22-7521 Spacer
29 20-1514 Cylinder housing
30 20-7429 Motor sub plate
31 20-7376 Sprocket flange
32 20-9672 Sprocket
33 54-2660 Drive belt
34 25-0982 Retaining bracket
35 30-7494 Upper oil line assembly
36 20-7008 Nut housing
37 24-0041 Ball screw assembly
38 30-7525 Oil line assembly
39 50-0017 Linear guide assembly
40 58-2071 ½ x ½ weatherhead
41 25-0957 Coolant jacket
42 58-0204 Coolant jacket tube
43 20-7005 Spindle head
44 59-9134 Bottom sound cover
45 25-7096 Bottom spindle head cover
46 58-1680 Anchor connector
47 25-5737 Gordillo adaptor plate
48 25-7284 Inspection plate
49 30-6656 Spindle
50 59-9132 Side sound foam
51 30-7365 P-cool assembly
52 58-5173 Conduit
53 52-0026 P-cool hose assembly
54 25-5820 P-cool mounting bracket
55 61-1040 Switch
56 30-7459 Manifold assembly
57 25-7600 Spindle head cover
58 59-9131 Front sound foam
59 25-6805 Top chip cover

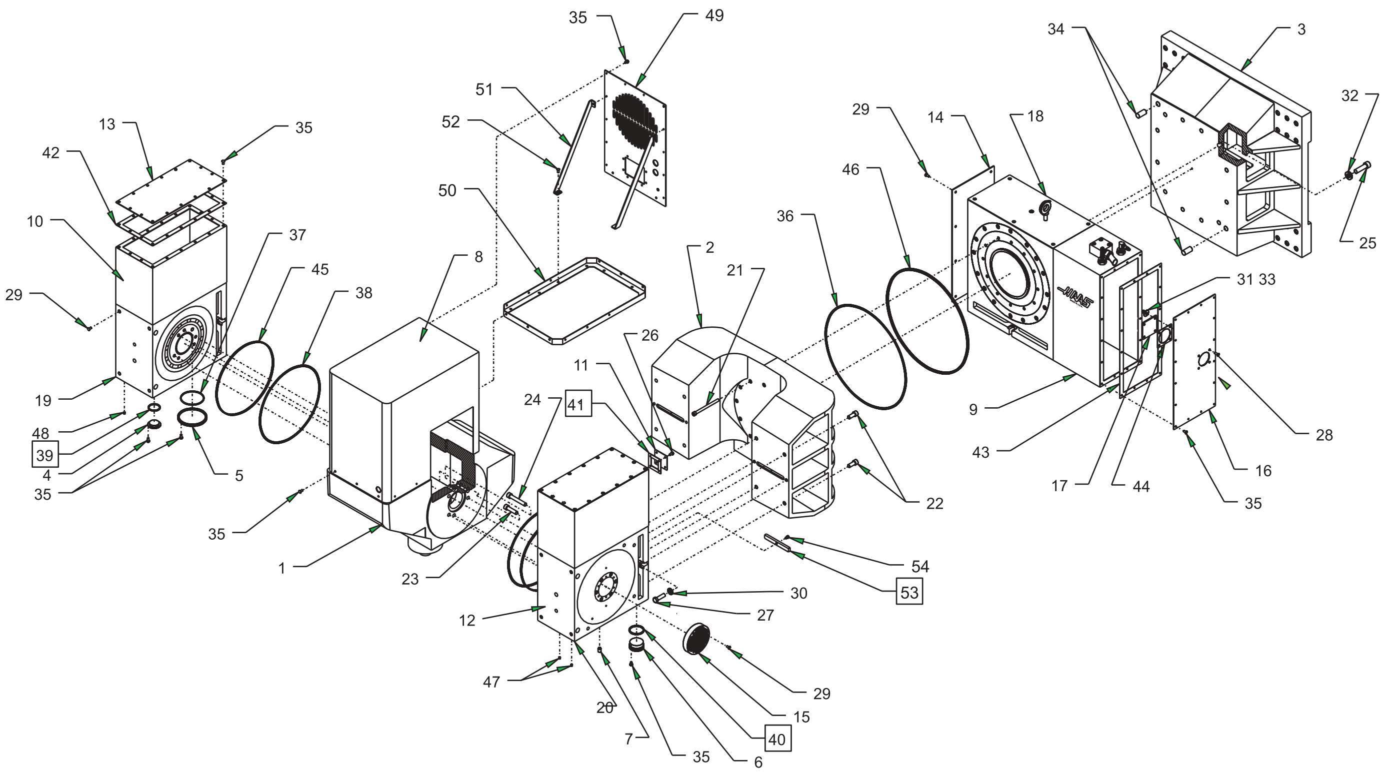
Mill Drill Spindle Head Assembly



ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	25-4424	BELT ENCLOSER 310 SP VB
2	1	25-4426	MOTOR ENCLOSER 310 SP VB
3	1	25-4428	MOTOR ENCLOSER COVER
4	2	25-4429	RADIUS COVER VB MILLS
5	1	25-4430	SIDE COVER
6	1	25-4431	CABLE COVER 310
7	1	25-4432	CABLE COVER C-AXIS VB
8	6	40-1669	BHCS, 8-32 X 3/8
9	54	40-1750	BHCS, 10-32 X 3/8
10	3	40-1850	SHCS, 10-32 3/8
11	36	40-1975	BHCS, 1/4-20 X 5/16

ITEM NO.	QTY.	PART NO.	DESCRIPTION
12	1	57-4134	GASKET, AIR FITTINGS
13	1	57-4425	GASKET, BELT ENCLOSER
14	1	57-4427	GASKET, MOTOR ENCLOSER
15	2	57-4433	GASKET, CABLE COVER VB
16	1	57-4443	GASKET, MOTOR
17	1	58-16708	1/4 NPT X 1/4 POLYLINE
18	2	58-16752	90 DEG. COMPRESSION TILT
19	1	58-1677	1/4 NPT ANCHOR FITTING
20	1	58-19900	COPPER TUBING 1/4 0D
21	1	58-3670	1/4 NPT M-1/8 F REDUCER

Bridge Mill Head Assembly

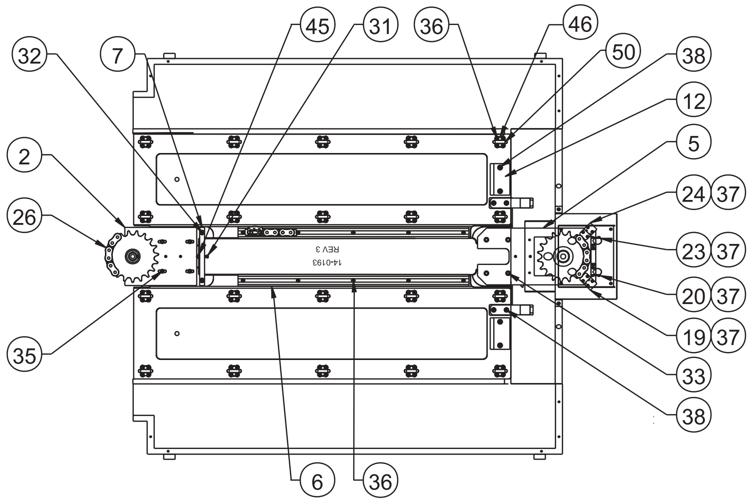


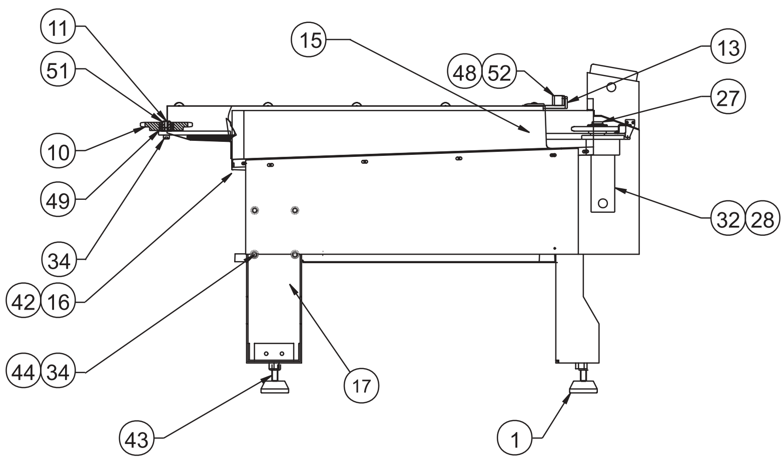
TORQUE SETTINGS	
ITEM	VALUE
21	45 FT LBS
22	88 FT LBS
23	100 FT LBS
24	100 FT LBS
25	160 FT LBS

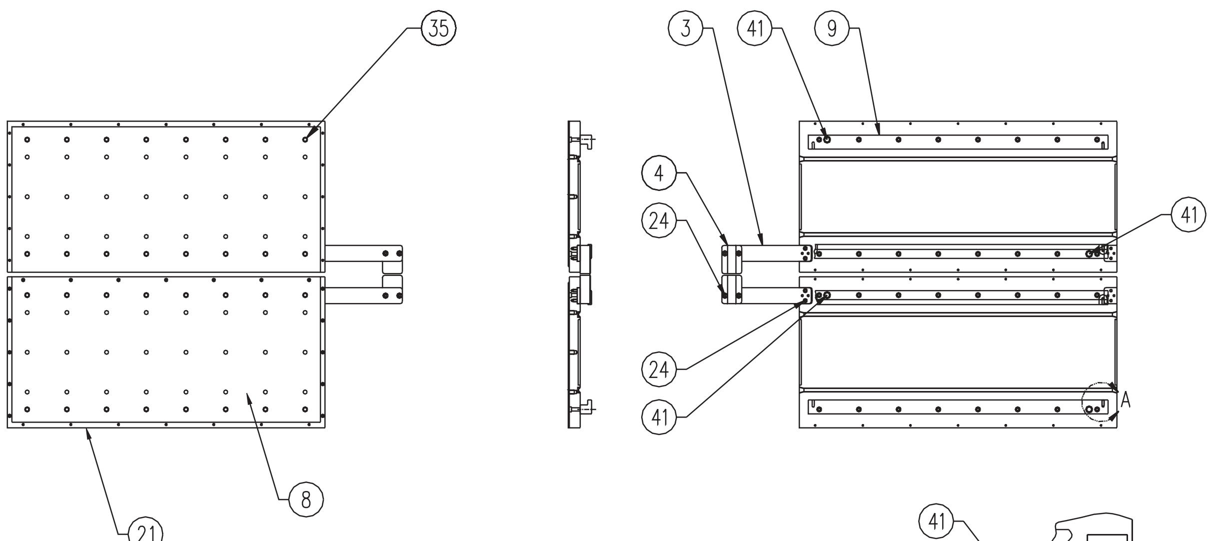
VR-Series Head Assembly

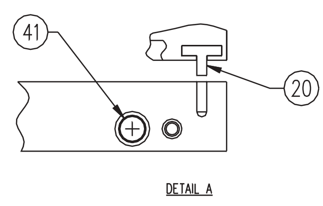
ITEM	QTY	DWG #	DESCRIPTON
1	1	20-4360	5AX SPINDLE HEAD (MACHINED)
2	1	20-4361	5AX YOKE, (MACHINED)
3	1	20-4367	5AX HEAD SPACER (MACHINED)
4	1	20-4381	SIGHT GLASS PLUG
5	1	20-4382	WORM HOUSING COVER, 5AX
6	1	20-4388	WORM PLUG 310 PULLEY SIDE
7	1	22-4040	MICRO SWITCH, PLUG
8	1	25-4363	5AX HEAD COVER
9	1	25-4366	MOTOR ENCLOSURE 450
10	2	25-4371	MOTOR ENCLOSURE 310/5AX
11	1	25-4372	BLOCK OFF PLATE 310/5AX
12	2	25-4373	TOP COVER 310/5AX
13	2	25-4375	ENCLOSURE COVER 310/5AX
14	1	25-4377	SIDE COVER 450/5AX
15	2	25-4380	PORT CHIP GUARD 5AX
16	1	25-4386	ENCLOSURE COVER 450/5AX
17	1	28-4278	SIGHT GLASS, PRESS GAGE
18	1	30-1070	HRT450 ASSY W/ 5AX MODS
19	1	30-1071	HRT310 DRIVE ASSY 5AX
20	1	30-1072	HRT310 DRIVEN ASSY 5AX
21	12	40-164391	SHCS, 3/8-16 X 5 1/4
22	8	40-16575	SHCS, 1/2-13 X 1 1/4
23	8	40-1661	SHCS, 1/2-13 X 2
24	4	40-16626	SHCS, 1/2-13 X 3 1/4.
25	12	40-16643	SHCS, 5/8-11 X 2 1/4
26	4	40-1669	BHCS, 8-32 X 3/8
27	4	40-1830	HHB, 1/2-13 X 1 3/4
28	4	40-1976	BHCS, 1/4-20 X 3/4
29	22	40-1980	BHCS, 1/4-20 X 1/2
30	4	45-1740	WASHER, BLACK HARD 1/2
31	4	45-1850	WASHER, FENDER 1/4 IDX1 OD
32	12	45-2011	HARD WASHER 5/8
33	4	46-1625	NUT HEX BLK OX 1/4-20
34	2	48-1757	DOWEL PIN 3/4 X 1 1/2.
35	85	49-1750	BHCS, 10-32 X 3/8
36	1	57-0093	O RING, 2-385 BUNA
37	1	57-2250	O-RING, 2-156 VITON
38	2	57-2252	O RING, 2-381 VITON
39	1	57-2831	0-RING, 2-130 BUVA
40	1	57-4120	O-RING, 2-226 VITON
41	1	57-4133	J-BOX GASKET
42	2	57-4223	GASKET MOTOR ENCLOSURE
43	1	57-4261	ENCLOSURE COVER GASKET 450
44	1	57-4279	GASKET, SIGHT GLASS
45	2	57-4384	HRT310 TEFLON SEAL
46	1	57-4385	HRT450 TEFLON SEAL
47	3	58-1627	1/8-27 PIPE PLUG
48	1	58-3105	1/4 NPT PIPE PLUG
49	1	25-4362	5AX HEAD COVER, BACK PLATE
50	1	25-4364	HEAD COVER MOUNTING ANGLE
51	2	25-4383	HEAD COVER BRACE, 5AX
52	10	40-1975	BHCS 1/4-20 X 5/19
53	2	20-4230	KEY, BODY
54	20	40-1630	SHCS 1/4-20 X 5/16

VR-Series Head Assembly





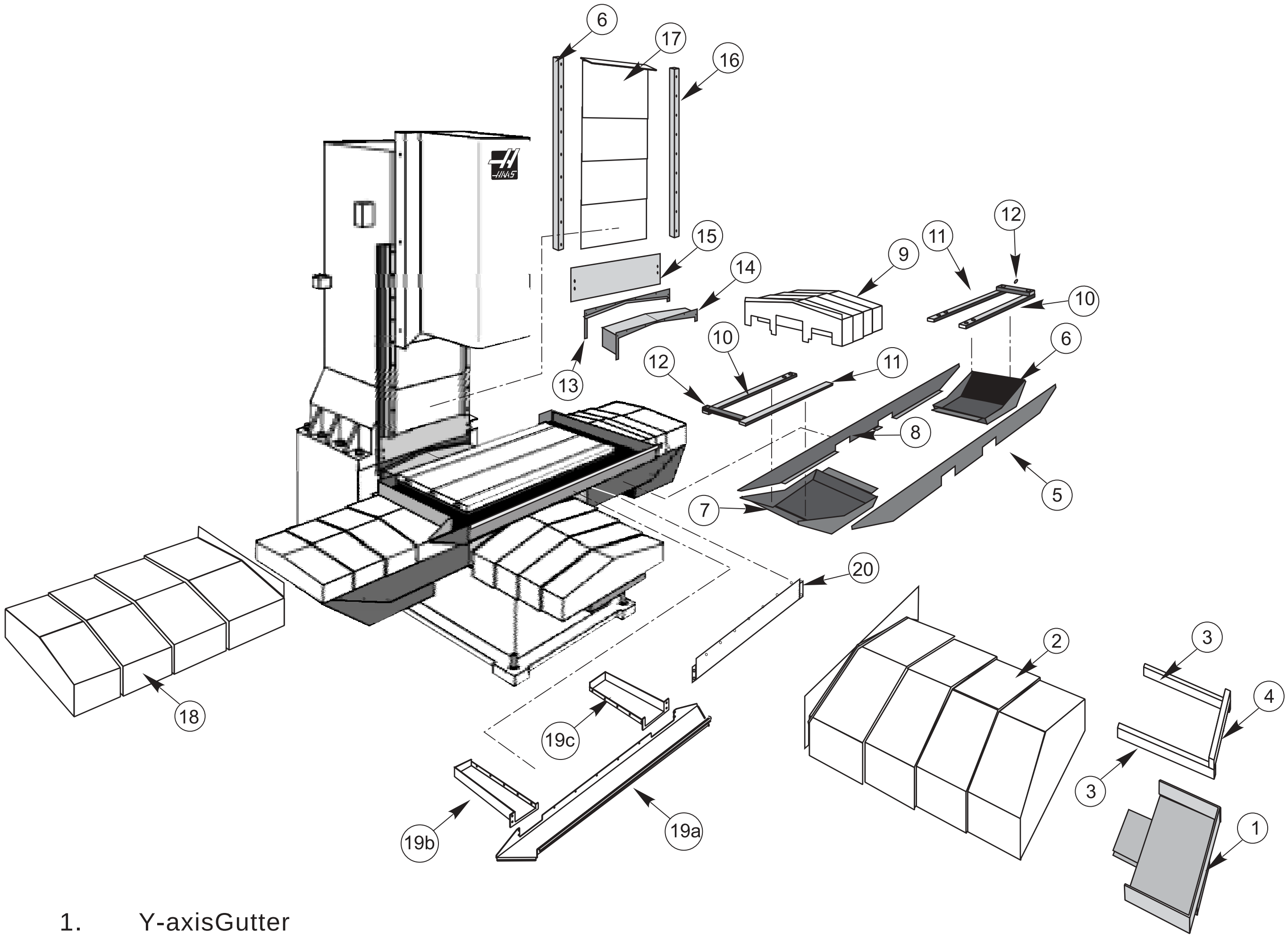




APC Assembly

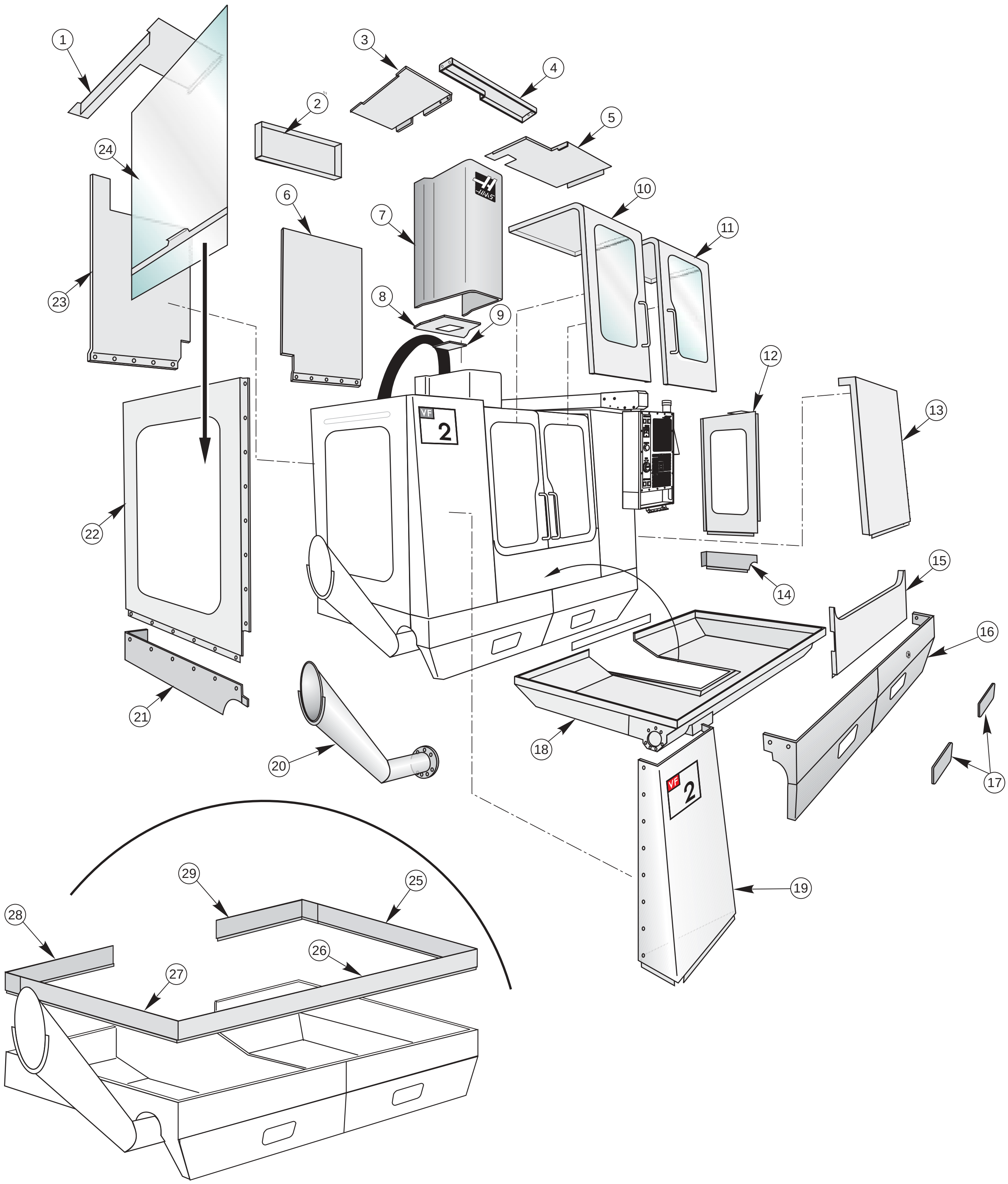
ITEM	QTY.	PART NO.	TITLE
1.	3	14-7068	CASTING, LEVEL PAD
2.	1	20-0046	SUPPORT, IDLER SPROCKET
3.	2	20-0048	DRIVE LEG, APC
4.	2	20-0049	DETENT, APC
5.	1	20-0050	SUPPORT, MOTOR, APC
6.	2	20-0051	GUIDE, CHAIN, APC
7.	1	20-0052	TENSIONER BLOCK
8.	2	20-0053	PALLET
9.	4	20-0054	CLAMPING RAIL
10.	1	20-0057	IDLER SPROCKET
11.	1	20-0060	JOURNAL, IDLER SPROCKET
12.	2	20-0065	FRICTION BLOCK
13.	2	20-0066	PALLET STOP, APC
14.			N/A
15.	1	20-0193	BASE, MACHINED
16	1	25-0066	SHIELD, SPLASH, LOW PROFILE
17.	3	25-0072	LEG, APC
18.	2	25-0077	PALLET, SKIRT, REAR
19.	1	25-0082	SWITCH BRACKET, CHAIN, LOW
20.	4	26-8964	WIPER APC
21.	2	25-0095	PALLET DRIP PAN
22.	4	25-0100	BRACKET, WIPER
23.	1	25-0101	SWITCH BRACKET ARM #2
24.	1	25-0102	SWITCH BRACKET, CHAIN, HIGH
25.	2	25-0105	PALLET SKIRT, FRONT
26.	1	30-0054	CHAIN ASSEMBLY, APC
27.	1	30-0055	SLIP CLUTCH ASSEMBLY
28.	1	32-1800	SHUTTLE MOTOR, 507-01-110AH
29.	8	40-0017	FHCS, 5/16-18 X 3/4”
30.	8	40-16081	BHCS, 6-32 X 5/16”
31.	1	40-1614	SHCS, 1/4-20 X 1 1/4
32.	2	40-1617	FHCS, 1/4-20 X 1”
33.	4	40-1636	SHCS, 3/8-16 X 1 1/4
34.	13	40-1654	SHCS, 1/2-13 X 1”
35.	4	40-1667	SHCS, 5/16-18 X 1 1/4
36.	124	40-1703	FHCS, 10-32 X 1/2
37.	8	40-1850	SHCS, 10-32 X 3/8”
38.	8	40-1920	FHCS, 1/4-20 X 5/8
39.	2	40-1950	SHCS, 10-32 X 3/4
40.	32	40-1961	SHCS, 3/8-16 X 2”
41.	4	40-1970	FHCS, 1/4-28 X 1”
42.	3	40-1981	FBHCS, 1/4-20 X 1/2
43.	3	44-1700	SSS, CUP PT. 3/4-10 X 4:”
44.	12	45-1666	WASHER, FLAT 1/2 I.D.
45.	1	46-1625	NUT, HEX, BLACK OX, 1/4-20
46.	20	48-0012	DOWEL PIN, 12mm X 30 mm LG.
47.	32	49-16201	BHCS, 10-32 X .38
48.	4	51-0030	BUSHING, DRILL .6260 I.D.
49.	2	51-2836	BEARING, RADIAL, #60052RS
50.	20	51-4000	BEARING, RADIAL 12 X 32 X 10MM
51.	1	56-0085	RETAINING RING 5100-100
52.	2	59-1057	BUMPER, PALLET

APC Assembly



1. Y-axisGutter
2. Y-axis Waycover
3. Y-axis Guide Rails
4. Way Cover Bracket
5. Saddle Cover
6. X-axis Gutter
7. X-axis Gutter
8. Saddle Cover
9. X-axis Waycover
10. X-axis Guide Rails
11. X-axis Guide Rails
12. Way Cover Bracket
13. Y-axis Wiper
14. Y-axis Rear Waycover
15. Z-axis Waycover Support
16. Z-axis Chip Guard
17. Z-axis Waycover
18. X-axis Waycover
19. Table Gutter
20. Table Cover

VF Interior Replaceable Parts

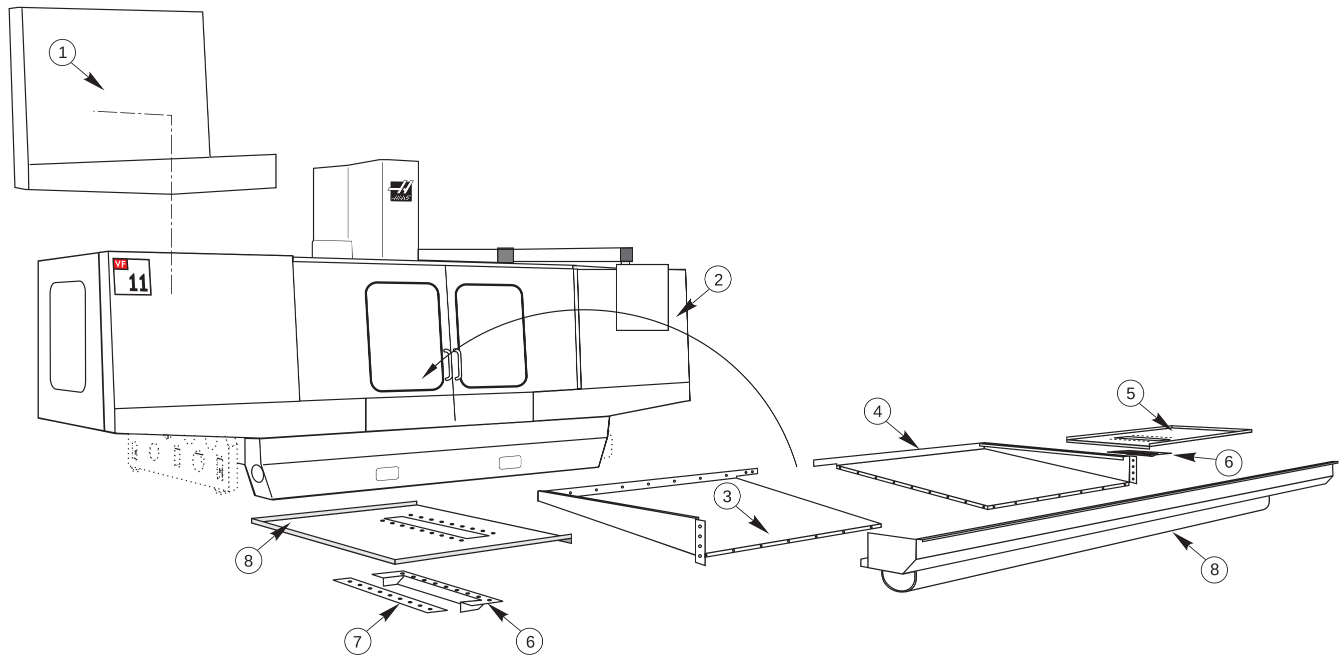


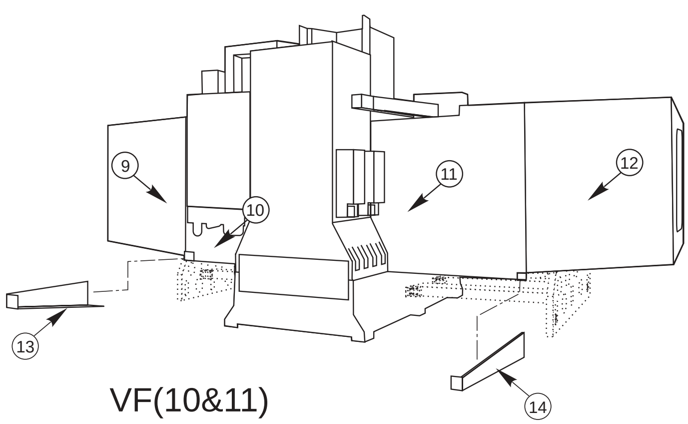
VF6 - 8 Extended Column - Riser Sheet Metal
(Optional)

VF Exterior Sheet Metal

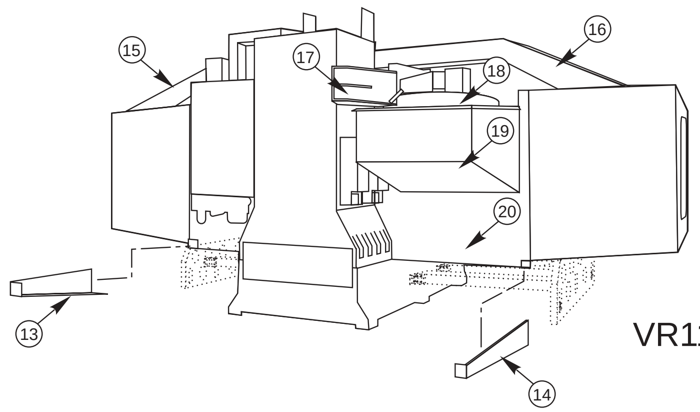
1. Plate, Top Left
2. Back Panel Spacer
3. Top Left Panel
4. Upper Door Brace
5. Plate, Top Right
6. Back Right Panel
7. Spindle Head Cover
8. Spindle Head Cover, Bottom
9. Bottom Head Cover Inspection Panel
10. Left Door Assembly
11. Right Door Assembly
12. Panel, Right Side
13. Panel, Front Right
14. Apron Extension, Right
15. Middle Front Panel
16. Apron, Left and Right
17. Access Panel
18. Pan, Chip Enclosure
19. Front Left Panel
20. Chip Chute
21. Apron Extension, Left
22. Side Panel, Left
23. Back, Left Panel
24. Side Window (handle not included)
25. Right Side Riser
26. Front Riser
27. Left Side Riser
28. Left Rear Riser
29. Right Rear Riser

VF Exterior Sheet Metal





VF(10&11)

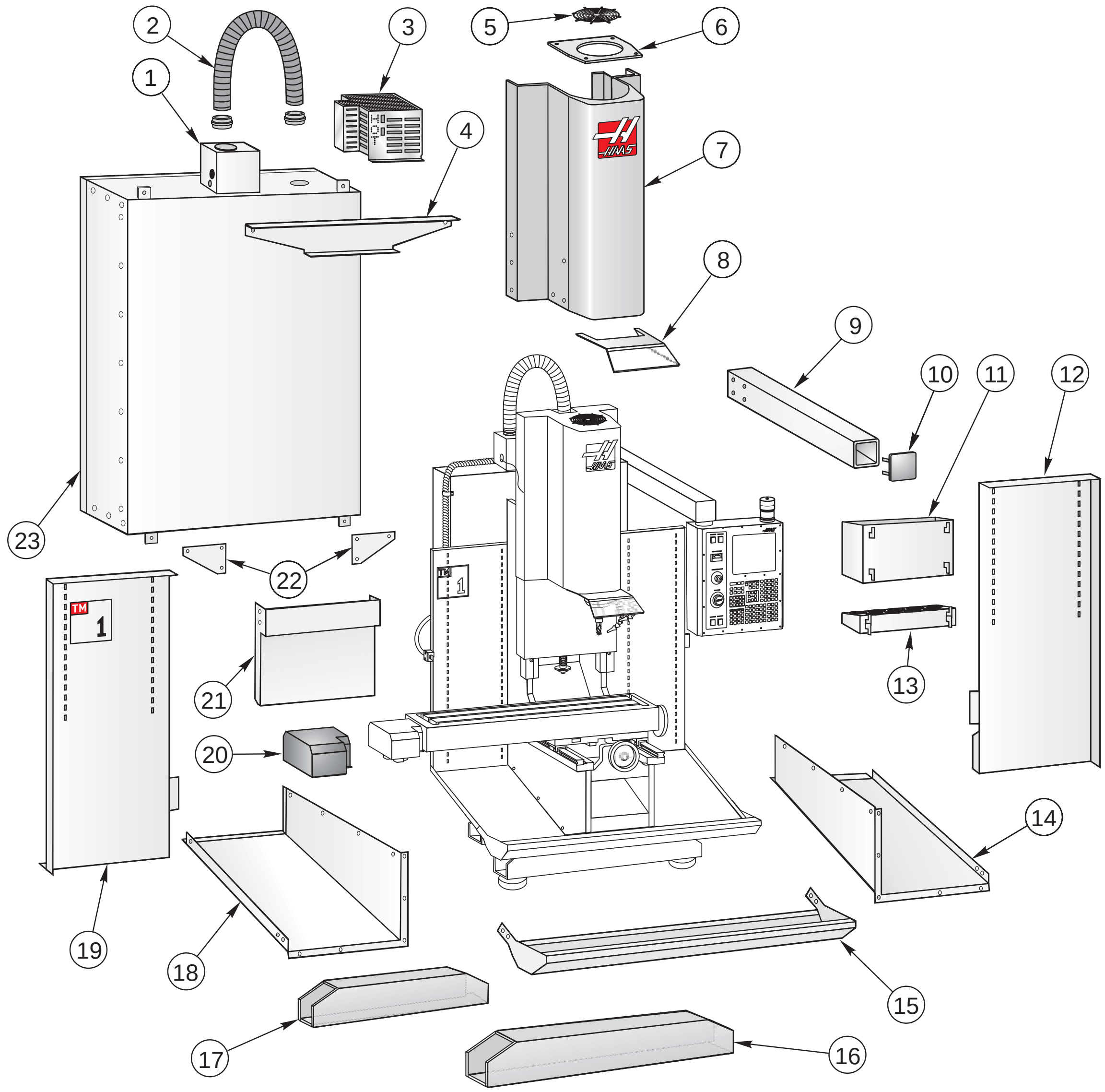


VR11

VF Exterior Sheet Metal

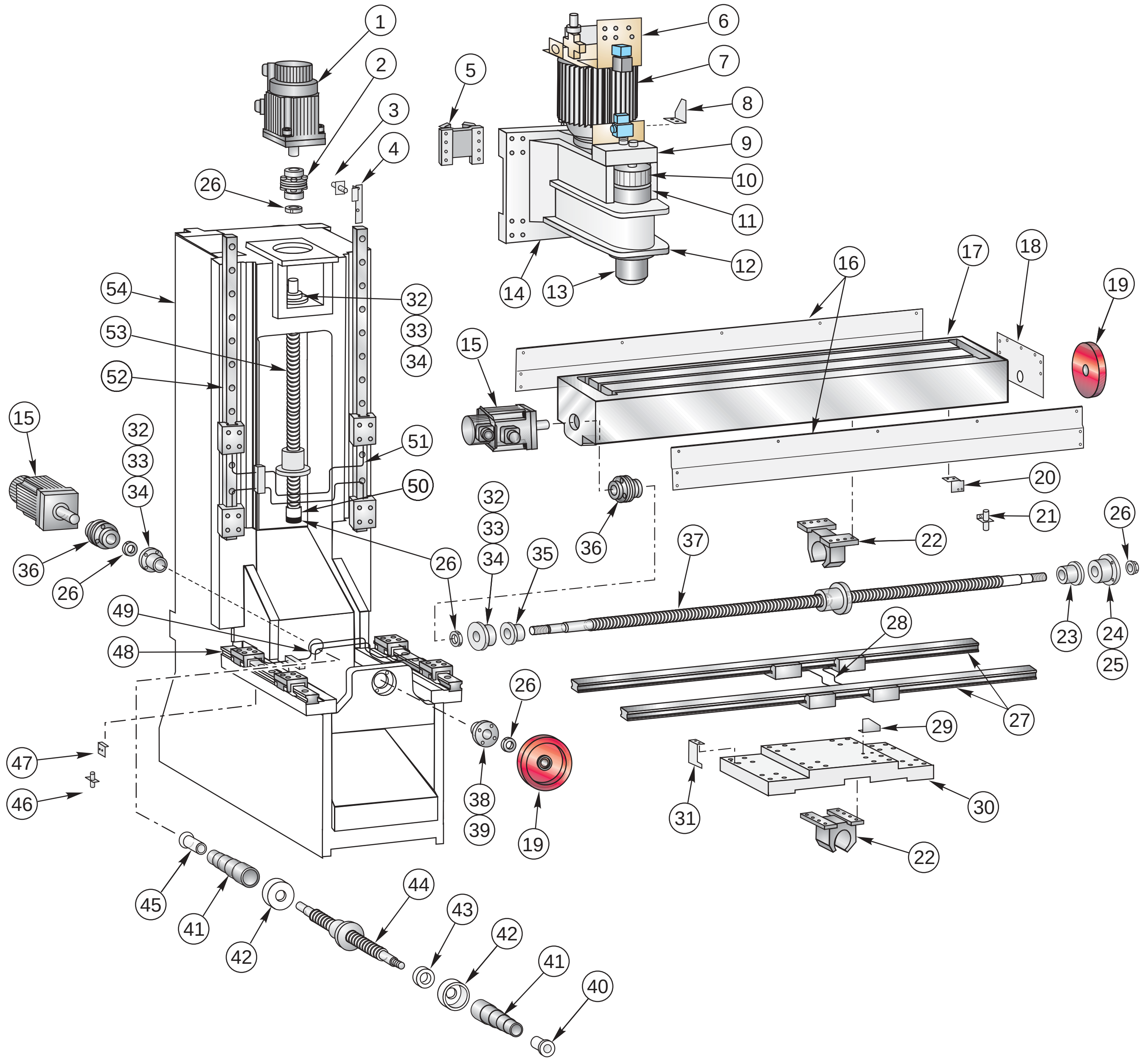
1. Front Left Panel
2. Front Right Panel
3. Floor Pan Left
4. Floor Pan Right
5. Pan Right, Outrigger
6. Pan Support
7. Pan Support
8. Pan Left, Outrigger
9. Back Right Panel Extension
10. Inner Back Panel, Right
11. Inner Back Panel, Left
12. Back Left Panel Extension
13. Apron Extension Right
14. Apron Extension Left
15. Support Beam
16. Support Beam
17. Tool Changer Bracket
18. Tool Changer Cover
19. Tool Changer Pan
20. Back Panel Left

VF Exterior Sheet Metal



1.	25-7198	Junction Box	12.	25-6596	Right Chip Pan
2.	59-0385	Corrugated Tubing Assembly	13.	25-0440A	Tool Crib
3.	32-0043	Regen Cover	14.	25-4006	Right Side Pan
4.	25-4044A	Control Box Top Mounting Bracket	15.	25-6656	Trough
5.	59-0144	Fan Guard	16.	20-1117A	Front Leg
6.	25-0389	Top Fan Bracket	17.	20-1116A	Rear Leg
7.	25-4003C	Spindle Head Cover	18.	25-4007	Left Side Pan
8.	25-4008	Safety Shield	19.	25-6597	Left Chip Pan
9.	25-1097	Pendant Arm	20.	25-4000A	Table Motor Cover
10.	14-1962	End Cap (2)	21.	25-4010	Spindle Waycover
	25-5394	End Cap Mounting Clip	22.	25-1091	Control Box Bottom Mount (2)
11.	25-0563	Storage Box	23.	25-0025	Control Box

Toolroom Mill Exterior Sheet Metal

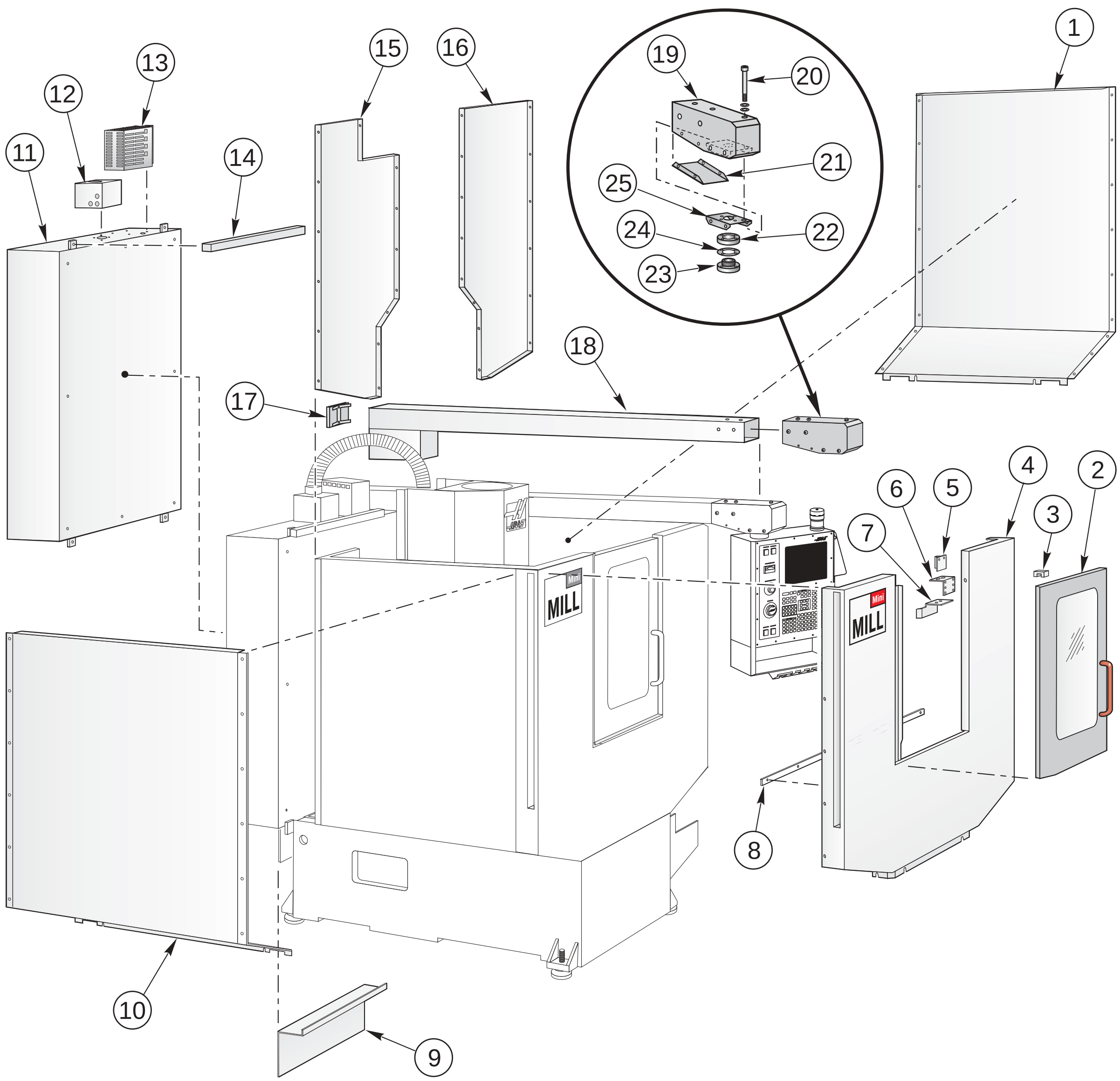


Toolroom Mill Interior Parts

1.	62-0024	Motor
2.	30-1220A	Coupling Assembly
3.	32-5060	Z-Axis Limit Switch
4.	25-4024	Z-Axis Limit Switch Mounting Bracket
5.	20-7008F	Z-Axis Ball Screw Nut Housing
6.	30-2465A	Air Solenoid Assembly
7.	30-1674	Linear Motor 5HP
8.	25-6578	Z-Axis Limit Switch Trip Bracket
9.	30-1668A	TRP Assembly
10.	20-7373	Pulley 1_7_8
11.	20-7442	Oil Injection Cover
12.	20-1330	Spindle Head Housing Machined
13.	30-1337	Spindle Assembly CT30
14.	20-3003A	Spindle Mounting Plate
15.	62-0014	Motor
16.	25-4001A	Table Side Covers (2)
17.	20-1302A	Table
18.	25-4002A	Table End Cover
19.	20-1256	Handwheel (2)
20.	25-4014	X-Axis Proximity Switch Bracket
21.	32-2133	X-Axis Proximity Switch
22.	20-1093	X and Y Axis Ball Screw Nut Housing (2)
23.	20-1147	X-Axis Support Bumper
24.	30-2780	Bearing Housing Assembly
25.	51-2025	Ball Bearing
26.	51-2012	Bearing Locknut (6)
27.	50-0012A	X-Axis Linear Guides (2)
28.	30-2767	X-Axis Oil Line Assembly
29.	25-4013	X-Axis Proximity Switch Trip Bracket
30.	20-1304B	Saddle
31.	25-5191	Y-Axis Proximity Switch Trip Bracket
32.	20-7416	Bearing Cartridge Housing (3)
33.	51-1011U	Ball Bearing (3)
34.	20-7418	Bearing Cartridge Lock (3)
35.	20-1146	Bumper (Motor Side)
36.	30-1220	Coupling Assembly (2)
37.	24-0019	X-Axis Ball screw
38.	30-2780	Bearing Housing Assembly
39.	51-2025	Ball Bearing
40.	20-1158	Y-Axis Support Bumper
41.	59-0264	Ball Screw Cover (2)
42.	20-1113	Ball Screw Cover Retainer (2)
43.	20-1114	Ball Screw Spacer
44.	24-0020	Y-Axis Ball Screw
45.	20-1148	Y-Axis Motor Bumper
46.	32-2133	Y-Axis Proximity Switch
47.	25-4012	Y-Axis Limit Switch Bracket
48.	50-0013A	Y-Axis Linear Guides (2)
49.	30-2794	Y-Axis Oil Line Assembly
50.	20-3017	Bumper
51.	30-2042	Z-Axis Oil Line Assembly
52.	50-0014A	Z-Axis Linear Guides (2)
53.	24-0021	Z-Axis Ball Screw
54.	20-1303A	Base Machined

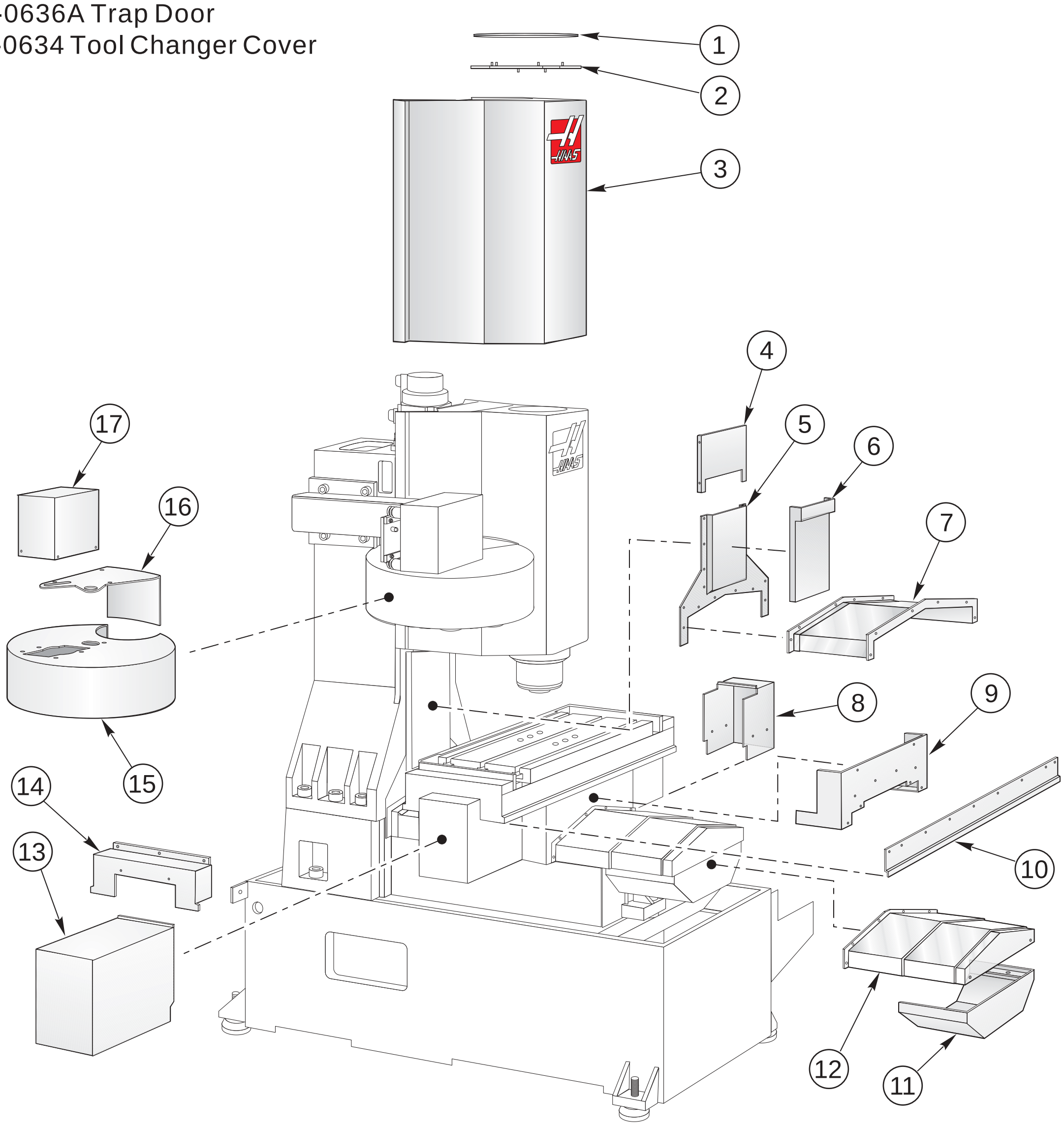
Toolroom Mill Interior Parts List

1. 25-0754 Enclosure Side
2. 25-0386 Door Assembly
   28-0011 Window
3. 20-0712 Guide Block
4. 25-0753 Panel Front Enclosure
5. 25-0958 Keybracket
6. 25-7050C Switch Mounting Bracket
7. 25-0757 Door Keeper
8. 22-7616 Lower Door Rail
9. 25-7195K Lube Panel Mounting
10. 25-0754 Enclosure Side Mirror
11. 25-0025D Main Electric Control Box
12. 25-7198B Junction Box
13. 25-0461 Regen Cover (Front)
    25-0462 Regen Cover (Back)
14. 20-3009 Box Bar
15. 25-0384A Back Panel Left
16. 25-0385A Back Panel Right
17. 14-1962 End Cap
    25-5394 End Cap Mounting Clip
18. 20-3008 Pendant Arm
19. 25-6661 Pendant Arm Knuckle
20. 44-0018 Leveling SHCS
21. 25-6660 Knuckle Cover
22. 20-7109A Pendant Arm Mount
23. 20-7110A Pendant Mount
24. 55-0020 Wavy Washer
25. 25-6659 Knuckle Swivel Plate

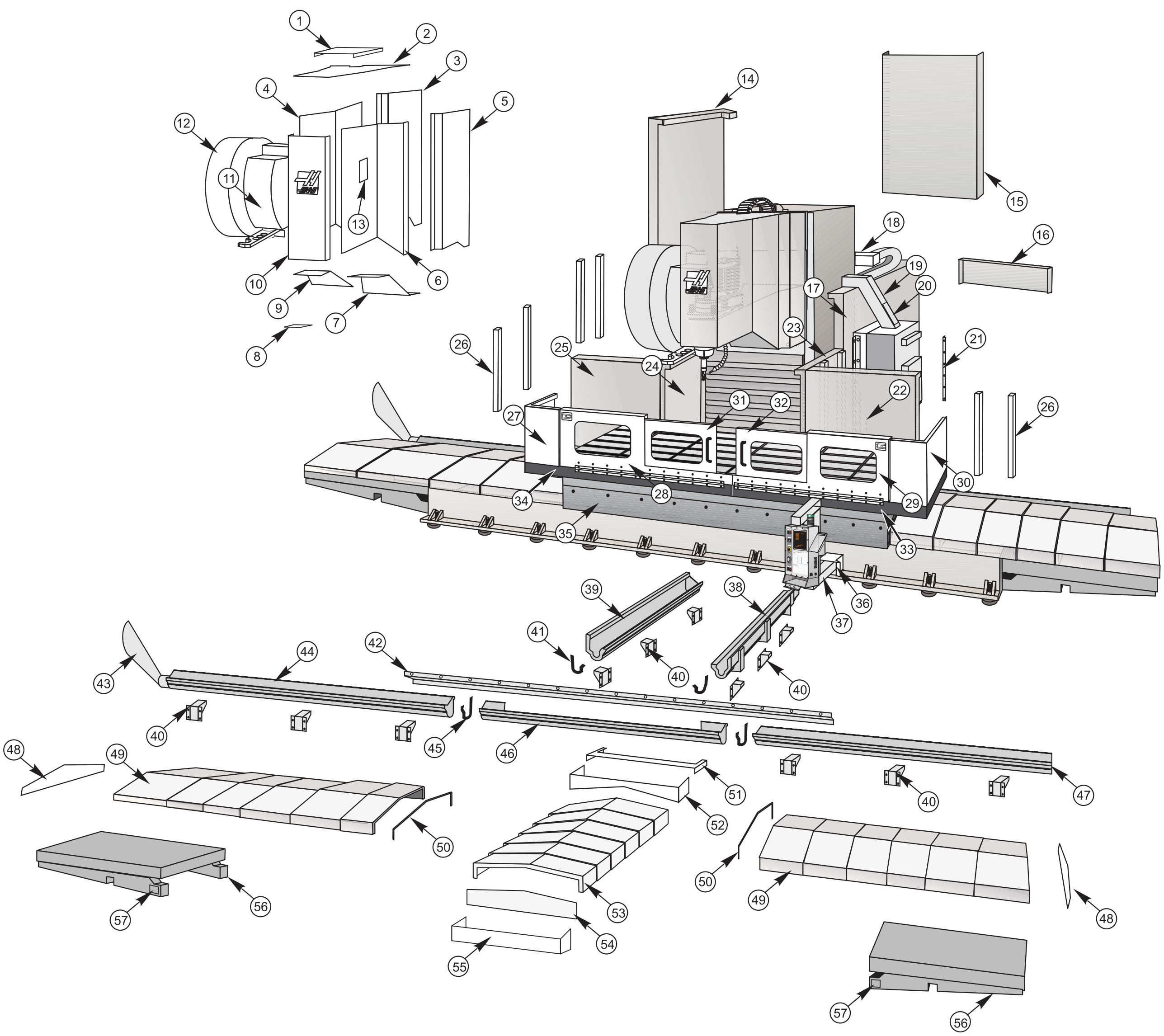


Mini Mill Exterior Sheet Metal

1. 59-0144 Fan guard
2. 25-0389 Fan bracket top
3. 25-0382A Head Cover
4. 25-0388 Back Head Cover
5. 25-0381 Z lower cover
6. 25-0380 Z upper cover
7. 25-0373 Y-axis way cover, rear
8. 25-0377 Support Cover
9. 25-0375 Saddle cover (2)
10. 25-0378 Tab side cover (2)
11. 25-0374 Front Y-axis motor cover
12. 25-0372 Y-axis Waycover, Front
13. 25-0376 Motor Cover, X-axis
14. 25-0379 Table End Cover (2)
15. 25-0633 Tool Changer Shroud
16. 25-0636A Trap Door
17. 25-0634 Tool Changer Cover



Mini Mill Interior Sheet Metal



VS-3 Sheet Metal Assembly

1	Fan guard
2	Head cover, top plate
3	Head cover, left rear cover
4	Head cover, left front cover
5	Head cover, right rear cover
6	Head cover, right front cover
7	Head cover, rear bottom
8	Bottom head access plate
9	Head cover, front bottom cover
10	Head cover, front
11	Tool changer housing
12	Tool changer shroud
13	Head cover access plate
14	Left rear enclosure panel
15	Rear enclosure panel
16	Center bottom sheet metal panel.
17	Right rear enclosure panel
18	Conduit box
19	Conduit enclosure
20	Conduit access plate
21	"L" bracket
22	Right front sheet metal
23	Right forward sheet metal
24	Left forward sheet metal
25	Left front sheet metal
26	Support brace
27	Left corner, door assembly
28	Left door
29	Right door
30	Right corner, door assembly
31	Center, left door
32	Center, right door
33	Right splash tray
34	Left, splash tray
35	Table splash guard
36	Pedant arm shroud
37	Pendant arm
38	Z Axis, right chip conveyor tray
39	Z Axis, left chip conveyor tray
40	Brace
41	Z Axis chip conveyor gasket
42	X Axis splash guard
43	Chip conveyor chute
44	X Axis chip conveyor tray, left
45	X Axis chip conveyor tray gasket
46	X Axis chip conveyor tray, middle
47	X Axis chip conveyor tray, right
48	X Axis way cover end plate
49	X Axis way covers
50	X Axis wiper
51	Z Axis way cover wiper cover
52	Z Axis way cover wiper
53	Z Axis way covers
54	Z Axis way cover end plate
55	Z Axis way cover end support
56	X Axis extension
57	X Axis extension access cover

VS-3 Sheet Metal Assembly Parts List