HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

VF Series Service Manual 96-8100 RevE English June 2002

- 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 USED IN HAAS MACHINES

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
CAD	Computer Assisted Design
CAM	Computer Assisted Manufacturing (Assisted Machining)
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
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
FADAL	The Other Guys
FHCS	Flat Head Cap Screw
FT	Foot
FU	Fuse
FWD	Forward
GA	Gauge
HAAS	The Right Tool
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
PWM	Pulse Width Modulation
RAM	Random Access Memory
REPT RIG TAP	Repeat Rigid Tap
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
VF	Vertical Mill (Very First)
VF-E	Vertical Mill - Extended
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/Leadscrews", 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 leadscrews (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/Leadscrews" 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 leadscrew (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 leadscrew (see "Thermal Growth" section).
- Check that the machine is level (see "Installation" section).
- Check for backlash (see "Servo Motors/Leadscrews" 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 leadscrew (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 leadscrew. As the machine warms up, the leadscrews 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 leadscrew 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 leadscrew 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 leadscrews to warm up to the correct temperature and stabilize. Once the machine is at temperature, the leadscrews 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.

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, **25psi.** Mini-Mill) 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.

1.3 Servo Motors / Leadscrews

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 lead screw. Replace or repair the coupling ("Axis Motor Removal/Installation")
- Check for a damaged lead screw, and replace if necessary ("Lead Screw Removal and Installation" section).

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

Noise

Lead 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 lead 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 lead 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.

Lead screw noise.

- Ensure oil is getting to the lead 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 lead screw. Loosen the clamp nuts at both ends of the lead screw. If the symptom disappears, replace the bearing sleeve. Be certain to check for damage to the lead screw shaft where the bearing sleeve is mounted.
  - •If the noise persists, the lead screw is damaged and must be replaced. When replacing the lead screw in an older machine, always replace the bearing sleeve with the current angular contact design bearing sleeve.
- Misalignment in the lead screw itself will tend to cause the lead 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 lead screw ball nut mounts is indicated by heating up of the ball nut on the lead screw, and noise and tightness through out the travel of the lead screw. Misalignment at the yoke where the ball nut mounts is indicated by noise and tightness at both ends of the travel of the lead screw. The ball nut may get hot.

NOTE: Customer complaints of Lead 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 lead 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 lead 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.

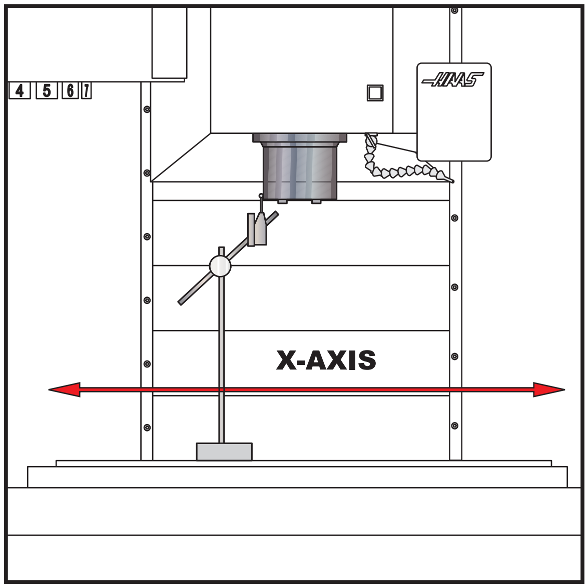


Figure 1-1. Dial indicator in position to check X-axis.

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.

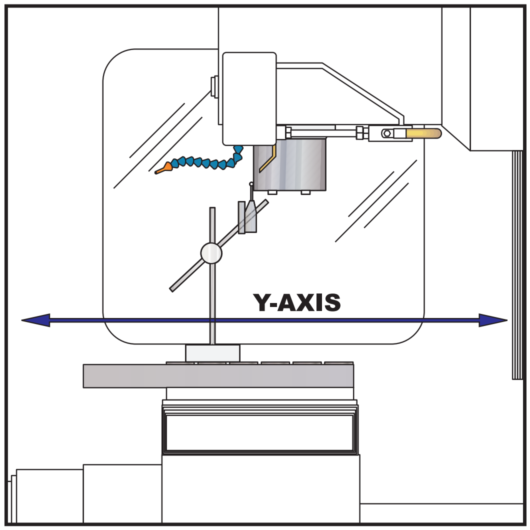


Figure 1-2. Dial indicator in position to check Y-axis.

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.

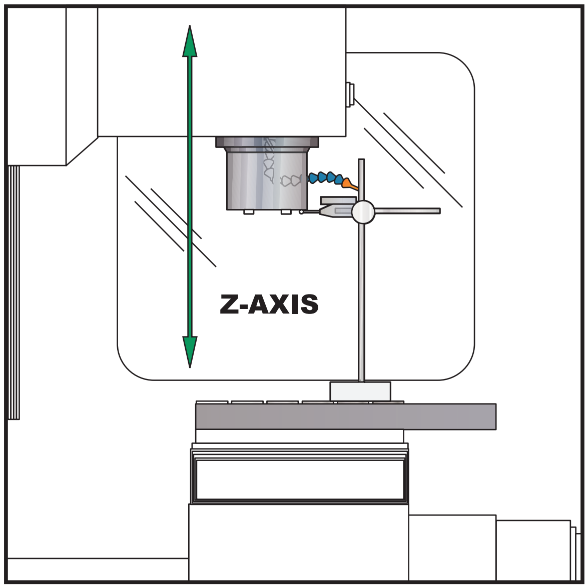


Figure 1-3 Dial indicator in position to check Z-axis.

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 "Lead 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 lead 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 lead 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 lead 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

Lead Screws - Visual Inspection

The three main causes of Lead 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 Lead Screw itself.

Loss of Lubrication:

The lubrication system of the machine provides a layer of oil for the Lead 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 Lead 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.
Lead 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 Lead Screws is material fatigue. Material fatigue typically occurs at the end of the Lead Screw service life. Signs of material fatigue include black, contaminated coolant, pitting of the screw surface, loss of preload, and metal flakes on the Lead Screw.
Lead 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 Lead Screws.

Check the condition of the lube on the Lead 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 Lead Screws for wear.

Contamination of the lube and/or coolant systems can be caused by a wearing Lead 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 Lead 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 Lead 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 Lead 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.

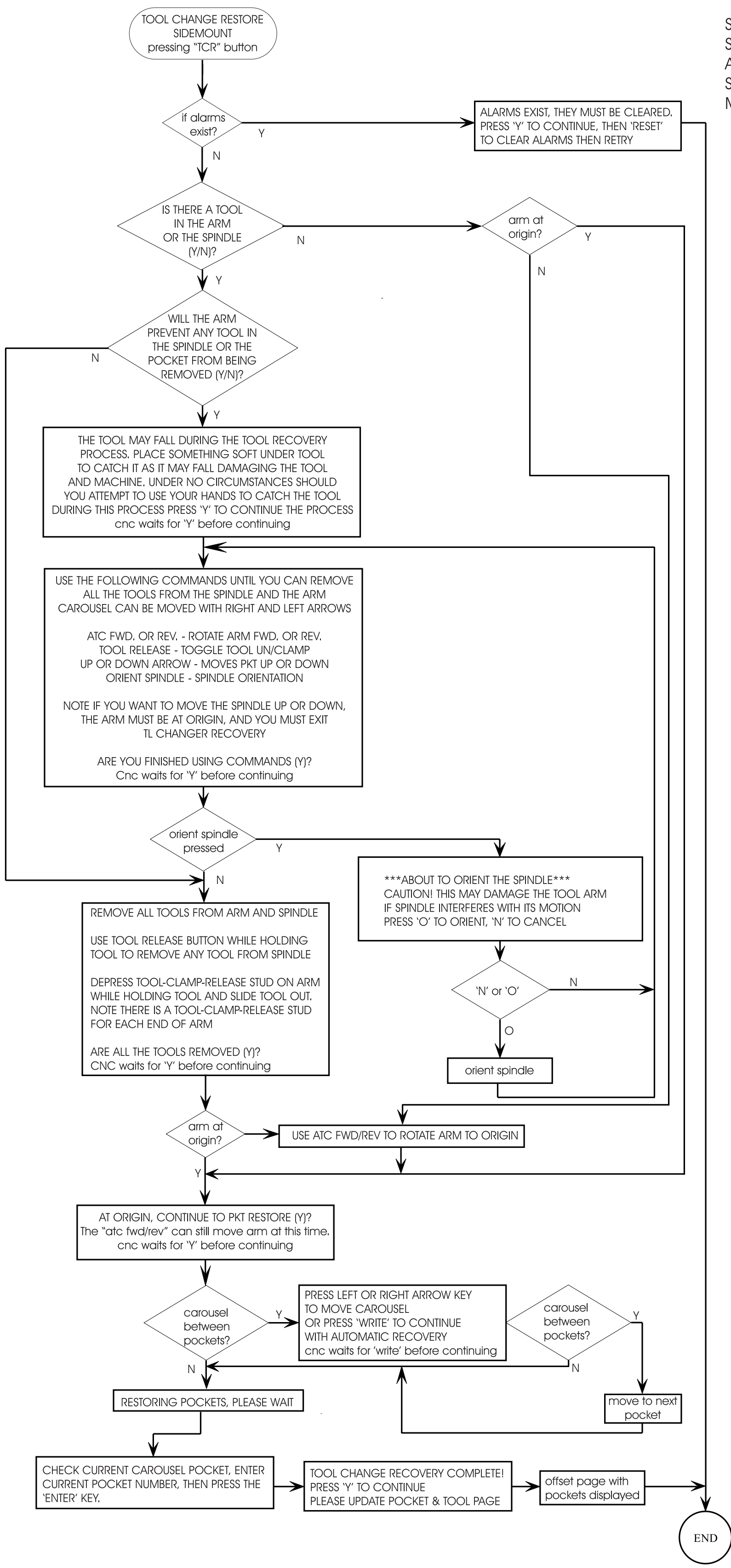
The part or fixture on the mill table crashes into long tooling or into the ATC itself when machining.

- 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

SIDEMOUNT MILL TOOL RECOVERY
SCREEN TEXT = UPPER CASE
ACTIONS - DECISIONS = LOWER CASE
S = SITUATION
M = NEXT MODE



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

A switch 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 this switch is wired to the spindle drive and commands it into the COAST STOP condition. This is done to make sure that the spindle motor is not powered when the pin is locking the spindle. If, during a tool change, the dogs on the spindle shaft do not align with the keys on the ATC carousel, the spindle orientation may be at fault.

The orientation of the spindle is as follows:

1. If the spindle is turning, it is commanded to stop,
2. Pause until spindle is stopped,
3. Spindle orientation speed is commanded forward,
4. Pause until spindle is at orientation speed,
5. Command spindle lock air solenoid active,
6. Pause until spindle locked status is active and stable,
7. If not locked after time-out time, alarm and stop.

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

To begin troubleshooting, check the alarm history to determine the problem's cause 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 for seal failure. If failure is found, replace the seal housing (30-3286A). Refer to the appropriate steps in "TSC-Tool Release Piston Replacement" section for procedure.
- 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. Single phase motors have a built in thermal cut out. 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.

Coolant Tip Wear

The carbide coolant tip should last for the life of the machine. The old bronze coolant tip should be checked every 1000 hours of TSC operation.

Coolant tip is wearing quickly and needs frequent replacement.

- Check the filtration system and that the coolant is not contaminated.
- Check precharge pressure (refer to the TSC Pressure Regulator Adjustment" section). Heavy wear will occur if this pressure is too high.
- Main air supply below 85 psi can cause excessive precharge pressure and heavy coolant tip wear.

NOTE: Abrasive swarf from grinding or ceramic machining operations will cause heavy wear of TSC coolant pump, coolant tip and drawbar. This is not covered by the warranty. Notify HAAS Service Dept. if machine is being used for this application.

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

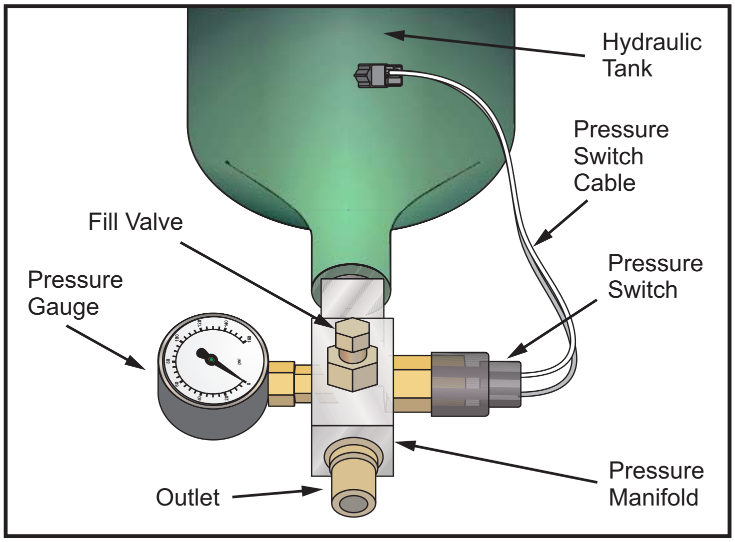
- Toggle Parameter 209 bit switch REV CNVR to reverse direction of conveyor.
- Check I/O Board conveyor relays.

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

TROUBLESHOOTING

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. 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.

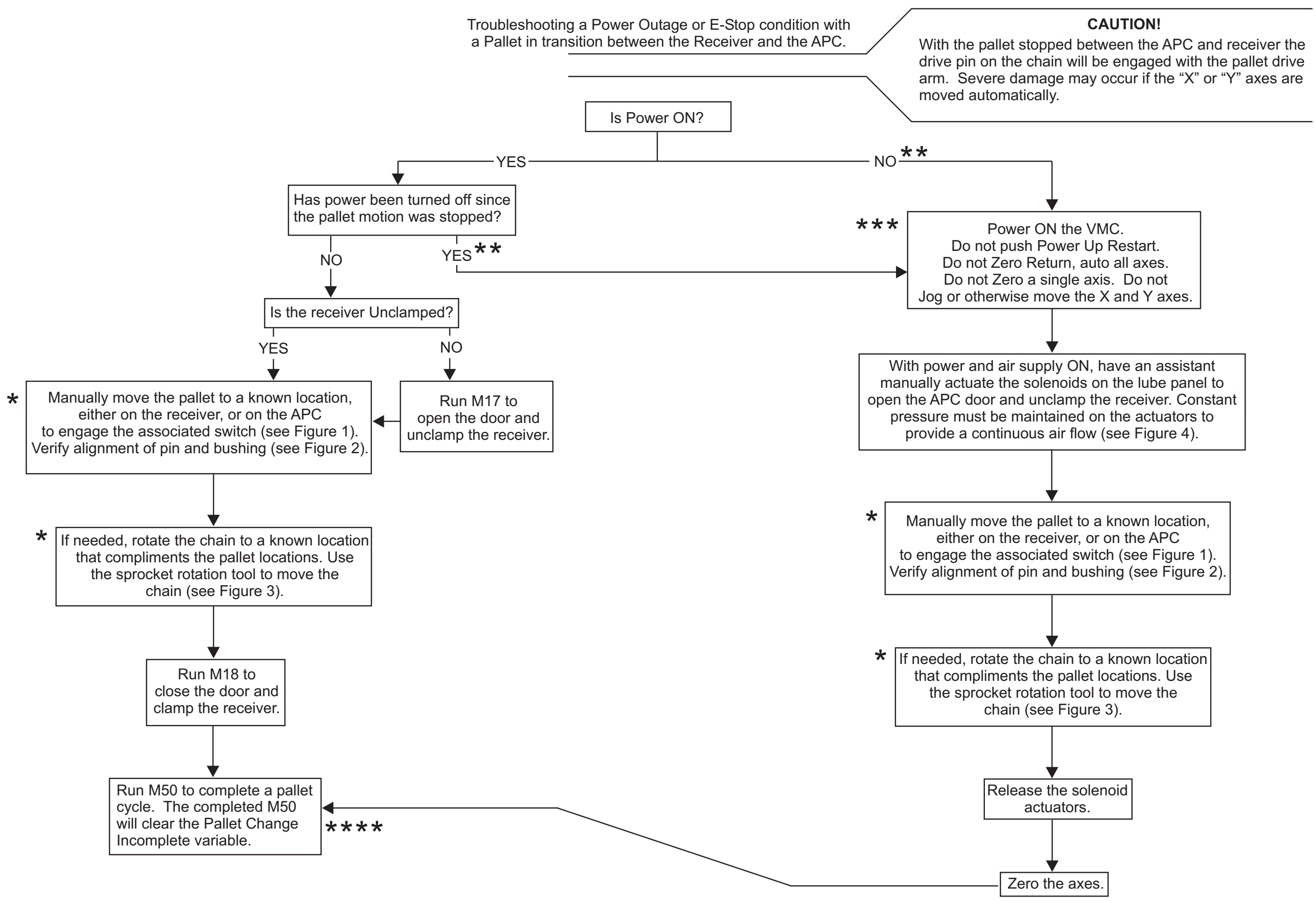
Sticking Pallet.

- 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.

Recovery from an E-Stop initiated during a pallet change



* 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.

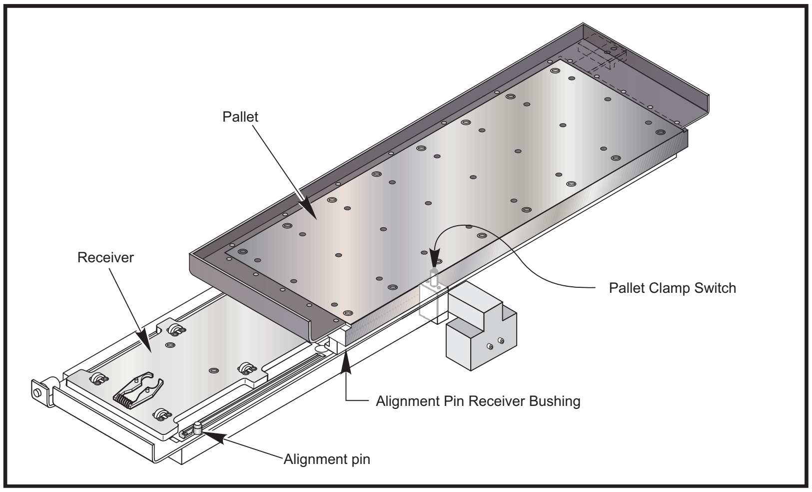


Figure 1
Pallet known locations. Pallet 1 is on the receiver and engaging the Pallet Clamped switch. Pallet 2 is on the APC and engaging the Pallet Home Switch under the control panel.

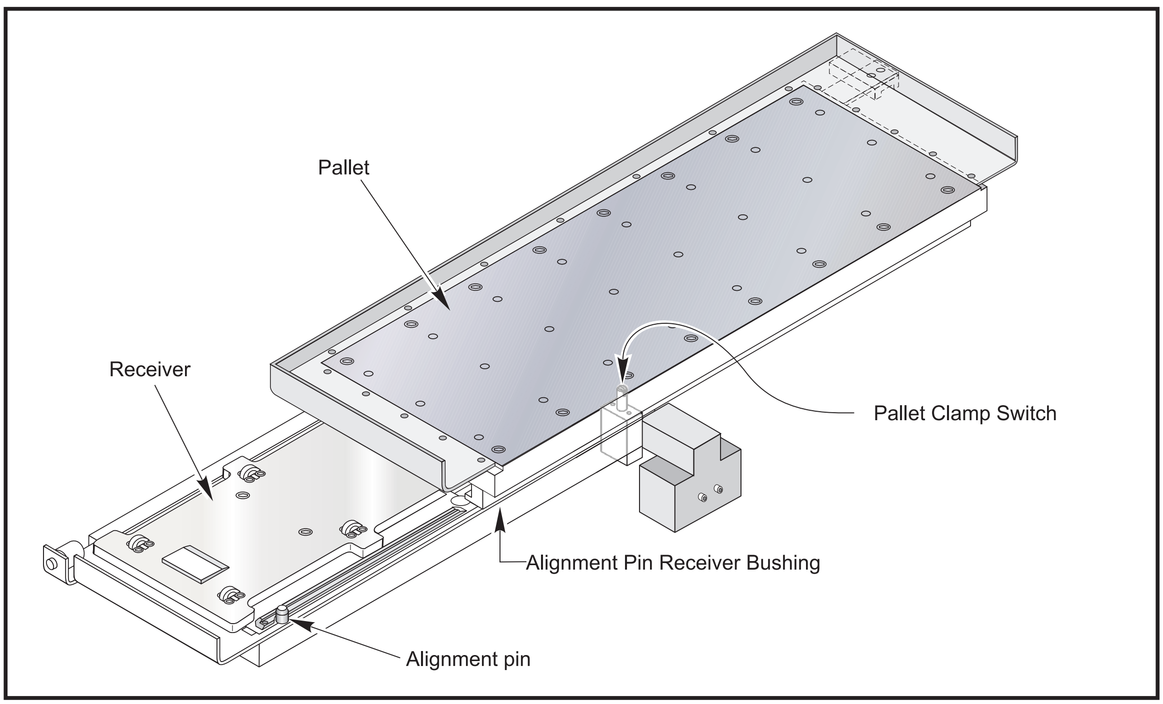


Figure 2
Alignment Pin and Bushing alignment must be verified when manually positioning a pallet on the receiver.

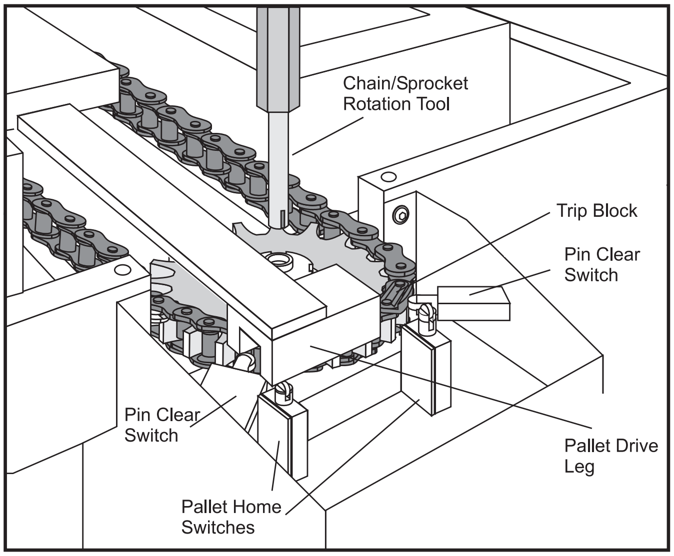


Figure 3
With pallet 2 clamped on the receiver, the trip block must be engaging the switch as shown.

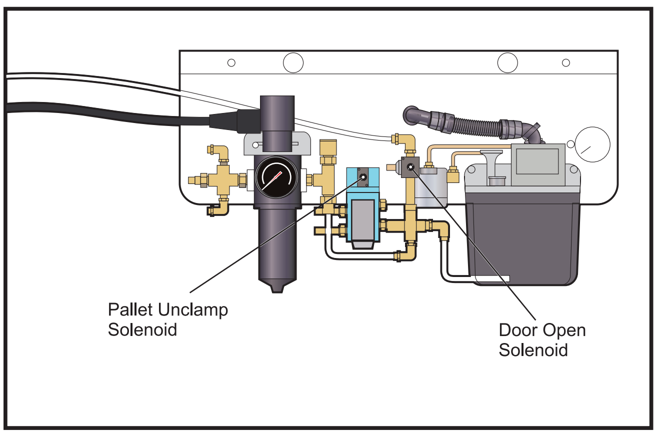


Figure 4
Press and hold the solenoid actuation buttons to keep air pressure flowing to unclamp the receiver and hold the door open. If the buttons are released the door will close and the receiver will clamp.

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.

Alarm 354 - Aux Axis Disconnected

When this alarm is generated, do not press **RESET**. Turn Setting 7 **OFF**. Enter **DEBUG** mode, then view the Alarms/Messages page. On the Messages page, a code will appear similar to WO1. The list of codes and their descriptions appears below:

WO1 Power was just turned on or failed. Check the ribbon cables from the Aux Axis PCB to the processor for correct routing. Check for communication problems between the processor and the Aux Axis PCB.

WO2 Servo following error too large. Check the encoder for contamination or dirt. Check for an intermittent connection at both ends of the motor cable.

WO3 Emergency Stop. The E-STOP button was pressed, or an E-STOP condition occurred.

WO4 High load. Check for binding in the tool changer gearbox and motor. Rotate the carousel by hand and feel for any binding. Make sure the tool holders are the correct weight.

WO5 Remote RS-232 commanded off. Check the ribbon cable and the voltage to the Aux Axis PCB. Check for 115VAC (minimum) to the Aux Axis PCB from the main transformer. Check the fuse holder and the fuse that is protecting this circuit.

WO6 Air or limit switch or motor overheat. Check that the motor is not hot. Check for any binding in the motor. Check for overweight tooling.

WO7 Z channel fault. Either the encoder or the cable is bad. Change the encoder first, as it is easier to change than the cable. If the problem persists, change the cable.

WO8 Over-current limit, stalled or PCB fault. Check for binding in the tool changer gearbox. Make sure the belt is not too tight. Ohm out the motor cable, checking pins G to F (should be open), G to H (should be open), and F to H (should read between 2.5 and 5 ohms). Check all the connections on the Aux Axis PCB and motor cable.

WO9 Encode ES. Z channel is missing. Bad encoder or cable. See **WO7.**

WOA High voltage. Check the incoming voltage to the Aux Axis PCB. Incoming voltage must be 115 VAC. See **WO5.**

WOB Cable fault. Check the cable from the motor to the Aux Axis PCB. Check for loose connections at each end.

Processor Stack Diagnostic

(DISCONNECT CABLES FROM A NORMAL OPERATING SYSTEM)

Remove low voltage cable from the Video & Keyboard PCB

- Processors LED's are normal
- Runs fine and the CRT is Normal
- No keypad beep

Remove low voltage cable from the MOTIF PCB

- Processors LED's are normal then RUN goes out
- No screen

Remove the Data & or Address buss from the Video & Keyboard PCB

- Processors LED's Normal - then Run goes out

Remove the Data & or Address buss from the MOTIF PCB

- Processors LED's Normal - then Run goes out

Remove the Data & or Address buss from the Micro Processor PCB

- Processors LED's - CRT and Run are out

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.

ETHERNET

Error 53 The computer name specified in the network path cannot be located

This error usually happens when NET USE C: \\SERVER\HAAS/PERSISTENT: NO /YES is entered during the setup phase.

To fix this error first verify the following:

1. A 10 Base-T network is present.
2. The network cable is coming from a hub (not the server).
3. The server name that you specified in your NET USE command is correct.
4. Your network is running IPX/SPX protocol.

If all of the above is correct and communications between the Haas CNC and the network are not established, there may be compatibility issues between an older Novell network and an NT 4.0 server. If the NWLink IPX/SPX Compatible Transport on the NT server is set to auto detect the protocol's frame, the NT server may be detecting the Novell server first and setting the NWLink IPX/SPX Compatible Transport frame protocol to 802.3 The NWLink IPX/SPX Compatible Transport required for the mills to connect to an NT server is 802.2. Since these two frame protocols are different the mill would never connect to the desired NT server. To remedy this check the following:

1. On the Ethernet boot disk, edit the protocol.ini file in the NETI directory.
2. Find the line FRAME=ETHERNET_802.2 and change it to FRAME=ETHERNET_802.3
3. Save the file
4. Insert the boot disk back into the CNC and cycle the power.

If an Error 53 is still present, restore the protocol.ini file to its previous state and do the following to the NT server:

1. Open the control panel
2. Double click on the Network icon
3. Select the Protocols tab.
4. Highlight NWLINK IPX/SPX Compatible Transport.
5. Select properties.
6. Select Manual Frame Type Detection.
7. Click on Add.
8. Select Ethernet 802.2
9. Click on Add.
10. Click OK.
11. Close all windows and reboot the NT server.

Once the NT server is rebooted the NWLINK IPX/SPX Compatible Transport Frames is set to 802.2 and the mill will be able to see the desired server.

Mill code will not work

Make sure the command in the server routes back to the mill.

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.

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.

Alarm number and text:		Possible causes:
101	Comm. Failure with MOCON	During a self-test of communications between the MOCON PCB and main processor, the main processor does not respond, one of them is possibly bad. Check cable connections and boards.
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 faults, tool changer problems, or power fail.
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 a parameter. 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. The motor may also be stalled, disconnected, or the driver failed.
104	Y Servo Error Too Large	Same as alarm 103.
105	Z Servo Error Too Large	Same as alarm 103.
106	A Servo Error Too Large	Same as alarm 103.
107	Emergency Off	EMERGENCY STOP button was pressed. After the E-STOP is released, the RESET button must be pressed once to correct this and clear the E-STOP 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 is large enough to exceed the continuous rating of the motor. This could be period of several seconds or even minutes. 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	Same as alarm 108.
110	Z Servo Overload	Same as alarm 108.
111	A Servo Overload	Same as alarm 108.
112	No Interrupt	Electronics fault. Call your dealer.
113	Shuttle In Fault	Tool changer is not completely to 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 delays. 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 not completely to left. During a tool change operation the tool in/out shuttle failed to get to the OUT 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	During a tool changer operation the tool turret failed to start moving, failed to stop moving or failed to stop at the right position. Parameters 60 and 61 can adjust the delays. 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. This is either a vector drive problem or a mechanical problem on machines without a vector drive. During a spindle orientation function, the spindle is rotated until the lock pin drops in; but the lock pin never dropped. Parameters 66, 70, 73, and 74 can adjust delays and spindle orient speeds. This can be caused by a trip of circuit breaker CB4, a lack of air pressure, or too much friction with the orientation pin.
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 change gears but the high gear sensor was not detected in time. Parameters 67, 70 and 75 can adjust the delays. Check the air pressure, circuit breaker CB4,the circuit breaker for the air pressure 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 change gears but the low gear sensor was not detected in time. Parameters 67, 70 and 75 can adjust the delays. Check the air pressure, the solenoid's circuit breaker CB4, and the spindle drive.
119	Over Voltage	Incoming line voltage is above maximum. The spindle, tool changer, and coolant pump will stop. If this condition persists, an automatic shutdown will begin after the time 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 the lube pressure is too high or low. 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 control is overheating. This alarm will turn off the 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 regenerative load. This can be caused by a shorted motor, overvoltage, overcurrent, undervoltage, failure of drive, or shorted or open regen load. Undervoltage 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 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	Transmission is out of position when a command is given to start a program or rotate the spindle. This means that the two speed transmission is not in either high or low gear but is somewhere in between. Check the air pressure, the solenoid's circuit breaker CB4, and the spindle drive. Use the POWER UP/ RESTART button to correct the problem.
127	No Turret Mark	Tool carousel motor not in position. This alarm is only generated at power-on. The AUTO ALL AXES button will correct this but be sure that the pocket facing the spindle afterwards does not contain a tool.
129	M Fin Fault	M-code relays were 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, relays on the I/O assembly, the drawbar assembly, or in the wiring.
131	Tool Not Clamped	When clamping or powering up the machine, the Tool Release Piston is not HOME. This is a possible fault in the air solenoids, relays on the IO 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 Power Interface card on power supply assembly, relays on the IO assembly, and the main contactor K1.
133	Spindle Locked	Shot pin did not release. This is detected when spindle motion is commanded. Check the solenoid that controls the air to the lock, relay K16, the wiring to the sense switch, and the switch.

134	Tool Clamp Fault	When UNCLAMPING, the tool did not release from spindle when commanded. Check air pressure and solenoid circuit breaker CB4. Can also be caused by misadjustment of drawbar assembly.
135	X Motor Over Heat	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 axis at the stops for several minutes.
136	Y Motor Over Heat	Same as alarm 135.
137	Z Motor Over Heat	Same as alarm 135.
138	A Motor Over Heat	Same as alarm 135.
139	X Motor Z Fault	Encoder 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	Same as alarm 139.
141	Z Motor Z Fault	Same as alarm 139.
142	A Motor Z Fault	Same as alarm 139.
143	Spindle Not Locked	Vector drive orientation lost or spindle shot pin not fully engaged when a tool change operation is being performed. Check air pressure and solenoid circuit breaker CB4. This can also be caused by a fault in the sense switch that detects the position of the lock pin.
144	Time-out- Call Your Dealer	Time allocated for use prior to payment exceeded. Call your dealer.
145	X Limit Switch	Axis tripped the limit switch or switch disconnected. This is not normally possible as the stored stroke limits will stop the axis before they reach the limit switches. Check the wiring to the limit switches 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	Same as alarm 145
147	Z Limit Switch	Same as alarm 145
148	A Limit Switch	Normally disabled for rotary axis.
149	Spindle Turning	Spindle not at zero speed for tool change. 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	Changer not at home and either the **Z** or A or B axis (or any combination) is not 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, spindle and pump, and purge the system. Check for low coolant tank level, any filter or intake strainer clogging, or for any kinked or clogged coolant lines. If no problems are found with any of these, and none of the coolant lines are clogged or kinked, call your dealer. Verify proper pump and machine phasing.
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 processors. Call your dealer.
153	X-axis Z Ch Missing	Z reference signal from encoder was not received as expected. Likely encoder contamination or parameter error.
154	Y-axis Z Ch Missing	Same as alarm 153.
155	Z-axis Z Ch Missing	Same as alarm 153.
156	A-axis Z Ch Missing	Same as alarm 153.
157	MOCON Watchdog Fault	The self-test of the MOCON has failed. Cal you dealer.
158	Video/Keyboard PCB Failure	Internal circuit board problem. This could also be caused by a short in the front panel membrane keypad. 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 into a mechanical stop. It can also be caused by a short in the motor or a short of one motor leads to ground.
162	Y-Axis Drive Fault	Same as alarm 161.
163	Z-Axis Drive Fault	Same as alarm 161.
164	A-Axis Drive Fault	Same as alarm 161.
165	X Zero Ret Margin Too Small	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. This alarm can occur if the home/limit switches are moved or misadjusted.
166	Y Zero Ret Margin Too Small	Same as alarm 165.
167	Z Zero Ret Margin Too Small	Same as alarm 165.
168	A Zero Ret Margin Too Small	Same as alarm 165.
169	Spindle Direction Fault	Problem with rigid tapping hardware. The spindle started turning in the wrong direction.
170	Phase Loss	Problem with incoming line voltage. This usually indicates that there was a transient loss of input power to the machine.

173	Spindle Ref Signal Missing	The **Z** channel pulse from the spindle encoder is missing for hard tapping synchronization.
174	Tool Load Exceeded	The tool load monitor option is selected and the maximum load for a tool was exceeded in a feed. This alarm can only occur if the tool load monitor function is installed in your machine.
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	Over Heat Shutdown	An overheat condition persisted longer than the interval specified by parameter 296 and caused an automatic shutdown.
177	Over Voltage Shutdown	An overvoltage condition persisted longer than the interval specified by parameter 296 and caused an automatic shutdown.
178	Divide by Zero	Software Error; Call your dealer.
179	Low Pressure Transmission Oil	Spindle coolant oil is low or low pressure condition in lines.
180	Pallet Not Clamped	The APC pallet change was not completed, pressing E-stop, reset, or feedhold, and an attempt was made to run the spindle. Run M50 pallet change to reset the machine.
182	X Cable Fault	Cable from X-axis encoder does not have valid differential signals.
183	Y Cable Fault	Same as alarm 182.
184	Z Cable Fault	Same as alarm 182.
185	A Cable Fault	Same as alarm 182.
186	Spindle Not Turning	Status from spindle drive indicates it is not at speed when expected.
187	B Servo Error Too Large	Same as alarm 103.
188	B Servo Overload	Same as alarm 108.
189	B Motor Overheat	Same as alarm 135.
190	B Motor Z Fault	Same as alarm 139
191	B Limit Switch	Same as alarm 148.
192	B Axis Z Ch Missing	Z reference signal from encoder was not received as expected. Likely encoder contamination or parameter error.
193	B Axis Drive Fault	Same as alarm 161.
194	B Zero Ret Margin Too Small	Same as alarm 165
195	B Cable Fault	Same as alarm 182.
196	Coolant Spigot Failure	Vertical mills only. Spigot failed to achieve commanded location after two (2) attempts.
197	100 Hours Unpaid Bill	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. If received, check all air lines and the air supply pressure.

199	Negative RPM	A negative spindle RPM was sensed.
201	Parameter CRC Error	Parameters lost. Check for a low battery and low battery alarm.
202	Setting CRC Error	Settings lost. Check for a low battery and low battery alarm.
203	Lead Screw CRC Error	Lead screw compensation tables lost. Check for low battery and low battery alarm.
204	Offset CRC Error	Offsets lost. Check for a low battery and low battery alarm.
205	Programs CRC Error	Users program lost. Check for a low battery and low battery alarm.
206	Internal Program Error	Possible corrupted program. Save all programs to floppy disk, delete all, then reload. Check for a low battery and low battery alarm.
207	Queue Advance Error	Software Error; Call your dealer.
208	Queue Allocation Error	Software Error; Call your dealer.
209	Queue Cutter Comp Error	Software Error; Call your dealer.
210	Insufficient Memory	Not enough memory to store users program. Check the space available in the LIST PROG mode and possibly create space by moving programs from the control and saving them to a disk.
211	Odd Prog Block	Possible corrupted program. Save all programs to floppy disk, delete all, then reload.
212	Program Integrity Error	Possible corrupted program. Save all programs to floppy 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 the amount of memory used by the programs counted in the changed system disagrees with the variable that points to free memory. Possible processor board problem.
216	EPROM Speed Failure	Possible processor board problem.
217	X Axis Phasing Error	Error occurred in phasing initialization of motor. This can be caused by a bad encoder, or a cabling error.
218	Y Axis Phasing Error	Same as alarm 217.
219	Z Axis Phasing Error	Same as alarm 217.
220	A Axis Phasing Error	Same as alarm 217.
221	B Axis Phasing Error	Same as alarm 217.
222	C Axis Phasing Error	Same as alarm 217.
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 PCB.
225	Y Transition Fault	Same as alarm 224.
226	Z Transition Fault	Same as alarm 224.
227	A Transition Fault	Same as alarm 224.
228	B Transition Fault	Same as alarm 224.
229	C Transition Fault	Same as alarm 224.
231	Jog Handle Transition Fault	Illegal transition of encoder 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 encoder 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 Enc. Cable Fault	Cable from spindle encoder does not have valid differential signals.
235	Spindle Z Fault	Same as alarm 139.
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	Door Fault	The safety switch was not tripped or release whent he door was commanded open or closed.
239	Unknown Mocon Alarm	Mocon has reported an alarm to the current software. The current version of software was unable to identify the alarm. See mocon software release notes for additional diagnostics.
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	No End	Check input file for a number that has too many digits
243	Bad Number	Data entered is not a number.
244	Missing)	Comment must end with a ") ".
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	Software Error; Call your dealer.

248	Number Range Error	Number entry is out of range.
249	Prog Data Begins Odd	Possible corrupted program. Save all programs to floppy disk, delete all, then reload.
250	Program Data Error	Same as alarm 249.
251	Prog Data Struct Error	Same as alarm 249.
252	Memory Overflow	Same as alarm 249.
253	Electronics Overheat	The control box temperature has exceeded 135 degrees F. This can be caused by an electronics problem, high ambient temperature, or clogged air filter.
254	Spindle Overheat	The motor driving the 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	Program Data Error	Possible corrupted program. Save all programs to floppy disk, delete all, then reload. Possible processor board problem.
258	Invalid DPRNT Format	Macro DPRNT statement not structured properly.
259	Language Version	Possible processor board problem.
260	Language CRC	Indicates FLASH memory has been corrupted or damaged. Possible processor board problem.
261	Rotary CRC Error	Rotary table saved parameters (used by Settings 30, 78) had a cyclic redundancy check (CRC) error. Indicates a loss of memory, possible processor board problem.
262	Parameter CRC Missing	RS-232 or disk read of parameter did not have a cyclic redundancy check (CRC) when loading from disk or RS-232.
263	Lead Screw CRC Missing	Lead screw compensation tables did not have a cyclic redundancy check (CRC) when loading from disk or RS-232.
264	Rotary CRC Missing	Rotary table parameters did not have cyclic redundancy check (CRC) when loading from disk or RS-232
265	Macro Variable File CRC Error	Macro variable file has a cyclic redundancy check (CRC) error. Indicates a loss of memory. Possible processor board problem.
266	Tool Changer Fault	The tool changer did not return to the proper starting position. Run Toolchanger Recovery.

267	Tool Door Out of Position	Horizontal mills only. Alarm will be generated during a tool change when parameter 278 TC DR SWITCH is set to 1, and the tool carousel air door and the tool carousel air door switch indicates that the door is open after commanded to be closed, or closed after it was commanded to be 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 toolchanger arm is not in position. Run Toolchanger Recovery.
270	C Servo Error Too Large	Same as alarm 103.
271	C Servo Overload	Same as alarm 108.
272	C Motor Overheat	Same as alarm 135.
273	C Motor Z Fault	Same as alarm 139.
274	C Limit Switch	Same as alarm 145.
275	C Axis Z Ch Missing	Same as alarm 153.
276	C Axis Drive Fault	Same as alarm 161.
277	C Zero Ret Margin Too Small	Same as alarm 165.
278	C Cable Fault	Same as alarm 182.
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	Same as alarm 279.
281	Z Axis Linear Scale Z Fault	Same as alarm 279.
282	A Axis Linear Scale Z Fault	Same as alarm 279.
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	Same as alarm 279.
285	Z Axis Linear Scale Z CH Missing	Same as alarm 279.
286	A Axis Linear Scale Z CH Missing	Same as alarm 279.
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	Incomming line voltage is above maximum. The servo will be turned off and the spindle, tool changer, and coolant pump will stop. If this persists, an automatic shutdown will begin after the interval specified by parameter 296.
293	Invalid Chamfer or Corner Rounding Distance in G01	This alarm supports the corner rounding and chamfering feature.
294	No End Move for G01 Chamfer Corner Rounding	This alarm supports the corner rounding and chamfering feature. 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	This alarm supports the corner rounding and chamfering feature. Tangent of half angle is zero. Move Angle must be greater than 1 deg.
296	Invalid Plane Selection in G01 Chamfer or Corner Rounding	This alarm supports the corner rounding and chamfering feature. Chamfer or corner rounding move and end move must be in the same plane as the begining move.
297	ATC Shuttle Overshoot	The ATC shuttle has failed to stop within the standby position window during a tool change. Check for a loose drive belt, damaged or over heated motor, sticking or damaged shuttle standby switch or shuttle mark switch, or burned ATC 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 within an accuracy of 0.0010 inches.
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 Cycle	**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 Feed Rate	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 of 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 M97, M98, or G65	In M97, M98 or G65 a subprogram number must be put in the P code. G47 must have P0 for text engraving or P1 for sequential serial numbers.
314	Subprogram or Macro Not In Memory	Check that a subroutine is in memory or that a macro is defined.
315	Invalid P Code In M97, M98 or 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. G47 must have P0 for text engraving or P1 for sequential serial numbers.
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	Same as alarm 316.
318	Z Over Travel Range	Same as alarm 316.
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 Specified	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.
324	Delay Time Range Error	**P** code in G04 is greater than or equal to 1000 seconds (over 999999 milliseconds).
325	Queue Full	Control problem; call your dealer.
326	G04 Without P Code	Put a **Pn.n** for seconds or a **Pn** for milliseconds.
327	No Loop For M Code Except M97, M98	**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	Parameters have disabled this axis. Not normally possible in VF Series Mills.
334	Y-Axis Disabled	Same as alarm 333.
335	Z-Axis Disabled	Same as alarm 333.
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).

337	GOTO or P line Not Found	Subprogram is not in memory, or **P** code is incorrect, or a P value is 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, or only one G code in the same group.
340	Cutter Comp Begin With G02 or G03	Select cutter compensation earlier. Cutter comp. must begin on a linear move.
341	Cutter Comp End With G02 or G03	Disable cutter comp later.
342	Cutter Comp Path Too Small	Geometry not possible. Check your geometry.
343	Display Queue Record Full	Software error. Call your dealer.
344	Cutter Comp With G18 and G19	Cutter comp only allowed in XY plane (G17).
346	Illegal M Code	There was an M80 or M81 commanded. These commands are not allowed while Setting 51 DOOR HOLD OVERRIDE is OFF. Also check Setting 131 for Auto Door and Parameter 57 for DOOR STOP SP.
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 W/O Cancel 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 comp 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. Status from control was LOST.
354	Aux Axis Disconnected	Aux axes not responding. Check auxiliary axes and RS-232 connections.
355	Aux Axis Position	Mismatch between machine and aux axes position. Check aux axes and Mismatch 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. Not a normal condition for VF Series Mills.
361	Gear Change Disabled	Check Parameter 57. Not a normal condition for VF Series Mills.

362	Tool Usage Alarm RESET.	Tool life limit was reached. To continue, reset the usage count in the Current Commands display and press
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.
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 or G44 Not Allowed in G36 or G136	Auto work offset probing must be done without tool offset.
382	D Code Required in G35	A **Dnnn** 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	G10 was used to change offsets but **L**, **P**, or **R** code is missing or Code In G10 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 comp cannot be used.
388	Cutter Comp Not Allowed With G10	Coordinates cannot be altered while cutter comp is active. Move 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).
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	Same as alarm 316.
395	No G107 Rotary Axis	A rotary axis must be specified in order to perform cylindrical mapping Specified (G107).
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.
403	RS-232 Too Many Progs	Cannot have more than 200 programs in memory.
404	RS-232 No Program 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 **Onnnnn** and must be at beginning of a block.
406	RS-232 Missing Code	A receive found bad data. 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	RS-232 Invalid N Code	Bad Parameter or Setting data. User was loading settings or parameters and something was wrong with the data.
410	RS-232 Invalid V Code	Bad parameter or setting data. User was loading settings or parameters and something was wrong with the data.
411	RS-232 Empty Program	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. This alarm is not normally possible as this control can keep up with 115200 bits per second. Computer sending data may not respond to X-OFF
415	RS-232 Overrun	Data sent too fast to CNC. This alarm is not normally possible as this control can keep up with 115200 bits per second.
416	RS-232 Parity Error	Data received by CNC has bad parity. Check parity settings, number of data bits and speed. Also check your wiring.
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 is equipped with a 50 taper spindle there must be 2 dashes between L's (large tools). L's must be surrounded by dashes.
429	Disk Dir Insufficient Memory	Disk memory was almost full when an attempt was made to read the disk directory.
430	Disk 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.
431	Disk No Prog Name	Need name in programs when receiving ALL; otherwise has no way to store them.
432	Disk Illegal Prog Name	Check files being loaded. Program must be **Onnnnn** and must be at the beginning of a block.
433	Disk Empty Prog Name	Check your program. Between % and % there was no program found.
434	Disk 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.
436	Disk File Not Found	Could not find disk file.
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. Call your dealer.
506	Operand Stack Error	The macro expression operand stack pointer is in error. Call your dealer.
507	Too Few Operands On Stack	An expression operand found too few operands on the expression stack. Call your dealer.
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	Var. Ref. 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	A macro variable was used incorrectly with an alpha address. Same as 513.
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 linked to N or O. Do not declare O[#1], etc.
518	Illegal Macro Exprsn Reference	An alpha address with expression, such as A[#1+#2], evaluated incorrectly. Same as 517.
519	Term Expected	In the evaluation of a macro expression, an operand was expected and not found.
520	Operator Expected	In the evaluation of a macro expression an operator was expected and 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 Reqd Prior To THEN	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 amount 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 and 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 syntax is not permitted.
541	Macro Alarm	This alarm was generated by a macro command in a program.
600	U Over Travel Range	Same as alarm 316.
601	V Over Travel Range	Same as alarm 316.
602	W Over Travel Range	Same as alarm 316.
603	U Limit Switch	Same as alarm 145.
604	V Limit Switch	Same as alarm 145.
605	W Limit Switch	Same as alarm 145.
609	U Servo Error Too Large	Same as alarm 103.
610	V Servo Error Too Large	Same as alarm 103.
611	W Servo Error Too Large	Same as alarm 103.
612	U Servo Overload	Same as alarm 108.
613	Command Not Allowed In Cutter Comp.	A command (M96, for example) in the highlighted block cannot be executed while cutter comp. Is invoked.
614	V Servo Overload	Same as alarm 108.
615	W Servo Overload	Same as alarm 108.

616 U Motor Over Heat — Same as alarm 135.

617 V Motor Over Heat — Same as alarm 135.

618 W Motor Over Heat — Same as alarm 135.

619 U Motor Z Fault — Same as alarm 139.

620 C Axis Disabled — Parameters have disabled this axis

621 C Over Travel Range — C-axis will exceed stored 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.

The following alarms apply only to the Vertical Mills with a sidemount tool changer:

622 Tool Arm Fault — This alarm supports the side mount tool changers. It is generated if the arm is not at the Origin position, or the arm motor is already on when a tool change process is started.

623 Side Mount Carousel Error — This alarm supports the side mount tool changers. It is generated if the carousel motor is still on when the tool pocket is unlocked and lowered prior to a tool change.

624 Invalid Tool — This alarm is generated by a side mount tool changer if the tool specified by the G-code program is not found in the POCKET-TOOL table, or the searching pocket is out of range.

625 Carousel Positioning Eror — This alarm is generated by a side mount tool changer if conditions are not correct when:
• The carousel or tool arm was started and one or more of the following incorrect conditions existed:
The carousel or arm motor already on, arm not at Origin, tool carousel not at TC mark.
• The tool carousel was in motion and Tool One Mark was detected but the current pocket facing the spindle was not at pocket one, or the current pocket was at pocket one but Tool One Mark was not detected.

626 Tool Pocket Slide Error — This alarm is generated by a side mount 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 Position Timeout — This alarm supports the side mount tool changers. It is generated if the tool arm has not moved after the allowed time or has not stopped after the allowed time. Refer to Parameter 309 MOTOR COAST TIME.

628 ATC ARM Positioning Error — This alarm supports the side mount tool changers. It is generated 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	Carousel Position Timeout	This alarm supports the side mount tool changers. It is generated 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.
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	APC-Pallet Not Clamped or Home	DO NOT ATTEMPT TO MOVE X OR Y AXES OF MILL UNTIL APC IS IN SAFE CONDITION. CAUTION—The APC is not in a safe operating 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 lub/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.
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 air line, 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 VMC 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, manually push the pallet against the hard stop and run M18. If the pallet is clamped, but not correctly, run an M17 to unclamp, manually push the pallet to the correct position, and run an M18 to clamp the pallet. Less common causes could be that the clutch is slipping, the motor is at fault, or an air line 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 and CH	The 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-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-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 air line, 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 air line, 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	APC-Incorrect Chain Location	Chain not in position to load or unload pallets when necessary. To correct this, the mislocated pallet must be moved back into the proper position by hand. After correcting the condition, run an M50 to continue machining.
643	RP-Index Station Unlocked...	The index station is not in the correct orientation for a pallet change or the front doors are open. Check whether the handle is in the fully up position, close the front doors, check the function of the front door switches. After correcting the condition, the M50 must be re-run to continue machining.
644	RP-Pallet Changer Will Not Raise...	The pallet did not begin to lift within a reasonable time after command, or did not complete lifting within a reasonable time. Verify air supply to the pallet changer valve assembly, verify proper adjustment of the lift cylinder regulator (40 PSI), verify the function of the lift cylinder air valve and solenoid, verify the operation of the lift cylinder position sense switches. After correcting the condition, run an M50 to continue machining.
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 pallet changer's 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. Consult the operations manual. 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 the Toolchanger Recovery the Z-axis must be zeroed. Once the Z-axis has been zeroed, continue with the Toolchanger Recovery.

652 U ZERO RET MARGIN TOO SMALL — Same as alarm 168.

653 V ZERO RET MARGIN TOO SMALL — Same as alarm 168.

654 W ZERO RET MARGIN TOO SMALL — Same as alarm 168.

655 U CABLE FAULT — Same as alarm 182.

656 V CABLE FAULT — Same as alarm 182.

657 W CABLE FAULT — Same as alarm 182.

658 U PHASING ERROR — Same as alarm 217.

659	V PHASING ERROR	Same as alarm 217.
660	W PHASING ERROR	Same as alarm 217.
661	U TRANSITION FAULT	Same as alarm 224.
662	V TRANSITION FAULT	Same as alarm 224.
663	W TRANSITION FAULT	Same as alarm 224.
664	U AXIS DISABLED	Same as alarm 336.
665	V AXIS DISABLED	Same as alarm 336.
666	W AXIS DISABLED	Same as alarm 336.
667	U AXIS LINEAR SCALE Z FAULT	Same as alarm 279.
668	V AXIS LINEAR SCALE Z FAULT	Same as alarm 279.
669	W AXIS LINEAR SCALE Z FAULT	Same as alarm 279.
670	TT OVER TRAVEL RANGE	Same as alarm 316.
671	TT LIMIT SWITCH	Same as alarm 145.
673	TT SERVO ERROR TOO LARGE	Same as alarm 103.
674	TT SERVO OVERLOAD	Same as alarm 108.
675	TT MOTOR OVER HEAT	Same as alarm 135.
676	TT MOTOR Z FAULT	Same as alarm 273.
677	TT AXIS Z CH MISSING	Same as alarm 275.
678	TT AXIS DRIVE FAULT	Same as alarm 161.
679	TT ZERO RET MARGIN TOO SMALL	Same as alarm 168.
680	TT CABLE FAULT	Same as alarm 182.
681	TT PHASING ERROR	Same as alarm 217.
682	TT TRANSITION FAULT	Same as alarm 224.
683	TT AXIS DISABLED	Same as alarm 336.
684	TT AXIS LINEAR SCALE Z FAULT	Same as alarm 279.
685	V MOTOR Z FAULT	Same as alarm 273.
686	W MOTOR Z FAULT	Same as alarm 273.
687	U MOTOR Z FAULT	Same as alarm 273.
688	U AXIS Z CH MISSING	Same as alarm 275.
689	V AXIS Z CH MISSING	Same as alarm 275.
690	W AXIS Z CH MISSING	Same as alarm 275.
691	U AXIS DRIVE FAULT	Same as alarm 161.
692	V AXIS DRIVE FAULT	Same as alarm 161.

693	W AXIS DRIVE FAULT	Same as alarm 161.
694	ATC SWITCH FAULT	Conflicting switch states detected, such as shuttle at spindle and shuttle at chain simultaneously. Check for damaged or sticking switches, damaged wiring, or debris build up.
695	ATC AIR 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, and correct chain guide strip adjustment. 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 ATC control board relays, damaged electrical wiring, or blown fuses on the ATC 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.
900	Par No xxx Has Changed. Old Value Was xxx.	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 file has been loaded from floppy 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 RS-232	When a 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	TOOL CHANGER 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	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-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-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	The control attempted to run a program that is not listed in the Pallet Schedule Table. To run the program enter the program name into the Pallet Schedule Table, column Program Number, for the pallet you want to operate on. Verify that the program and the pallet are compatible.
910 APC-PROGRAM CONFLICT	The current program is not assigned to the loaded pallet in the Pallet Schedule Table. To run the program enter the program name into the Pallet Schedule Table, column Program Number, for the pallet you want to operate on. Verify that the program 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 your APC model for correct setting numbers.
912 ATC-NO P CODE OR Q CODE FOR M46	M46 must have a P code and a Q code. The P code must be the name of a program stored in memory. The Q code is the number of the pallet to run the program on.
913 ATC-NO P CODE OR Q CODE FOR M49	M49 must have a P code and a Q code. The P code is the pallet number to change the status of. The Q code the status to give the pallet.
914 ATC-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 ATC-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 ATC-NEGATIVE PAL PRIORITY INDEX	Software Error; Call your dealer.

NOTE: Alarms 1000-1999 are user defined by macro programs.

The following alarms only apply to horizontal 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
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.

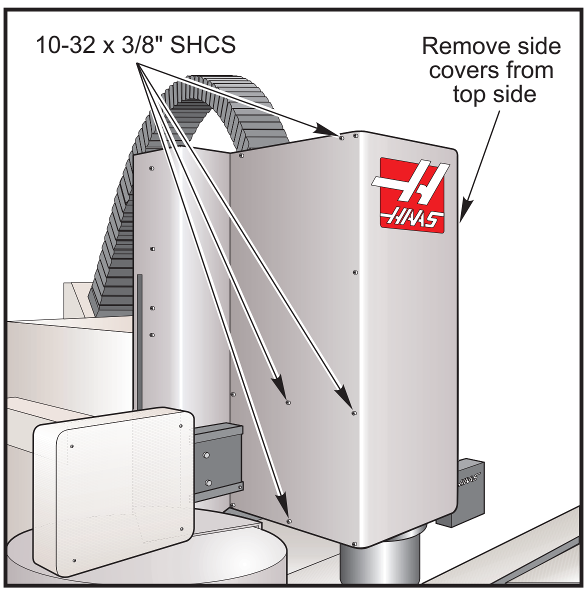


Figure 3.1-1 View of VF-3/4 head covers.

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 is different tool release piston for the 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

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.

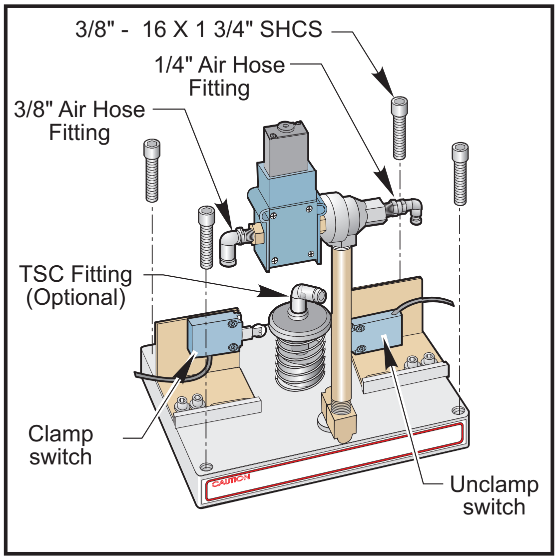


Figure 3.2-1 Tool Release Piston with Optional TSC fitting.

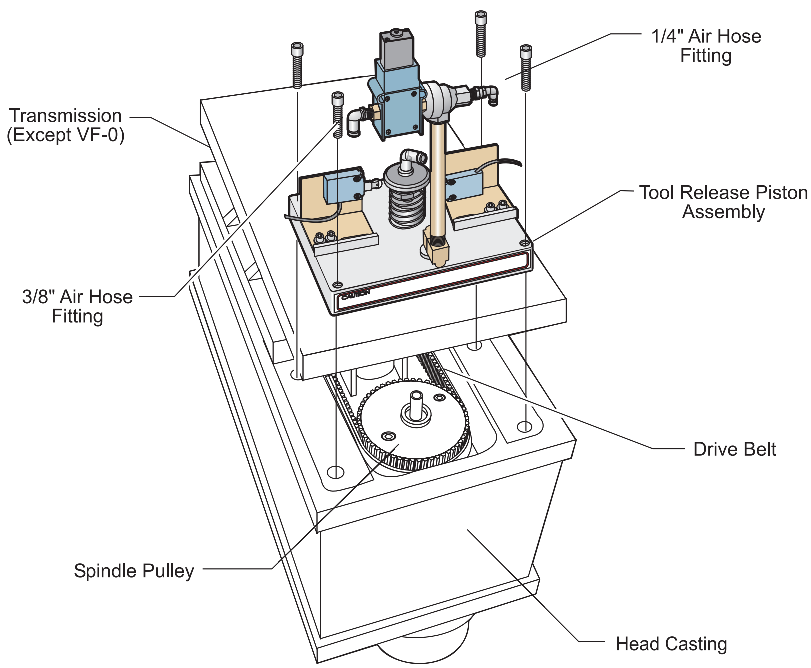


Figure 3.3-2 Mounting location for tool release piston assembly

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

NOTE: 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.

10. Turn the air pressure regulator down to zero (0). The knob must be pulled out to unlock before adjusting.

NOTE: At "0" pressure on the precharge regulator, the adjustment knob is out as far as it will turn.

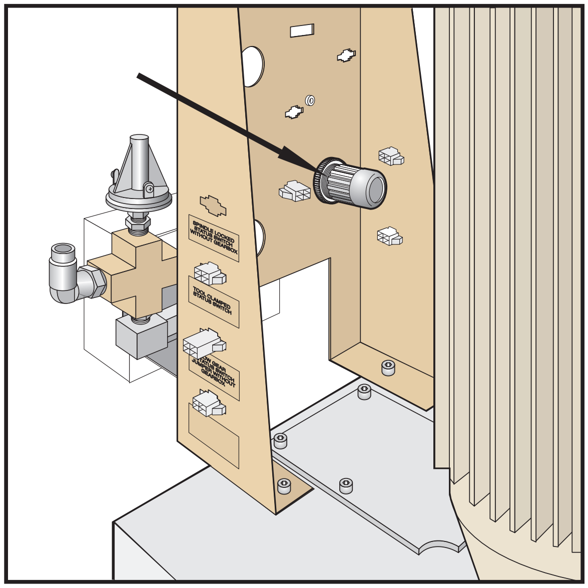


Figure 3.2-3. Air pressure regulator adjustment knob.

11. Ensure Parameter 149, Precharge DELAY, is set to 300. If not, set it at this time.

12. Execute a tool change. A banging noise will be heard as the tool release piston contacts the drawbar.

13. 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.

---

14. 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.

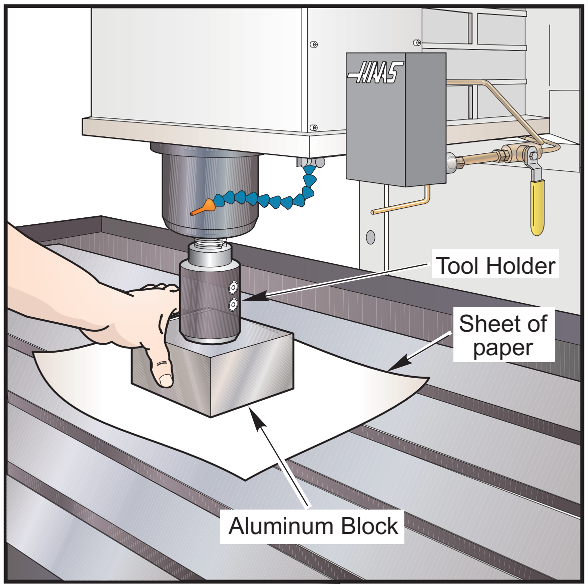


Figure 3.2-4 Placement of aluminum block under spindle.

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.
6. Jog Z-axis in the negative (-) direction until the tool holder is approximately .03 from the block. At this point, stop jogging the spindle and push the TOOL RELEASE button (top left). You will notice that the tool holder comes out of the taper.

NOTE: The clearance from the tool holder to the block should be zero (0).

7. To accomplish this, set the jog increments to .001 and jog in the negative (-) Z direction a few increments of the hand wheel at a time. Between these moves, push the tool release button and feel for movement by placing your finger between the tool holder and the spindle. Do this until no movement is felt. You are now at zero (0).

CAUTION! Do not jog too far in the negative (-) direction or else it will cause an overload of the Z-axis.

Setting Drawbar 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 coolant tip 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.

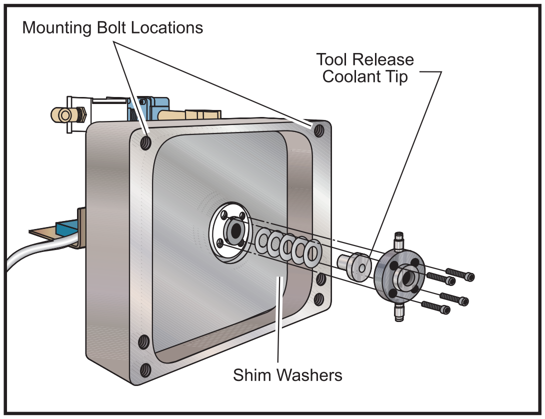


Figure 3.2-5 Tool release piston assembly (TSC shown).

3. Remove tool release bolt. If 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.

Adjustment of Switches

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.

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" above from where the tool holder was resting on the aluminum block.

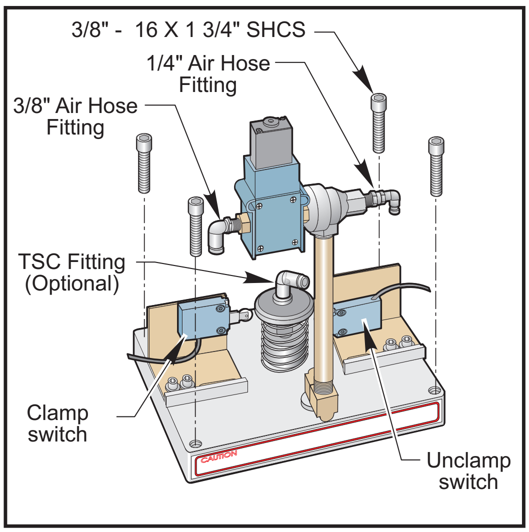


Figure 3.2-6 Tool release piston assembly.

4. Using the pressure regulator on the air/lube panel to reduce the inlet pressure to 75 PSI. Be sure to back regulator down past 75 PSI then adjust back up to 75 PSI. This will decrease the amount of upward deflection on the spindle head from TRP force.

5. Press the tool release button and hold it in. Adjust the switch in or out until the switch just trips (DB OPN =1).

6. Check the adjustment. 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.

7. Re-adjust and repeat steps 1-6 if necessary.

8. Set the pressure regulator back to 85PSI.

UPPER (CLAMP) SWITCH -

1. Remove the tool holder from the spindle.

2. Delete everything in MDI mode and write “#1120=1”.

3. Start with the upper switch all the way in. Place a 0.02” shim between the tool release piston adjustment bolt and the drawbar.

4. Push the PARAM/DGNOS button twice to enter the diagnostics mode.

5. Press CYCLE START.

6. 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).

7. Press RESET. Replace the 0.02” shim with a 0.04” shim. Press CYCLE START. See that DB CLS=1. Readjust and repeat steps 1-7 if necessary.

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.

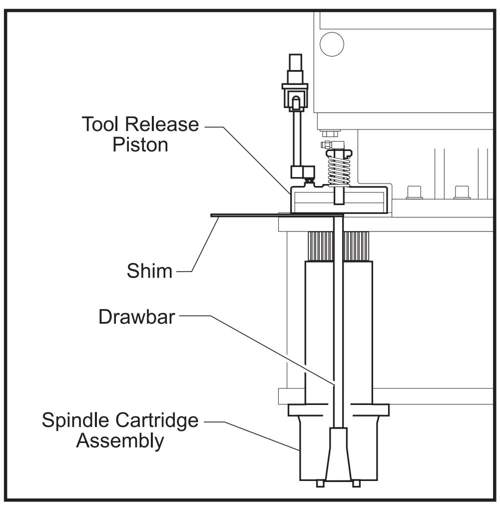


Figure 3.2-7 Placement of shim before checking switch adjustment.

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 rotary union and extension tube must be removed before proceeding. **They both have left handed threads.**
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 100 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.

50 Taper Spindle TRP Installation

The following sections must be completed after installation:

- Tool Push-Out Adjustment
- Setting TRP Switches
- Extension Tube Installation (if equipped with TSC)

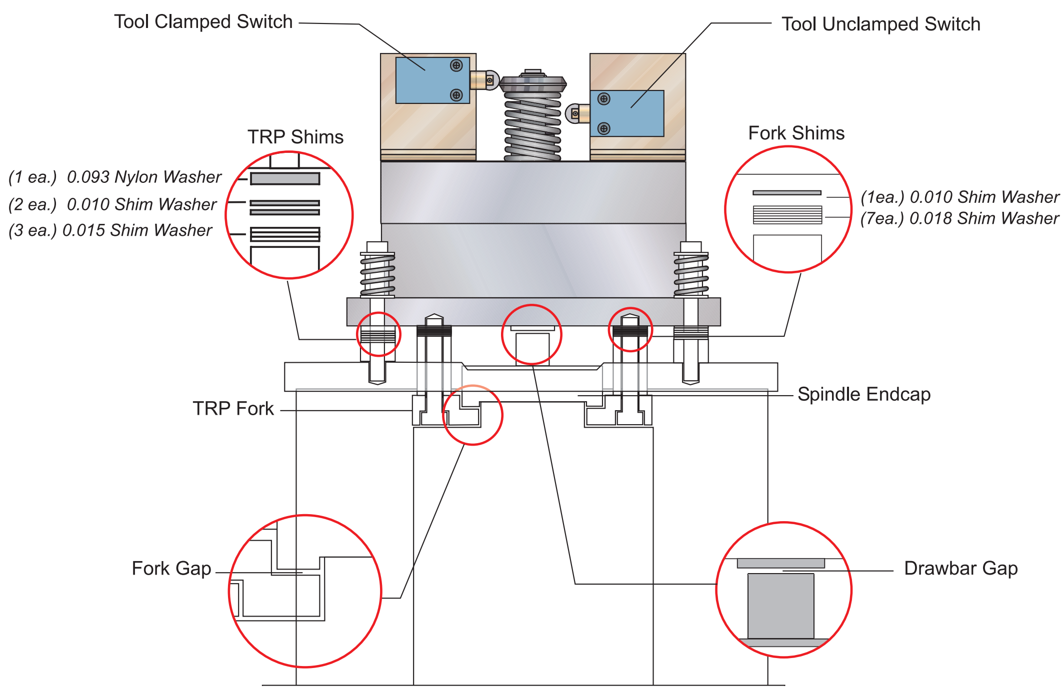


Figure 3-10.. Shim and spacer location diagram.

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.

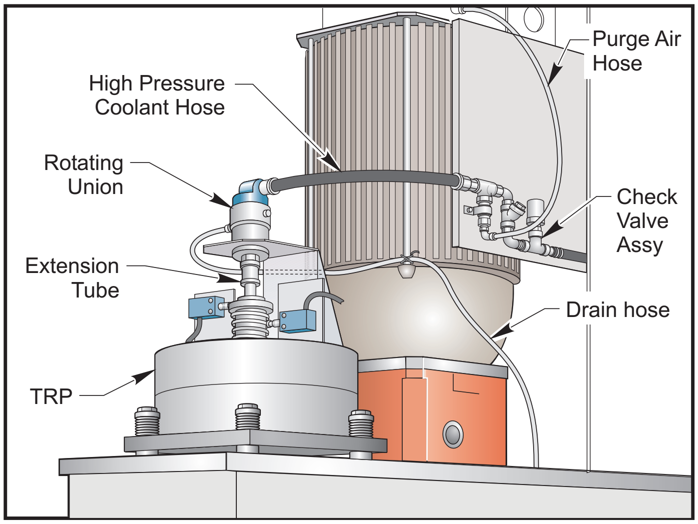
2. Install the 4 bolts, with the shim stock and spacers under the TRP.

	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) Put a tool holder in the Spindle (this is absolutely required!).

b) Prevent Spindle from rotating to allow for tightening of Extension Tube (inserting a bolt into one of the holes in the pulley and bracing a bar against the inside of the spindle head is one way of doing this).

c) Apply grease lightly to the O-ring on the end of the extension tube.

d) Apply blue Loctite to end of extension tube threads.

e) Insert the extension tube into drawbar. The Extension Tube has **left hand threads**. Tighten the Extension Tube and turn until the reference marks line up (there should be a paint line on the extension tube and on the drawbar).

f) Check the runout of the extension tube with a dial indicator at the top of the extension tube. **If the runout is greater than 0.010 TIR max., follow the instructions for Adjusting Extension Tube Runout.**

g) Slip Support Bracket over Rotating Union (check that the edge strip is intact).

h) Lightly grease the O-ring on the Rotating Union, and install the union onto the top of the extension tube (it has left hand threads). Tighten using two wrenches.

i) Install the (4) support bracket screws loosely. Allow the Rotating Union to find its own center. Tighten the screws carefully so the bracket does not pull to one side.

j) Apply grease to the surface of the Rotating Union that passes through the Support Bracket.

k) Connect the hose to the check valve assembly and the drain line hose (secure the hose with a cable tie so coolant drains downward to protect rotating union).

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. Place machined aluminum block onto machine table. Place a clean sheet of paper under the block to protect the table.

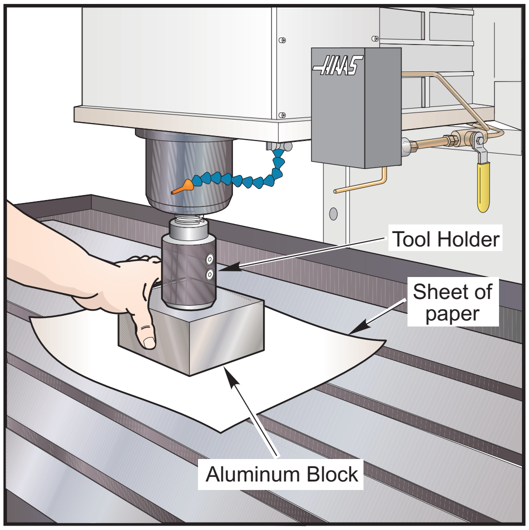


Figure 3.2-9 Pushout Adjustment.

3. Jog Z-Axis down until tool holder is about 0.030 above the aluminum block. Switch to 0.001 increments. Jog down one increment at a time until no movement can be felt in the block. This is our zero point. Do not press the tool release button now, this can cause a Z-Axis overload!

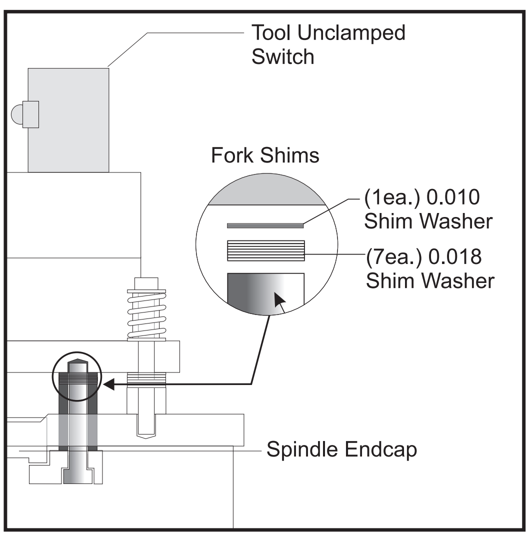


Figure 3.2-10 Fork shim location.

4. 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.

5. 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.

6. Apply red grease to the shoulder bolts used to mount the TRP when the shim adjustments are complete. Use blue Loctite on the threads.

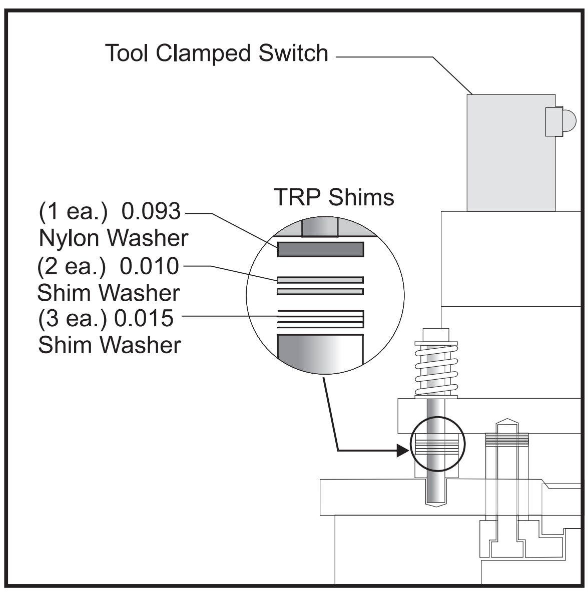


Figure 3.2-11 TRP shim location

Setting TRP Switches

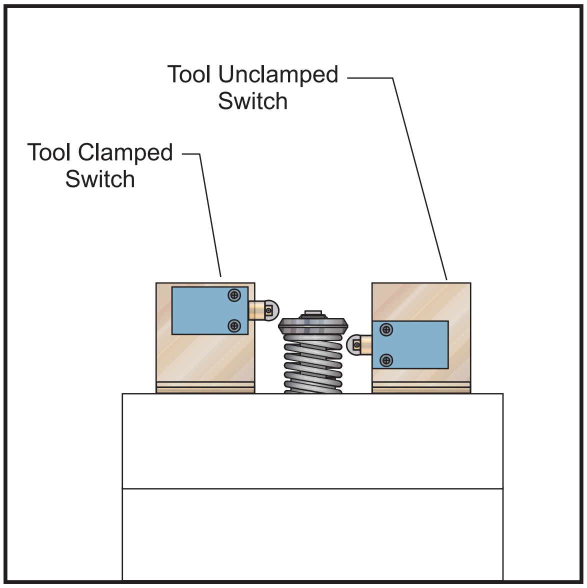


Figure 3.2-12 Tool Clamp / Unclamp Switches.

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.

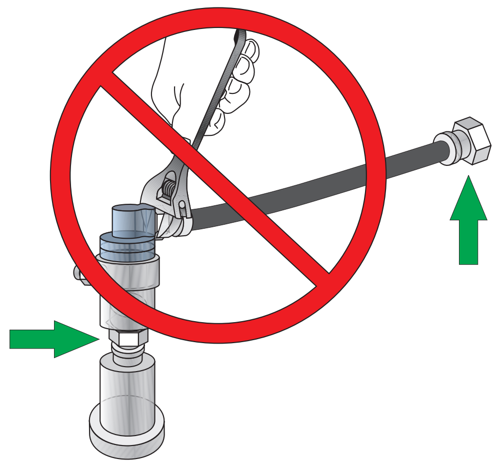
2. Setting the lower switch (Tool Unclamped). Use the air pressure regulator on the back of the machine or an extra regulator placed in line.
   a) Jog the Z-Axis to 0.030 above the aluminum block.
   b) Put a jumper across the air switch to prevent a low pressure alarm.
   c) Back off the air pressure 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.

Coolant Union

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:



Coolant Union Removal

1. 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.

2. 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.)

3. 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.

4. Return the Coolant Union with all pipe thread connectors and black coolant hose <u>intact</u> to Haas Automation for warranty. <u>Removal of any of the pipe connectors from the union will void any claims for warranty.</u>

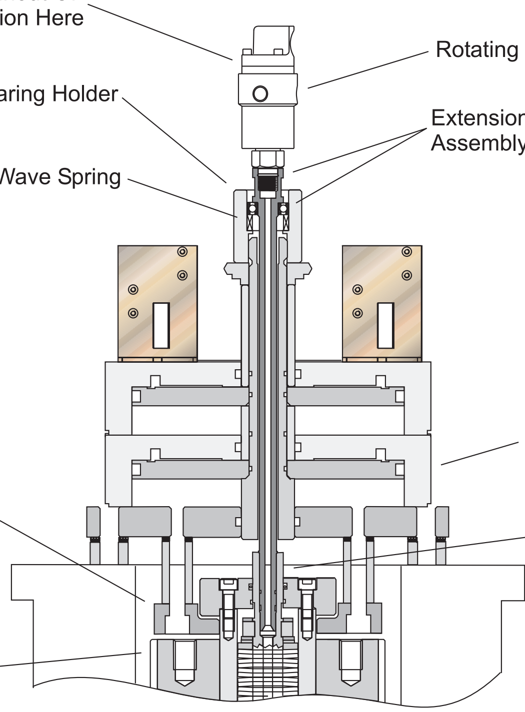
Coolant Union Installation

1. 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.

2. 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.

3. Thread the black coolant hose onto the connector on the check valve assembly. Tighten with a wrench. Do not over-tighten!

Extension Tube



Special Tools Required:

- 5/8 Allen Wrench
- Molybdenum Grease
- Wrench or Pliers large enough to tighten a 2” nut.

1) Place a Tool Holder in the Spindle.

2) Remove the Rotating Union.

3) Remove the old Extension Tube **(It has left hand threads).**

4) Remove the Tool Release Piston, and lay it on its side with the air connectors facing up.

5) Insert a 5/8 Allen wrench into the lower end of the piston shaft. Loosen off 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.

6) Screw the Bearing Holder (20-7655) onto the piston shaft, and tighten using a large wrench or pliers.

7) Wipe clean the hole in the end of the Drawbar.

8) Replace the Tool Release Piston.

9) Apply a light layer of Molybdenum Grease to the inside of the Bearing Holder. Insert the Wave Spring (59-0176) into the Bearing Holder.

10) 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).**

11) Block Spindle rotation with a bolt, bar or socket inserted into one of the Pulley holes. It will stop against the TRP Fork.

12) Tighten the Extension Tube to 15-20 ft-lbs. Remove the bolt from the Spindle Pulley.

13) Re-install the Rotating Union. Lightly grease the O-ring. DO NOT put Loctite on the threads.

14) Measure the runout at the top of the rotating union with a dial indicator. Record the measurement on the Service Report.

15) Check the Tool Clamp and Unclamp switches. They should not have moved.

16) Test run the TSC system to check for leaks before putting the head covers back on.

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".

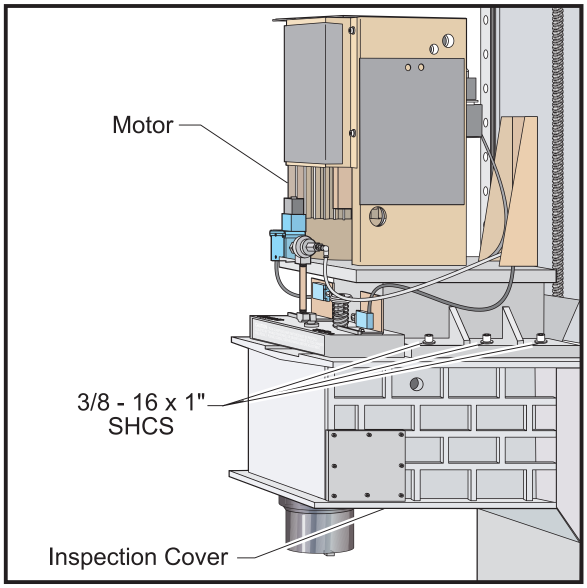


Figure 3.3-1 Spindle head casting disconnect points.

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.

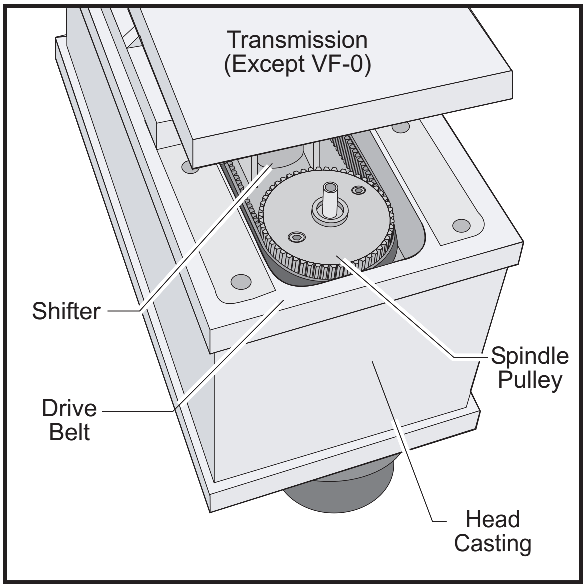


Figure 3.3-2 Head casting area showing belt location.

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.

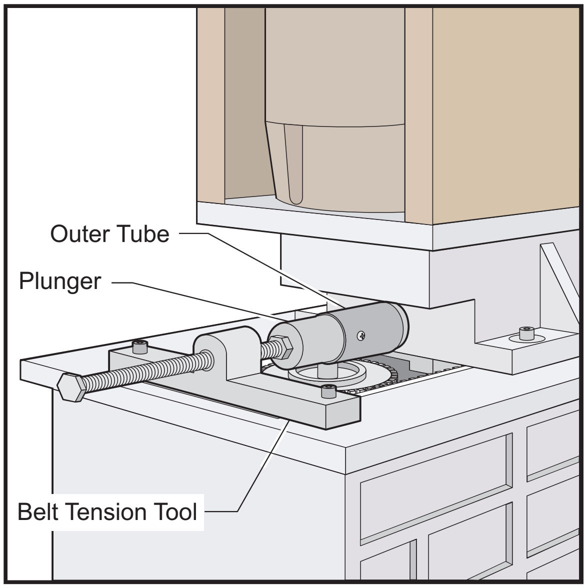


Figure 3.3-3 Belt tension tool.

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.

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.

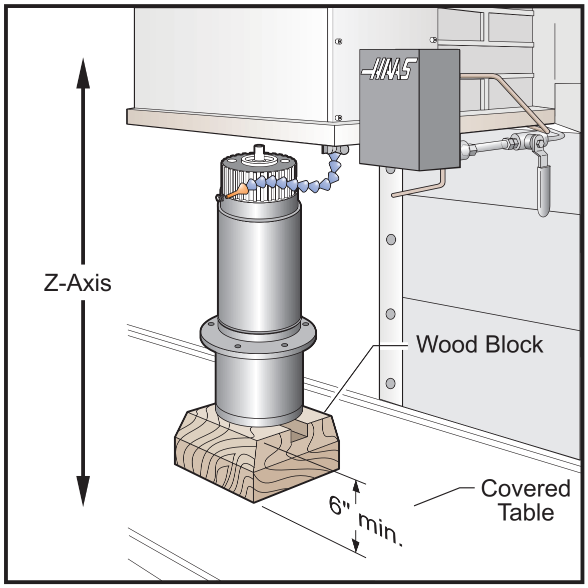


Figure 3.4-1. Position wood block under spindle.

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

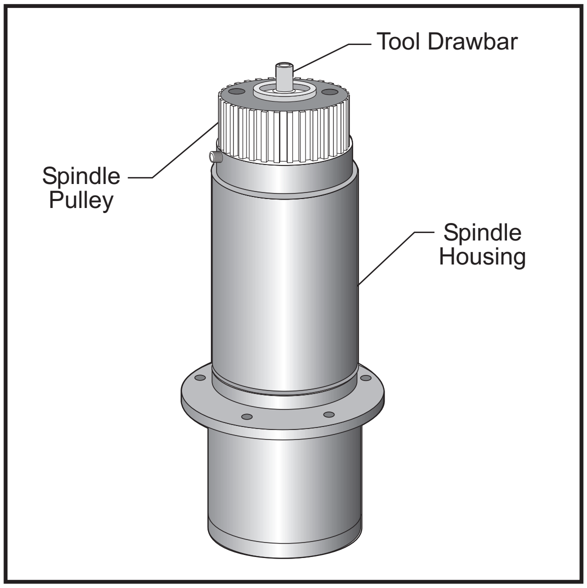


Figure 3.4-2. Spindle cartridge.

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.

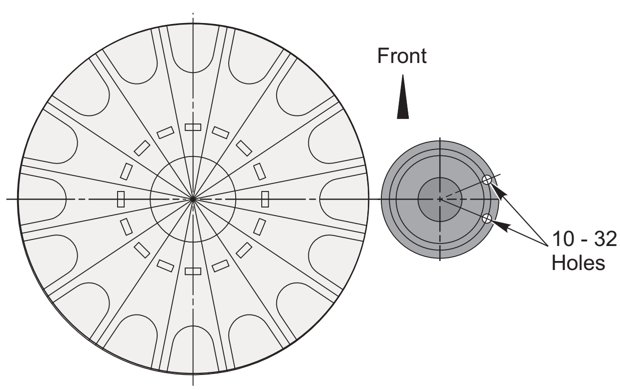


Figure 3.4-3 Underside view of spindle cartridge.

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 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.

NOTE: Refer to the appropriate sections and check the spindle orientation and ATC alignment.

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 - 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.

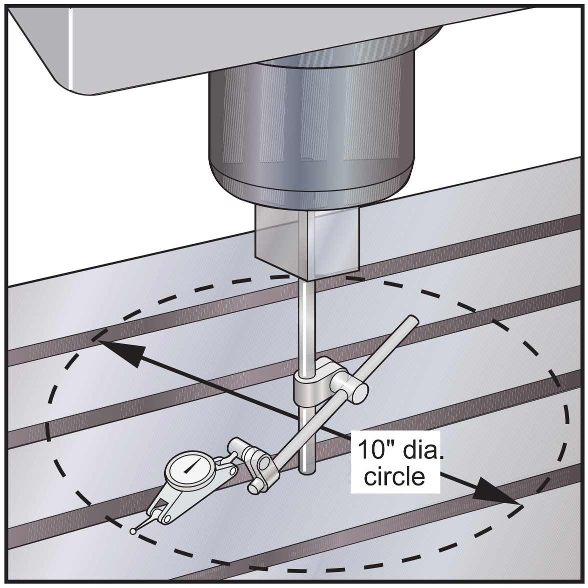


Figure 3.4-4 Spindle sweep area

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.

NOTE: If machine is equipped with a vector drive, skip to the next section.

Orientation of the spindle is automatically performed for tool changes and can be programmed with M19. Orientation is performed by turning the spindle slowly until an air pressure driven pin drops into a detent and locks the spindle in place. This pin is located behind the spindle motor and above the gear box. If the spindle is oriented and locked, commanding spindle forward or reverse will release the lock.

Orientation - Spindle Drive with Shot Pin Orientation

1. Remove cover panels from the head stock area ("Head Covers Removal"), and tool changer front cover.
2. In MDI mode, press the ORIENT SPINDLE button.
3. Loosen the four 1/4"-20 bolts on the orientation ring. Remove two of these bolts and insert them into the two threaded holes on the ring. Evenly tighten these two bolts until the taper lock is broken.
4. Remove the two 1/4"-20 bolts and place them into their original holes. Tighten them finger tight, then 1/2 of a turn more. Ensure that the orientation ring is snug, but not tight.

NOTE: If replacing the orientation ring, clean the shaft and the ring bore thoroughly with alcohol. They must be free of grease and oil.

5. Set up a magnetic base with a 0.0005" indicator on the table. Zero the indicator on the spindle dog in the X- plane.
6. Jog the indicator across the spindle dogs and note the indicator reading. The spindle dogs should be parallel to the X axis within 0.030".

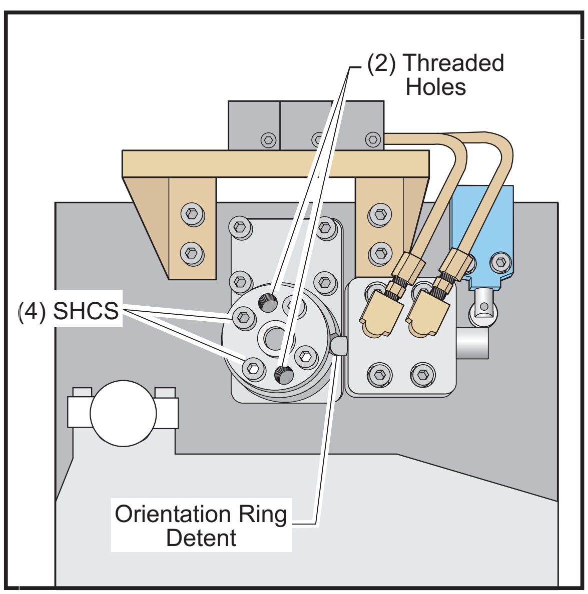


Figure 3.5-1 Top view of spindle orientation components.

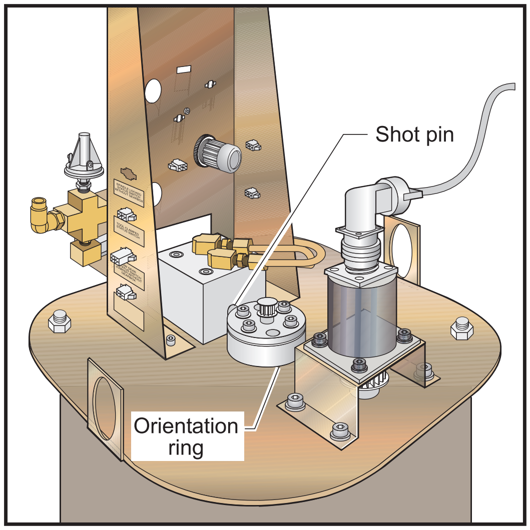


Figure 3.5-2 Direct drive motor with orient ring location.

7. There is a 0.015"-0.030" backlash in the spindle system when it is oriented. Be certain to compensate for this backlash when performing the adjustment.

8. Using a 5/8" open end wrench, rotate the spindle until the appropriate alignment is attained. If the spindle is very difficult to rotate, STOP and return to Step 4.

9. Disconnect the main air line to the machine.

10. Manually turn the orientation ring and push the shot pin until it drops into the orient ring detent.

11. Tighten the orient screws (evenly) to 15 ft-lbs. Verify that spindle alignment has not changed.

NOTE: It is vital that the orient screws be tightened evenly. If not, the top of the orientation ring will run out and the ring will slip.

NOTE: Ensure the orientation ring has an adequate layer of grease around the circumference before starting operation.

12. Make at least 50 tool changes to test the spindle orientation.

Orientation - Vector Drive

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.

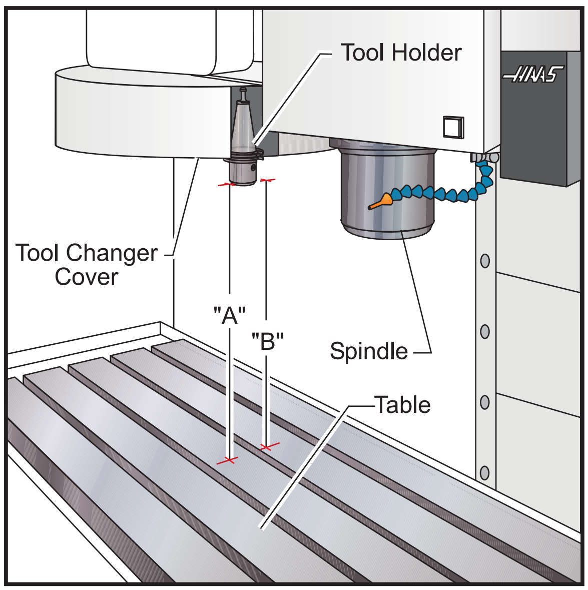


Figure 3.6-1 Checking tool offset reference.

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.

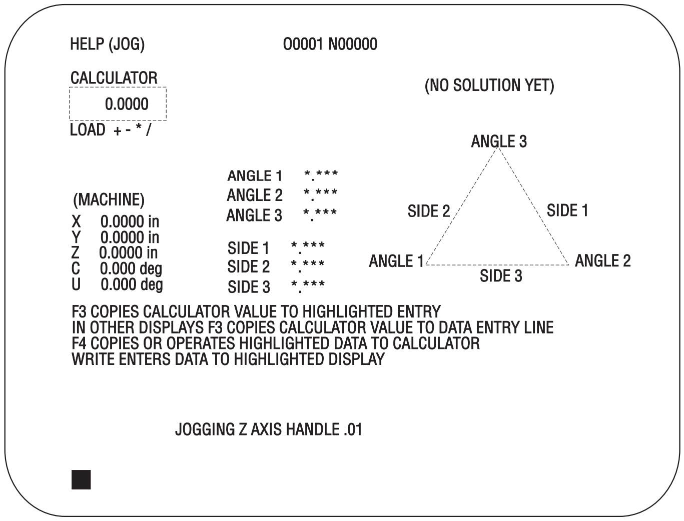


Figure 3.6-2 Screen showing calculator.

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 (Direct Drive)

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.

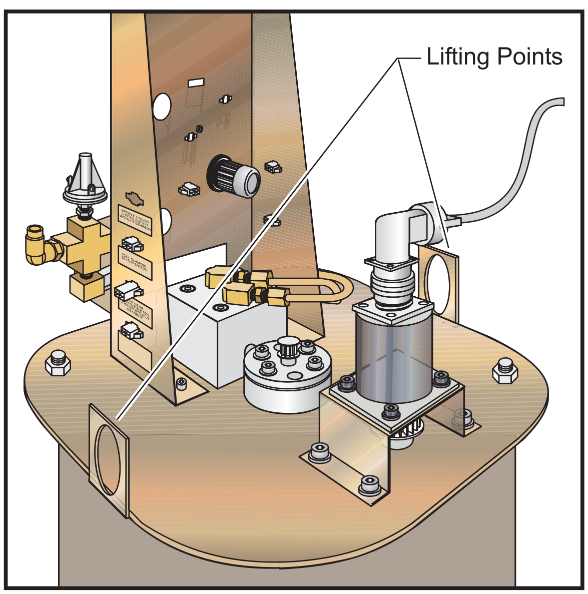


Figure 3.7-1 Direct Drive with lifting eyeholes.

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.

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.

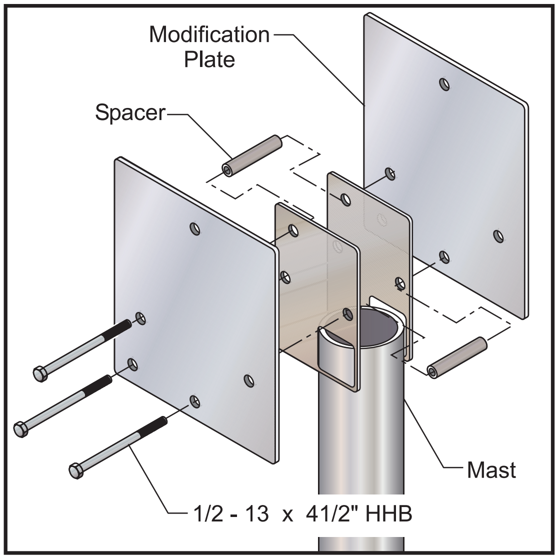


Figure 3.7-2 Support base/mast support assembly.

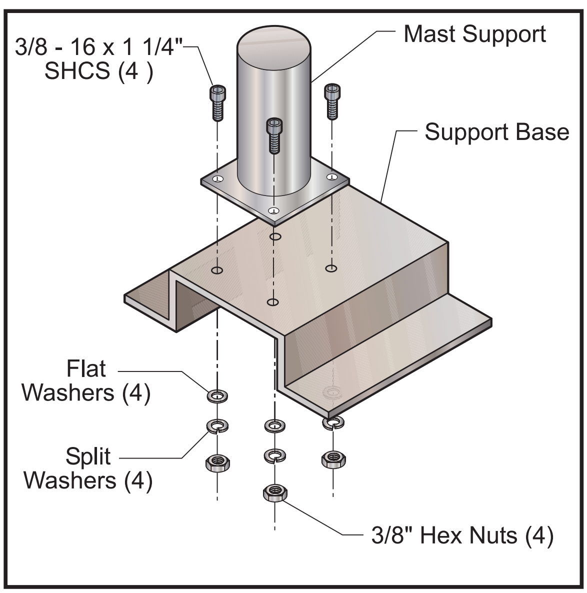


Figure 3.7-3 Exploded view of boom modification plate components.

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.

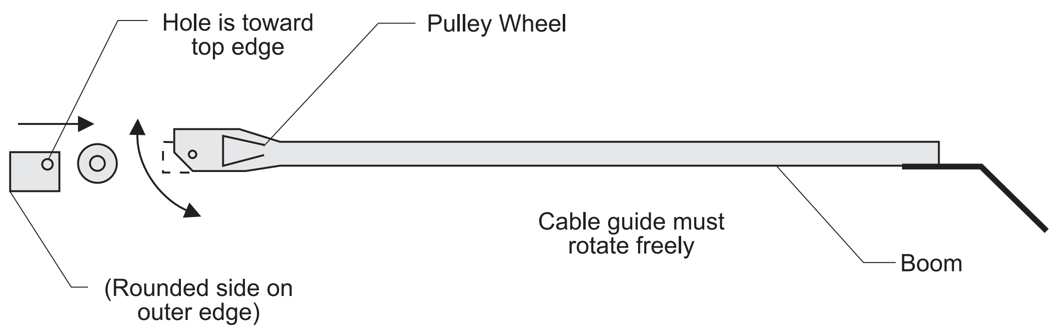


Figure 3.7-4 Mounting cable guide and pulley wheel to boom.

   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.**

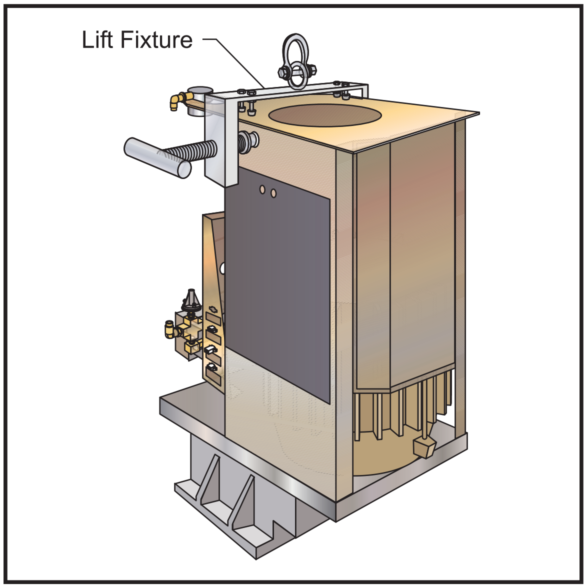


Figure 3.7-5 View of transmission lift fixture.

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.

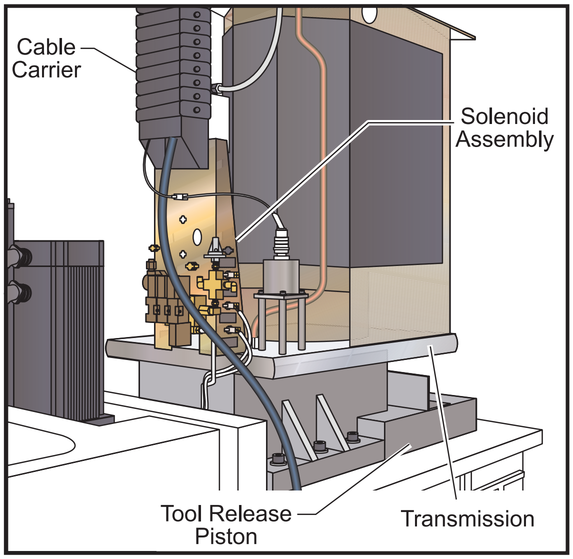


Figure 3.7-6 Solenoid bracket with all lines connected.

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.

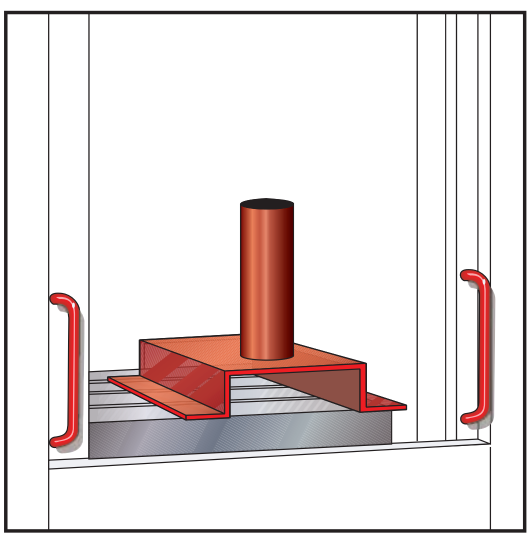


Figure 3.7-7 Support base/mast support assembly location.

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.

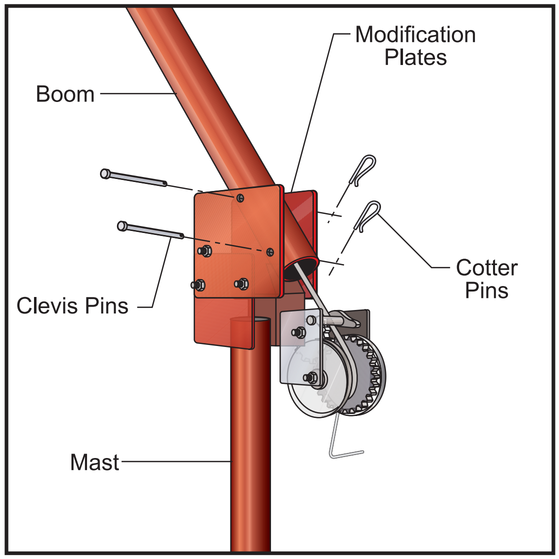


Figure 3.7-8 Mounting boom assembly to mast.

11. Place the hoist directly over the transmission and attach the hook to the cradle's eye bolt.

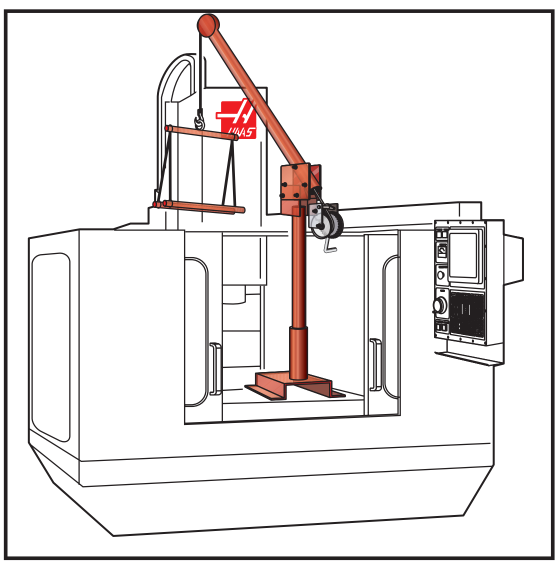


Figure 3.7-9 Fully assembled hoist in position

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.

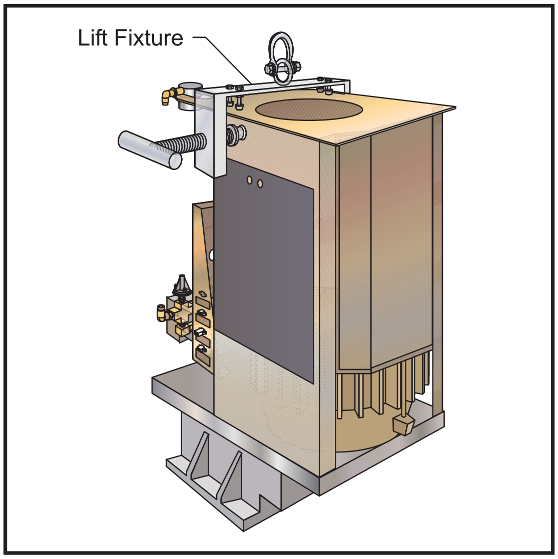


Figure 3.7-10 Lifting position for VF-1 through 4.

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.

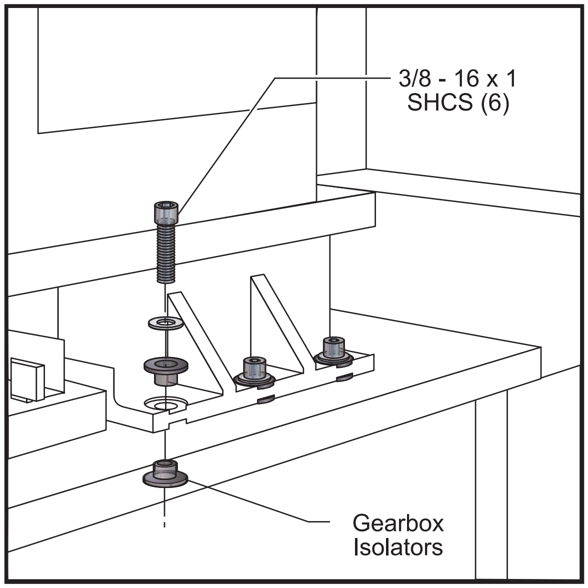


Figure 3.7-11 Gearbox isolators.

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.

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.

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.

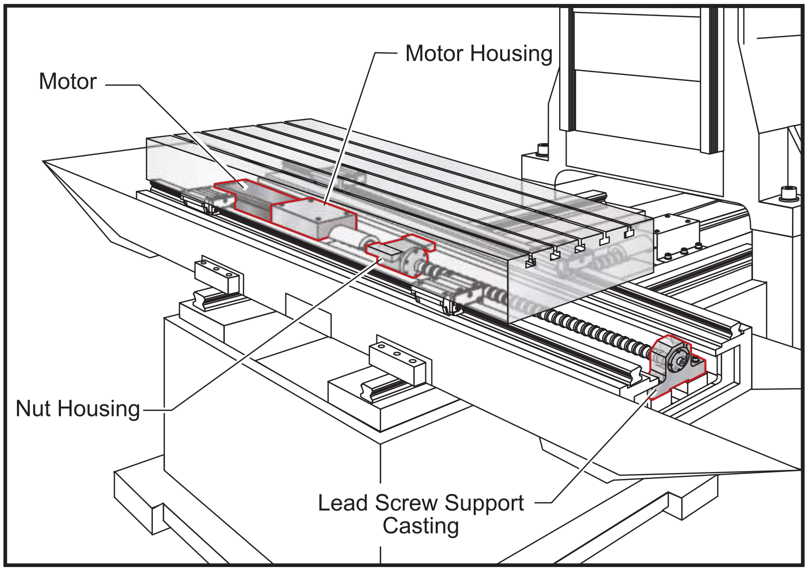


Figure 3.8-1 X-axis motor and components.

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 lead 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 lead screw in the motor coupling.

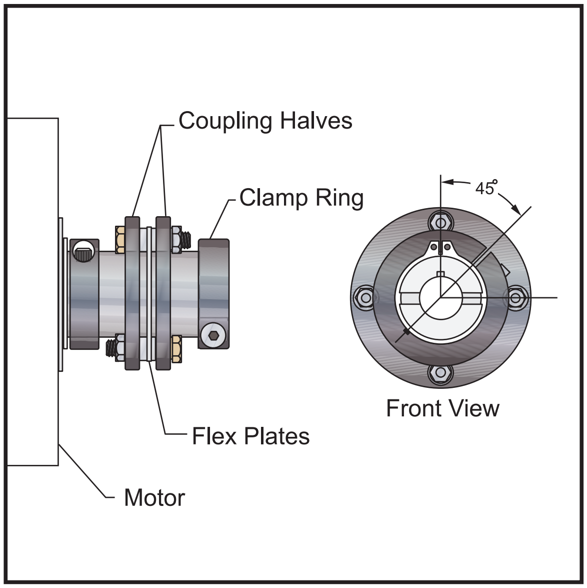


Figure 3.8-2 Motor coupling components.

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 leadscrew or motor shaft.

Tighten the SHCS on the motor coupling at the lead 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 lead screw (Troubleshooting section) or noisy operation.

10. Zero X axis and set grid offset.

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.

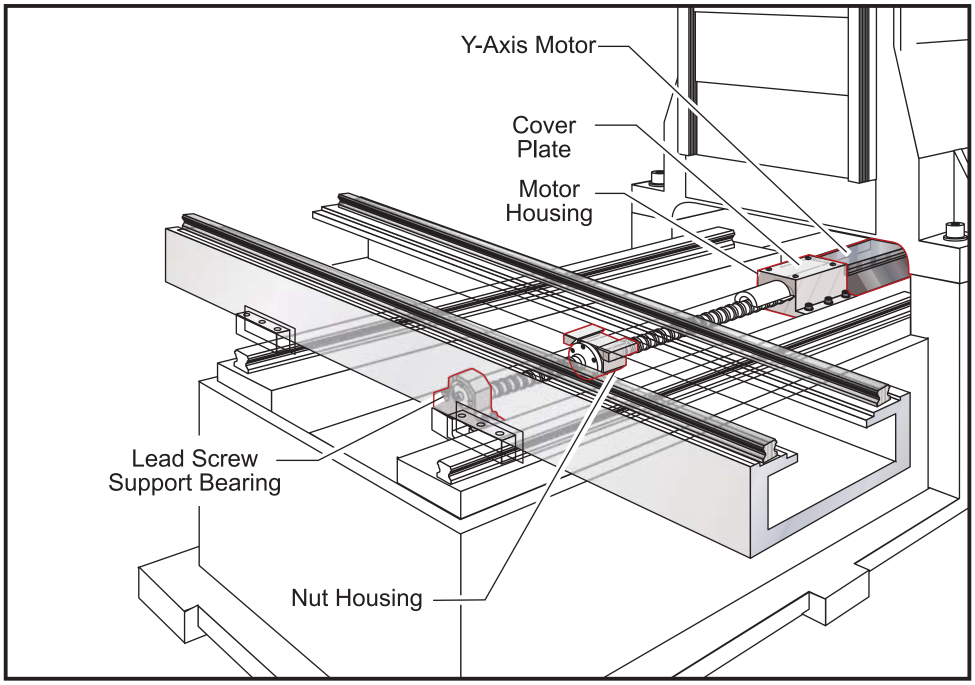


Figure 3.8-3 Y-axis motor and components.

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 lead screw.

14. On the motor housing, loosen the 4 SHCS, remove all wiring from the motor and remove the motor from the housing.

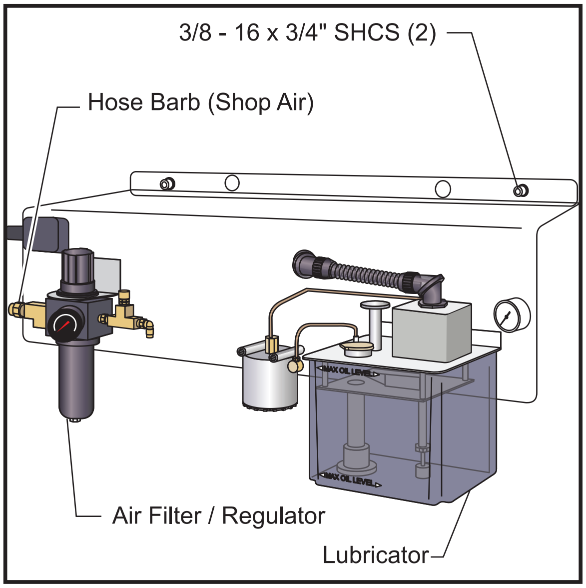


Figure 3.8-4 Lube/Air Panel.

INSTALLATION -

1. Slide motor into motor housing, inserting the end of the lead 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 leads screw or motor shaft.

Tighten the SHCS on the motor coupling at the lead 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 lead screw (Troubleshooting section) or noisy operation.
15. Zero return the Y axis and set grid offset according to section.

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, VCE 700/750, or right side spindle head cover for VF-3/4, VCE 1000/1250.

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 lead screw can be easily accessed. This can be done by turning the ball screw manually.

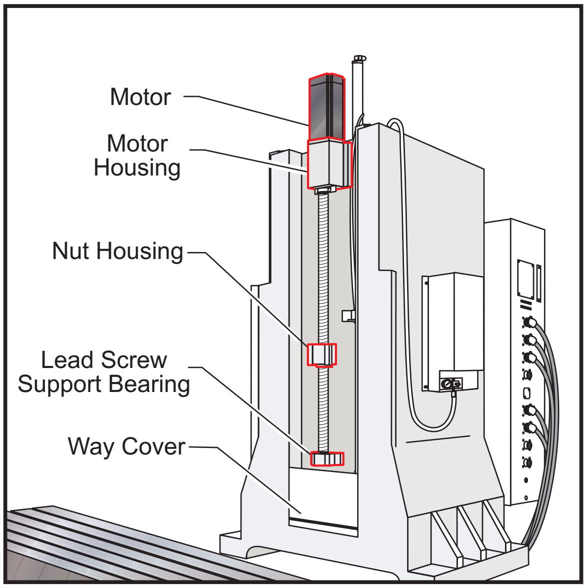


Figure 3.8-5 Z-axis motor and components.

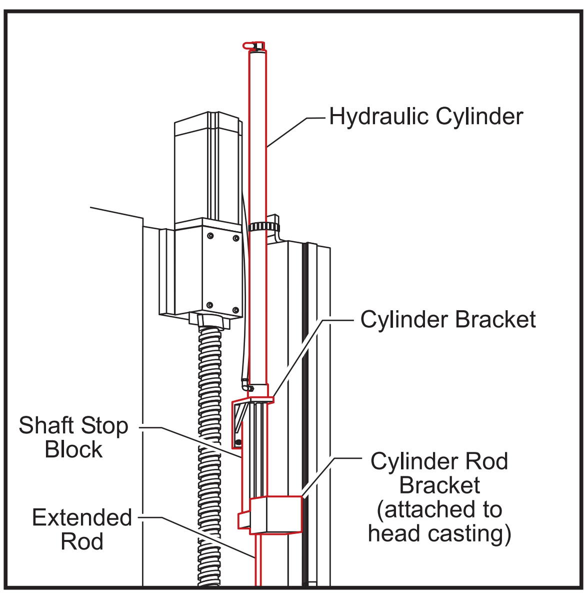


Figure 3.8-6 Z-axis motor and components for machines equipped with hydraulic counterbalance.

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 lead 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 leads screw or motor shaft.

Tighten the SHCS on the motor coupling at the lead 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 lead screw (Troubleshooting section), or noisy operation.

12. Zero return Z axis and set grid offset and parameter 64 (section 3.6).

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 leads screw or motor shaft.

Tighten the SHCS on the motor coupling at the lead screw. (Place a drop of blue Loctite® on the screw before inserting.)

4. Reinstall the axis motor.

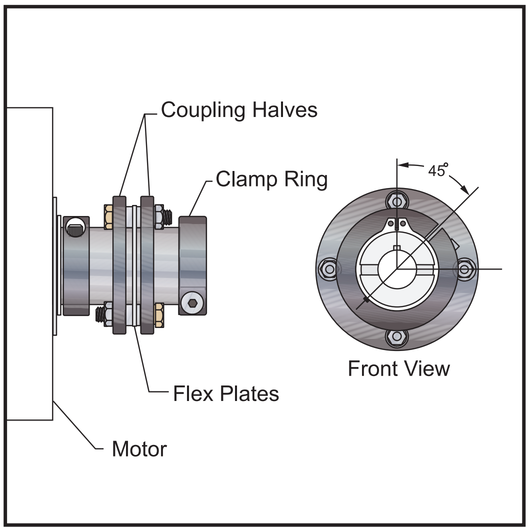


Figure 3.8-7 Motor coupling.

3.9 Lead Screw Removal and Installation

Please read this section in its entirety before attempting to remove or replace the lead 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 lead screws.

X-Axis Lead 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 lead screw.

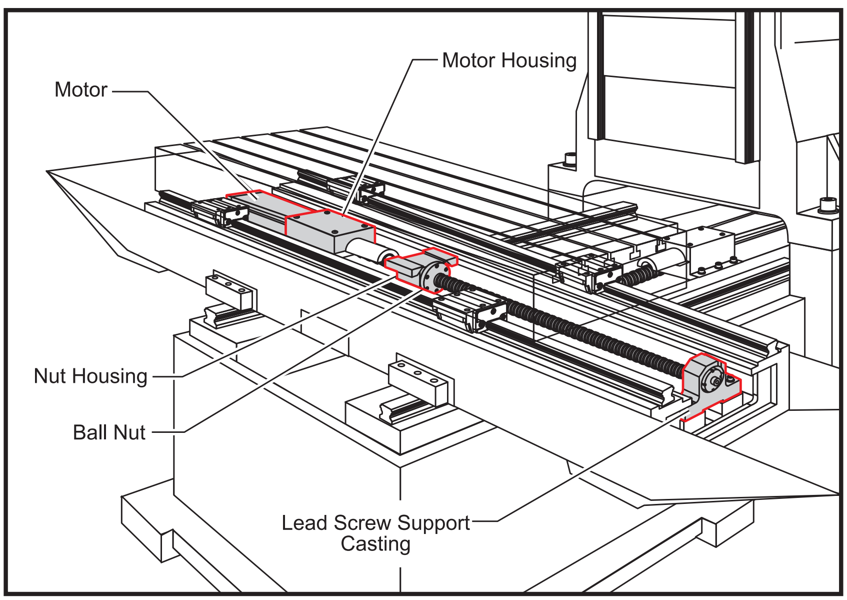


Figure 39-1. X-axis lead screw and components.

7. Disconnect the oil line from the ball nut.

8. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the lead screw support bearing end.

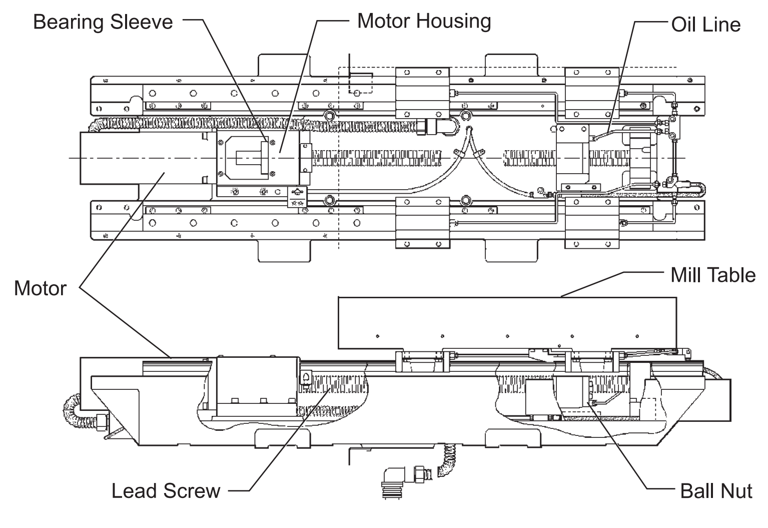


Figure 3.9-2 Lead screw assembly.

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 lead screw in the motor housing.

11. **For 32 mm lead 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 lead screw to loosen.
•Push the mill table towards the motor end until the lead screw clears the bearing support. Remove the SHCS from the ball nut and remove the lead 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 lead screw will result.

For 40 and 50 mm lead 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 lead 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 lead 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.

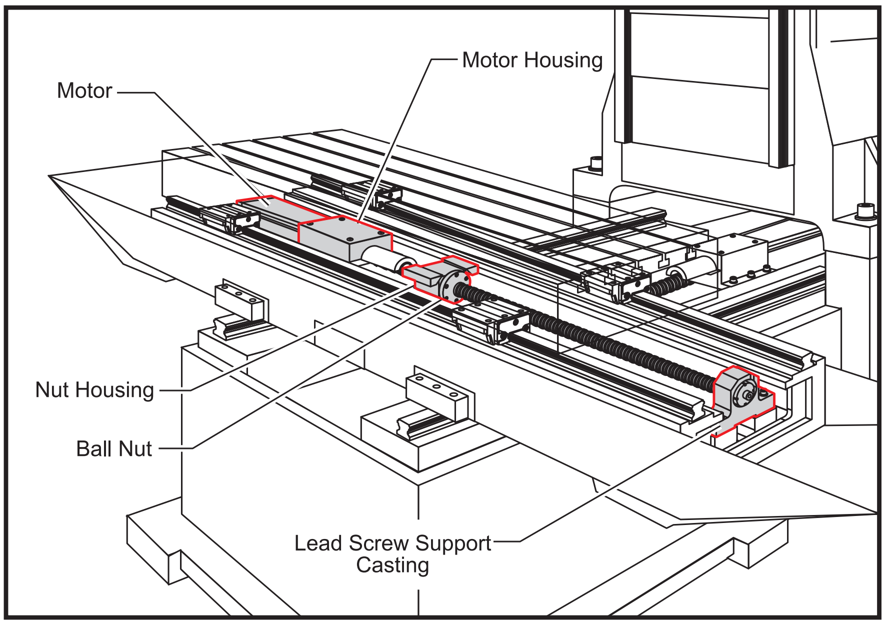


Figure 3.9-3 Install lead screw from right side.

4. **If 40 or 50 mm lead 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 lead 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 lead screw.)

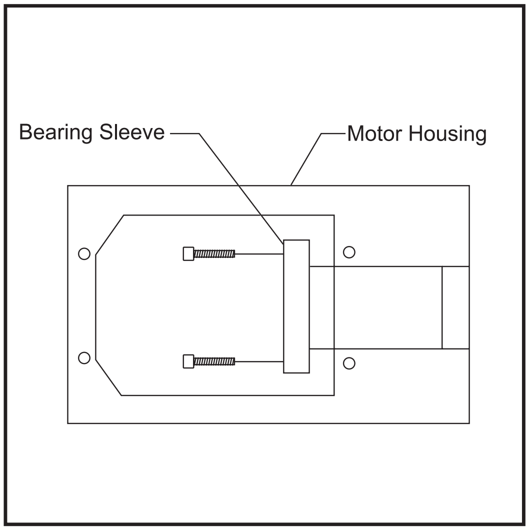


Figure 3.9-4 Bearing sleeve mounting location.

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 lead 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 lead screw. This will keep the lead 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 leadscrew 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 lead 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 lead screw torque at bearing support end with torque tester. Jog the table all the way to the right. Check the lead 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 lead screw ("Accuracy/Backlash" section) or noisy operation.

16. Zero return X axis and set grid offset.

Y-Axis Lead 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 lead screw support bearing end of the lead 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 lead screw bearing support end.

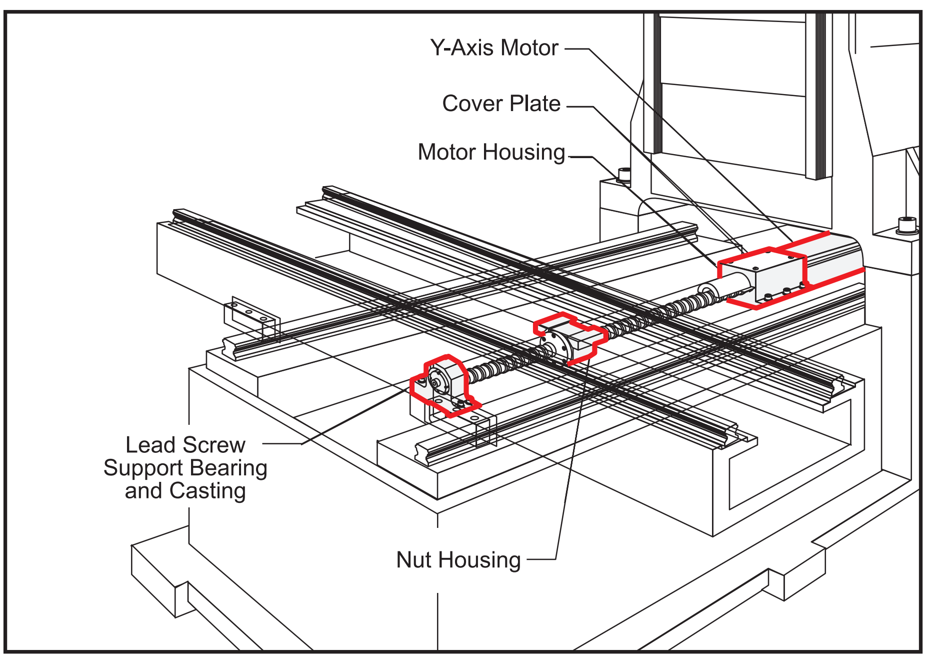


Figure 3.9-5 Y-axis lead screw and components.

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 lead screw in the motor housing.

7. **For 32 mm lead 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 lead screw to loosen.

CAUTION! Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or lead screw will result.

•Remove the five SHCS attaching the ball nut to the nut housing.
•Hand-turn the lead screw toward the rear of the machine until the front end of the lead screw clears the bearing by approximately six inches (6").
•Carefully pull the lead screw forward, to the right of the support bearing, under the front way cover until the rear of the lead screw clears the nut housing. Shift the rear end of the lead screw to the right side of the nut housing and move the lead screw to the rear of the machine until it clears the front way cover. Remove lead screw from the machine.

For 40 and 50 mm lead 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 lead screw by pulling from the bearing support end.

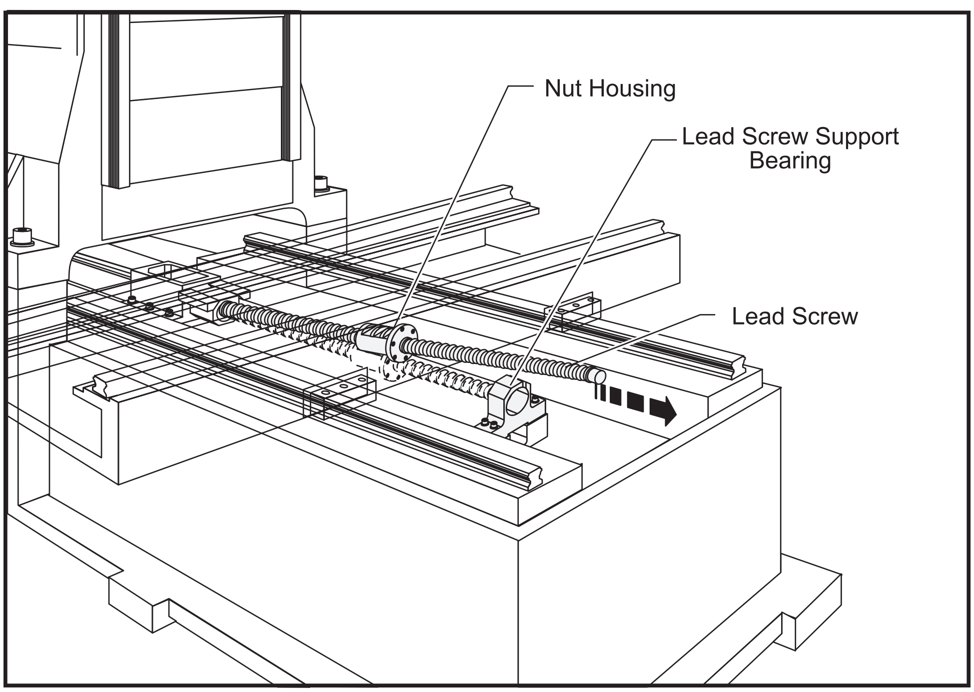
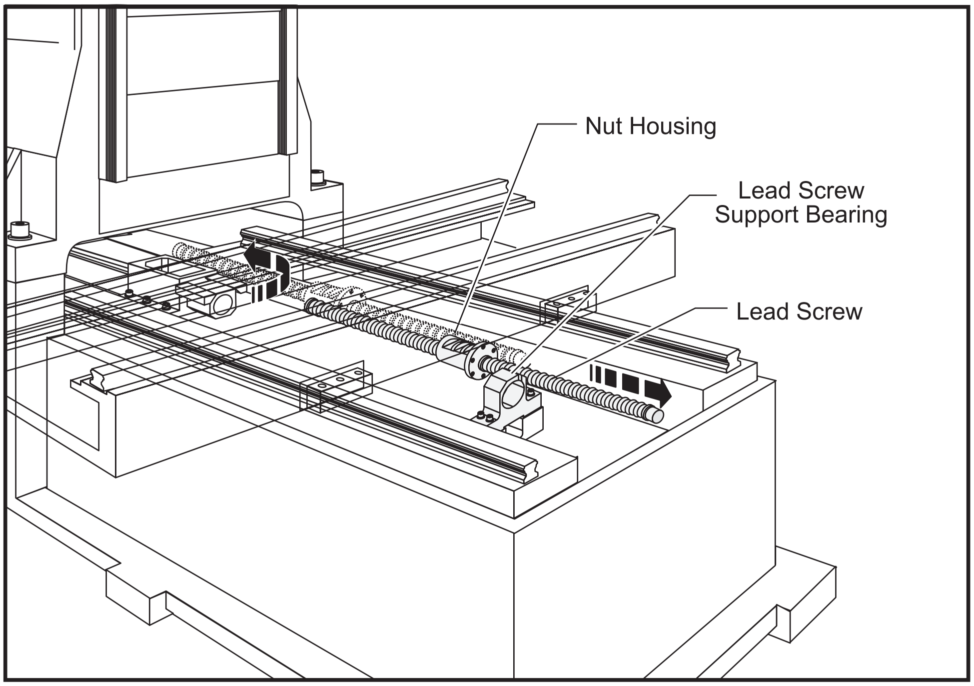


Figure 3.9-6 Pull lead screw forward around bearing support,...



...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 lead screw under the saddle, taking care not to damage the screw threads. Position the lead 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 lead screw forward until it is against the front way covers. Place the motor end of the lead screw through the nut housing and push the lead screw toward the back of the machine until the ball nut is seated in the nut housing.

4. **If 40 or 50 mm lead 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 lead 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 lead 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 lead 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 lead screw. This will keep the lead 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 leadscrew 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 lead 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 lead screw support bearing end of the lead screw.

12. Reconnect oil line to the ballnut.

13. Check lead screw torque at bearing support end with torque tester. Jog the table all the way to the front. Check the lead screw torque again. It should be the same as the previous reading.

14. Check for backlash in the lead screw ("Accuracy/Backlash" section) or noisy operation.

15. Zero return Y axis and set grid offset.

Z-Axis Lead 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 LEAD 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 lead 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 lead 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 lead screw in the motor housing.

10. **For 32 mm lead 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 lead screw to loosen.

CAUTION! Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or lead screw will result.

•Hand-turn the lead 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 lead screw down and to the right of the support bearing, past the Z-axis way cover. For the VF-6, remove the lead screw from top of column.

CAUTION! Do not damage the threads on the lead screw.

For 40 and 50 mm lead 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 lead screw by pulling from the bearing support end.

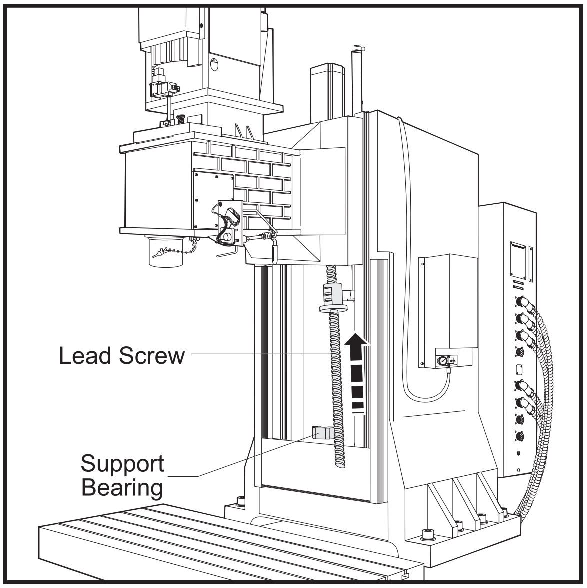


Figure 3.9-7 Z-axis lead screw and components.

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 lead screw:**
   • Insert the lead screw into the bearing support. Screw the clamp nut on a few turns.
   • Insert the lead screw, with the bearing support attached, into place on the column. Ensure the lead 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 lead screw.
   • Hand-turn the ball nut until it comes into contact with the nut housing mounting surface. If necessary, turn the leadscrew 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 lead screw up into the nut housing and gently lower it until it is resting in the support bearing.

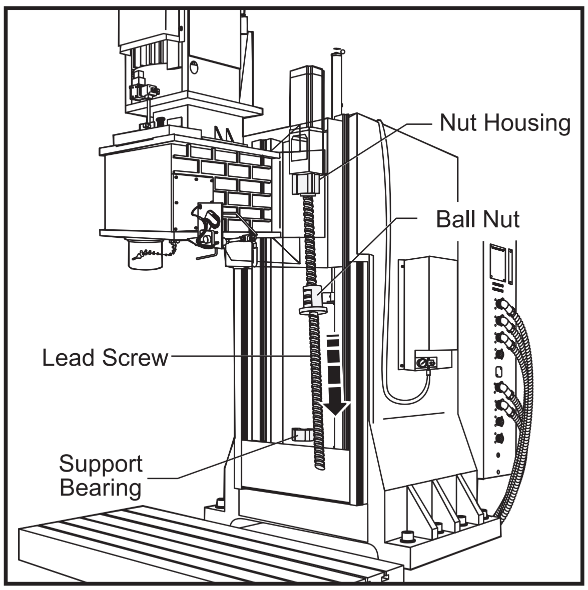


Figure 3.9-8 Reinstalling the lead screw.

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 lead 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 leadscrew 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 lead 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 lead screw while the other end is tightened.
   • Install the shaft lock onto the bearing support end of the lead screw. This will keep the lead 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 leadscrew 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 lead 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 lead 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 lead 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 lead screw torque at bearing support end with torque tester. Jog the spindle head to its highest position. Check the lead screw torque again. It should be the same as the previous reading.

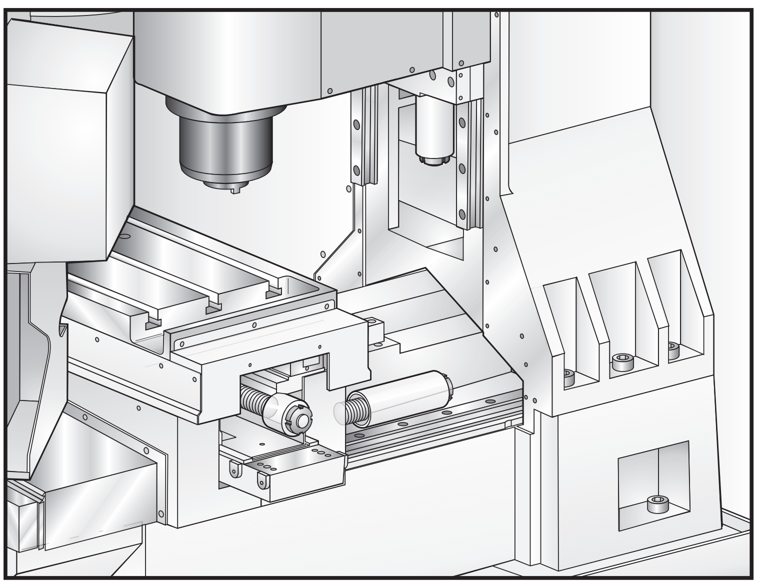
15. Check for backlash in the lead screw ("Accuracy/Backlash" section) or noisy operation.

16. Zero return Z axis and set grid offset and parameter 64 (section 3.6).

Mini Mill Lead Screws

Replacement of the mini-mill leadscrews follow the same procedures as the other mills. The leadscrews are only supported at the motor end, thereby simplifing the alignment procedure.

1. Use a standard ballscrew support bearing assembly to prevent the leadscrew 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 leadscrew 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 leadscrew 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.



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 lead screws, the lead screw must be removed in order to remove the bearing sleeve. Refer to the "Lead 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.

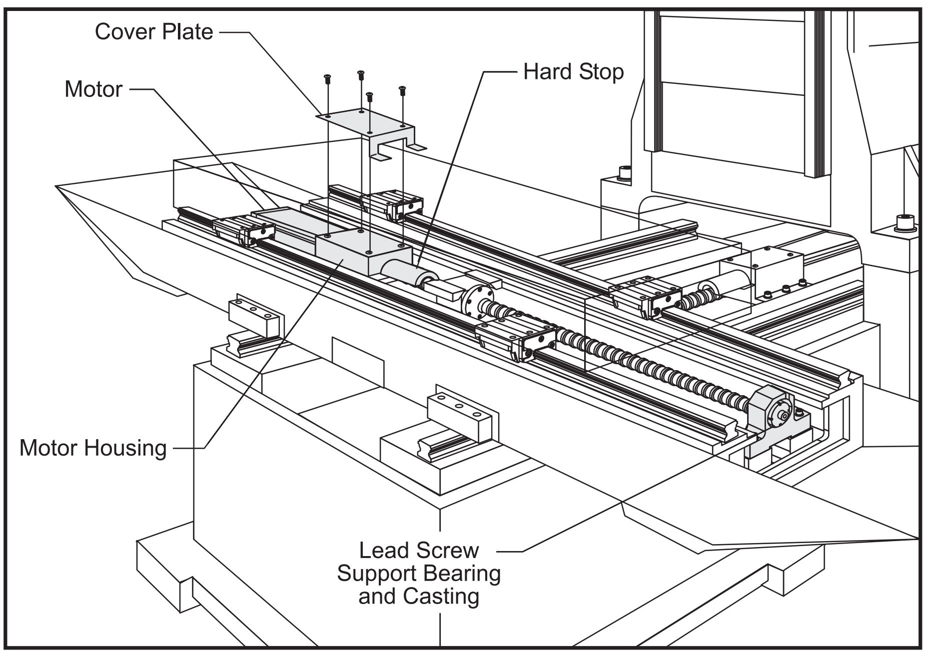


Figure 3.10-1 X-axis lead screw and components.

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 lead 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 lead screw to loosen.

CAUTION! Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or lead 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.)

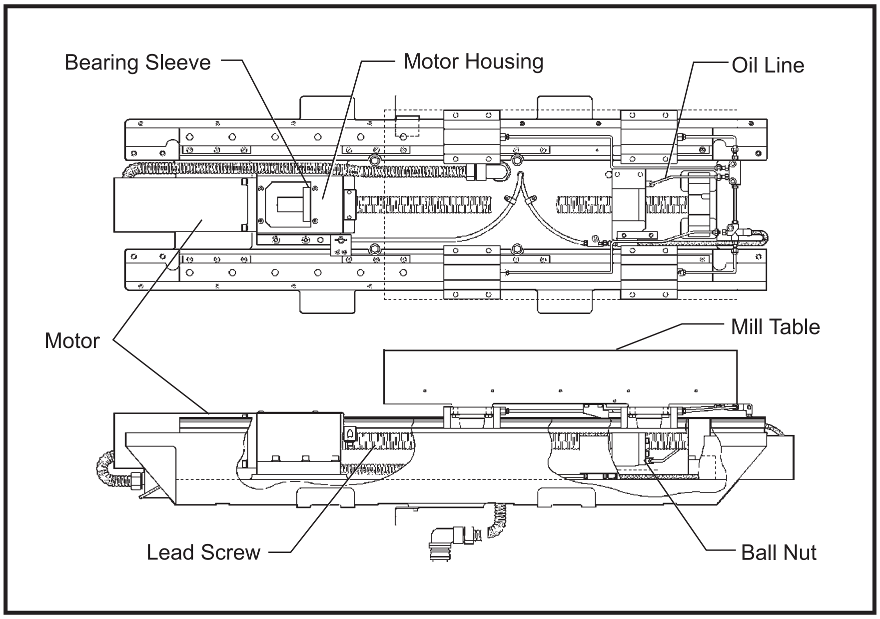


Figure 3.101-2 Lead screw assembly.

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 lead 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 lead 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 lead 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 lead 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 lead screw.

4. Loosen the 10-32 x ½" SHCS and remove the clamp nut from the bearing support end of the lead 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 lead screw to loosen.

CAUTION! Do not pry the bearing sleeve away from the motor housing. Damage to the sleeve, bearing, or the lead 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 lead screw at the motor housing end

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 lead 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, VCE 550/700/750, or right side spindle head cover for VF-3/4, VCE 1000/1250.

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 lead screw.

5. Loosen the 10-32 x ½" SHCS and remove the clamp nut from the bearing support end of the lead 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.

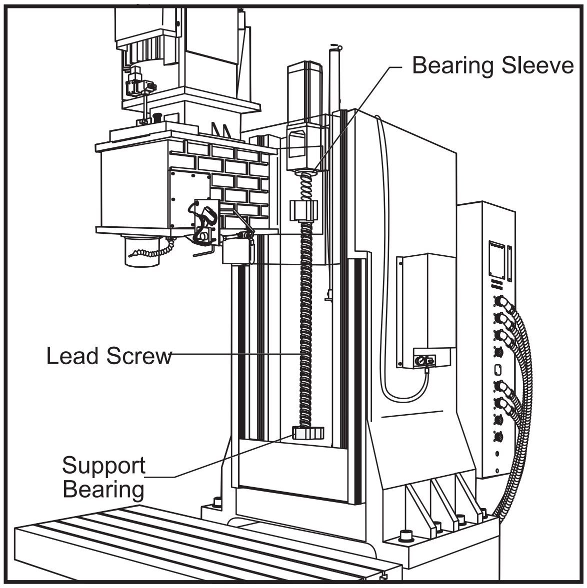


Figure 3.10-3 Z-axis bearing sleeve.

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 lead screw.

11. Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Hand-turn the lead 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 lead 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 lead screw at the motor housing end.

5. Reinstall the hard stop on the bearing housing end of the lead screw.

NOTE: For the angular contact design bearing, no pre-load is necessary. Follow the procedures as outlined in "X-Axis Bearing Sleeve" section.

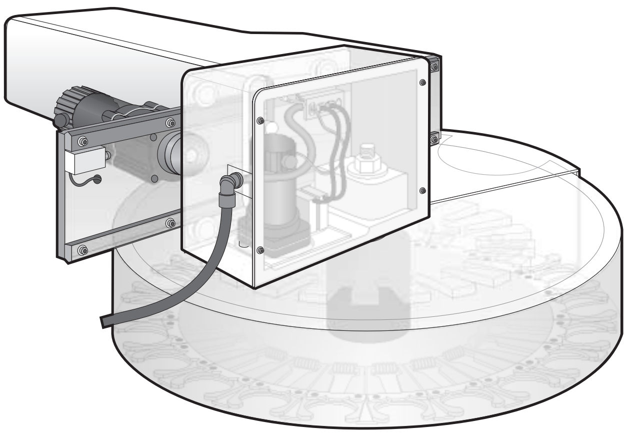
6. Reinstall the axis motor in accordance with "Z-Axis Motor-Installation".

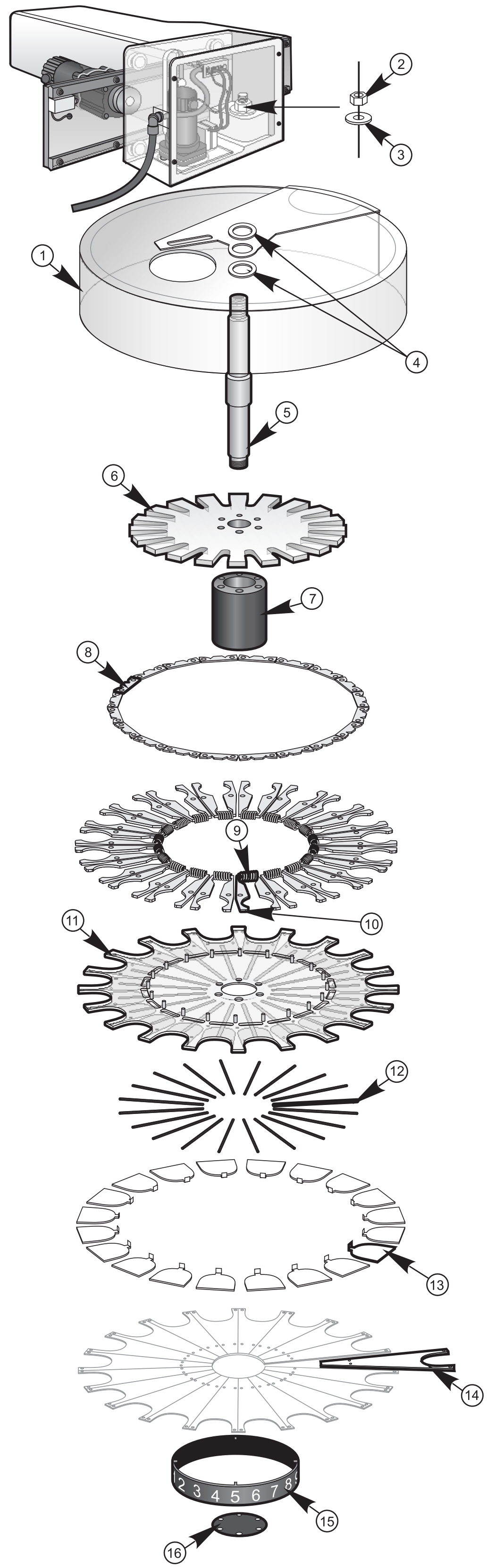
7. Remove shaft stop.

8. Check for backlash in the Z-axis lead screw (Troubleshooting section) or noisy operation.

9. Zero return Z axis and set grid offset and parameter 64 according to section 3.6.

3.11 Automatic Tool Changer





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.

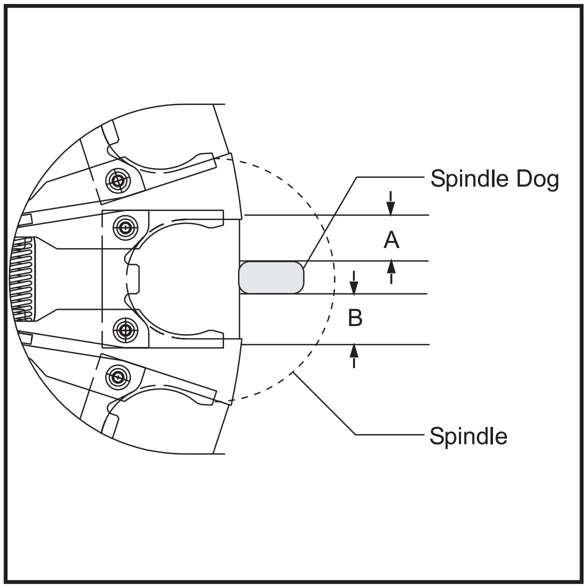


Figure 3.11-1. Underside showing centering measurements.

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.

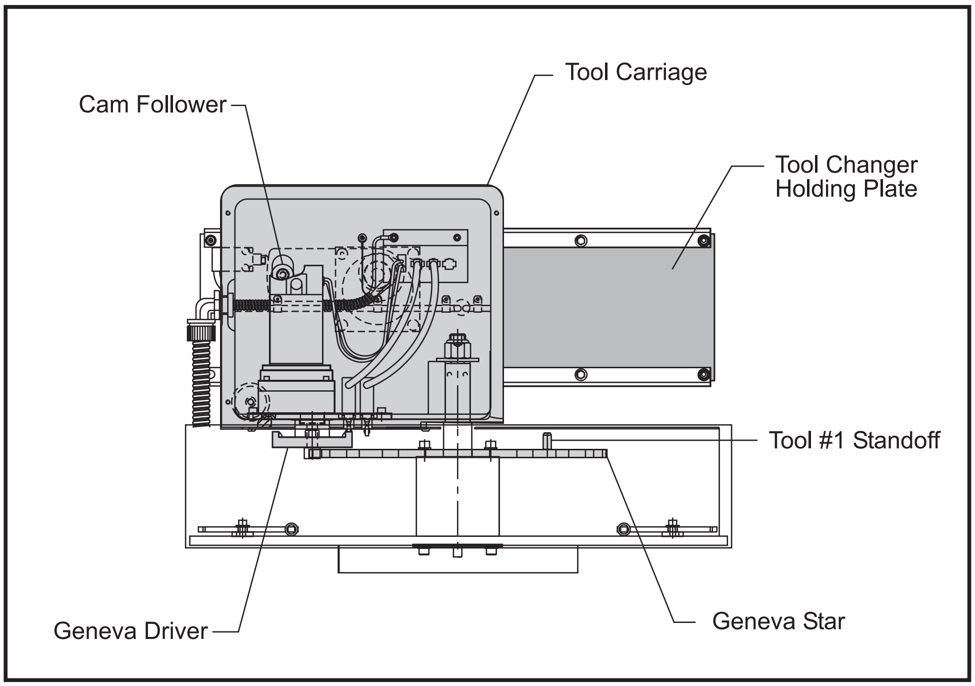


Figure 3.11-2 Automatic Tool Changer - Mechanical Assembly (Side View)

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.

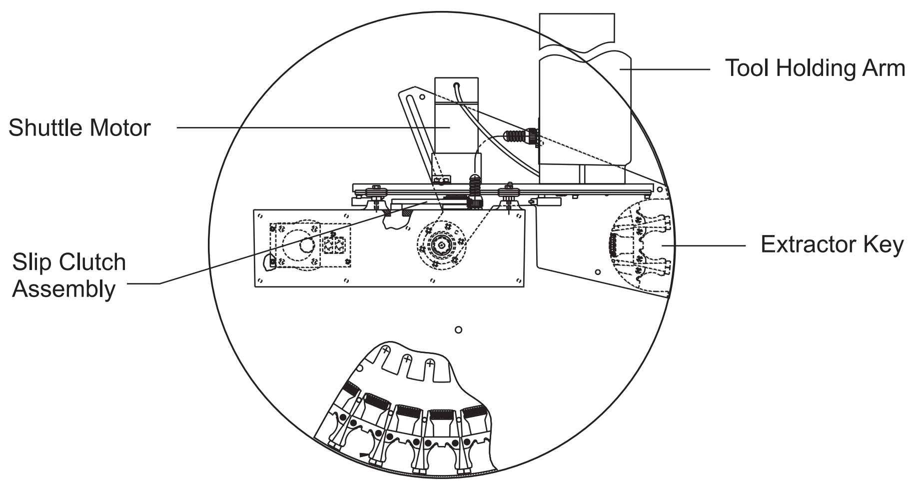


Figure 3.11-3 Automatic Tool Changer - Mechanical Assembly (Top View)

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.

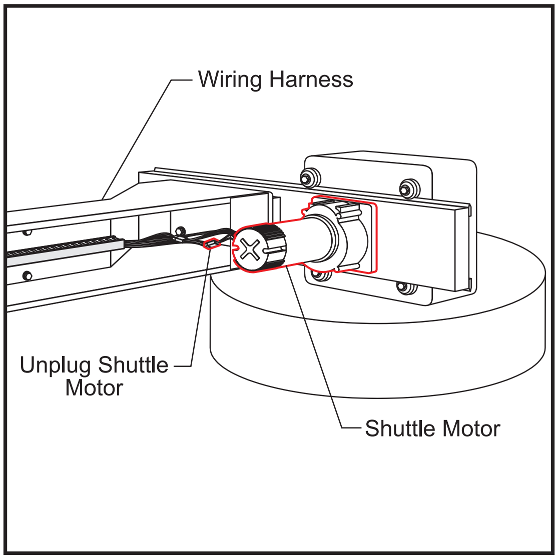


Figure 3.11-4 Wiring harness for shuttle motor.

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.

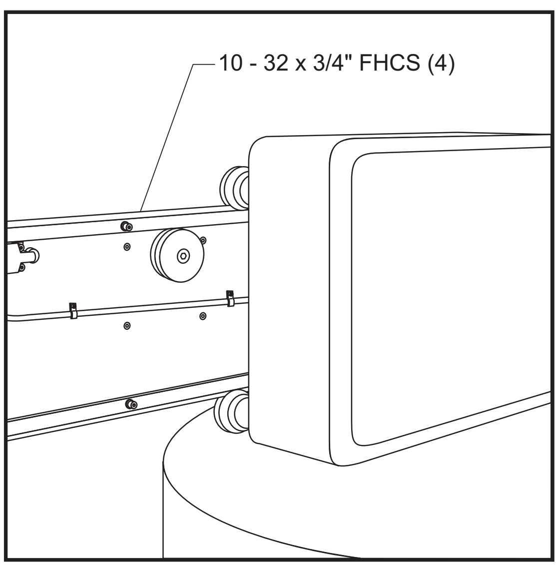


Figure 3.11-5 Front view of holding plate showing FHCS location.

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.

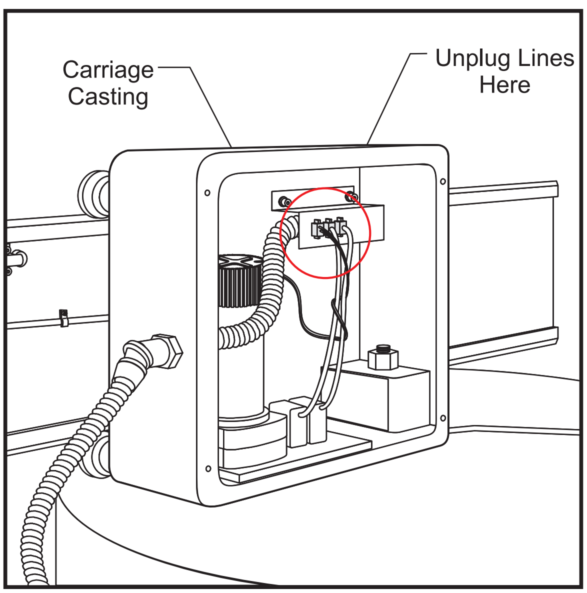
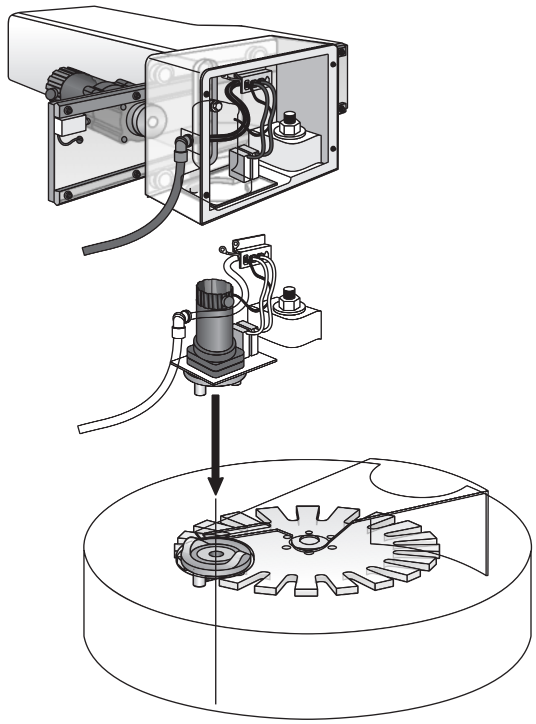


Figure 3.11-6 Carriage casting with cover removed.

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.

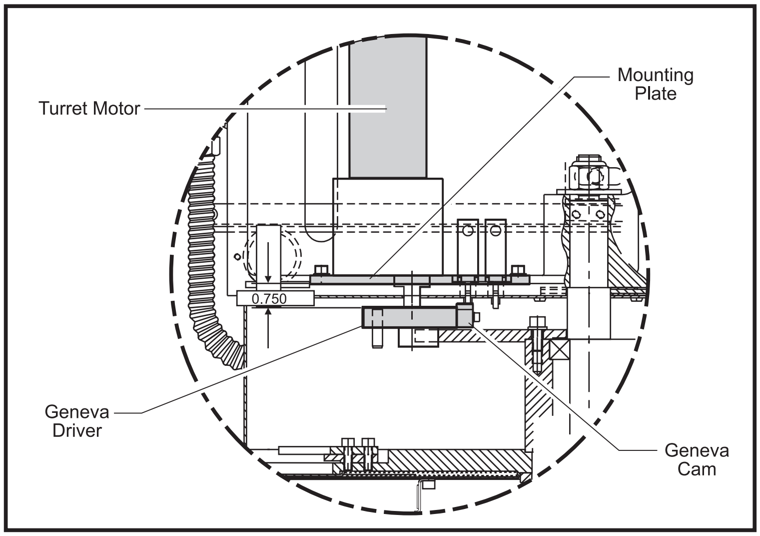


Figure 3.11-7 Required spacing for Geneva driver.

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.

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.

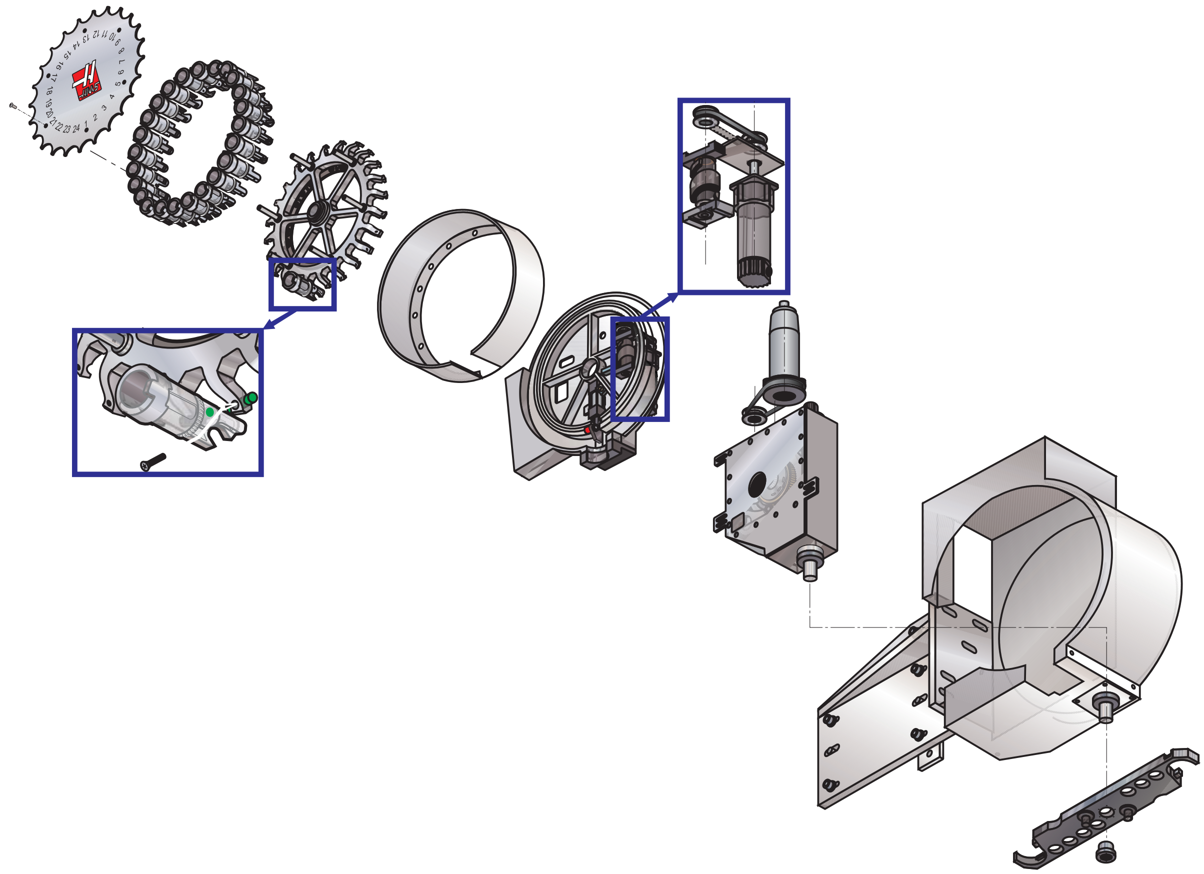
2) Select the ALARMS screen and enter DEBUG mode.

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".

3.12 40 Taper Carousel Side Mount Tool Changer



Special Tools Required: • Lifting Device (1000lb capacity for ATC removal)
• Spanner Wrench

40 Taper Carousel Removal and Installation

Removal:

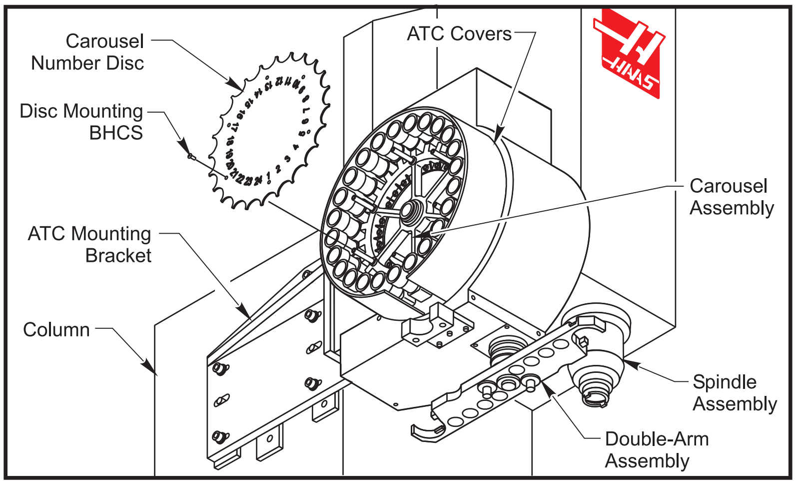


Figure 3.12-1 ATC Assembly, Carousel Removal

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.

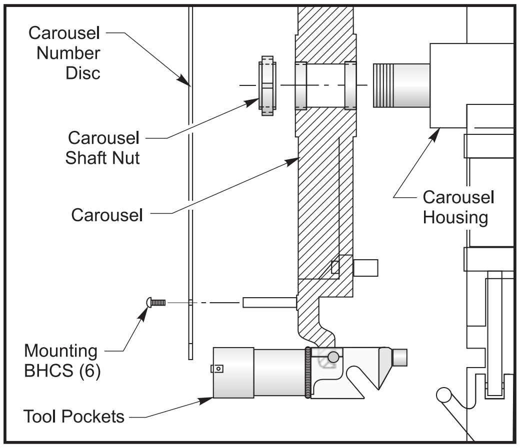


Figure 3.12-2 Carousel Assembly

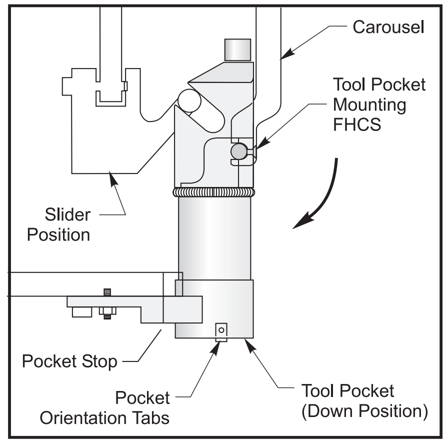


Figure 3.12-3 Carousel and Tool Pocket Installation

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

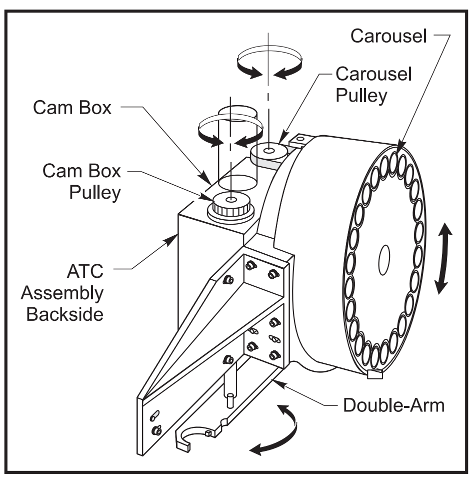


Figure 3.12-4 Pulley locations and ATC movement

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.

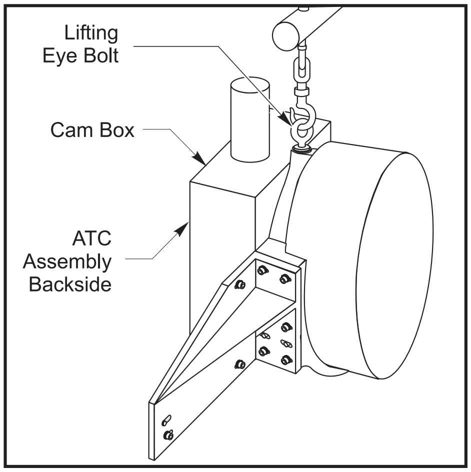


Figure 3.12-5 ATC Assembly Lifting Position

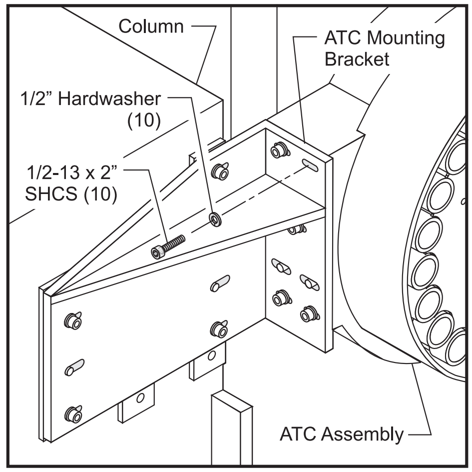


Figure 3.12-6 ATC Mounting Bracket

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

This procedure is for a newly mounted ATC assembly without the double-arm installed.

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.

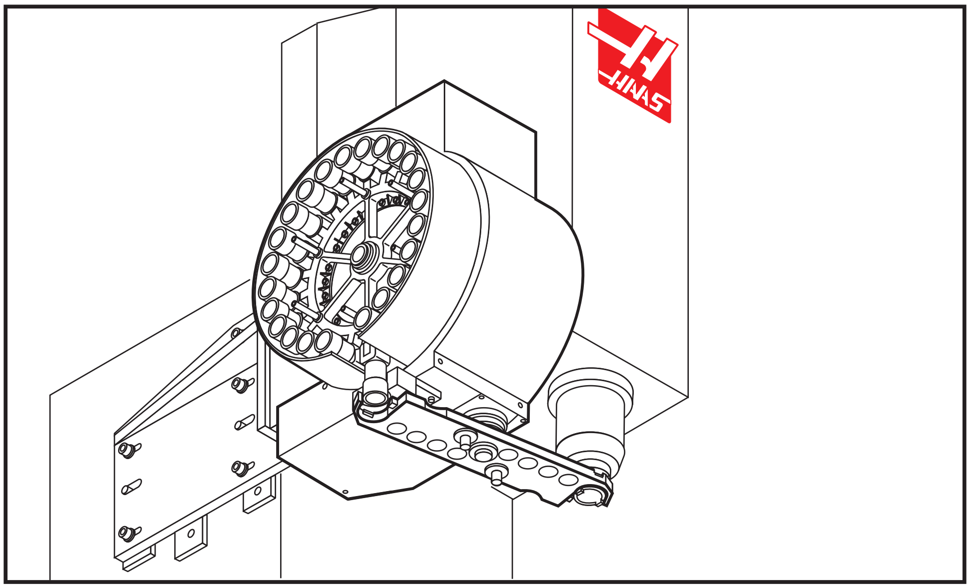


Figure 3.12-7 Double Arm Alignment

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)

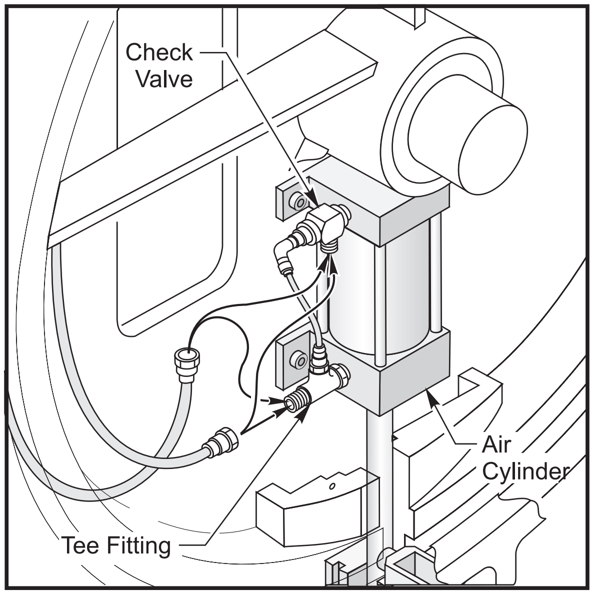


Figure 3.12-8 Airline connection location

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 an empty tool holder without a pull stud into the double arm end beneath the tool pocket. Depress the tool release button on top of the double-arm and insert a tool holder. 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 tool pocket holder. Visually check the centerline alignment of the tool holder to the centerline of the tool pocket.

10. In order to adjust the radial alignment of the tool pocket holder 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 tool pocket holder, loosen the four cam box SHCS and insert a pry-bar between the slots. Adjust the cam box until the centerline of tool holder is aligned with the centerline of the tool pocket.

12. Torque the cam box SHCS to 100 ft-lbs.

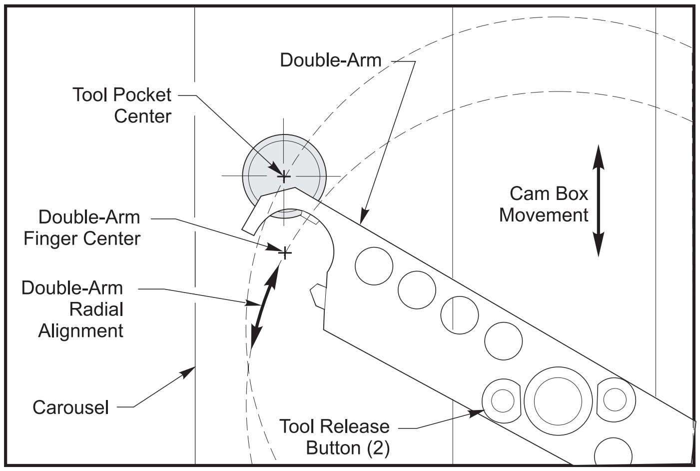


Figure 3.12-9 Cam Box / Double Arm Alignment, top view.

Checking Parallelism of Double-arm to Table:

13. Rotate the cam box pulley clockwise to lower the double arm. Remove the tool holder 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 short tool holder 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 the tool holder to the nearest .001."

18. Move the tool holder and indicator setup to the other end of the double-arm. Measure the bottom of the tool holder 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 tool holder 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 a tool holder <u>with</u> a 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 tool holder. If neces- sary loosen the lock ring SHCS and adjust the height of the double arm. Torque the lock ring SHCS to 7 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 short tool holder without pull stud 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 tool holder to the spindle center. Refer to Figure 3.12-10.

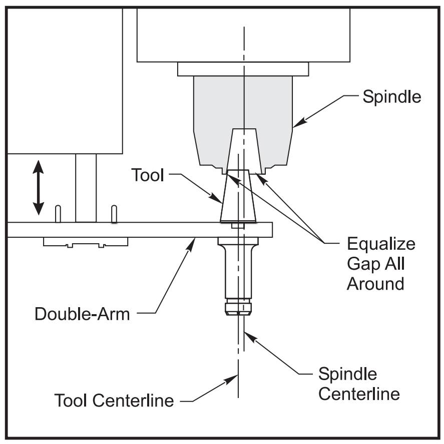


Figure 3.12-10 Double Arm to Spindle Center Alignment, along the Y-axis.

5. If necessary, loosen the five ATC mounting SHCS. Refer to Figure 3.12-11.

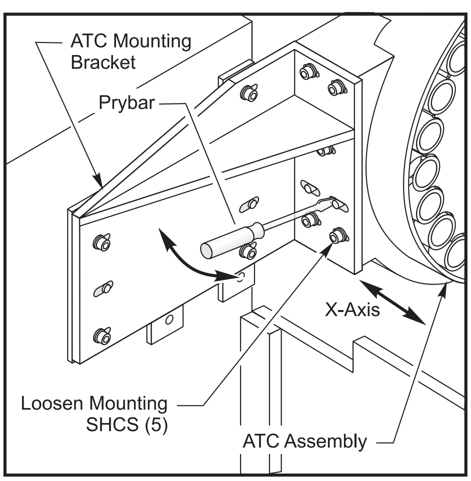


Figure 3.12-11 ATC Assembly X-axis alignment

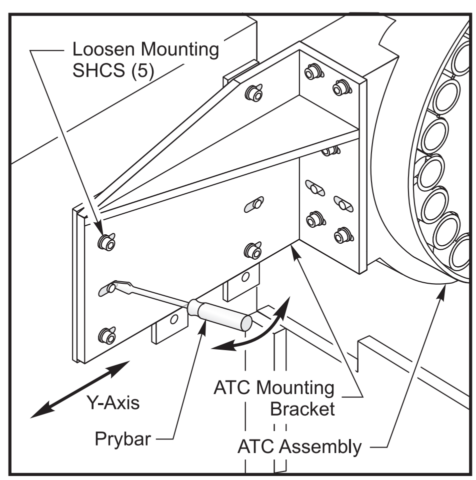


Figure 3.12-12 ATC Assembly Y-axis alignment.

6. Insert a pry-bar between the locating pins and the ATC mounting bracket. Adjust the bracket to align the tool holder 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 tool holder 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.

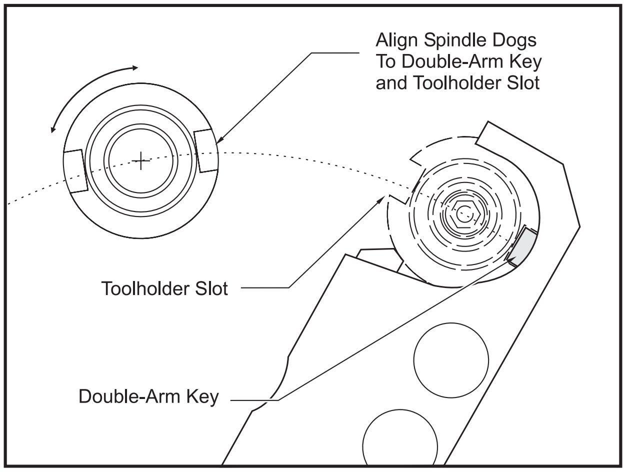


Figure 3.12-13 Spindle Orientation Setting

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.

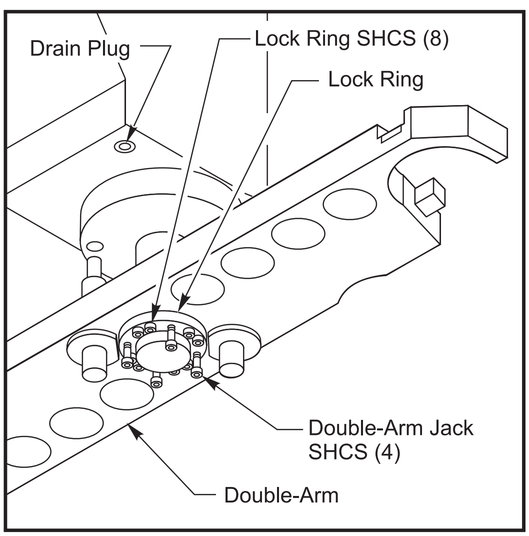


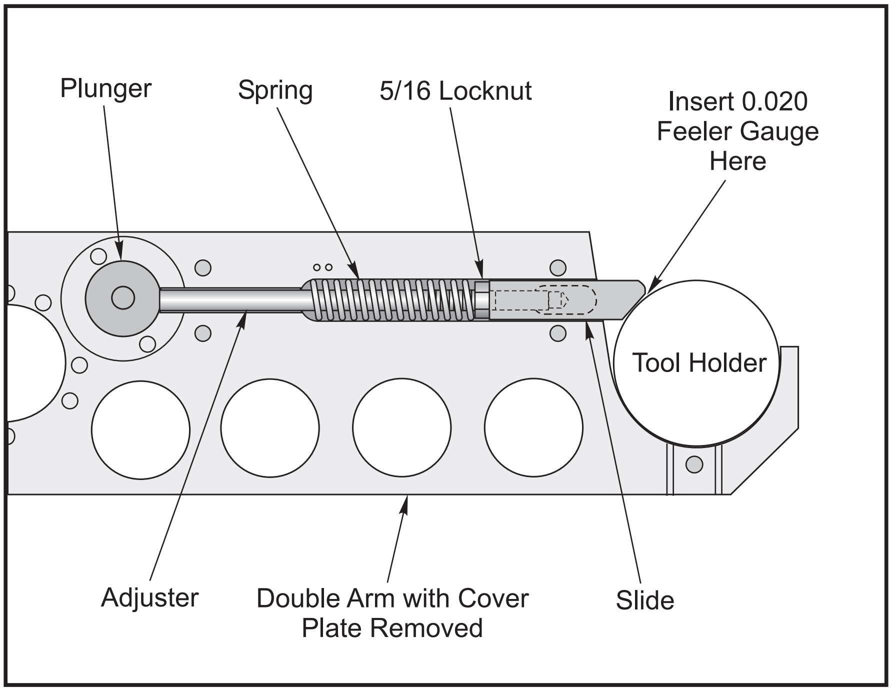
Figure 3-12-14 Removal of the Double Arm

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 six (6) SHCS. Verify the slides are correctly adjusted on the double arm with the following procedure:

   With the double arm lowered, and a 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 tool holder 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 toolholder 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 locknut and adjust the clearance. Apply blue Locktite 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 section on ATC alignment.

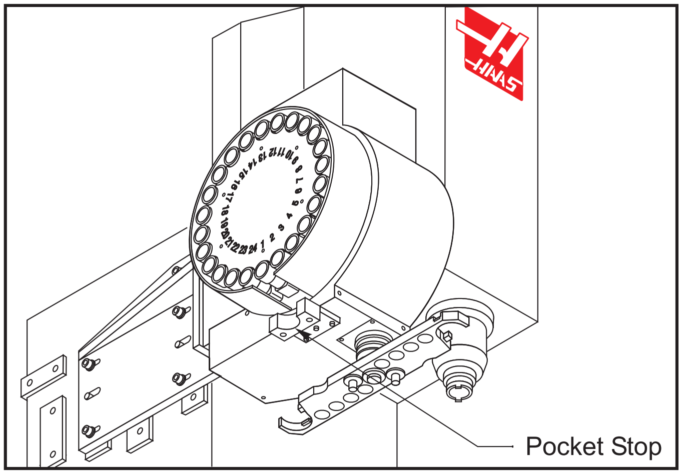
40 Taper SMTC Pocket Removal and Installation

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.

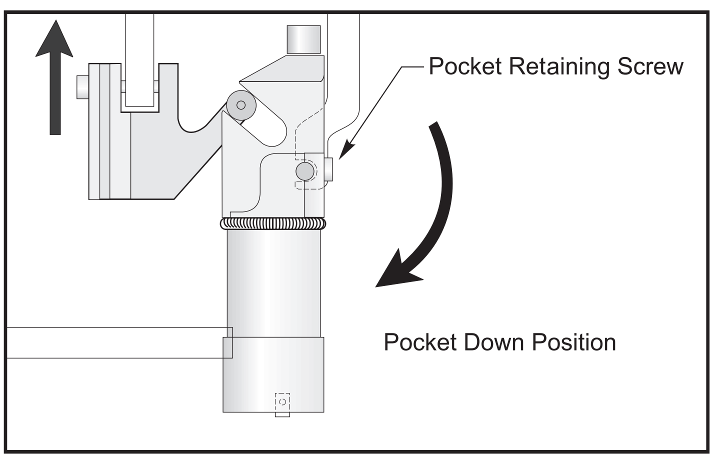
3. Remove the four SHCS that hold the pocket stop. See the following figure:



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.

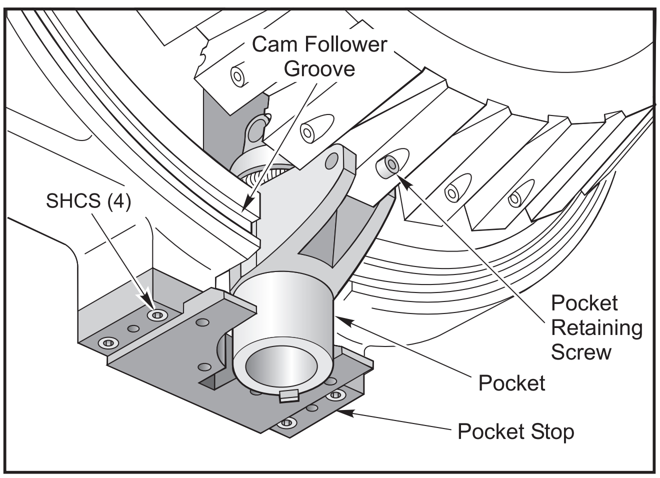
50 Taper SMTC Pocket Removal and Installation

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.

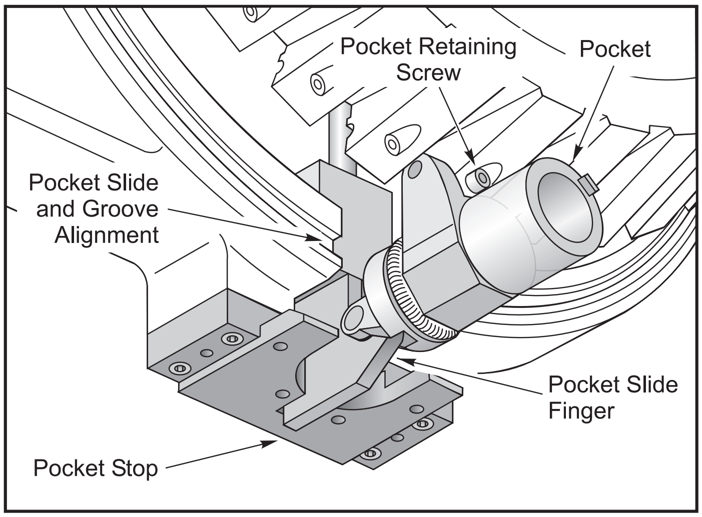
Installation

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.

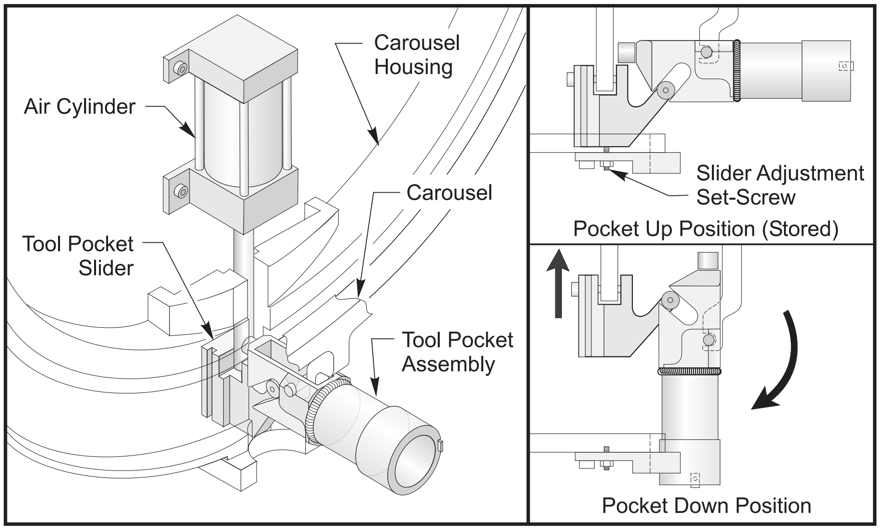


Figure 3.12-15 Tool Pocket Orientation / Set-Screw Adjustment

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.

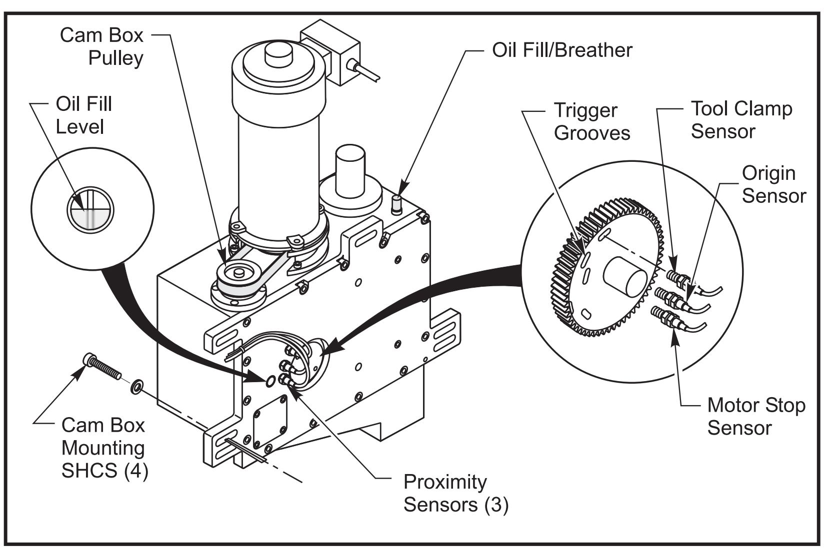


Figure 3.12-16 Proximity Sensor Switch Location

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.

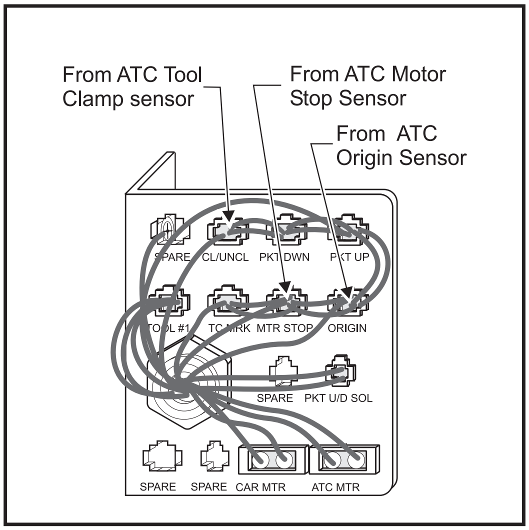


Figure 3.12-17 Proximity Switch Connection Bracket.

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 a Vertical mill: For Z-axis; displacement from home switch to tool change position and machine zero. 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 1378718 = 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.

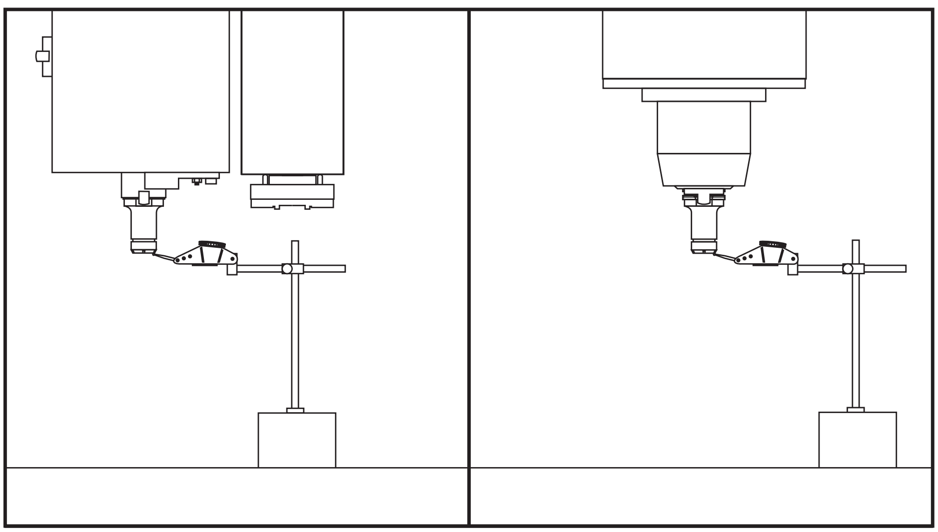


Figure 3.12-18 Setting Parameter 64, indicator reference measurement.

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.

3.13 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.

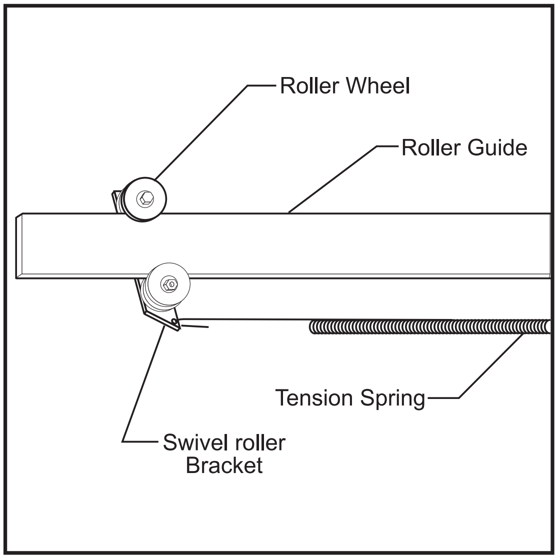


Figure 3.13-1 Roller/roller guide assembly.

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.

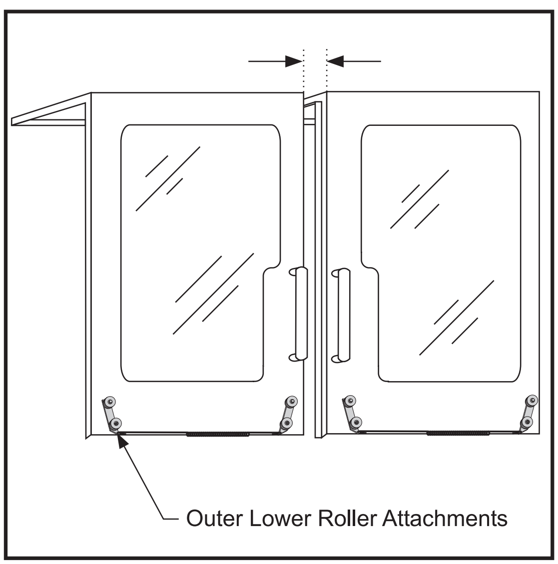


Figure 3.13-2 View of vertical gap between front doors.

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.

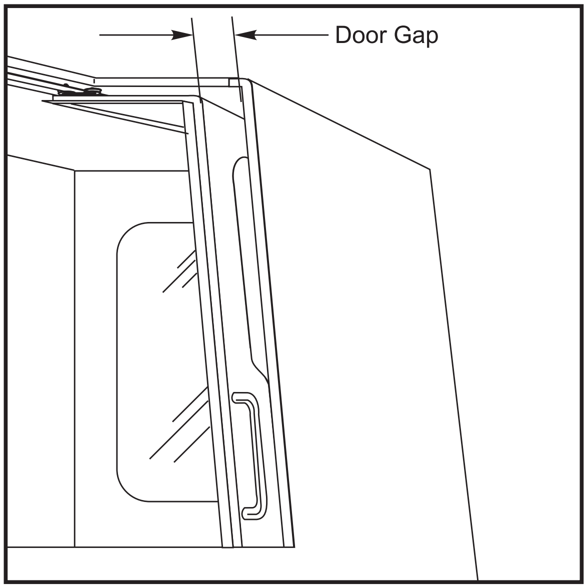


Figure 3.13-3 View of gap between front of door and front panel flange.

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.

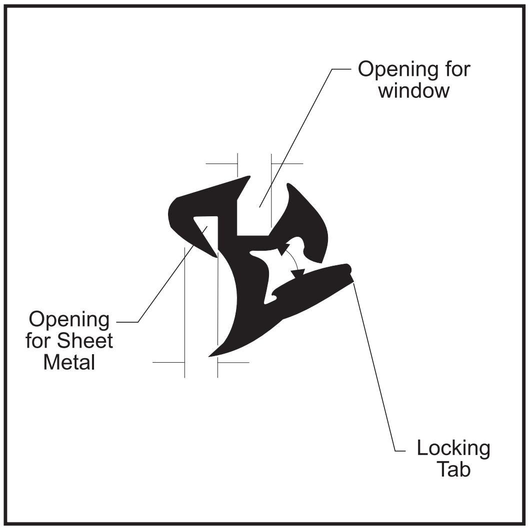


Figure 3.13-4 Cross-section of window seal.

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.

3.14 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.

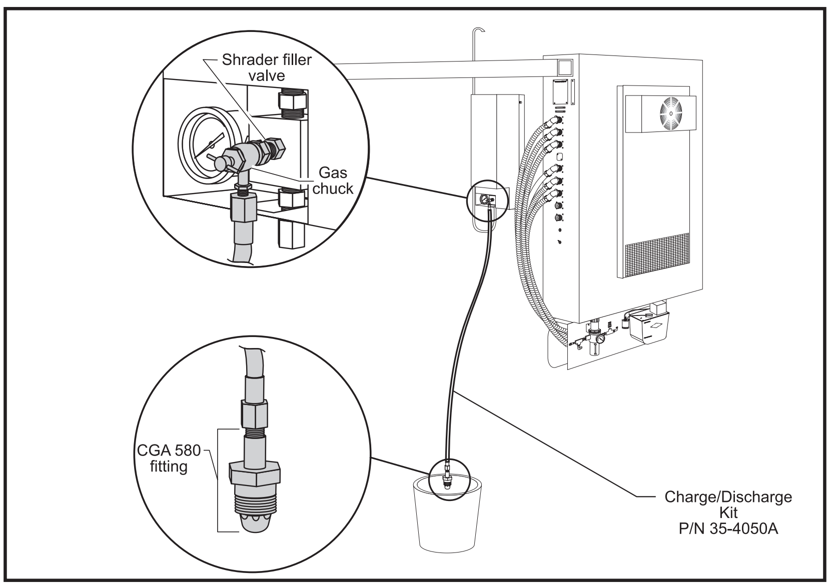


Figure 3.14-1 Hydraulic counterbalance charge/discharge kit (shown in place to discharge system).

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 Figure 3.14-1).

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 Figure 3.14-2.

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
Machine at top of travel	1150 psi	750 psi	1150 psi	1550 psi	875 psi	1100 psi

Figure 3.14-2 Tank pressure requirements.

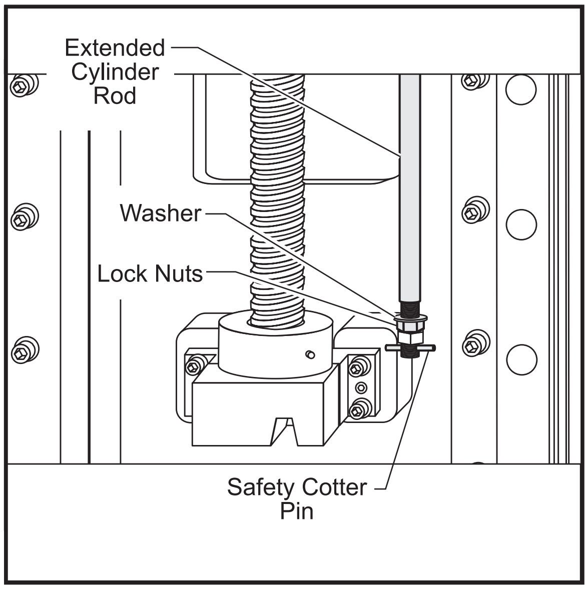
6. Power on the machine and zero return (ZERO RET) Z-axis only. Check for any leaks or abnormal noises. Verify tank pressure at top of travel. Remove charging system and replace valve cap.

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.



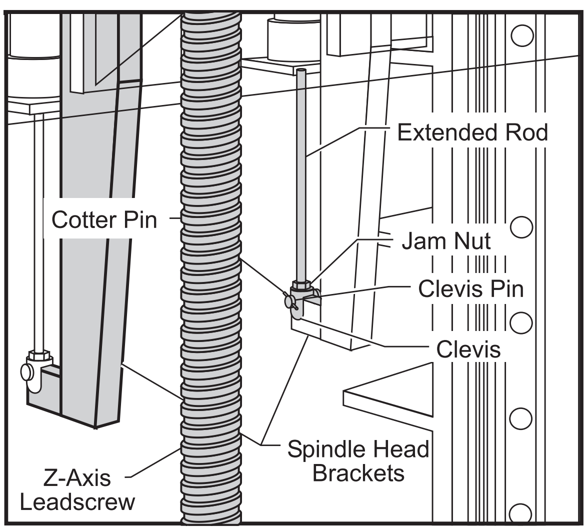


Figure 3.14-3 Hydraulic Cylinder Rod Installation for VF-1 through 4 and (VF-6/8).

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.

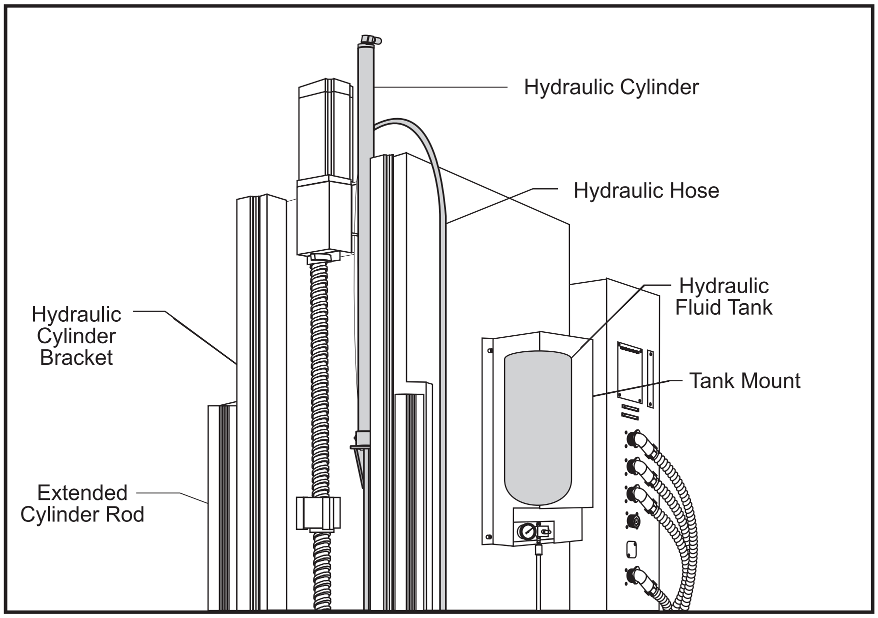


Figure 3.14-4 VF-Series hydraulic counterbalance - right side view.

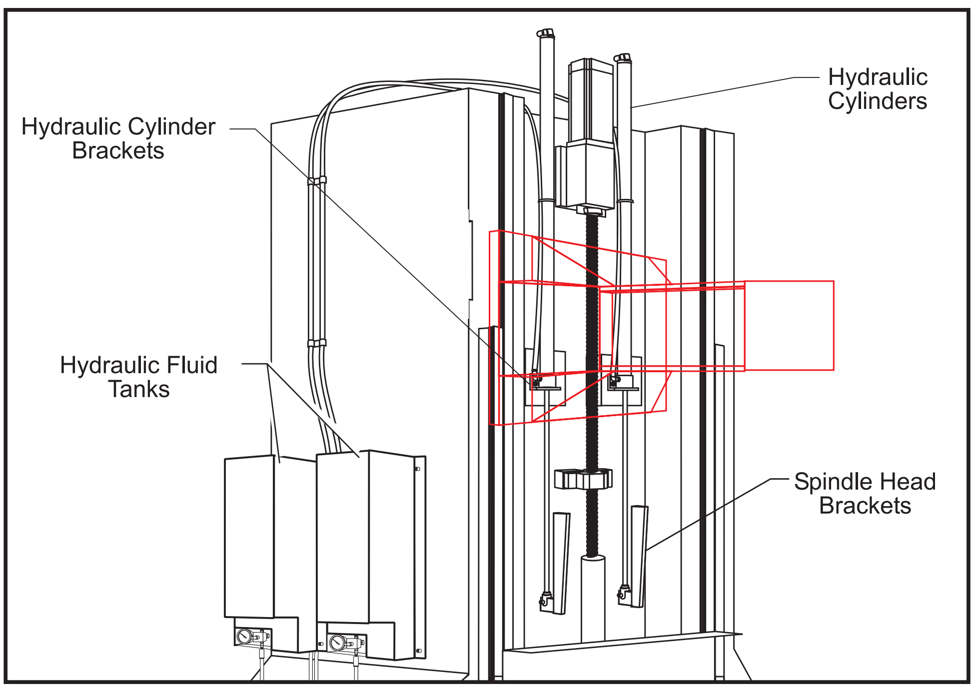


Fig. 3.14-5 VF-Series hydraulic counterbalance view - left side view.

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 lead screw.

NOTE: For VF-6/8 orient cylinder bodies with hydraulic hose facing the lead 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. Install the band clamp and tighten the two SHCS that attach the stabilizer bracket to the column.

7. Zero return (ZERO RET) machine. HANDLE JOG Z-axis in 0.1 increments. Verify full Z travel.

8. 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

9. 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.

10. Reinstall Z-axis way cover with three SHCS that hold it to the spindle head.

3.15 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!

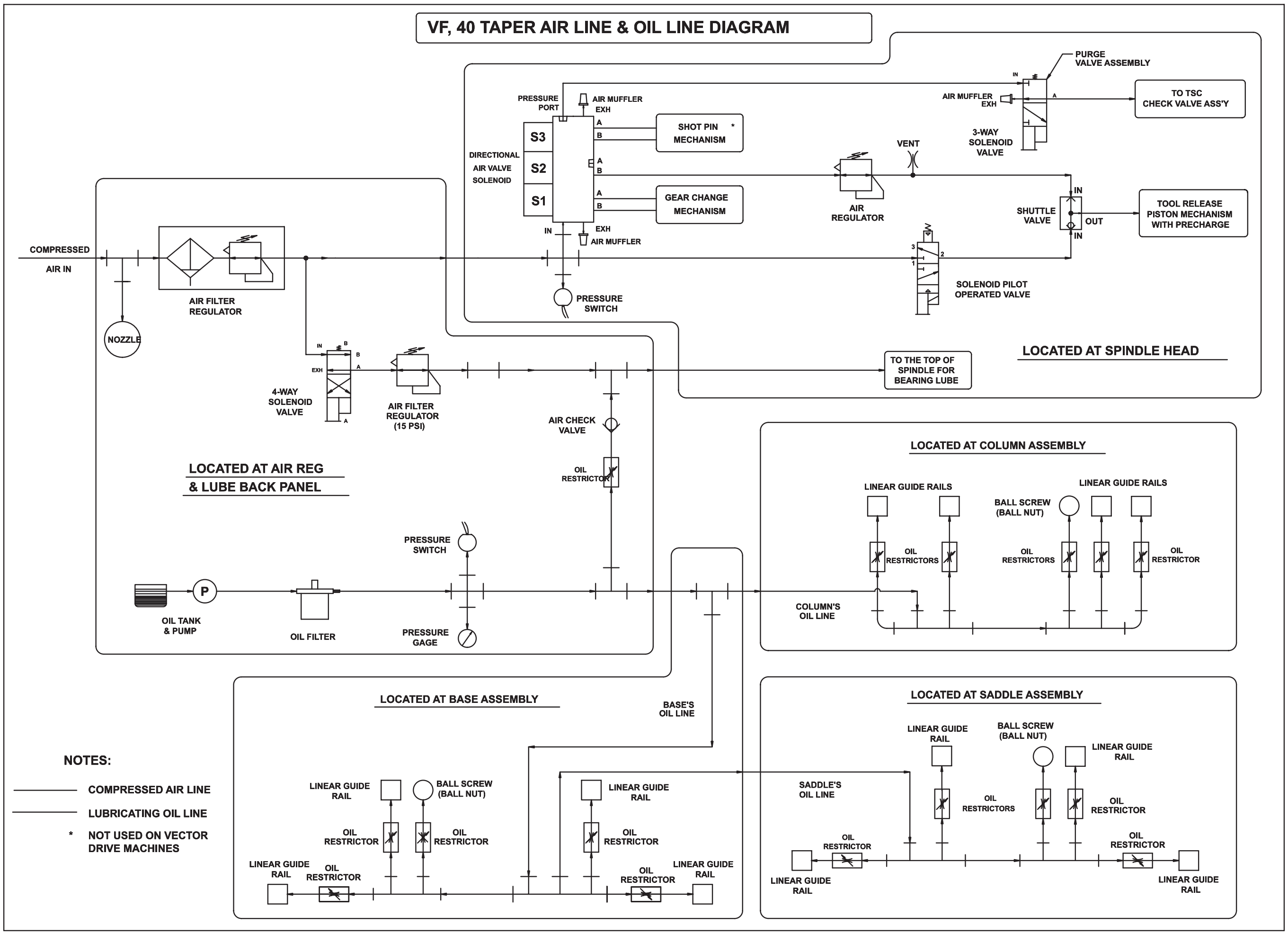
Do not put your hands in the high pressure coolant stream as coolant and particles can be blown into your skin.

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.

3.16 Air / Oil Line Diagram



THROUGH THE SPINDLE COOLANT SYSTEM FLOW DIAGRAM - 40 TAPER SPINDLE

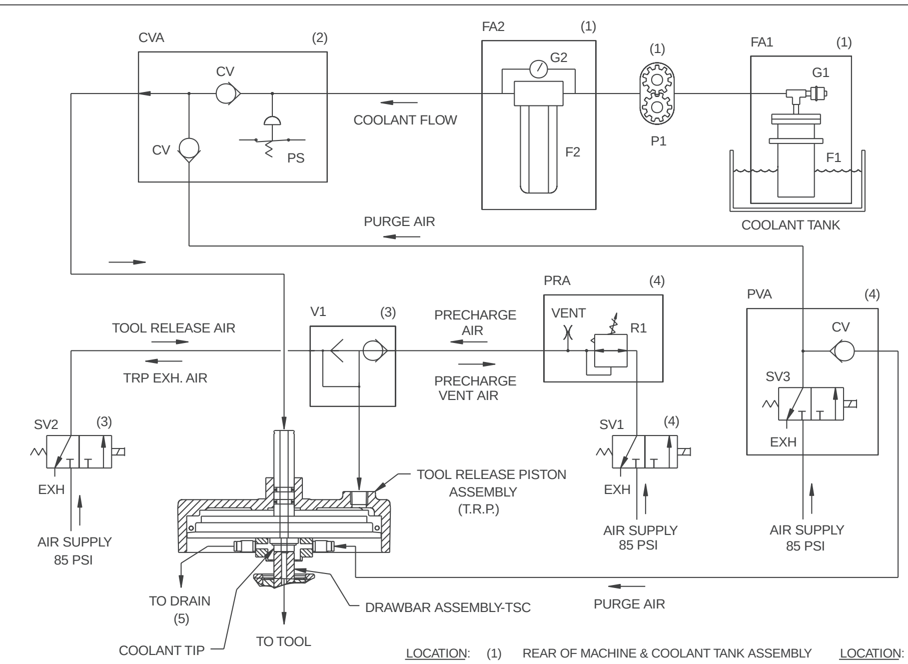
TSC SYSTEM WARNING!

THE TSC PUMP IS A PRECISION GEAR PUMP AND WILL WEAR OUT FASTER AND LOSE PRESSURE IF ABRASIVE PARTICLES ARE PRESENT IN THE COOLANT.

SHORTENED PUMP LIFE, REDUCTION OF PRESSURE AND INCREASED MAINTENANCE ARE NORMAL AND TO BE EXPECTED IN ABRASIVE ENVIRONMENTS AND ARE NOT COVERED BY WARRANTY.

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.

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 TANK IS RECOMMENDED.



CV	CHECK VALVE
CVA	CHECK VALVE ASSY - TSC
F1	INTAKE FILTER, 100 MESH
F2	TSC FILTER, 100 MICRON
FA1	INTAKE FILTER ASSEMBLY
FA2	TSC FILTER ASSEMBLY
G1	DIRT INDICATOR, INTAKE FILTER
G2	DIRT INDICATOR, 100 MICRON FILTER
P1	TSC PUMP
R1	PRECHARGE REGULATOR SET AT 3.6 - 4.4 PSI
PRA	PRECHARGE REGULATOR ASSY (30-3270A)
PS	PRESSURE SWITCH SET AT 40 PSI
PVA	PURGE VALVE ASSEMBLY (30-3276)
SV1	SOLENOID VALVE (PRECHARGE) 2 POSITION, 3 WAY, SP. RET.
SV2	SOLENOID VALVE (TOOL RELEASE) 2 POSITION, 3 WAY, SP. RET.
SV3	SOLENOID VALVE (PURGE) 2 POSITION, 3 WAY, SP. RET.
V1	SHUTTLE VALVE

THROUGH SPINDLE COOLANT SYSTEM
FLOW DIAGRAM

LOCATION: HMC

(1)	REAR OF MACHINE & COOLANT TANK ASSEMBLY
(2)	REAR SIDE OF TRANSMISSION ASSEMBLY
(3)	ON TOOL RELEASE PISTON ASSEMBLY
(4)	TOP & SIDE OF TRANSMISSION ASSEMBLY
(5)	AT REAR INSIDE OF ENCLOSURE PAN

LOCATION: VMC

(1)	REAR OF MACHINE & COOLANT TANK ASSEMBLY
(2)	SIDE OF GEAR BOX/SPINDLE MOTOR ASSEMBLY
(3)	ON TOOL RELEASE PISTON ASSEMBLY
(4)	REAR OF GEAR BOX/SPINDLE MOTOR ASSEMBLY
(5)	AT BOTTOM REAR OF SPINDLE HEAD

THROUGH SPINDLE COOLANT (TSC) WARNINGS!!

1. TSC REQUIRES TOOL HOLDER WITH THROUGH HOLE IN PULL STUD AND TOOL. FAILURE TO DO SO CAN FLOOD SPINDLE HEAD WITH COOLANT.
2. DO NOT RUN TSC WITH LOW COOLANT LEVEL IN TANK.
3. WEAR SAFETY GLASSES WHEN MANUALLY CHANGING TSC TOOLS. COOLANT CAN SPRAY OUT.

THROUGH SPINDLE COOLANT ALARMS

1. LOW THRU SPINDLE COOLANT (ALARM 151):
   CAUSE: COOLANT PRESSURE IN SYSTEM FELL BELOW 40 PSI.
   A) CHECK FOR LOW COOLANT IN TANK, B) CHECK DIRT INDICATORS ON BOTH FILTERS,
   C) PRESS RESET AND RUN TSC AGAIN TO PURGE AIR FROM SYSTEM.
2. PRE-CHARGE FAILURE (ALARM 198):
   CAUSES: TOOL RELEASE PISTON DID NOT MOVE DOWN WHEN COMMANDED OR IT MOVED UP DURING TSC OPERATION, OR ANOTHER ALARM OCCURED DURING TSC OPERATION.
   A) CHECK FOR LOW AIR SUPPLY PRESSURE, B) CHECK FOR T.R.P. FAILURE.

THROUGH SPINDLE COOLANT (TSC) MAINTENANCE SCHEDULE

1. TOP-OFF COOLANT TANK DAILY (EVERY 8 HOUR SHIFT) DURING HEAVY TSC USAGE.
2. CHECK GAGE (G2) ON 100 MICRON FILTER WITH TSC SYSTEM RUNNING AND NO TOOL IN SPINDLE. CHANGE ELEMENT WHEN THE INDICATOR REACHES THE RED ZONE. USE 100 MICRON FILTER ELEMENT (58-6045) OR COMMERCIALLY AVAILABLE EQUIVALENT.
3. CLEAN PUMP INTAKE FILTER WHEN INDICATOR (G1) IS IN RED ZONE. RESET WITH BUTTON.

SPECIAL INSTRUCTIONS: AFTER CHANGING OR CLEANING FILTER ELEMENTS, RUN TSC SYSTEM WITH NO TOOL IN SPINDLE FOR AT LEAST ONE MINUTE TO PURGE AIR.

ADJUSTABLE TSC PARAMETER: PARAMETER 237 (TSC CLNT LINE PURGE) MINIMUM (DEFAULT) VALUE IS 2500, NO MAXIMUM LIMIT.

THROUGH THE SPINDLE COOLANT SYSTEM FLOW DIAGRAM - 50 TAPER SPINDLE

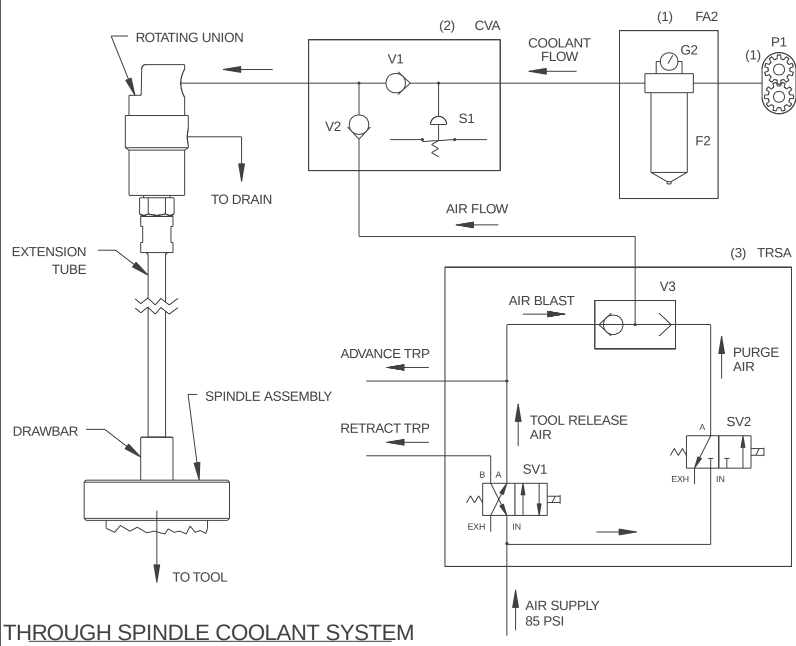
TSC SYSTEM WARNING!

THE TSC PUMP IS A PRECISION GEAR PUMP AND WILL WEAR OUT FASTER AND LOSE PRESSURE IF ABRASIVE PARTICLES ARE PRESENT IN THE COOLANT.

SHORTENED PUMP LIFE, REDUCTION OF PRESSURE AND INCREASED MAINTENANCE ARE NORMAL AND TO BE EXPECTED IN ABRASIVE ENVIRONMENTS AND ARE NOT COVERED BY WARRANTY.

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.

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 TANK IS RECOMMENDED.



CVA	CHECK VALVE ASSEMBLY (30-3275B)
F1	INTAKE FILTER ASSEMBLY 100 MESH
F2	TSC FILTER, 20 MICRON USE 20 MICRON FILTER ELEMENT
FA1	INTAKE FILTER ASSEMBLY (30-0072)
FA2	TSCHP FILTER ASSEMBLY (30-3287A)
G1	SUCTION GAGE, INTAKE FILTER
G2	FILTER GAGE, TSC FILTER
P1	TSCHP PUMP 300 PSI MAX.
TRSA	TOOL RELEASE SOLENOID ASSEMBLY (30-0066A)
S1	PRESSURE SWITCH 40 PSI
SV1	SOLENOID VALVE (TOOL RELEASE) 2 POSITION, 4 WAY, SP. RET.
SV2	SOLENOID VALVE (PURGE) 2 POSITION, 3 WAY, SP. RET.
V1	COOLANT CHECK VALVE
V2	PURGE CHECK VALVE
V3	SHUTTLE VALVE

THROUGH SPINDLE COOLANT SYSTEM
50 TAPER SPINDLE OPTION
FLOW DIAGRAM

LOCATION: (1) REAR OF MACHINE & COOLANT TANK
(2) SIDE OF SPINDLE MOTOR
(3) TOP OF SPINDLE MOTOR

THROUGH SPINDLE COOLANT (TSC) WARNINGS!!

1. TSC REQUIRES TOOL HOLDER WITH HOLE THROUGH PULL STUD AND TOOL. FAILURE TO USE PROPER TOOLING CAN DAMAGE PUMP.
2. DO NOT RUN TSC WITH LOW COOLANT LEVEL IN TANK.
3. WEAR SAFETY GLASSES WHEN MANUALLY CHANGING TSC TOOLS. COOLANT CAN SPRAY OUT!

THROUGH SPINDLE COOLANT ALARMS

1. LOW THRU SPINDLE COOLANT (ALARM 151):
   CAUSE: COOLANT PRESSURE IN SYSTEM FELL BELOW 40 PSI.
   A) CHECK FOR LOW COOLANT LEVEL IN TANK.
   B) CHECK GAGES ON BOTH FILTERS.
   C) CHECK HOSES FOR KINKS OR DAMAGE AND THAT ALL CONNECTIONS ARE TIGHT.
2. PRE-CHARGE FAILURE (ALARM 198) DOES NOT APPLY TO THIS SYSTEM.

THROUGH SPINDLE COOLANT (TSC) MAINTENANCE SCHEDULE

1. TOP OFF COOLANT TANK BEFORE EACH SHIFT DURING HEAVY TSC USAGE.
2. CHECK GAGE (G2) ON TSC FILTER WITH NO TOOL IN SPINDLE AND TSC RUNNING. CHANGE ELEMENT WHEN THE INDICATOR IS IN THE YELLOW ZONE. USE 20 MICRON FILTER ELEMENT (58-6046) OR COMMERCIALLY AVAILABLE EQUIVALENT.
3. CLEAN INTAKE FILTER WHEN SUCTION GAGE (G1) IS IN THE RED ZONE.

SPECIAL INSTRUCTIONS: AFTER CHANGING OR CLEANING FILTER ELEMENTS, RUN TSC SYSTEM WITH NO TOOL IN SPINDLE FOR AT LEAST ONE MINUTE TO PURGE AIR.

ADJUSTABLE PARAMETER: PARAMETER 237 (TSC CLNT LINE PURGE) MINIMUM (DEFAULT) VALUE IS 2500, NO MAXIMUM LIMIT.

3.17 Automatic Pallet changer (APC)

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.

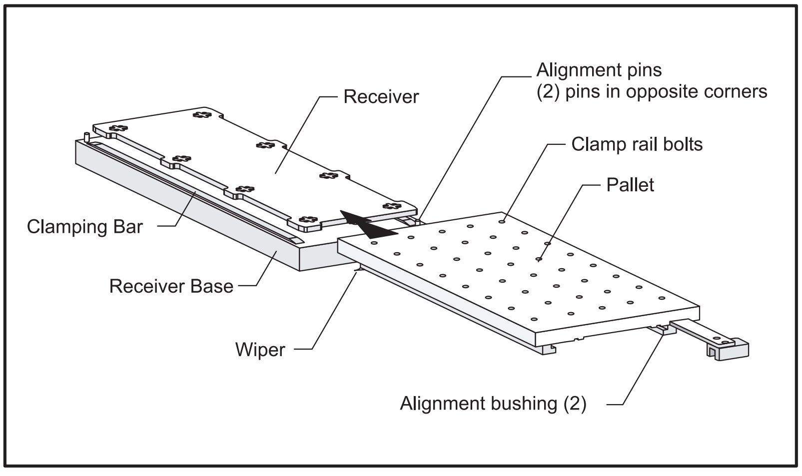


Figure 3.17-1 Pallet Replacement

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.

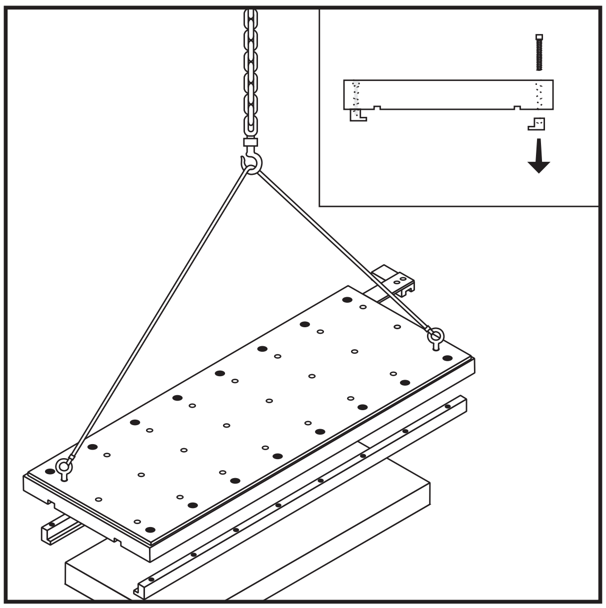


Figure 3.17-2

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.

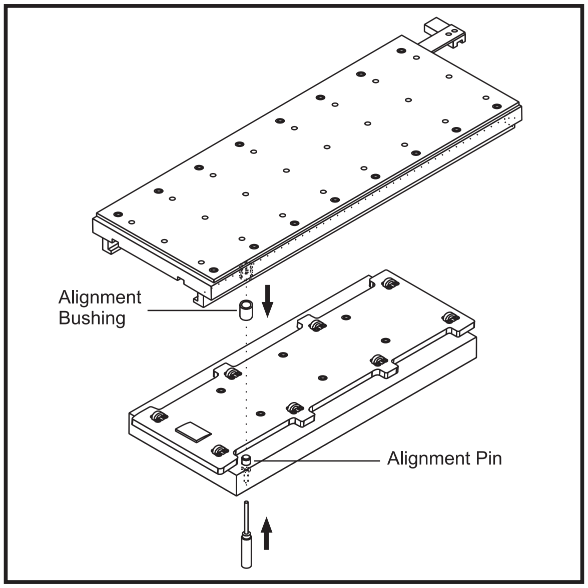


Figure 3.17-3 Alignment Pin Removal

3. Remove the six (6) receiver mounting bolts.
4. Use a hoist and the two eyebolts supplied with the APC, lift the receiver off the table.
5. Use a punch to remove the alignment pins.
6. 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.
7. Position the receiver back onto the table.
8. Install the six mounting bolts.

9. Reconnect the air to the machine.

10. 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.

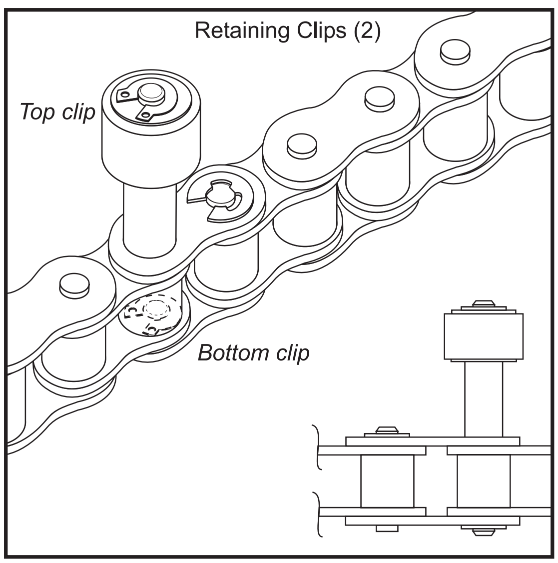


Figure 3.17-4 Drive Pin Assembly

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.

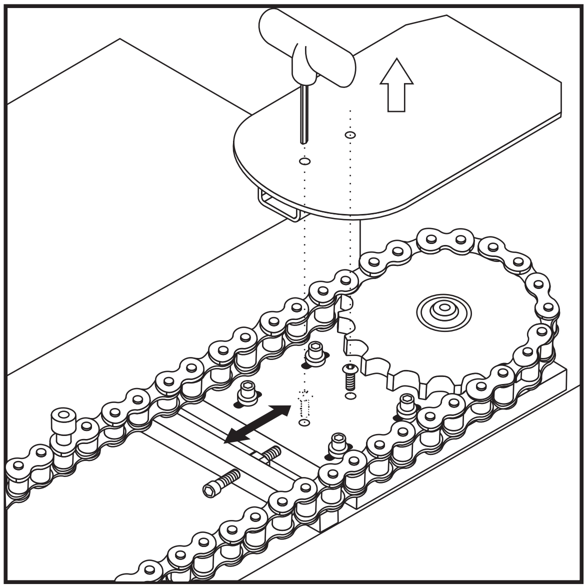
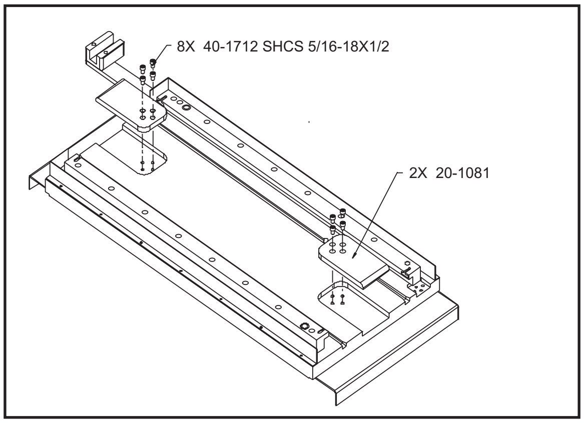


Figure 3.17-5 Loosening Chain Sprocket

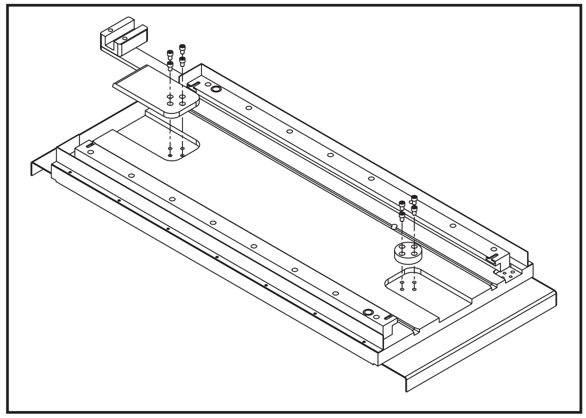
6. Loosen the 4 bolts that mount the sprocket bracket to the casting.
7. Loosen the chain sprocket tensioner screw slightly.
8. At this point there should be enough slack in the chain to slide the drive pin out.
9. Re-assemble the drive pin assembly according to the assembly drawing.
10. Re-tension the chain in the reverse order.

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)



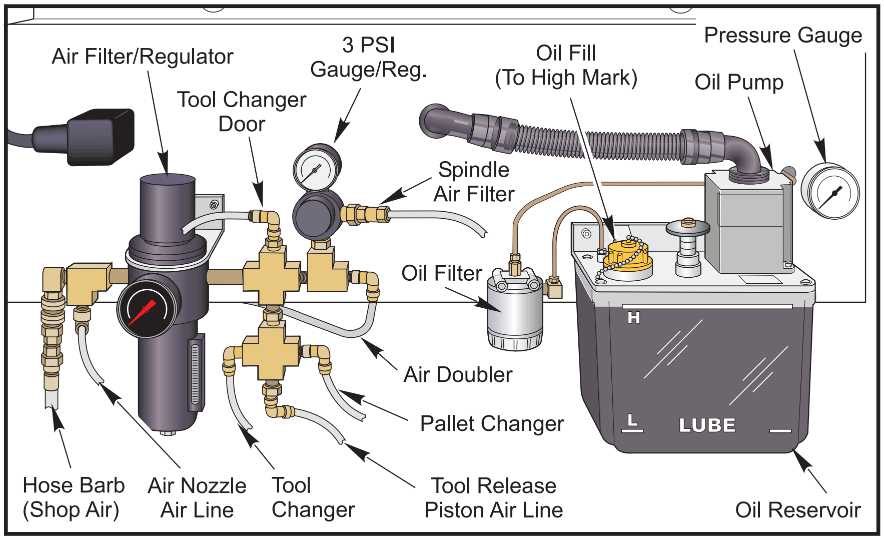
Pallet Part number 20-0053a (metric 20-0579a)

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.

Air Lubrication Panel



Lube Air Panel

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.

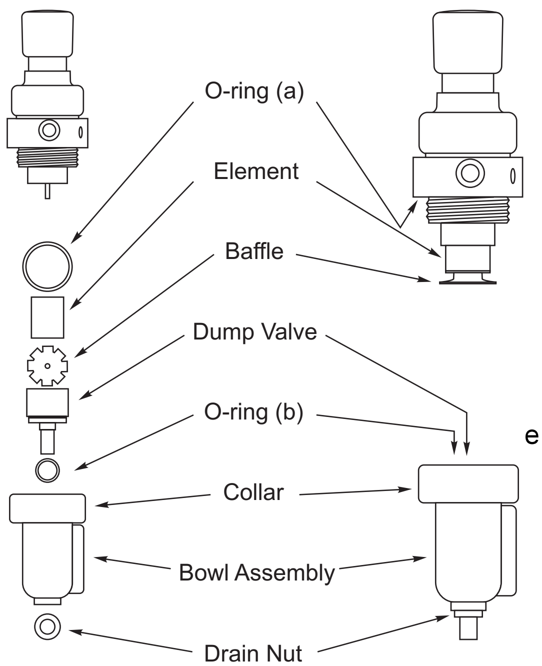
c. After cleaning the Bowl Assembly reassemble the Dump Valve in the Bowl Assembly. Care should be taken so as not to pinch the O-ring (b). Do not over tighten the plastic Drain Nut.

4. Install the New Element.

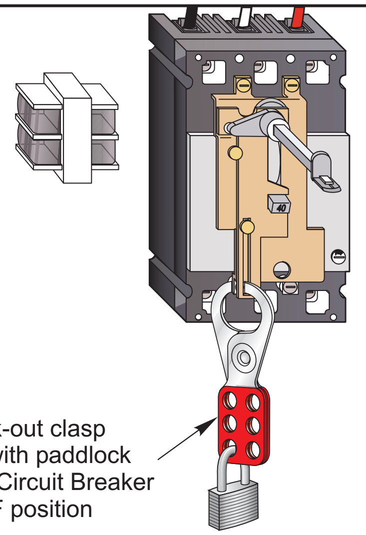
5. Attach the Baffle and finger tighten firmly.

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.



4. ELECTRICAL SERVICE



Make sure the circuit breaker is locked in the off position before attemting 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".

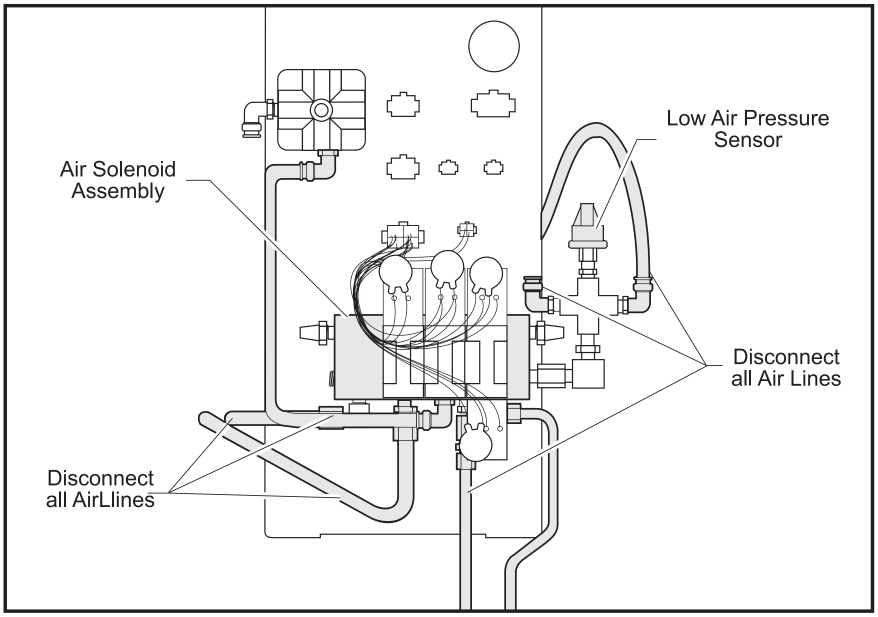


Figure 4.1-1 Air solenoid assembly.

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.

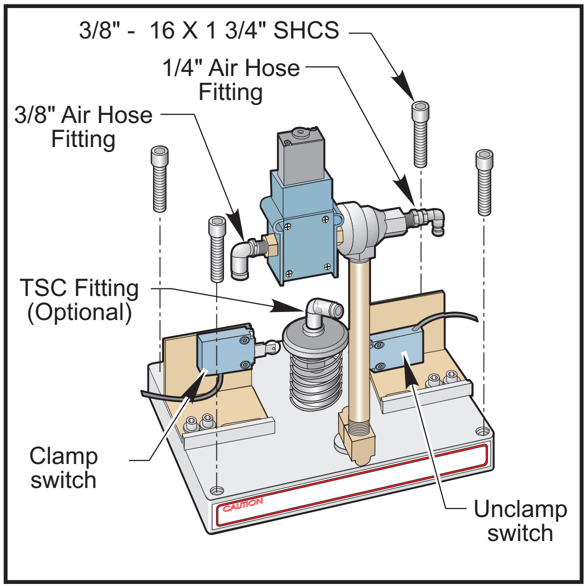


Figure 4.2-2 Tool release piston assembly with air solenoid assembly.

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.

Spindle Lube Air Solenoid

1. Turn the machine power off and remove the air supply from the machine.

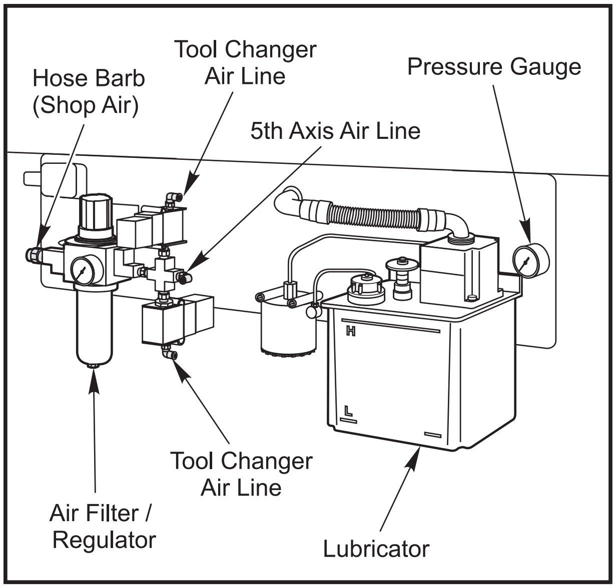


Figure 4.1-3 Front side of lube/air panel.

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.

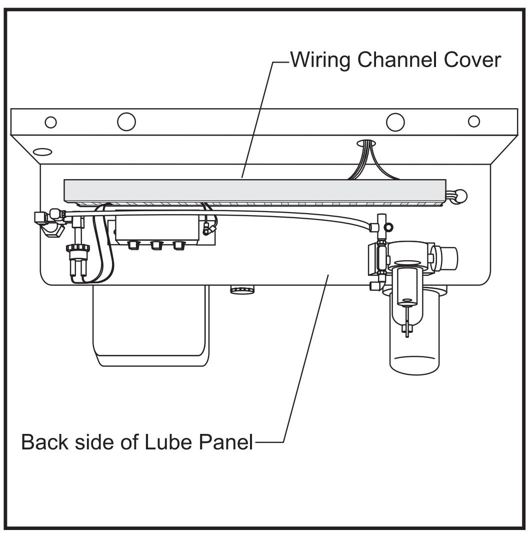


Figure 4.1-4 Top view of spindle lube/air solenoid assembly.

4. Unscrew the assembly from the T-fitting.

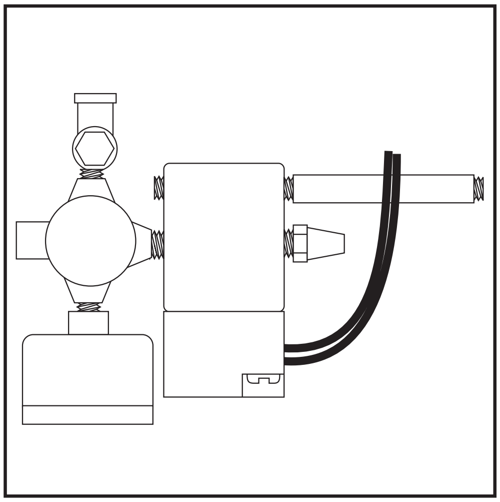


Figure 4.1-5 Top view of spindle lube/air solenoid assembly.

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.

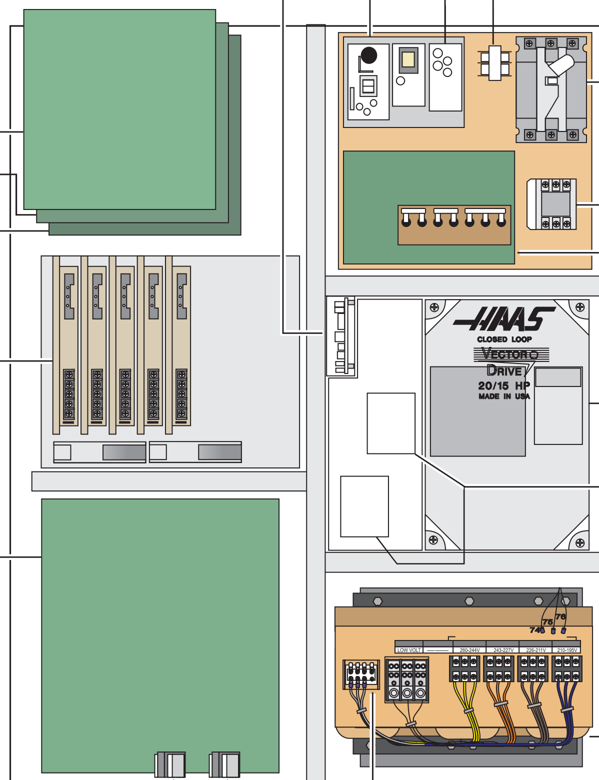


Figure 4.2-1 Control cabinet general overview.

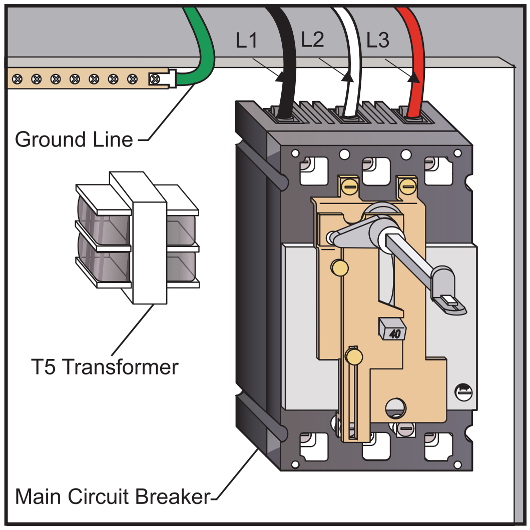
Electrical Connections

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.

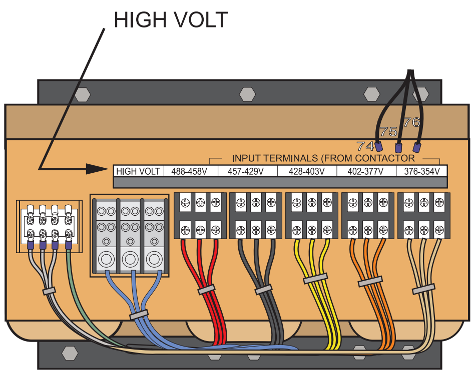
2. After the line voltage is connected to the machine, make sure that main circuit breaker (at top-right of rear cabinet) is OFF (rotate the shaft that connects to the breaker counterclockwise until it snaps OFF). Turn ON the power at the source. Using an accurate digital voltmeter and appropriate safety 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).

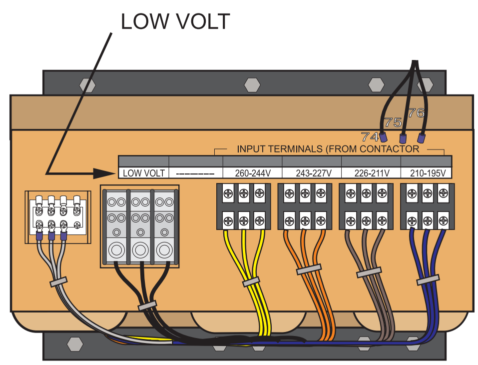
NOTE: Wide voltage fluctuations are common in many industrial areas; you need to know the minimum and maximum voltage which will be supplied to the machine while it is in operation. U.S. National Electrical Code specifies that machines should operate with a variation of +5% to -5% around an average supply 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.

---

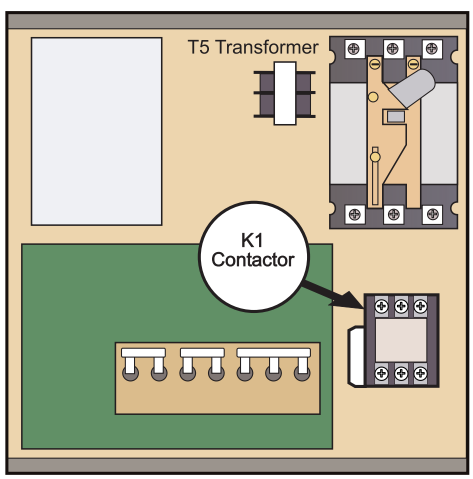
3. Check the connections on the transformer at the bottom-right corner of the rear cabinet. The three black wires labeled **74, 75,** and **76** must be moved to the terminal block triple which corresponds to the average voltage measured in **step 2** above. There are four positions for the input power 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.



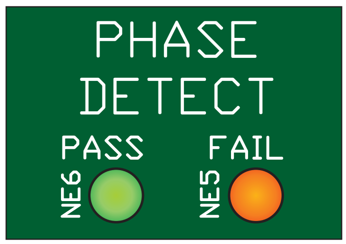
WARNING!

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.

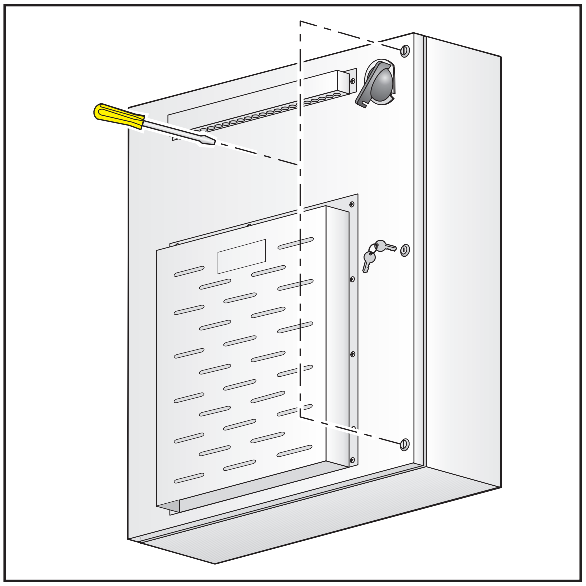


Figure 4.3-1. Unscrew the three screws to open the cabinet door. (Control cabinets may require a key)

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).

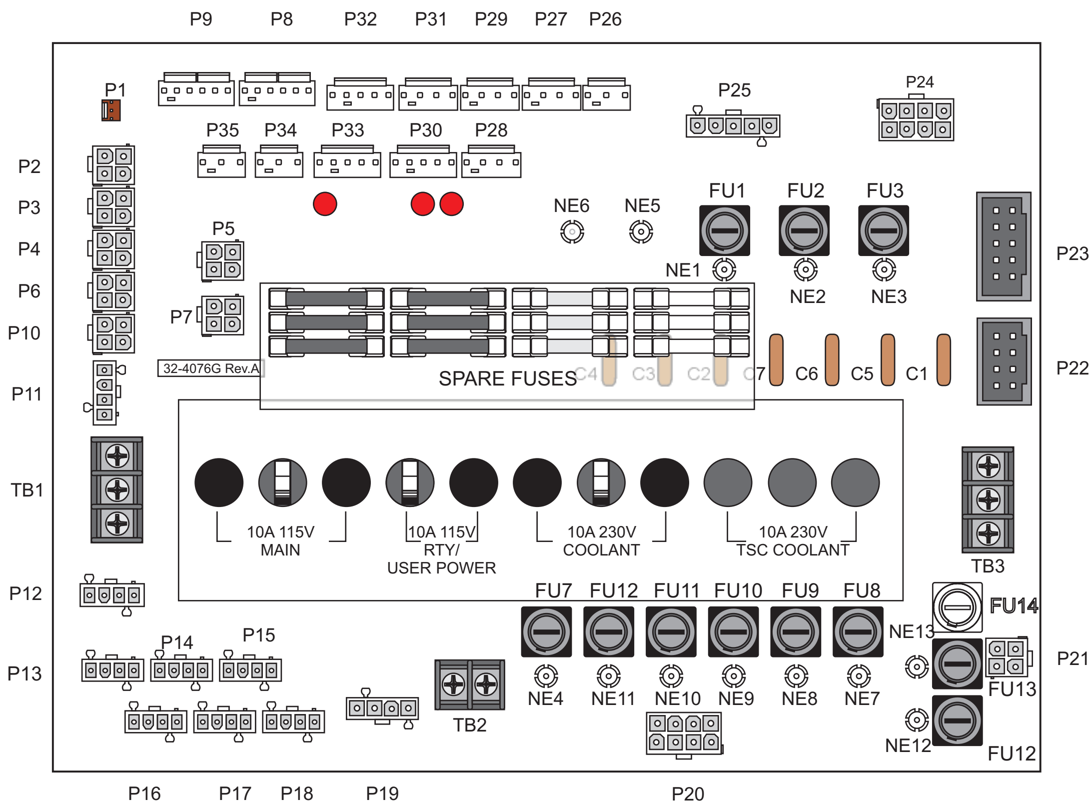


Figure 4.3-2 Power supply board; fuse locations.

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 260 volts.

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).

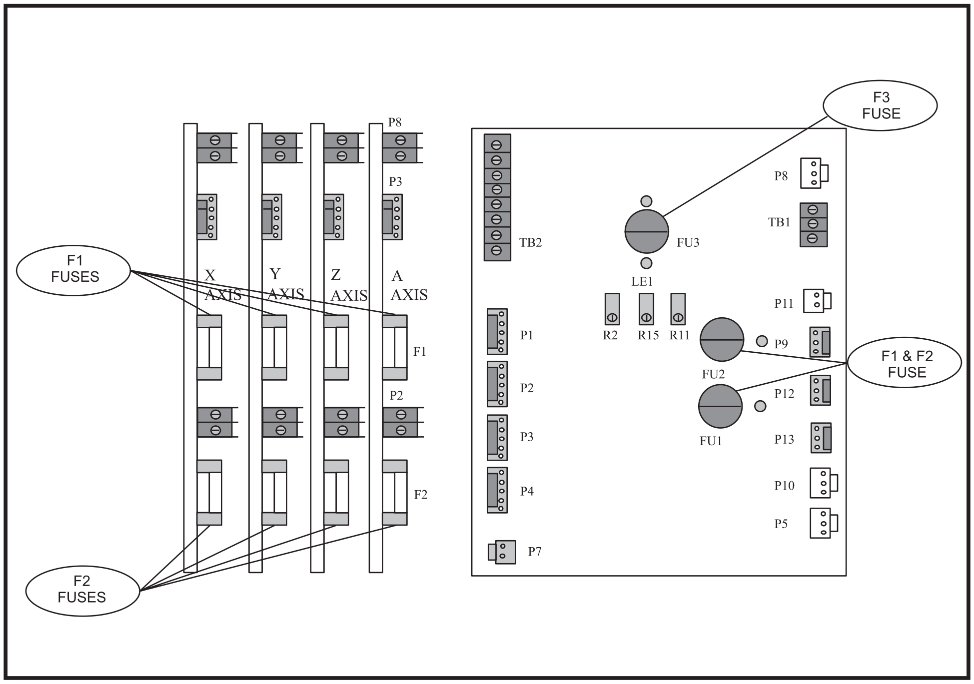


Figure 4.3-3 Servo Drive Assembly; fuse locations

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 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.

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 need 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.

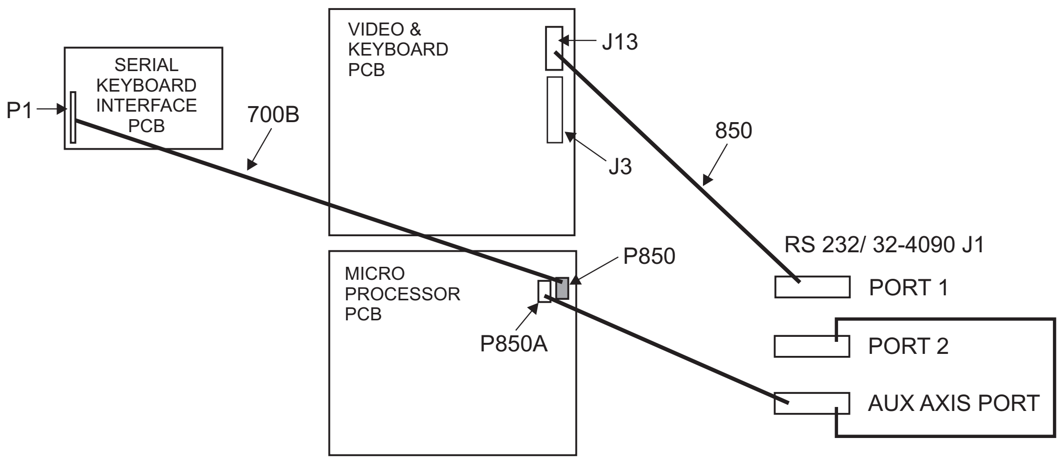
1. Follow all precautions noted previously before working in the electrical cabinet (See warning at beginning of "Servo Driver" section).

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.

Also, disconnect both shield connections on the RS-232 ribbon cables. One connection is at the red-box to the chassis, the second connection is at the processor stack with the shields for the active circuitry.

These two adjustments make a very big difference in the signals and will minimize and possibly eliminate RS-232 communications problems.

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. 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.

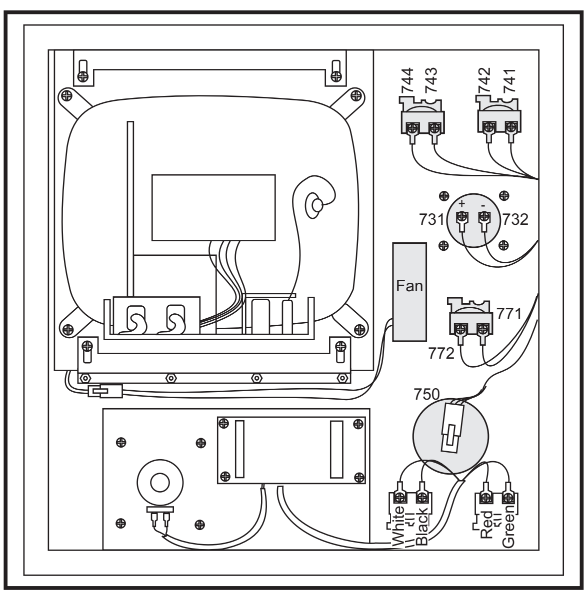


Figure 4.5-1 Interior of control panel (rear).

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.

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.

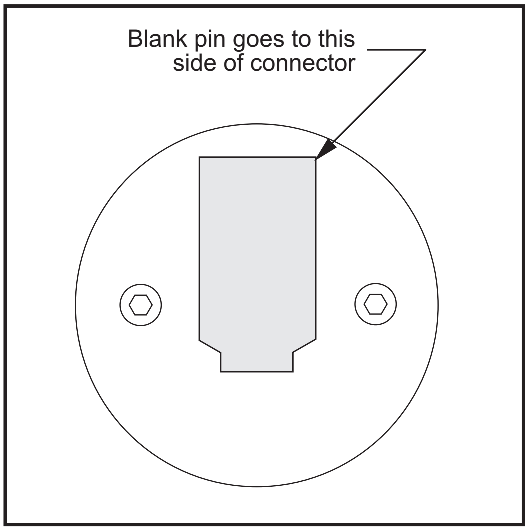


Figure 4.5-2 Jog handle encoder.

4. Using a 5/64" allen wrench, loosen the two screws holding the knob to the control panel and remove.

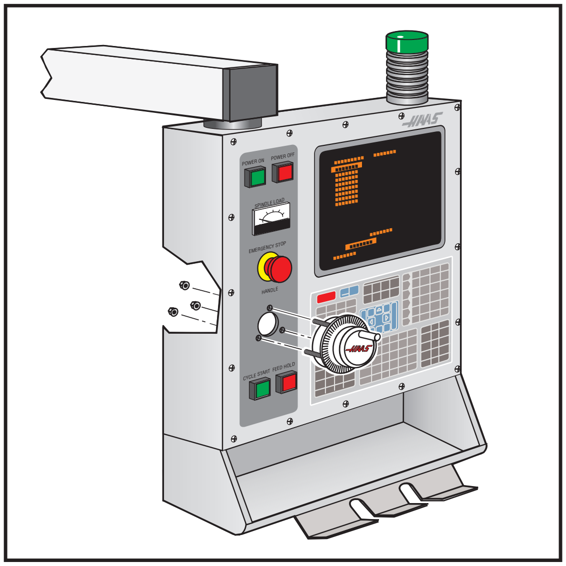


Figure 4.5-3 Jog Handle removal

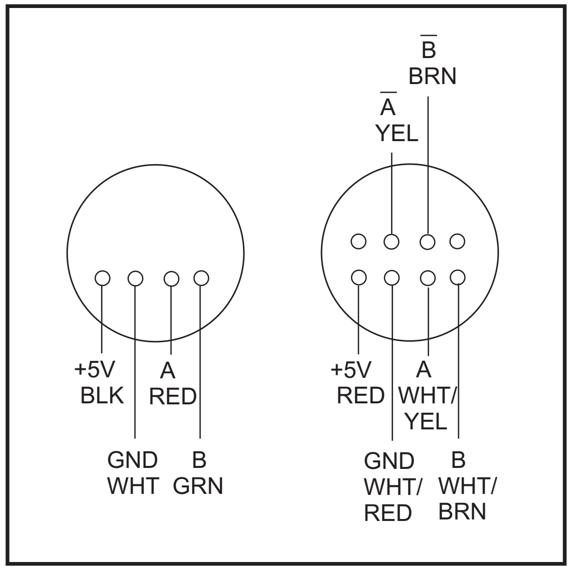


Figure 4.5-4. Jog Handle wiring diagram

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.

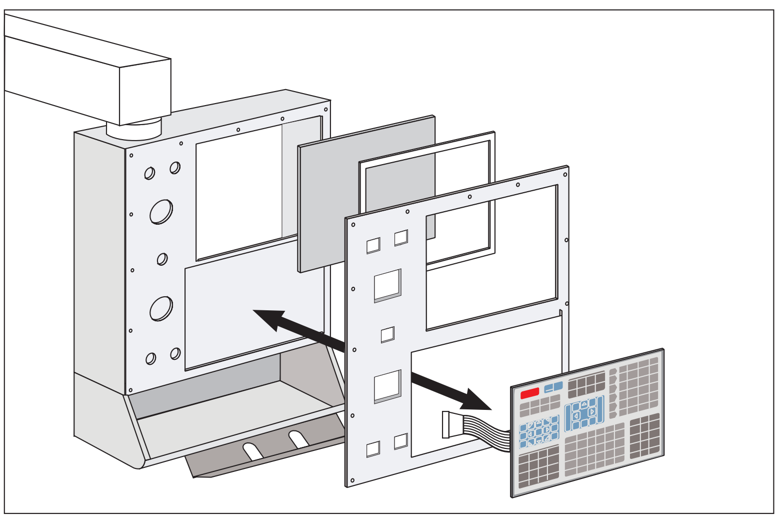


Figure 4.5-5. Keypad installation.

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 5; 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.

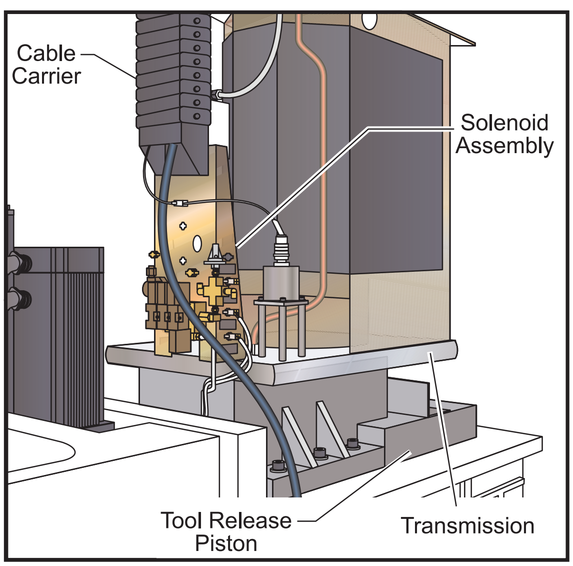


Figure 4.6-1 Spindle encoder installation (VF-1/VF-2).

5. 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.

6. Unscrew the four screws and remove the cover panel on the box at the base of the flexible tube.

7. Feed the encoder cable through the flexible tube and connect at the plug in the box on top of the electrical cabinet.

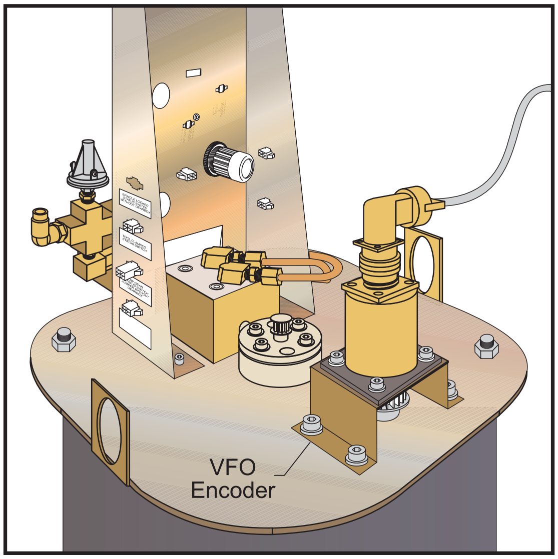


Figure 4.6-2 Encoder installation for direct drive machines

8. 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.

9. 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 (VF-0/E/0E) 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.

Spindle Orientation Sequence

When spindle orientation is commanded, the following sequence of operations occurs:

1) If the spindle is turning, it is commanded to stop,
2) Pause until spindle is stopped,
3) Spindle orientation speed is commanded forward,
4) Pause until spindle is at orientation speed,
5) Spindle encoder rotates past a reference mark,
6) The spindle drive stops and holds the spindle position at a parameter distance from the reference mark,
7) Command spindle lock air solenoid active,
8) Pause until spindle locked status is active and stable,
9) If not locked after time-out time, alarm and stop.

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.

Spindle Air Pressure

Verify Spindle air pressure using the gauge located behind the Air Regulator panel. VF machines should show 17 psi. Adjust if necessary (see Air Connection in the Installation section). VF machines equipped with a 15K spindle, must have the regulator set to 20 psi.

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.

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.

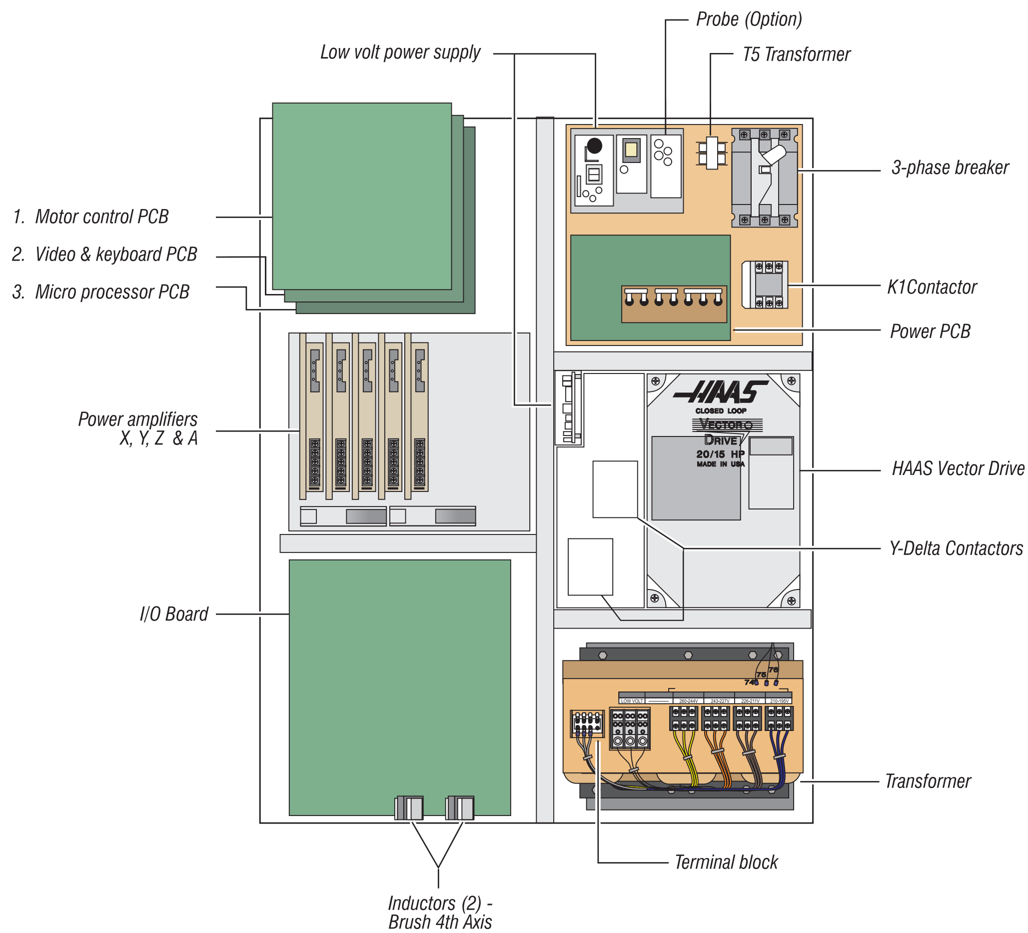
To select A or B axis when in the jog mode, use the shift key on the keyboard then select A or B axis.

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.

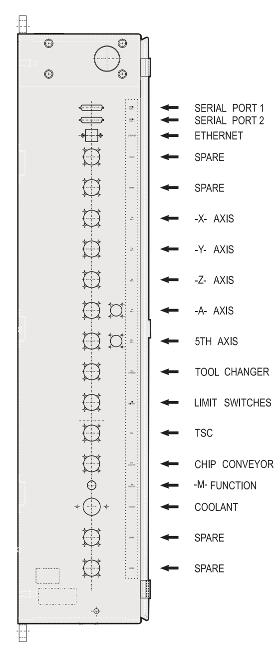
The rule of thumb is that for every .001” out of position, you **add or subtract** 100 from the appropriate parameter. This will re-calibrate the distance from the A/B axes home switch. Parameters 212 and 213 are the tool change offset parameters for the A and B-axis. These parameters also control the 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 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 printer 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. The VF-0/E/0E does not have a gearbox and is air-cooled.

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 keyboard 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; between 1MB and 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:

+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.

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.

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.

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.

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.

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.

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.

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 microprocessor 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.

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. This resistor is overtemp protected at 100^0 C. At that temperature, an alarm is generated and the control will begin an automatic shutdown. 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)

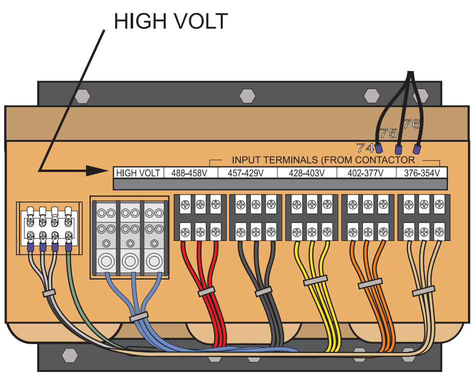
The low voltage control transformer, T5, supplies power to the coil of the main contactor K1. It guarantees that the maximum voltage leaving the Power Supply assembly when power is off is 12V AC to earth ground. It is connected via P5 to the POWER PCB.

5.13 Power Transformer Assembly (T1)

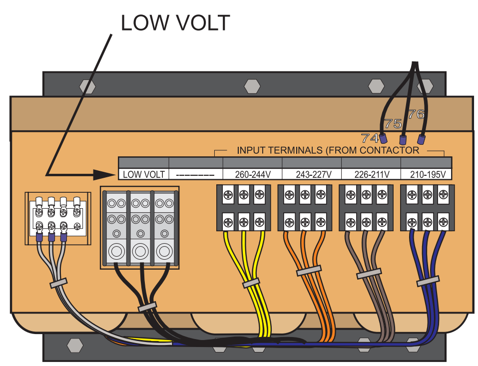
The power transformer assembly is used to convert three-phase input power (50/60Hz) to three phase 230V and 115V power. Two different transformers are used depending on the input voltage range. The low voltage transformer has four different input connections to allow for a range of voltages from 195 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. This will only happen if there is a failure of the amplifier card. **The user should never attempt to replace these fuses.**

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). FU7-12 are ultra fast 20A fuses. They will only blow in the case of a cable short for either the TSC or coolant pump. Spare fuses for the power card are located above the breakers on the spare fuse PCB.

SIZE	FUSE NAME	TYPE	RATING (amps)	VOLTAGE	LOCATION
5mm	FU1	Slo-Blo	½	250V	PSUP pcb, upper right
5mm	FU2	AGC	½	250V	" "
5mm	FU3	AGC	½	250V	" "
1/4	FU1	Ultra fast	10	250V	I/O PCB
1/4	F1	Ultra fast	15	250V	Amplifier (X,Y,Z,A,B)
5mm	FU4,5	Fast blow	5A	250V	PSUP, bottom right corner
1/4	FU7-12	Ultra fast	20A	250V	PSUP, bottom

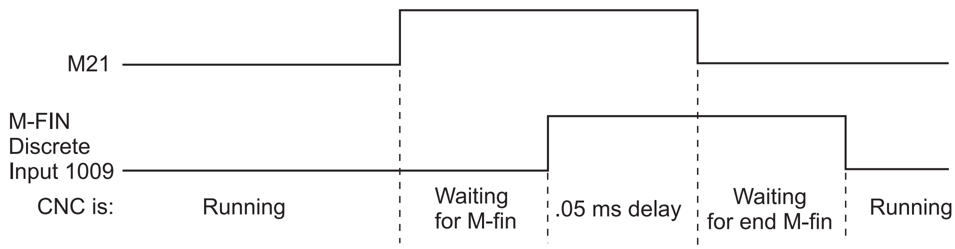
FU2 on the IOPCB is a spare.

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:



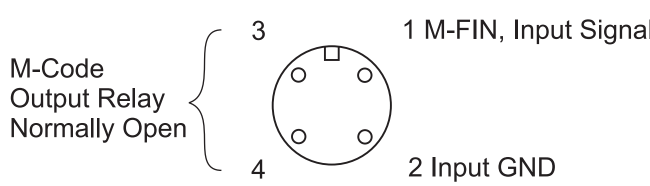
The Diagnostic Data display page may be used to observe the state of these signals.

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.

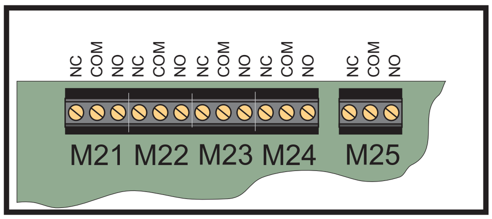
NOTE: Refer to the Diagnostic section in the manual for specific machine Inputs and Outputs.

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 lead 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° 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 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. 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 SMTC Pocket Down	1023	Spare 3 APC Pin Clr #2
1001	TC Changer Out SMTC Pocket Up	1024	Tool Unclmp Rmt*
		1025	Low Phasing 115V
1002	Tool One In Pos.	1026	Spare 3A APC Pal #2 Home
1003	Low TSC Pressure		
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* APC: APC Pal Clamp	1032	Spare 4A
		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 APC Door	1045	Spare 10B
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	1122	Brake 5TH Axis
1104	Brake 4th Axis	1123	CE Door Lock
1105	Coolant Pump On	1124	M21
1106	Auto Power Off	1125	M22
1107	Spind. Motor Fan	1126	M23 (Air Drive Shuttle: Move Shuttle Out)
1108	Move T.C. In APC Chain Dr Fwd	1127	TSC Coolant
1109	Move T.C. Out APC Chain Dr Rev	1128	Green Beacon On
1110	Rotate T.C. CW	1129	Red Beacon On
1111	Rotate T.C. CCW	1130	Enable Conveyor
1112	Spindle Hi Gear	1131	Reverse Conveyor
1113	Spindle Low Gear	1132	M-fin
1114	Unclamp Tool	1133	Probe
1115	Spare	1134	spare
1116	Move Spigot CW	1135	spare
1117	Move Spigot CCW	1136	spare
1118	Pal Ready Light	1137	spare
		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, lead 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

Parameter 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	ROT ALM LMSW	Rotary alarms at the limit switch.
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

Parameter 2 X P GAIN
Proportional gain in servo loop.

Parameter 3 X D GAIN
Derivative gain in servo loop.

Parameter 4 X I GAIN
Integral gain in servo loop.

Parameter 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)

Parameter 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

Parameter 7 X ACCELERATION
Maximum acceleration of axis in steps per second per second.

Parameter 8 X MAX SPEED
Max speed for this axis in steps per second.

Parameter 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.

Parameter 10 X FUSE LEVEL
Used to limit average power to motor. If not set correctly, this parameter can cause an “overload” alarm.

Parameter 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. However, when an axis with the brake has been disabled, the brake must not be released at all. This feature takes care of that situation. Normally, this parameter should be set to zero on all axes. Exceptions are:
Mini-mills with the axis brake instead of a counterbalance, parameter 39 Z axis TORQUE PRELOAD must be set to 300. The TORQUE PRELOAD parameter for the remaining axes must be set to zero.
Vertical mills with the axis brake instead of a counterbalance, parameter 39 Z axis TORQUE PRELOAD must be set to 600. The TORQUE PRELOAD parameter for the remaining axes must be set to zero.
Horizontal mills with the axis brake instead of a counterbalance, parameter 25 Y axis TORQUE PRELOAD must be set to 500. The TORQUE PRELOAD parameter for the remaining axes must be set to zero.

Parameter 12 X STEPS/REVOLUTION
Encoder steps per revolution of motor. Thus, an 8192 line encoder gives:

8192 x 4 = 32768

Parameter 13 X BACKLASH
Backlash correction in encoder steps.

Parameter 14 X DEAD ZONE
Dead zone correction for driver electronics. Units are 0.0000001 seconds.

Parameter 15 Y SWITCHES
See Parameter 1 for description.

Parameter 16 Y P GAIN
See Parameter 2 for description.

Parameter 17 Y D GAIN
See Parameter 3 for description.

Parameter 18 Y I GAIN
See Parameter 4 for description.

Parameter 19 Y RATIO (STEPS/UNIT)
See Parameter 5 for description.

Parameter 20 Y MAX TRAVEL (STEPS)
See Parameter 6 for description.

Parameter 21 Y ACCELERATION
See Parameter 7 for description.

Parameter 22 Y MAX SPEED
See Parameter 8 for description.

Parameter 23 Y MAX ERROR
See Parameter 9 for description.

Parameter 24 Y FUSE LEVEL
See Parameter 10 for description.

Parameter 25 Y TORQUE PRELOAD
See Parameter 11 for description.

Parameter 26 Y STEPS/REVOLUTION
See Parameter 12 for description.

Parameter 27 Y BACKLASH
See Parameter 13 for description.

Parameter 28 Y DEAD ZONE
See Parameter 14 for description.

Parameter 29 Z SWITCHES
See Parameter 1 for description.

Parameter 30 Z P GAIN
See Parameter 2 for description.

Parameter 31 Z D GAIN
See Parameter 3 for description.

Parameter 32 Z I GAIN
See Parameter 4 for description.

Parameter 33 Z RATIO (STEPS/UNIT)
See Parameter 5 for description.

Parameter 34 Z MAX TRAVEL (STEPS)
See Parameter 6 for description.

Parameter 35 Z ACCELERATION
See Parameter 7 for description.

Parameter 36 Z MAX SPEED
See Parameter 8 for description.

Parameter 37 Z MAX ERROR
See Parameter 9 for description.

Parameter 38 Z FUSE LEVEL
See Parameter 10 for description.

Parameter 39 Z TORQUE PRELOAD
See Parameter 11 for description.

Parameter 40 Z STEPS/REVOLUTION
See Parameter 12 for description.

Parameter 41 Z BACKLASH
See Parameter 13 for description.

Parameter 42 Z DEAD ZONE
See Parameter 14 for description.

Parameter 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.

Parameter 44 A P GAIN
See Parameter 2 for description.

Parameter 45 A D GAIN
See Parameter 3 for description.

Parameter 46 A I GAIN
See Parameter 4 for description.

Parameter 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

Parameter 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.

Parameter 49 A ACCELERATION
See Parameter 7 for description.

Parameter 50 A MAX SPEED
See Parameter 8 for description.

Parameter 51 A MAX ERROR
See Parameter 9 for description.

Parameter 52 A FUSE LEVEL
See Parameter 10 for description.

Parameter 53 A BACK EMF
See Parameter 11 for description.

Parameter 54 A STEPS/REVOLUTION
See Parameter 12 for description

Parameter 55 A BACKLASH
See Parameter 13 for description.

Parameter 56 A DEAD ZONE
See Parameter 14 for description.

Parameters 57 through 128 are used to control other machine dependent functions. They are:

Parameter 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	REV CRANK	Reverses direction of jog handle.
1	DISABLE T.C.	Disables tool changer operations.
2	DISABLE G.B.	Disables gear box functions.
3	POF AT E-STP	Stops spindle then turns the power off at EMERGENCY STOP
4	RIGID TAP	Indicates hardware option for rigid tap.
5	REV SPIN ENC	Reverses sense direction of spindle encoder.
6	REPT RIG TAP	Selects repeatable rigid tapping.
7	EX ST MD CHG	Selects exact stop in moves when mode changes.
8	SAFETY CIRC.	This enables safety hardware, if machine is so equipped.
9	SP DR LIN AC	Selects linear deceleration for rigid tapping. 0 is quadratic.
10	PH LOSS DET	When enabled, will detect a phase loss.
11	COOLANT SPGT	Enables coolant spigot control and display.
12	OVER T IS NC	Selects Regen over temp sensor as N.C.
13	SKIP OVERSHT	Causes Skip (G31) to act like Fanuc and overshoot sense point.
14	NONINV SP ST	Non-inverted spindle stopped status.
15	SP LOAD MONI	Spindle load monitor option is enabled.
16	SP TEMP MONI	Spindle temperature monitor option is enabled.
17	ENA ROT & SC	Enables rotation and scaling.
18	ENABLE DNC	Enables DNC selection from MDI.
19	ENABLE BGEDT	Enables BACKGROUND EDIT mode.
20	ENA GRND FLT	Enables ground fault detector.

21	M19 SPND ORT	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 of all new machines. 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 CURSR	Enable use of jog handle to move cursor.
25	NEG WORK OFS	Selects use of work offsets in negative direction.
26	TRANS OIL	Enables transmission low oil pressure detection.
27	ENA QUIKCODE	Enables conversational programming.
28	OILER ON/OFF	Enables oiler power when servos or spindle is in motion.
29	NC OVER VOLT	Inverts sense of over voltage signal.
30	SP MOTOR ENC	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 SP	Enables functions to stop spindle and manual operations at door switch.

Parameter 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.

Parameter 59 MAXIMUM FEED

Maximum feed rate in inches per minute.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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

On Horizontal mills, this parameter is not used. It should be set to zero.

Parameter 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.

Parameter 66 SPINDLE ORI DELAY
Maximum delay allowed when orienting spindle. Units are milliseconds. After this time, an alarm is generated.

Parameter 67 GEAR CHANGE DELAY
Maximum delay allowed when changing gears. Units are milliseconds. After this time, an alarm is generated.

Parameter 68 DRAW BAR MAX DELAY
Maximum delay allowed when clamping and unclamping tool. Units are milliseconds. After this, time an alarm is generated.

Parameter 69 A AIR BRAKE DELAY
Delay provided for air to release from brake on A-axis prior to moving. Units are milliseconds.

Parameter 70 MIN SPIN DELAY TIME
Minimum delay time in program after commanding new spindle speed and before proceeding. Units are milliseconds.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 75 GEAR CHANGE SPEED
Command speed used to rotate spindle motor when changing gears. Units are maximum spindle RPM divided by 4096.

Parameter 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.

Parameter 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.

Parameter 78 GEAR CH REV TIME
Time in milliseconds before motor direction is reversed while in a gear change.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 82 M MACRO CALL O9001
See parameter 81 for description

Parameter 83 M MACRO CALL O9002
See parameter 81 for description

Parameter 84 M MACRO CALL O9003
See parameter 81 for description

Parameter 85 M MACRO CALL O9004
See parameter 81 for description

Parameter 86 M MACRO CALL O9005
See parameter 81 for description

Parameter 87 M MACRO CALL O9006
See parameter 81 for description

Parameter 88 M MACRO CALL O9007
See parameter 81 for description

Parameter 89 M MACRO CALL O9008
See parameter 81 for description

Parameter 90 M MACRO CALL O9009
See parameter 81 for description

Parameter 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.

Parameter 92 G MACRO CALL O9011
See parameter 91 for description

Parameter 93 G MACRO CALL O9012
See parameter 91 for description

Parameter 94 G MACRO CALL O9013
See parameter 91 for description

Parameter 95 G MACRO CALL O9014
See parameter 91 for description

Parameter 96 G MACRO CALL O9015
See parameter 91 for description

Parameter 97 G MACRO CALL O9016
See parameter 91 for description

Parameter 98 G MACRO CALL O9017
See parameter 91 for description

Parameter 99 G MACRO CALL O9018
See parameter 91 for description

Parameter 100 G MACRO CALL O9019
See parameter 91 for description

Parameter 101 IN POSITION LIMIT X
How close motor must be to endpoint before any move is considered complete when not in exact stop (G09 or G61). Units are encoder steps. This parameter does not apply to feeds.

Parameter 102 IN POSITION LIMIT Y
See Parameter 101 for description

Parameter 103 IN POSITION LIMIT Z
See Parameter 101 for description

Parameter 104 IN POSITION LIMIT A
See Parameter 101 for description

Parameter 105 X MAX CURRENT
Fuse level in % of max power to motor. Applies only when motor is stopped.

Parameter 106 Y MAX CURRENT
See Parameter 105 for description

Parameter 107 Z MAX CURRENT
See Parameter 105 for description

Parameter 108 A MAX CURRENT
See Parameter 105 for description

Parameter 109 D*D GAIN FOR X
Second derivative gain in servo loop.

Parameter 110 D*D GAIN FOR Y
Second derivative gain in servo loop.

Parameter 111 D*D GAIN FOR Z
Second derivative gain in servo loop.

Parameter 112 D*D GAIN FOR A
Second derivative gain in servo loop.

Parameter 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.

Parameter 114 Y ACC/DEC T CONST
See Parameter 113 for description

Parameter 115 Z ACC/DEC T CONST
See Parameter 113 for description

Parameter 116 A ACC/DEC T CONST
See Parameter 113 for description

Parameter 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.

Parameter 118 SPINDLE REV TIME
Time in milliseconds to reverse spindle motor.

Parameter 119 SPINDLE DECEL DELAY
Time in milliseconds to decelerate spindle motor.

Parameter 120 SPINDLE ACC/DECEL
Accel/decel time constant in 200ths of a step/ms/ms for spindle motor.

Parameter 121 X PHASE OFFSET
The motor phase offset for **X** motor. This is arbitrary units.

Parameter 122 Y PHASE OFFSET
See Parameter 121 for description.

Parameter 123 Z PHASE OFFSET
See Parameter 121 for description.

Parameter 124 A PHASE OFFSET
See Parameter 121 for description.

Parameter 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.

Parameter 126 Y GRID OFFSET
See Parameter 125 for description.

Parameter 127 Z GRID OFFSET
See Parameter 125 for description.

Parameter 128 A GRID OFFSET
See Parameter 125 for description.

Parameter 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.

Parameter 130 GEAR STROKE DELAY
This parameter controls the delay time to the gear change solenoids when performing a gear change.

Parameter 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.

Parameter 132 Y SCREW COMP. COEF.
This is the coefficient of heating of the lead screw and is used to decrease or shorten the screw length.

Parameter 133 Z SCREW COMP. COEF.
This is the coefficient of heating of the lead screw and is used to decrease or shorten the screw length.

Parameter 134 X EXACT STOP DIST.

Parameter 135 Y EXACT STOP DIST.

Parameter 136 Z EXACT STOP DIST.

Parameter 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.

Parameter 138 X FRICTION COMPENSATION

Parameter 139 Y FRICTION COMPENSATION

Parameter 140 Z FRICTION COMPENSATION

Parameter 141 A FRICTION COMPENSATION
These parameters compensate for friction on each of the four axes. The units are in 0.004V.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 145 X ACCEL FEED FORWARD

Parameter 146 Y ACCEL FEED FORWARD

Parameter 147 Z ACCEL FEED FORWARD

Parameter 148 A ACCEL FEED FORWARD
These parameters set the feed forward gain for the axis servo. They have no units.

Parameter 149 Precharge DELAY
This parameter sets the delay time from precharge to tool release. Units are milliseconds.

Parameter 150 MAX SP RPM LOW GEAR
Max spindle RPM in low gear.

Parameter 151 B SWITCHES
See Parameter 1 for description.

Parameter 152 B P GAIN
See Parameter 2 for description.

Parameter 153 B D GAIN
See Parameter 3 for description.

Parameter 154 B I GAIN
See Parameter 4 for description.

Parameter 155 B RATIO (STEPS/UNIT)
See Parameter 47 for description.

Parameter 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.

Parameter 157 B ACCELERATION
See Parameter 7 for description.

Parameter 158 B MAX SPEED
See Parameter 8 for description.

Parameter 159 B MAX ERROR
See Parameter 9 for description.

Parameter 160 B FUSE LEVEL
See Parameter 10 for description.

Parameter 161 B BACK EMF
See Parameter 11 for description.

Parameter 162 B STEPS/REVOLUTION
See Parameter 12 for description.

Parameter 163 B BACKLASH
See Parameter 13 for description.

Parameter 164 B DEAD ZONE
See Parameter 14 for description.

Parameter 165 IN POSITION LIMIT B
Same definition as Parameter 101.

Parameter 166 B MAX CURRENT
Same definition as Parameter 105.

Parameter 167 D*D GAIN FOR B
Second derivative gain in servo loop.

Parameter 168 B ACC/DEC T CONST
Same definition as Parameter 113.

Parameter 169 B PHASE OFFSET
See Parameter 121 for description.

Parameter 170 B GRID OFFSET
See Parameter 125 for description.

Parameter 171 B EXACT STOP DIST.
See Parameters 134 for description.

Parameter 172 B FRICTION COMPENSATION
See Parameter 138 for description.

Parameter 173 B ACCEL FEED FORWARD
Same description as Parameter 145.

Parameter 174 B SCREW COMP. COEF.
This is the coefficient of heating of the lead screw and is used to decrease or shorten the screw length.

Parameter 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.

Parameter 176 C SWITCHES
See Parameter 1 for description.

Parameter 177 C P GAIN
See Parameter 2 for description.

Parameter 178 C D GAIN
See Parameter 3 for description.

Parameter 179 C I GAIN
See Parameter 4 for description.

Parameter 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).

Parameter 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).

Parameter 182 C ACCELERATION
Maximum acceleration of axis. The value is the units of encoder steps / second / second at the motor.

Parameter 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).

Parameter 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.

Parameter 185 C FUSE LEVEL
See Parameter 10 for description.

Parameter 186 C DECELERATION
Maximum deceleration of axis in encoder steps per second per second.

Parameter 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.

Parameter 188 C ORIENT GAIN
The value is the proportional gain used in the position control loop when performing a spindle orientation.

Parameter 189 C BASE FREQ
This is the rated frequency of the motor.

Parameter 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.

Parameter 191 C MAX CURRENT
See Parameter 105 for description

Parameter 192 C MAG CURRENT
This is the magnetization component of the current in the motor, also called the flux or field current.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 201 X SCREW COMP. COEF.

This is the coefficient of heating of the lead screw and is used to shorten the screw length.

Parameter 205 A SCREW COMP. COEF.

This parameter should be set to 0.

Parameter 206 SPIGOT POSITION

Vertical mills only. Maximum number of spigot positions.

Parameter 207 SPIGOT TIMEOUT (MS)

Vertical mills only. Maximum timeout allowed for spigot to traverse one spigot location.

Parameter 208 SPIN. FAN OFF DELAY

Delay for turning the spindle fan off after the spindle has been turned off.

Parameter 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	HORIZONTAL	When set to (1), the control identifies the machine as a horizontal mill. The control will then make the necessary adjustments, such as enabling the horizontal tool changer.
1	RST STOPS T.C.	Tool changer can be stopped with RESET button.
2	CHAIN TC	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	ENA CONVEYOR	Enables chip conveyor, if machine is so equipped.
4	50% RPD KBD	When (1) the control will support the new style keyboards with 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	TC Z NO HOME	In Horizontal mills only. This bit prevents Z-axis motion to machine zero prior to a tool change.
7	M36 AUTO MOT	In Horizontal only. When set to (1), an M36 rotates the A-axis after the PART READY button is pressed.

8	AUX AXIS TC	In Horizontal mills only. When enabled, means the tool changer carousel is driven by an aux. axis.
9	SPIGOT KEY INV	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	REV CONVEYOR	Reverses the direction of the chip conveyor.
13	M27-M28 CONVYR	Usually the chip conveyor motor and direction relays are attached to the user relays M21 and M22. When this bit is set, the control expects to see the conveyor hooked up to M27 and M28.
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	CONVY DR 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	DSBL CLNT IN	If set to 1 low coolant input will not be used.
19	DSC INP PR	Discrete pallet rotate/part ready; inputs enabled if set to 1.
20	RMT TOOLS RLS	If set to 1, allows use of remote tool release button on spindle head.
21	DISK ENABL	If set to 1, enables the optional disk drive.
22	TCR KEYPAD	If set to 1, enables tool changer restore button on keypad.
23	MCD RLY BRD	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	ALISM PRGRST	Alias M codes during program restart.
27	DSBL JOG TST	Disables the encoder test for the jog handle.
28	AIR DR @ M24	Used on horizontal mills only.
29	PAL ENABLE	This parameter accommodates both the APC on the vertical mill the Rotary Pallet Changer on the Horizontal mill. This parameter bit should be set to 1 if an APC is present. Otherwise, it should be 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	P RDY @ Y160	Used on horizontal mills only.
31	SPNDL 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.

Parameter 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.**

Parameter 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.**

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 215 CAROUSEL OFFSET
Used on horizontal mills only. Parameter used to align tool 1 of tool changing carousel precisely. Units are encoder steps.

Parameter 216 CNVYR RELAY DELAY
Delay time in 1/50 seconds required on conveyor relays before another action can be commanded. Default is 50.

Parameter 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.

Parameter 218 CONVYR RETRY REV TIM
Amount of time that the conveyor is reversed in 1/50 seconds after overcurrent is sensed. Default is 2000.

Parameter 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.

Parameter 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.

Parameter 221 MAX TIME NO DISPLAY
The maximum time (in 1/50 sec.) between screen updates.

Parameter 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.

Parameter 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.

Parameter 224 ROT AXIS ZERO OFSET
This parameter shifts the zero point of A for a wheel fixture or tombstone.

Parameter 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.

Parameter 226 EDITOR CLIPBOARD
This parameter assigns a program number (nnnnn) to the contents of the clipboard (for the advanced editor).

Parameter 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.

Parameter 228 QUICKCODE FILE
This parameter set the program numbers to store in the Quick Code definition program. Usually, this is 9999.

Parameter 229 X LEAD COMP 10E9
This parameter sets the X-axis lead screw compensation signed parts per billion.

Parameter 230 Y LEAD COMP 10E9
This parameter sets the Y-axis lead screw compensation signed parts per billion.

Parameter 231 Z LEAD COMP 10E9
This parameter sets the Z-axis lead screw compensation signed parts per billion.

Parameter 232 A LEAD COMP 10E9
This parameter sets the A-axis lead screw compensation signed parts per billion.

Parameter 233 B LEAD COMP 10E9
This parameter sets the B-axis lead screw compensation signed parts per billion.

Parameter 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.**

Parameter 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.

Parameter 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.

Parameter 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

Parameter 239 SPNDL ENC STEPS/REV
This parameter sets the number of encoder steps per revolution of the spindle encoder.

Parameter 240 1ST AUX MAX TRAVEL
This parameter sets the maximum travel of the first auxiliary (C) axis in the positive direction.

Parameter 241 2ND AUX MAX TRAVEL
This parameter sets the maximum travel of the second auxiliary (U) axis in the positive direction.

Parameter 242 3RD AUX MAX TRAVEL
This parameter sets the maximum travel of the third auxiliary (V) axis in the positive direction.

Parameter 243 4TH AUX MAX TRAVEL
This parameter sets the maximum travel of the fourth auxiliary (W) axis in the positive direction.

Parameter 244 1ST AUX MIN TRAVEL
This parameter sets the maximum travel of the first auxiliary (C) axis in the negative direction.

Parameter 245 2ND AUX MIN TRAVEL
This parameter sets the maximum travel of the second auxiliary (U) axis in the negative direction.

Parameter 246 3RD AUX MIN TRAVEL
This parameter sets the maximum travel of the third auxiliary (V) axis in the negative direction.

Parameter 247 4TH AUX MIN TRAVEL
This parameter sets the maximum travel of the fourth auxiliary (W) axis in the negative direction.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 254 VB AIR DOOR CLEARANCE

This is a new parameter to support 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.

Parameter 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.

Parameter 256 PALLET LOCK INPUT

This parameter selects the discrete input (0 to 31) that is to be used to monitor the pallet locked status. Used in horizontal mills only.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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 zero prior to tool change (5-axes mills) .
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 Lead 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.

Parameter 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 zero prior to tool change (5-axes mills).
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 Lead 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.

Parameter 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 zero prior to tool change (5-axes mills) .
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 Lead 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.

Parameter 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 zero prior to tool change (5-axes mills).
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 Lead 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.

Parameter 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 zero prior to tool change (5-axes mills). On HS mills with the 60 or 120 pocket chain-style tool changer, this bit must be set to 1. It will cause the TOOL CHANGE 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 Lead 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.

Parameter 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 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 zero prior to tool change (5-axes mills).

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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 275 A SCREW COMP T. CONST.
This parameter should be set to 0.

Parameter 276 B SCREW COMP T. CONST.
This parameter should be set to 0.

Parameter 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 G.B.	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 IN	This bit is used on horizontal mills only.
3	CHECK HIDN VAR	This bit is used on horizontal mills only.
4	DISPLAY ACTUAL	When set to 1, displays the actual spindle speed on the Current Commands display page.
5	TSC PRG ENBL	Enables purge output on TSC option.
6	SNGL SW CLMP	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	SPND DRV LCK	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.
9	CNCR SPINDLE	(Concurrent 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 HYD TC	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 VECT DR	(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 ENCL TEMP	(Microprocessor Enclosure Temperature) When set to 1, the enclosure temperature will be displayed on INPUTS2 screen of the diagnostics display.
13	HAAS RJH	(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	SP MOT OT 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 DRV SHTL	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 SPNDL	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 CKPU	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 new Haas Automatic Pallet Changer attached, and 0 for all other machines.
18	D:Y SW 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	D:Y SW 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	TC DR 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 old configuration where the door is driven open by a timed operation. If it is set to 1, this indicates the new 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 SDMTCRSL — This parameter bit is for the HS-2 sidemount tool changer. It must be set to 1 on all HS-2 mills, and 0 on all other mills.

25 HS3 SDMTCRSL — This parameter bit is for the HS-3 sidemount tool changer. It must be set to 1 on all HS-3 mills, and 0 on all other mills.

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 SAFETY INVERT — 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 — 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 SPD DCEL — Inverse Spindle Speed Deceleration. When this parameter is set to 1, the spindle decelerates faster at lower speeds, resulting in a shorter deceleration time.

Parameter 279 X SCALE GAIN MULT

This parameter 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.

Parameter 280 Y SCALE GAIN MULT

See parameter 279 for description

Parameter 281 Z SCALE GAIN MULT

See parameter 279 for description

Parameter 282 A SCALE GAIN MULT

See parameter 279 for description

Parameter 283 B SCALE GAIN MULT

See parameter 279 for description

Parameter 284 RESERVED

Parameter 285 X LINEAR SCREW OFFS

This parameter is used on machines with linear scales. This parameters account for the unused portion of the lead 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.)

Parameter 286 Y LINEAR SCREW OFFS
See parameter 285 for description.

Parameter 287 Z LINEAR SCREW OFFS
See parameter 285 for description.

Parameter 288 A LINEAR SCREW OFFS
See parameter 285 for description.

Parameter 289 B LINEAR SCREW OFFS
See parameter 285 for description.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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 mill, 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 311 ARM BUMP TIME
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.

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.

Parameter 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.

Parameter 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.

Parameter 314 FEED DELTA V
This parameter supports the motion control feature. It is the maximum change in velocity in encoder steps per millisecond.

Model	Basic Value
HS-1	8
HS-1R	8
HS-1RP	8
HS-15AXT	8
HS-2RP	8
HS-3	8
HS-3R	8
MM-1	32
VR-11	16
VB-1	8
VB-3	8
VS-3	8
G-1	8

Model	Basic Value
VF-0	32
VF-0E	32
VF-EC	32
VF-1	32
VF-2	32
VF-3	24
VF-3D	24
VF-4	24
VF-4D	24
VF-5	24
VF-6	16
VF-7	16
VF-8	16
VF-9	16
VF-10	8
VF-11	8

Parameter 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 MV NXTL	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	XL 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. Note that when this parameter bit is set to 1, the following tool pocket configuration is not allowed (see alarm 422). An example of a tool pocket table with extra large tools: 1 - 2 L 3 - 4 - 5 L 6 -
4	HIGH SPEED	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 SPIN	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 TC	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	RST STOP PAL	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 MILL	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 SW	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 PAL 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 ADVANCED JOG — This parameter bit enables the Index Jog and Jog Travel Limits features.

12 MANUAL JOG — 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 DR — This parameter supports the HS-60/120 chain-style tool changer. When such a machine has a cage door, this parameter must be set to 1. On all other machines, it must be set to zero. With this bit properly set, the control will recognize the new switch and buttons and halt tool changes when the door is opened, perform tool change recovery appropriately, etc.

17 VIBRN 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.

Parameter 316 APC PAL. CLAMP TIME
This is the time required to clamp the APC pallet to the receiver. It should be set to 4000. Units are milliseconds.

Parameter 317 APC UNCLAMP TIME
This is the time required to unclamp the APC pallet from the receiver. It should be set to 4000. Units are milliseconds.

Parameter 318 APC PAL. CHAIN TIME
This is the time required to cycle the chain. It should be set to 8000. Units are milliseconds.

Parameter 319 APC DOOR CLOSE TIME
This is the time required to close the door. It should be set to 6000. Units are milliseconds.

Parameter 320 RP DRAWBAR DOWN
This is the time required for the drawbar to move down. Units are milliseconds.

Parameter 321 RP DRAWBAR UP TIME
This is the time required for the drawbar to move up. Units are milliseconds.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 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.

Parameter 339 X SPINDLE THERM COEF.
This parameter supports the Spindle Head Thermal Compensation feature, and should be set to 0.

Parameter 340 Y SPINDLE THERM COEF.
See parameter 339 for description.

Parameter 341 Z SPINDLE THERM COEF.
See parameter 339 for description.

Parameter 342 A SPINDLE THERM COEF.
See parameter 339 for description.

Parameter 343 B SPINDLE THERM COEF.
See parameter 339 for description.

Parameter 345 X SPINDLE THERM TIME.CONST.
This parameter supports the Spindle Head Thermal Compensation feature, and should be set to 0.

Parameter 346 Y SPINDLE THERM TIME.CONST.
See parameter 345 for description.

Parameter 347 Z SPINDLE THERM TIME.CONST.
See parameter 345 for description.

Parameter 348 A SPINDLE THERM TIME.CONST.
See parameter 345 for description.

Parameter 349 B SPINDLE THERM TIME.CONST.
See parameter 345 for description.

Parameter 351 THRML SENSOR OFFSET
This is a parameter used for Lead Screw Thermal Compensation via a temperature sensor attached to the ball nut.

Parameter 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	2nd M-code relay board. Typically used for built in options such as, side mount tool changer, etc.

Parameter 588 X ENC. SCALE FACTOR
These are new axis parameters that 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).

Parameter 589 Y ENC. SCALE FACTOR
See parameter 588 for description

Parameter 590 Z ENC. SCALE FACTOR
See parameter 588 for description

Parameter 591 A ENC. SCALE FACTOR
See parameter 588 for description

Parameter 592 B ENC. SCALE FACTOR
See parameter 588 for description

Parameter 593 Sp ENC. SCALE FACTOR
See parameter 588 for description

Parameter 594 U ENC. SCALE FACTOR
See parameter 588 for description

Parameter 595 V ENC. SCALE FACTOR
See parameter 588 for description

Parameter 596 W ENC. SCALE FACTOR
See parameter 588 for description

Parameter 600 PEAK SPIN. PWR - KW
This is a new parameter that has been added to support 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.

Parameter 605 Pallet Changer Type
This parameter is for use with the Horizontal Mill pallet changer feature (hard coded). On an HS-1RP or HS-2RP which has the hard coded pallet changer feature, this parameter must be set to 1. On all other mills including VF series mills with an APC, this parameter must be set to zero.

Parameter 606 Number of Pallets
This parameter is for use with the Horizontal Mill and Vertical mill APC hard coded pallet changers. On both of these machines which use the hard coded pallet changer feature, this parameter must be set to 2. On all other mills, this parameter must be set to zero.

Lead Screw Compensation

Separate lead 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 lead 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.

7. MAINTENANCE

7.1 General Requirements

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: less than 90% 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 ± 5%
Harmonic distortion not to exceed 10% of the total RMS voltage

20-15 HP System	Voltage Requirements	High-Voltage Requirements
STANDARD VF and 10K	(195-260V)	(354-488V)
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	Voltage Requirements	High-Voltage Requirements[2]
50 TAPER, 10K (50T), and HT10K (40T)	(195-260V)	(354-488V)
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

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 Europeon machines. Domestic and all other users must use the External 480V option.

Air Requirements

The VMC requires a minimum of 100 psi at 4 scfm at the input to the pressure regulator on the back of the machine. 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 Air line Hose Size
VF-1 through VF-11 (40 taper)	85 psi	3/8" I.D.
VF-5 through VF-11 (50 taper)	85 psi	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 3/8" for 40 taper machines, or a 1/2" for 50 taper machines and machines with the side mount tool changer option.

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: The nipple between the air filter/regulator and the oil lubricator (See illustration in "Air Connection" section) reservoir tank below the control box on the back of the machine is for the optional rotary table. DO NOT use this as a connection for an auxiliary air line. Auxiliary connections should be made on the left 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, insufficient air is being supplied to the machine.

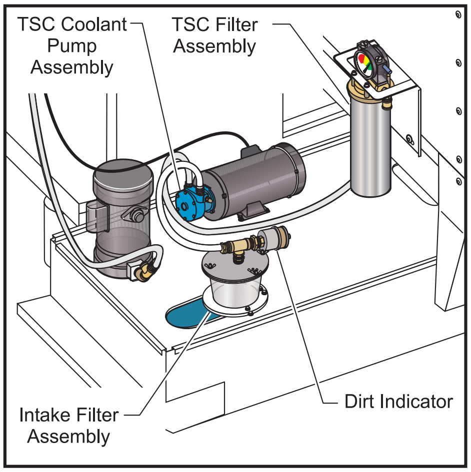
7.2 Maintenance Schedule

The following is a list of required regular maintenance for the HAAS VF Series Vertical Machining Centers. 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.

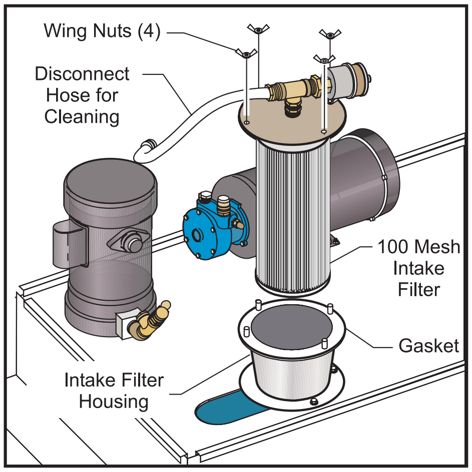
INTERVAL	MAINTENANCE PERFORMED
DAILY	✓Check coolant level each eight-hour shift (especially during heavy TSC usage). ✓Check way lube lubrication tank level. ✓Clean chips from way covers and bottom pan. ✓Clean chips from tool changer. ✓Wipe spindle taper with a clean cloth rag and apply light oil.
WEEKLY	✓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. Be careful to disconnect the coolant pump from the controller and POWER OFF the control before working on the coolant tank. **Do this MONTHLY for machines without the TSC option.** ✓Check air gauge/regulator for 85 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. See section 1.4. **For 50 taper spindles:** Check oil level in sightglass. Add from side of gearbox if necessary. See section 1.5. ✓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.
SIX MONTHS	✓Replace coolant and thoroughly clean the coolant tank. ✓Check all hoses and lubrication lines for cracking.
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. ✓**Replace air filter on control box every 2 years.**1.1 TSC Maintenance ✓Check SMTC oil level in sight glass, (see Side Mount Tool Changer Oil Level in this section).

7.3 TSC Maintenance

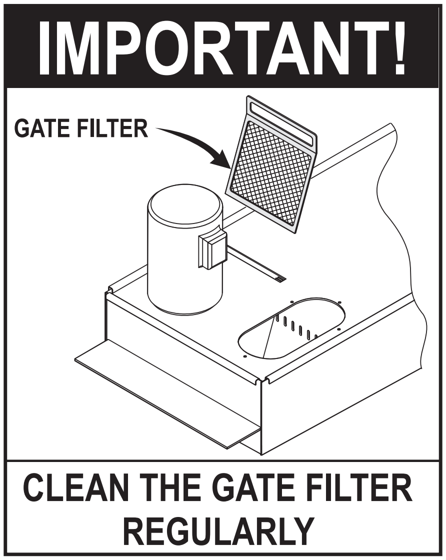
- Check the dirt indicator on the 100-micron mesh filter with the TSC system running and no tool in the spindle. Change the element when the indicator reaches the red zone.
- On newer machines, clean the pump intake filter when indicator is in the red zone. Reset indicator with button. All intake filters 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.



TSC coolant pump assembly.



Cleaning the intake filter.



To clean the filter:

Turn off the coolant pump.
Remove the filter.
Clean and reinstall filter.

7.4 Lubrication Chart

SYSTEM	WAY LUBE AND PNEUMATICS	TRANSMISSION	COOLANT TANK
LOCATION	Under the control panel at the rear of the machine	Above the spindle head	Side of machine
DESCRIPTION	Piston pump with 30 minute cycle time. Pump is only on when spindle is turning or when axis is moving.		
LUBRICATES	Linear guides, ball nuts and spindle	Transmission only	
QUANTITY	2-2.5 qts. depending on pump style	40 taper 34 oz 50 taper 51 oz	40 Gallons 80 Gallons VF 6-11
LUBRICANT	Mobil Vactra #2	Mobil DTE 25	Water based coolant only * **No Flammable Liquids.**

*** Mineral cutting oils will damage rubber components throughout the machine.**

WARNING!

The TSC pump is a precision gear pump and will wear out faster and lose pressure if abrasive particles are present in the coolant.

Use of coolants with extremely low lubricity can damage the TSC Coolant tip and pump.

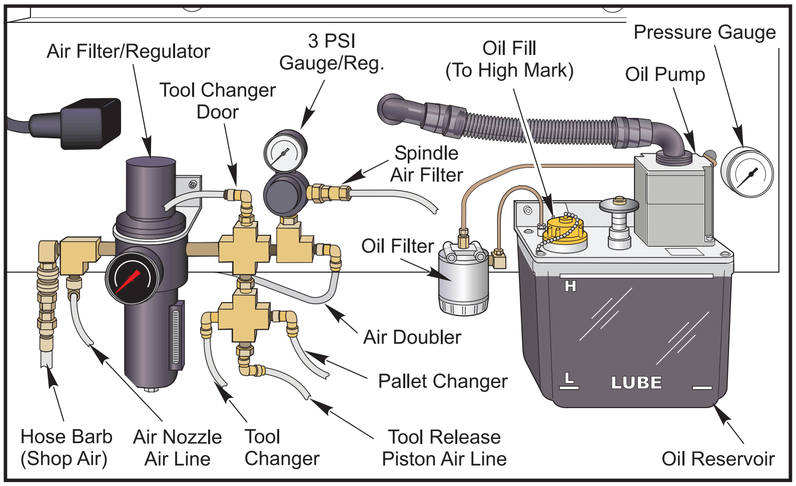
When machining castings, sand from the casting process and the abrasive properties of cast aluminum and cast iron will shorten pump life unless a special filter is used in addition to the 100-micron mesh suction filter. Contact Haas Automation for recommendations.

Machining of ceramics and the like voids all warranty claims for wear and is done entirely at the 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. A larger coolant tank is recommended.

Shortened pump life, reduction of pressure and increased maintenance are normal and to be expected in abrasive environments and are not covered by warranty.

7.5 Lubrication System

All machine lubrication is supplied by the external lubrication system. The reservoir is located on the lower rear of the machine (see figure below). Current lube level is visible in the reservoir. If additional lube needs to be added, remove the cap from the fill port and add lube to the proper level.



External Lubrication System

WARNING!

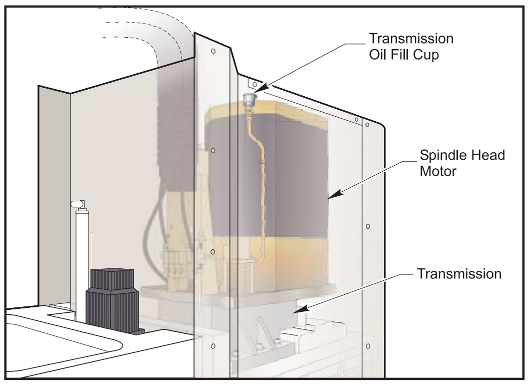
DO NOT ADD LUBE ABOVE THE "HIGH" LINE MARKED ON THE RESERVOIR. DO NOT ALLOW THE LUBE LEVEL TO GO BELOW THE "LOW" LINE MARKED ON THE RESERVOIR AS MACHINE DAMAGE COULD RESULT.

To lubricate the system, pull up on the primer pull-tab located next to the fill port. The primer will automatically send 3 cc of lube through the system.

7.6 VF-1 through 6 / 40T - Transmission Oil

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 (see figure below). 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 your transmission oil 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.

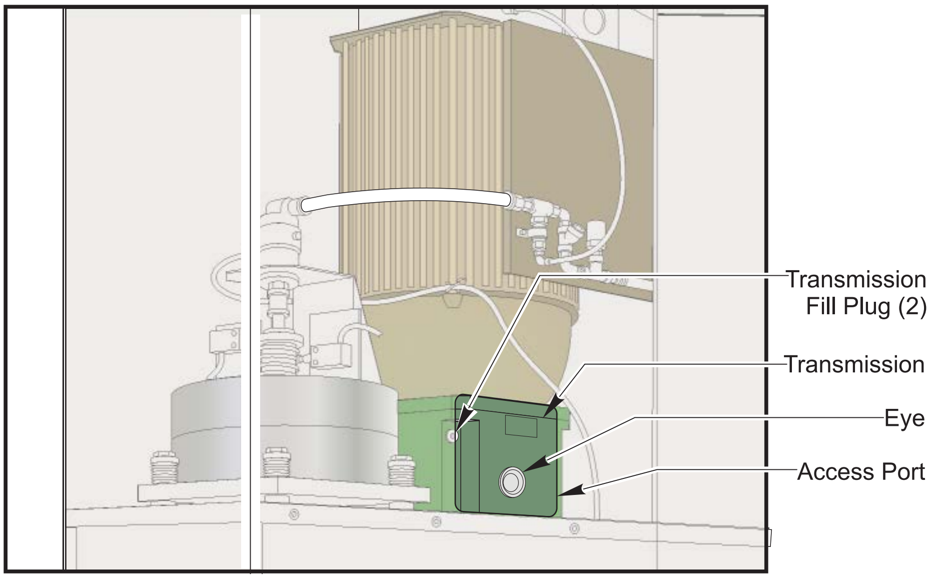


VF 1-6/40T Transmission Oil Fill Cup

7.7 VF-6 through 11 50T - Transmission Oil

CAUTION! Power down the machine before performing any maintenance tasks.

The VF 6 through 11 50T machines provide a means to check the transmission oil level. The transmission oil level eye 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 eye will be visible. The oil level should reach the middle of the eye.



VF 6 through 11 50T Oil Level

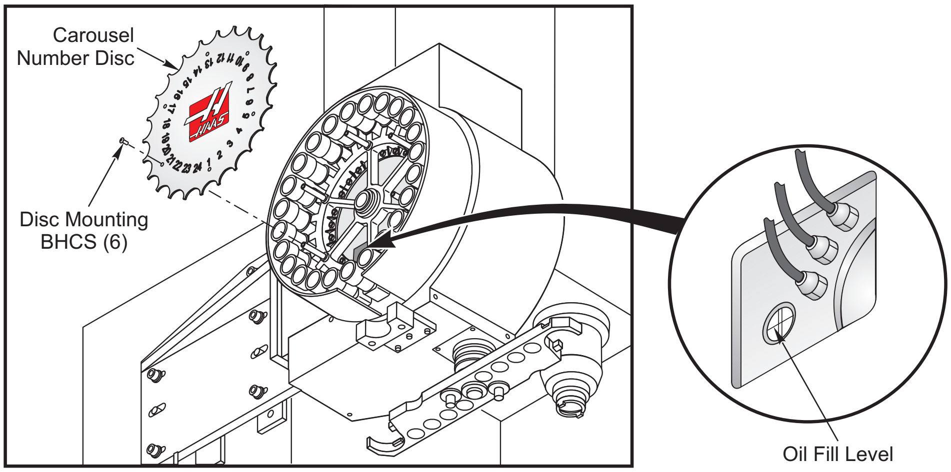
If additional oil is necessary, remove the fill port plug located just to the left of the eye. Add Mobil DTE 25 oil until the proper level is reached. Replace the fill port bolt and tighten. Securely reattach the access panel.

7.8 Chip Auger

MAINTENANCE

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 trap regularly. Should the drain become clogged and cause coolant to collect in the machine's pan, stop the machine, loosen the chips blocking the drain, and allow the coolant to drain. Empty the coolant tank strainer, then resume operation.

7.9 Side Mount Tool Changer Oil Level Check



The SMTC is factory filled with the appropriate level of oil and does not need to be changed under normal conditions. As a precaution, check the oil level annually. Oil will not need to be added as long as the level remains viewable in the sight glass as shown above. Should the level drop below the sight glass, call the HAAS service department.

7.10 Periodic Maintenance

A periodic maintenance page has been added to the control, it is found on the Current Commands screens titled SCHEDULED MAINTENANCE and accessed by pressing PAGE UP or PAGE DOWN which allows the operator to activate and deactivate a series of checks (see list below).

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 to the right. If an item is deactivated, "—" will be displayed instead. Items are tracked either by the time accumulated while power is on (ON-TIME) or by cycle-start time (CS-TIME). When power is applied, and every hour thereafter, the remaining time for each item is decremented. When it reaches zero (or has gone negative) the message MAINTENANCE DUE is displayed at the bottom of the screen. A negative number of hours indicates the hours past expiration. The maintenance item can have its time adjusted by using the left and right arrows. One hour is added or subtracted for each keypress, upto a maximum of 10,000 hours, and a minimum of 1 hour. Pressing the Origin key will reinstate the default time.

This message is not an alarm and does not interfere with machine operation in any way. The intent is to warn the operator that one of the items on the list requires attention. After the necessary maintenance has been performed, the operator can select that item on the SCHEDULED MAINTENANCE screen, press ORIGIN to deactivate it, then press ORIGIN again to reactivate it, and the countdown begins again with a default number of hours remaining (this value is determined by the software and cannot be altered by the operator.) Items available for checking are:

COOLANT - needs replacement	100 ON-TIME
AIR FILTER in control enclosure - replace	250 ON-TIME
OIL FILTER - replace	250 ON-TIME
GEARBOX OIL - replace	1800 ON-TIME
COOLANT TANK - check level, leakage, oil in coolant	10 ON-TIME
WAY LUBE SYSTEM - check level	50 CS-TIME
GEARBOX OIL - check level	250 ON-TIME
SEALS/WIPERS missing, torn, leaking - check	50 CS-TIME
AIR SUPPLY FILTER - check for water	10 ON-TIME
HYDRAULIC OIL - check level	250 ON-TIME

7.11 Windows / Guarding

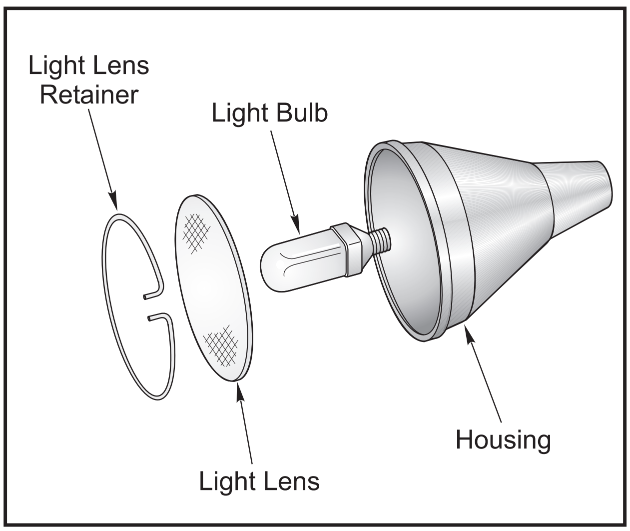
Polycarbonate windows and guarding can be weakened by exposure to cutting liquids and chemicals that contain amines. It is possible to loose up to 10% of the remaining strength annually. If degradation is suspected, window replacement should occur at no more than a six year interval.

Windows and guarding should be replaced if damaged or severely scratched - Replace damaged windows immediately

7.12 Interior Worklight

Bulb Replacement

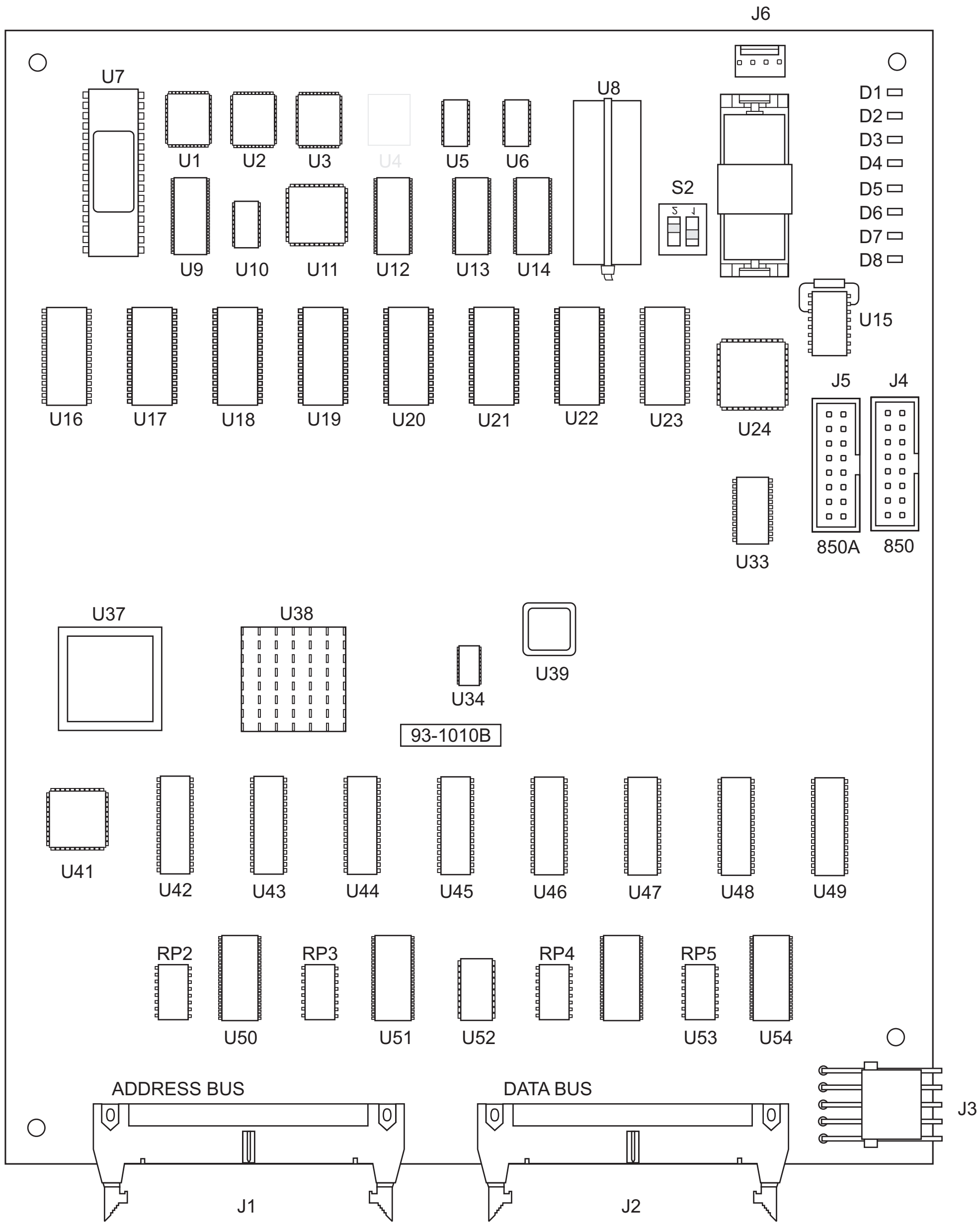
1. TURN OFF power to the machine at the main breaker.
3. Remove the retainer and the light lens.
4. Remove the light bulb and replace.
5. Replace the light lens and retainer.
6. Restore power to the machine.



Interior worklight assembly.

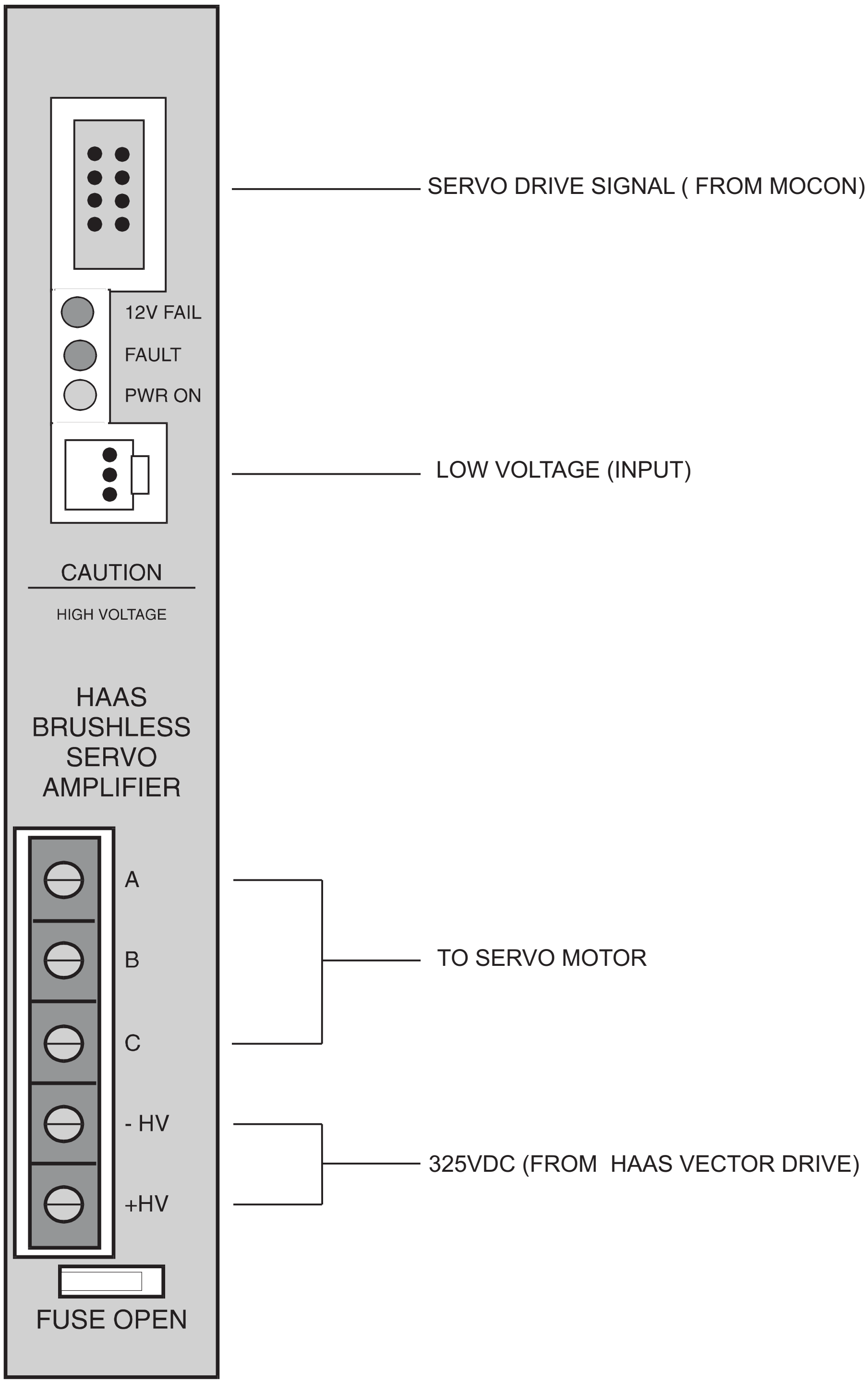
8. PCB'S, CABLE LOCATIONS AND BOARD DIAGRAMS

MICRO PROCESSOR PCB - P/N 93-1010B



PROC. PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨ LOCATION	PLUG #
J1 ADDRESS		ADDRESS BUSS	VIDEO	——
J2 DATA		DATA BUSS	MOTIF PCB	——
J3	860	LOW VOLTAGE	POWER SUPPLY PCB	——
J6	N/A	REPLACEMENT BAT. CONNECTION		——
PORT 1	850	SERIAL PORT #1	KEY. INTERFACE	——
PORT 2	850A	SERIAL PORT #2	SERIAL PORT #2	——

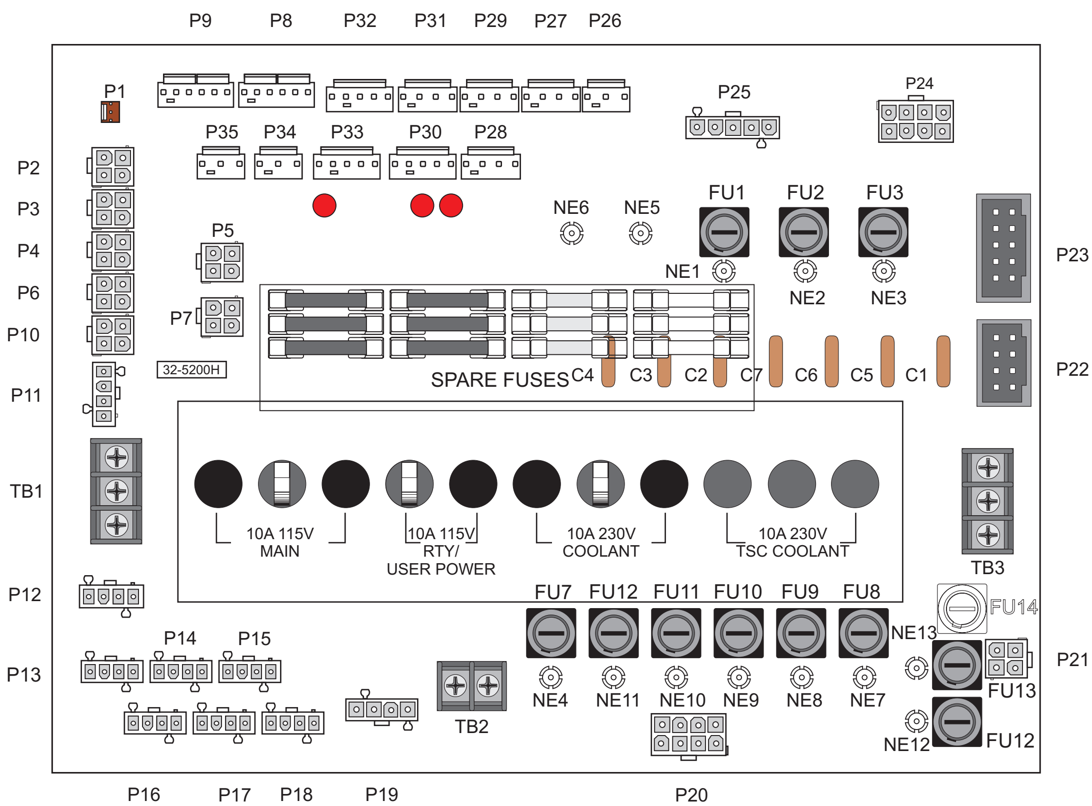
BRUSHLESS SERVO AMPLIFIER - P/N 93-5550C



BRUSHLESS SERVO AMPLIFIER - P/N 93-5550C CABLE CONNECTIONS

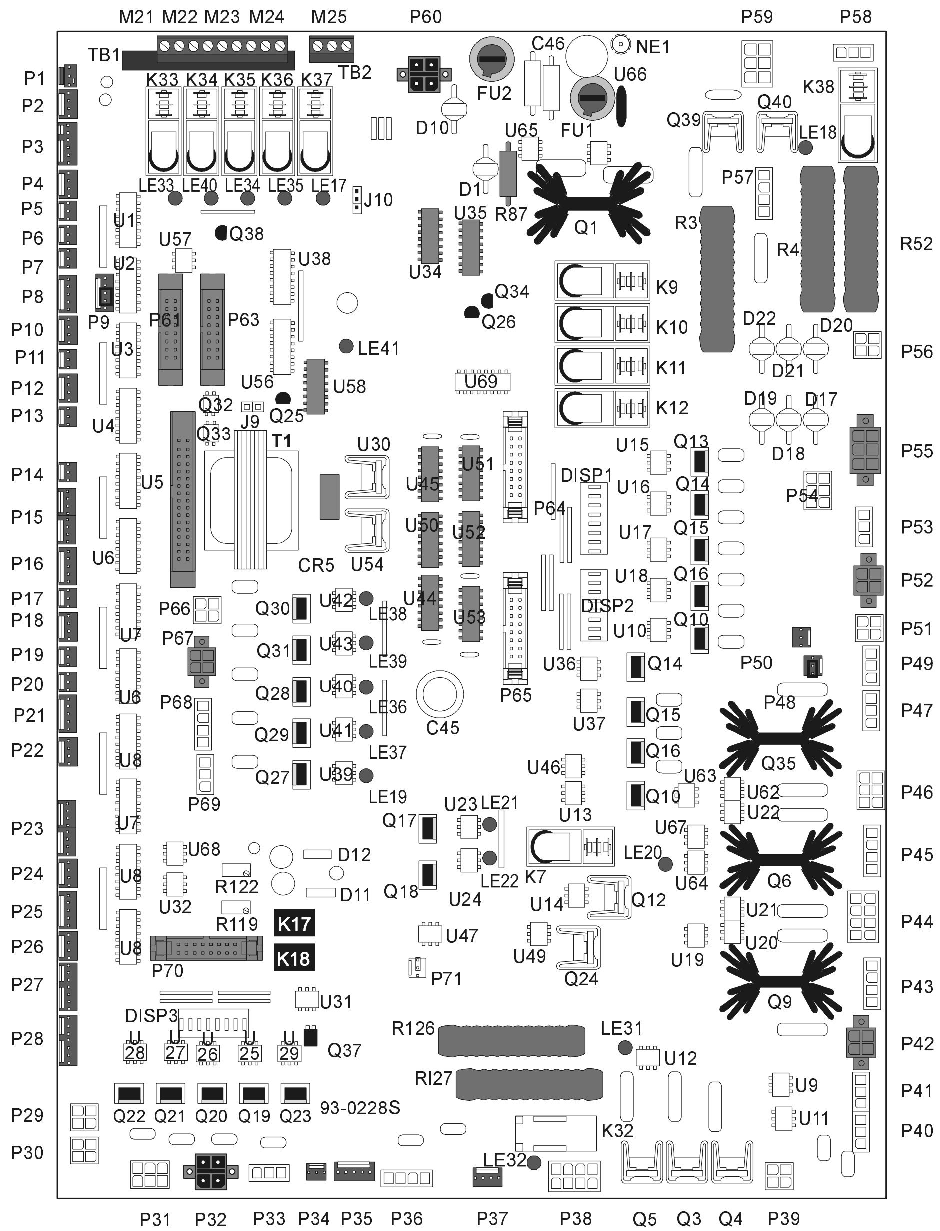
MOCON PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨ LOCATION	PLUG #
X AXIS AMP				
P	570	LOW VOLTAGE	L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE	X SERVO MOTOR	——
P	610	X DRIVE SIGNAL	MOCON PCB	P2
TB -HV +HV	——	320VDC	SPINDLE DRIVE	——
Y AXIS AMP				
P	580	LOW VOLTAGE	L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE	Y SERVO MOTOR	——
P	620	Y DRIVE SIGNAL	MOCON PCB	P3
TB -HV +HV	——	320VDC	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	——	320VDC	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	——	320VDC	SPINDLE DRIVE	——

POWER PCB 93-0227A



POWER PCB - P/N 93-0227A
CABLE CONNECTIONS

I/O 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
P19	90	3PH 115VAC	IO PCB	P56
P18	90C	115VAC	spare	
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	



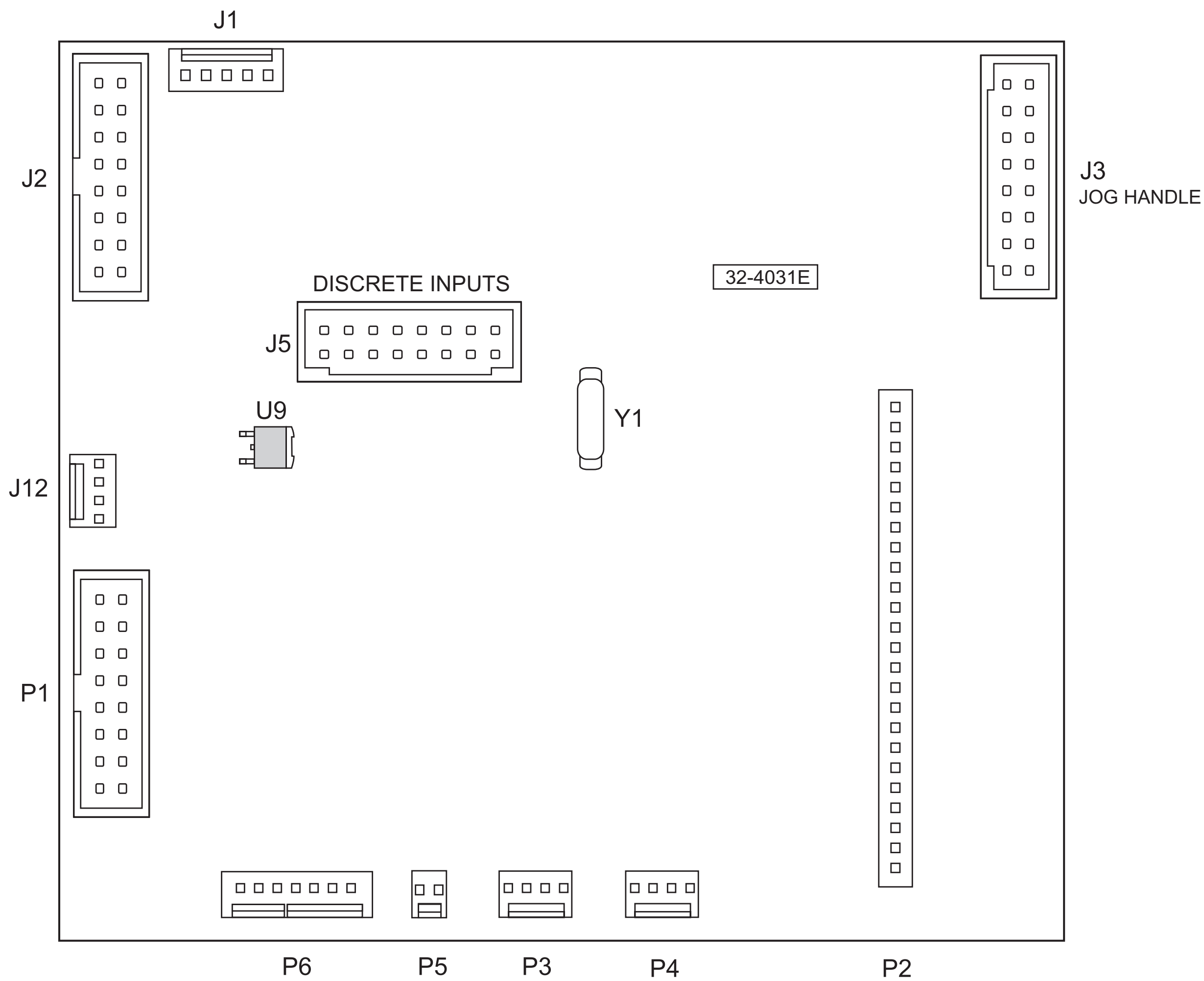
I/O PCB T - P/N 93-0228A CABLE CONNECTIONS

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	

I/O PCB T - P/N 93-0228A CABLE CONNECTIONS

I/O PLUG #	CABLE #	⇨ TO ⇨ LOCATION	PLUG #
P15	890	SPDB Open/Closed	
P16	780	2nd VD OV/contactor On / counterbalance	
P17	410	APC Door Open , VB Clamshell	
P18	790	APC Pin Clear	
P19	190	Remote Unclamp SW / Low phase	
P20	190A	Not Used	
P21	240	Spare APC Pallet Home / Ground fault	
P22	1070	Skip	M22
P23	420	Spare	
P24	440	Auto Door Open / Spare	
P25	450	Spare	
P26	460	Spare	
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	Spare A/B	
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 Clutch	
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
P/N 93-1072B

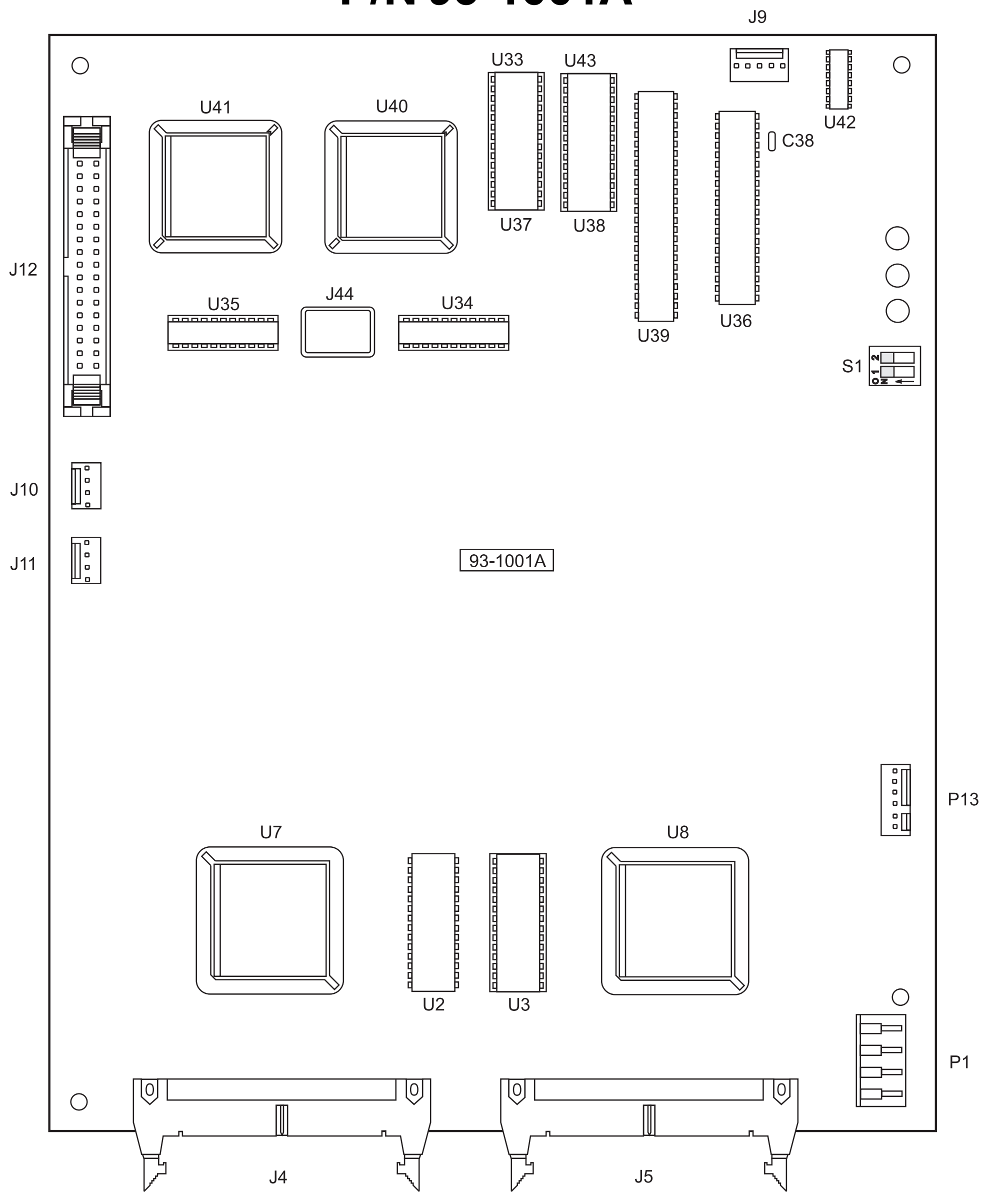


SERIAL KEYBOARD INTERFACE PCB WITH HANDLE JOG P/N 93-1072B CABLE CONNECTIONS

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.

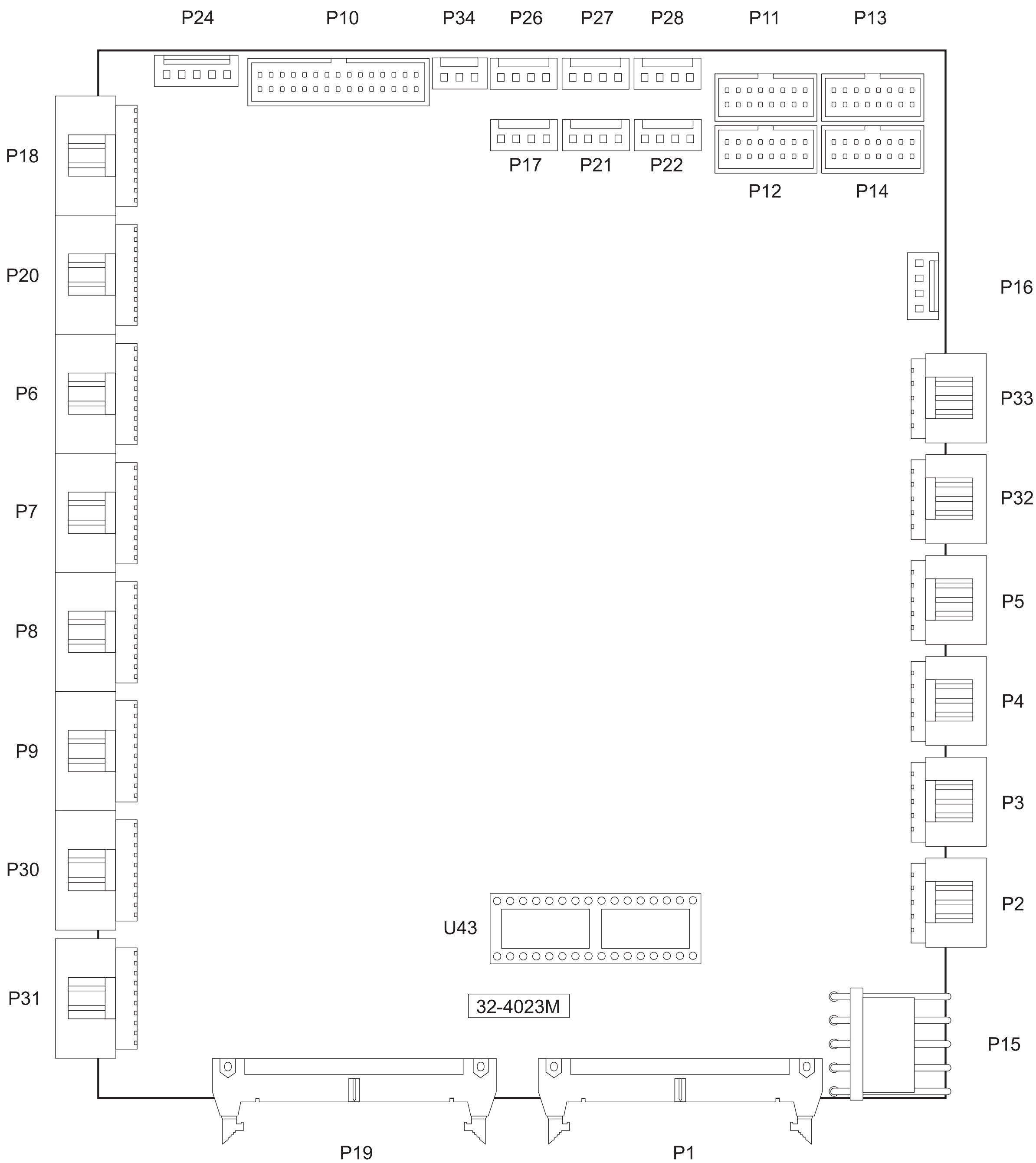
VIDEO & KEYBOARD PCB W/ FLOPPY DRIVE
P/N 93-1001A



VIDEO PLUG #	CABLE #	SIGNAL NAME ⇨	TO ⇨ LOCATION	PLUG #
P1	860	LOW VOLTAGE	POWER SUPPLY PCB	——
J3*	700	KEYBOARD INFO.	KEYBOARD INT.	——
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	——
P13	760	VIDEO SIGNAL	CRT	——
J9	——	RS422 B	N/A	N/A
J13	850	SERIAL DATA	N/A	J1

* Not used with Serial Keyboard Interface

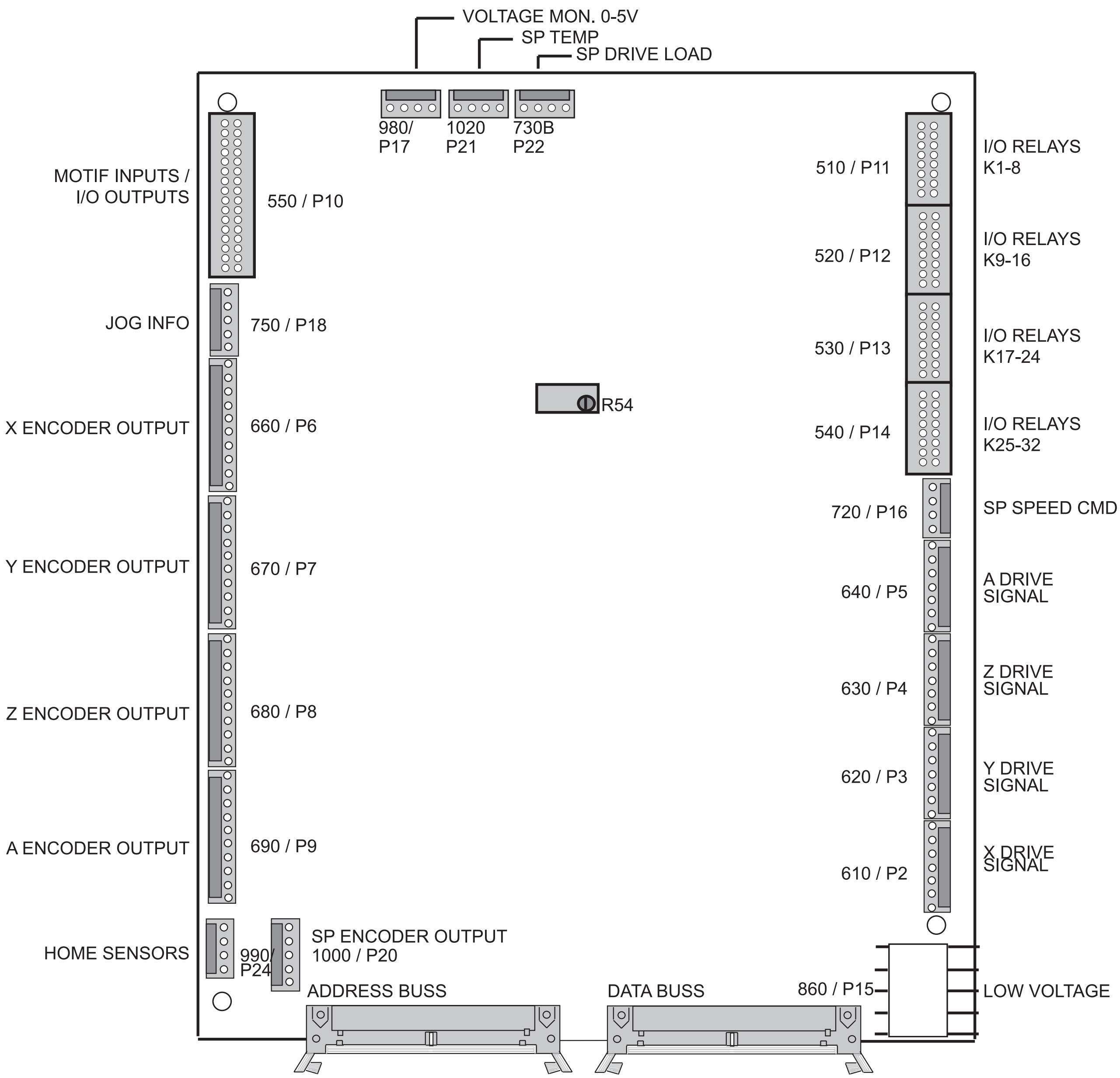
MOCON PCB - P/N 93-1067F



MOCON PCB - P/N 93-1067F
CABLE CONNECTIONS

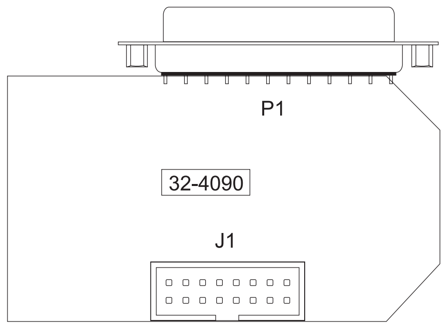
MOCON PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨	LOCATION	PLUG #
P1	——	DATA BUSS		VIDEO PCB	——
				MICRO PROC. PCB	——
P2	610	X DRIVE SIGNAL		X SERVO DRIVE AMP.	P
P3	620	Y DRIVE SIGNAL		Y SERVO DRIVE AMP.	P
P4	630	Z DRIVE SIGNAL		Z SERVO DRIVE AMP.	P
P5	640	A DRIVE SIGNAL		A SERVO DRIVE AMP.	P
P32	640B	B DRIVE 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 1-8I/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

MOTIF PCB - P/N 93-1066



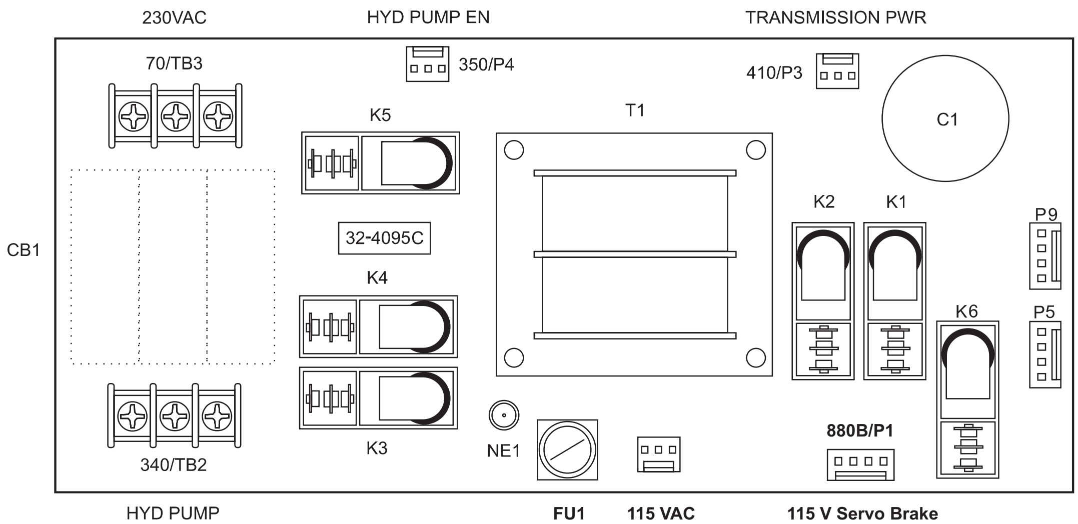
MOTIF PCB - P/N 93-1066
CABLE CONNECTIONS

MOTIF PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨ LOCATION	PLUG #
ADDRESS	——	ADDRESS BUSS	VIDEO PCB	——
& DATA	——	DATA BUSS	MICRO PROC. PCB	——
P2	610	X DRIVE SIGNAL	X SERVO DRIVE	P3
P3	620	Y DRIVE SIGNAL	Y SERVO DRIVE	P3
P4	630	Z DRIVE SIGNAL	Z SERVO DRIVE	P3
P5	640	A DRIVE SIGNAL	A SERVO DRIVE	P3
P6	660	X ENCODER OUTPUT	X ENCODER	——
P7	670	Y ENCODER OUTPUT	Y ENCODER	——
P8	680	Z ENCODER OUTPUT	Z ENCODER	——
P9	690	A ENCODER OUTPUT	A ENCODER	——
P10	550	MOTIF INPUTS / I/O OUTPUTS	I/O PCB	P4
P11	510	I/O RELAYS 1-8	I/O PCB	P1
P12	520	I/O RELAYS 9-16	I/O PCB	P2
P13	530	I/O RELAYS 17-24	I/O PCB	P51
P14	540	I/O RELAYS 25-32	I/O PCB	P3
P15	860	LOW VOLTAGE	POWER SUPPLY PCB	——
P16	720	SP. SPEED COMMAND	SPINDLE DRIVE	——
P17	980	VOLTAGE MONITOR	SDIST PCB	P9
P18	750	JOG INFO.	JOG HANDLE	——
P20	1000	SP. ENCODER OUTPUT	SPINDLE ENCODER	——
P21	1020	SP. TEMP	SPINDLE	——
P22	730B	SP. DRIVE LOAD	SPINDLE DRIVE	——
P24	990	HOME SENSORS	X, Y & Z LIMIT SW.	——



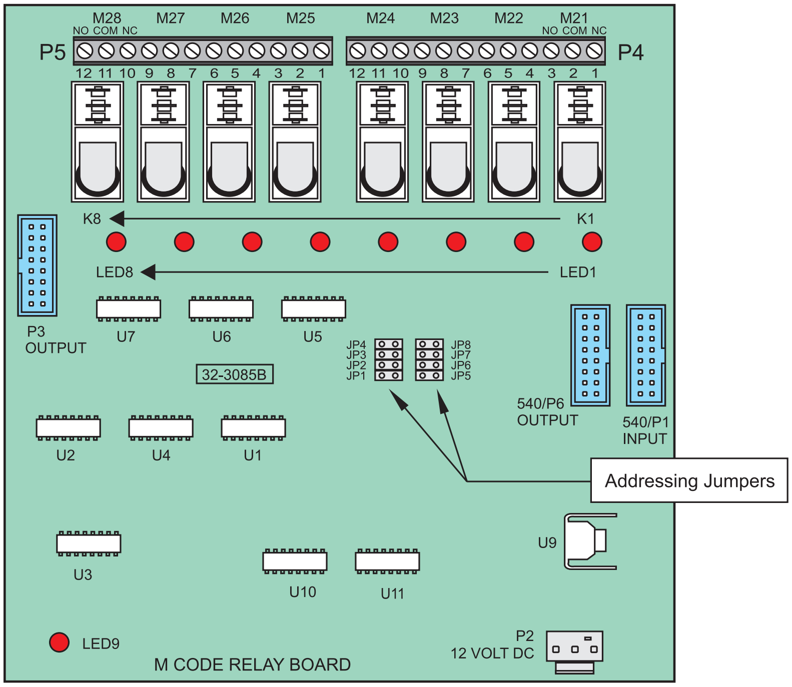
RS-232 PORT #1 PCB - P/N 32-4090 CABLE CONNECTIONS

PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1 INTERNAL	850		VIDEO & KEYBOARD	J13
J1 EXTERNAL	——		——	——



50T TRANSMISSION P.S. / HYDRAULIC C.B. PCB
P/N 93-4095D
CABLE CONNECTIONS

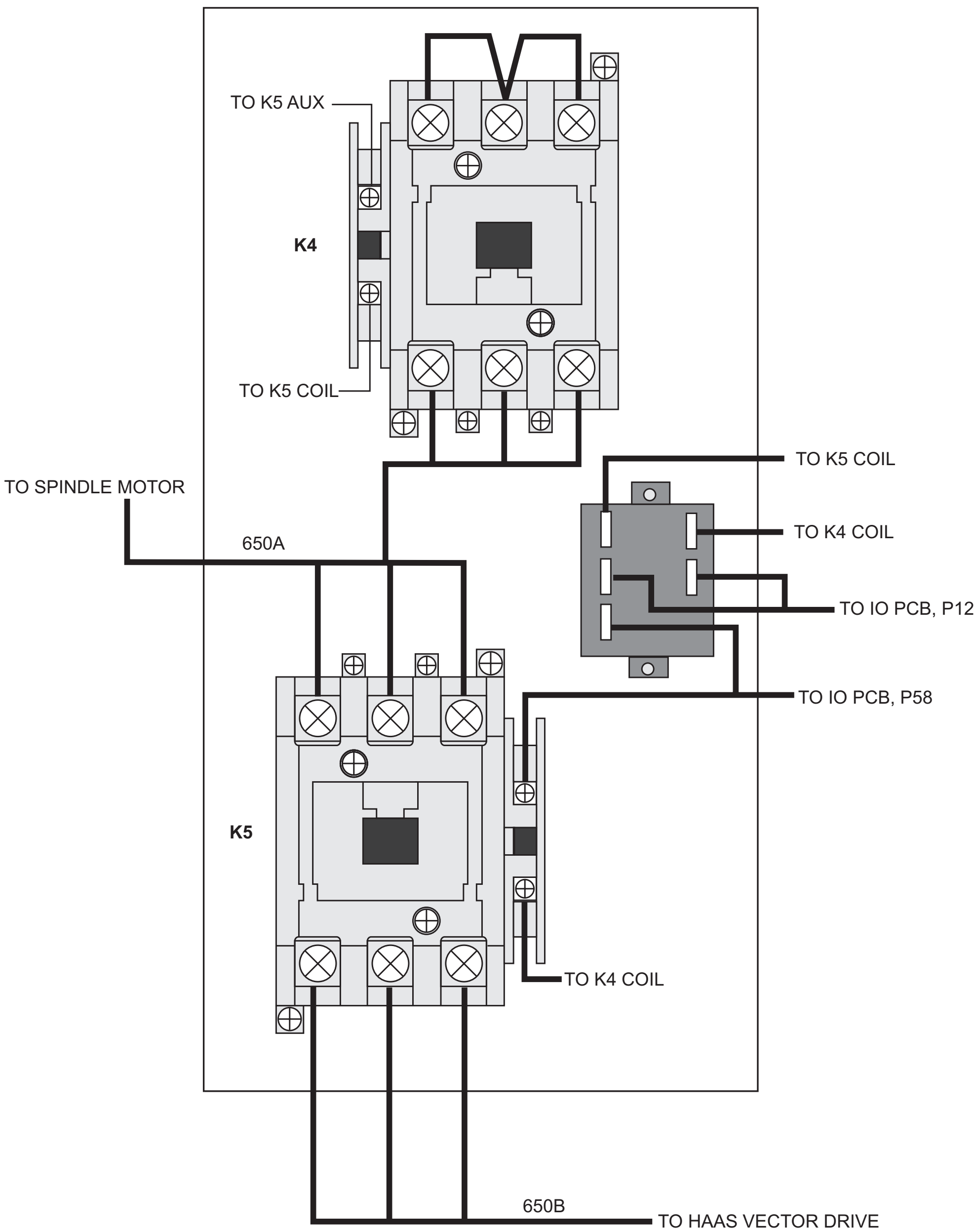
PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1	880B		IO PCB	P12
P2	90		POWER PCB	P8
P3	410		GEAR BOX	
P4	350		IO PCB	P54
TB2	340		HYDRAULIC MTR	
TB3	70		MAIN TRANSFORMER (VECTOR DRIVE UNIT)	



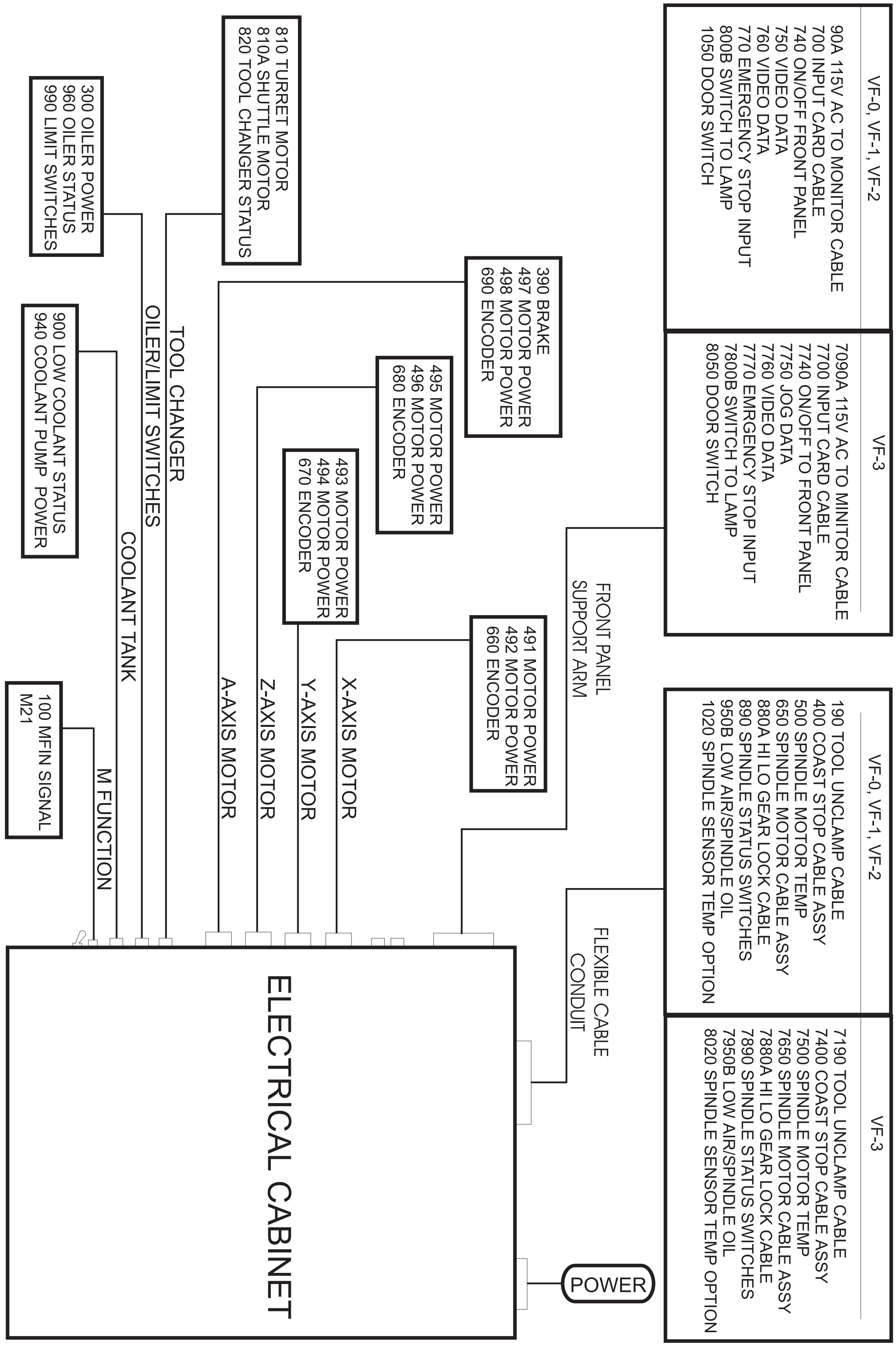
M CODE RELAY BOARD
P/N 93-1057B CABLE CONNECTIONS

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

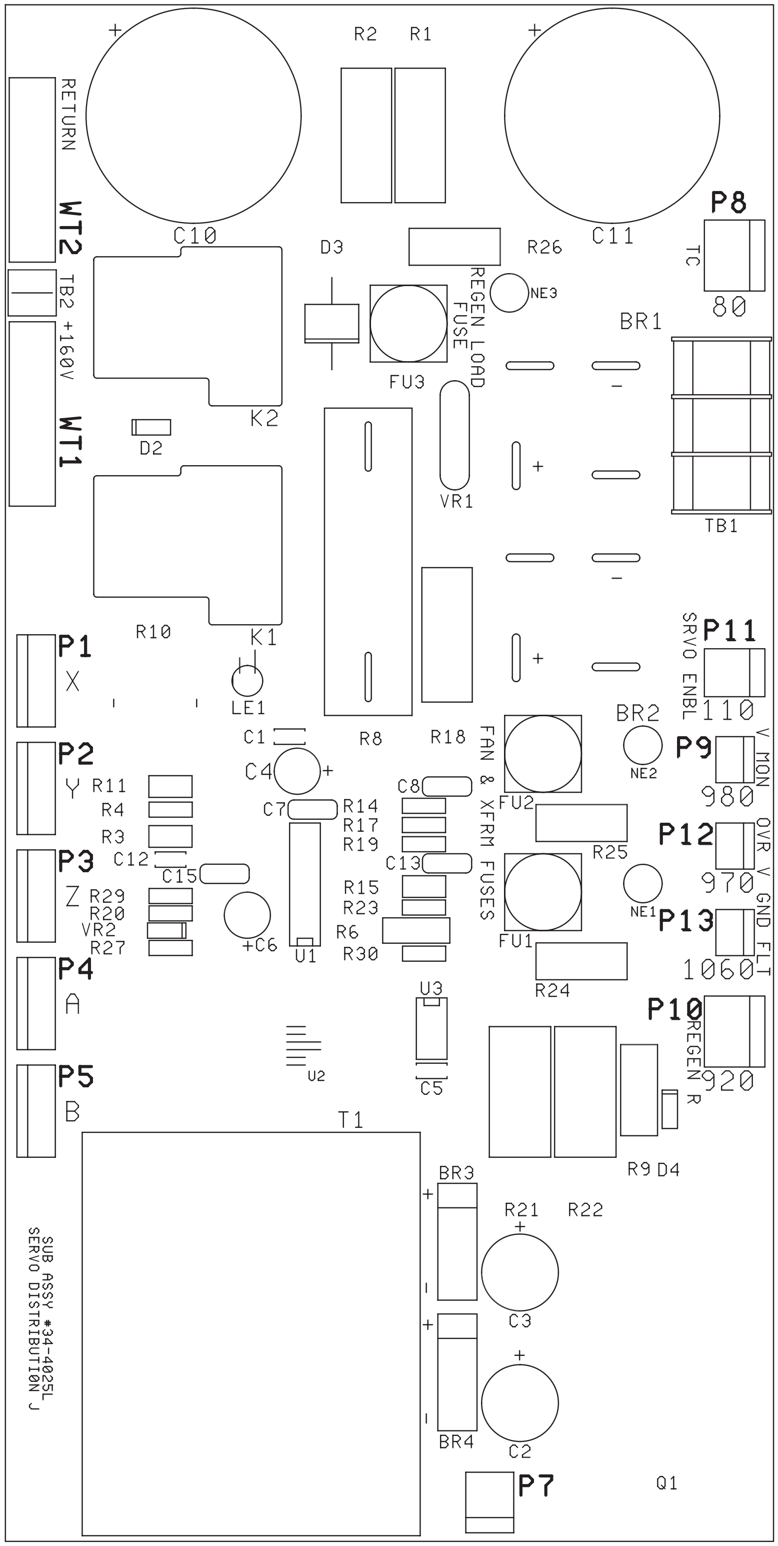
Y-DELTA SWITCH ASSEMBLY
P/N 32-5850A



CABLE LOCATION DIAGRAM



SERVO DISTRIBUTION J CABLE CONNECTIONS P/N 34-4025J



SERVO DISTRIBUTION J
CABLE CONNECTIONS
P/N 34-4025J

PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1	X			
P2	Y			
P3	Z			
P4	A			
P5	B			
P7				
P8	80			
P9	980			
P10	920			
P11	110			
P12	970			
P13	1060			

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 - (3 + SHIELD)
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 (CB2 INPUT)
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 - (2 + SHIELD)
91A	LEG 1 #16
92A	LEG 2 #16
93A	SHIELD DRAIN
90B	115 VAC TO HEAT EXCHANGER - (2 + SHIELD)
91B	LEG 1 #16
92B	LEG 2 #16
93B	SHIELD DRAIN

90C	115 VAC TO CB4 - (2 + SHIELD)
91C	LEG 1 #16
92C	LEG 2 #16
93C	SHIELD DRAIN

100 M-FIN (IOASM TO SIDE OF BOX) - (2 + SHIELD)

101	SIGNAL #20
102	COMMON #20
101	SIGNAL #20
102	COMMON #20
103	SHIELD DRAIN

140 230VAC 3PH POWER TO CHIP CONVEYOR MOTOR (5 + SHIELD)

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 (3 + SHIELD)

161	PHASE A 230VAC
162	PHASE B 230VAC
163	PHASE C 230VAC
164	SHIELD DRAIN

170 AUTO OFF FUNCTION - (2 + SHIELD)

171	UNSWITCHED LEG 1 #20
172	SWITCHED LEG 2 #20
173	SHIELD DRAIN

180 COOLANT SPIGOT DETENT SWITCH (2 + SHIELD)

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 (40 PINS)

220 SERVO BRAKE 115VAC - (2 + SHIELD)

221	115VAC COMMON
222	115VAC SWITCHED
223	SHIELD DRAIN

230 5'th AXIS BRAKE

240 SPARE INPUTS FROM IOPCB P25

250 SPARE OUTPUTS FROM IOPCB P45

260 K210 CABLING FOR EC

270 K111 CABLING FOR EC

280	RED/GREEN STATUS LIGHT WIRING (3+ SHIELD)
281	RED LAMP 115VAC
282	GREEN LAMP 115VAC
283	COMMON 115VAC
284	SHIELD DRAIN
300	115VAC TO SPINDLE MOTOR FAN/OIL PUMP/OILER (2 + SHIELD)
301	LEG 1 115VAC PROTECTED #18
302	LEG 2 115VAC PROTECTED #18
303	SHIELD DRAIN
350	SERVO BRAKE RELEASE 115VAC - (2 + SHIELD)
351	LEG 1 COMMON
352	LEG 2 SWITCHED
353	SHIELD DRAIN
360-389	RESERVED
390	115VAC TO 4'TH AXIS BRAKE (LATHE PART DOOR) - (2 + SHIELD)
391	LEG 1 COMMON
392	LEG 2 SWITCHED
393	SHIELD DRAIN
410-483	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 - (2 + SHIELD)
501	OVERTEMP WIRE 1 #20 (N.C.)
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 (MOTIF-P10) 34 WIRE RIBBON #24
610	X AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD (MOTOR CONTROLLER BOARD SIDE CONNECTION)
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 - (3 + SHIELD)
651	LEG 1 OF 230VAC
652	LEG 2
653	LEG 3
654	SHIELD DRAIN

650A	THREE PHASE POWER TO SPINDLE MOTOR - (3 + SHIELD)
651A	LEG 1 OF 230VAC
652A	LEG 2
653A	LEG 3
654A	SHIELD DRAIN
650B	THREE PHASE POWER TO SPINDLE MOTOR - (3 + SHIELD)
651B	LEG 1 OF 230VAC
652B	LEG 2
653B	LEG 3
654B	SHIELD DRAIN
660	X-ENCODER CABLE (ALL #24)
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	FORWARD/REVERSE/RESET TO SPINDLE - (4 + SHIELD)	(BRUSH SYSTEMS)
711	FORWARD COMMAND (CN1-19 TO IO P9-3)	
712	REVERSE COMMAND (CN1-19 TO IO P9-3)	
713	RESET COMMAND (CN1-21 TO IO P9-2)	
714	COMMON (CN1-14 TO IO P9-1)	
715	SHIELD DRAIN	
720	ANALOG SPEED COMMAND TO SPINDLE - (2 + SHIELD)	(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 - (2 + SHIELD)	(BRUSH SYSTEMS)
731	METER + (SPINDLE DRIVE CN1-5 TO KBIF) #24	
732	METER - (CN1-6 TO KBIF) #24	
723	SHILD DRAIN	
730A	POWER METER FROM KBIF TO METER - (2 + SHIELD)	(BRUSH SYSTEMS)
733	METER + AFTER TRIM POT (KBIF TO METER) #24	
734	METER - AFTER TRIM POT (KBIF TO METER) #24	
734	METER - AFTER TRIM POT (KBIF TO METER) #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 - (4 + SHIELD)	
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) - (4 + SHIELD) (ALL #28) (CABLE NUMBER 33-5750)	
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 - (9 + SHIELD) (ALL #24) (FROM VIDEO P3 TO CRT)
770	EMERGENCY STOP INPUT CABLE - SHIELD +2
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 - (4 + SHIELD) (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	SPARE INPUTS FROM IOPCB P24
791	SPARE 1
792	SPARE 2
793	COMMON
810	TOOL CHANGER MOTORS - (2 + SHIELD) #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 - (2 + SHIELD) #20
813	SHUTTLE MOTOR - (IO P30-4 TO P6-A) #14
814	SHUTTLE MOTOR + (IO P30-3 TO P6-B) #14
812	SHIELD DRAIN
820	TOOL CHANGER STATUS - (7 + SHIELD)7
821	LOGIC RETURN (D GROUND) (P6-F/H/L/M) #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

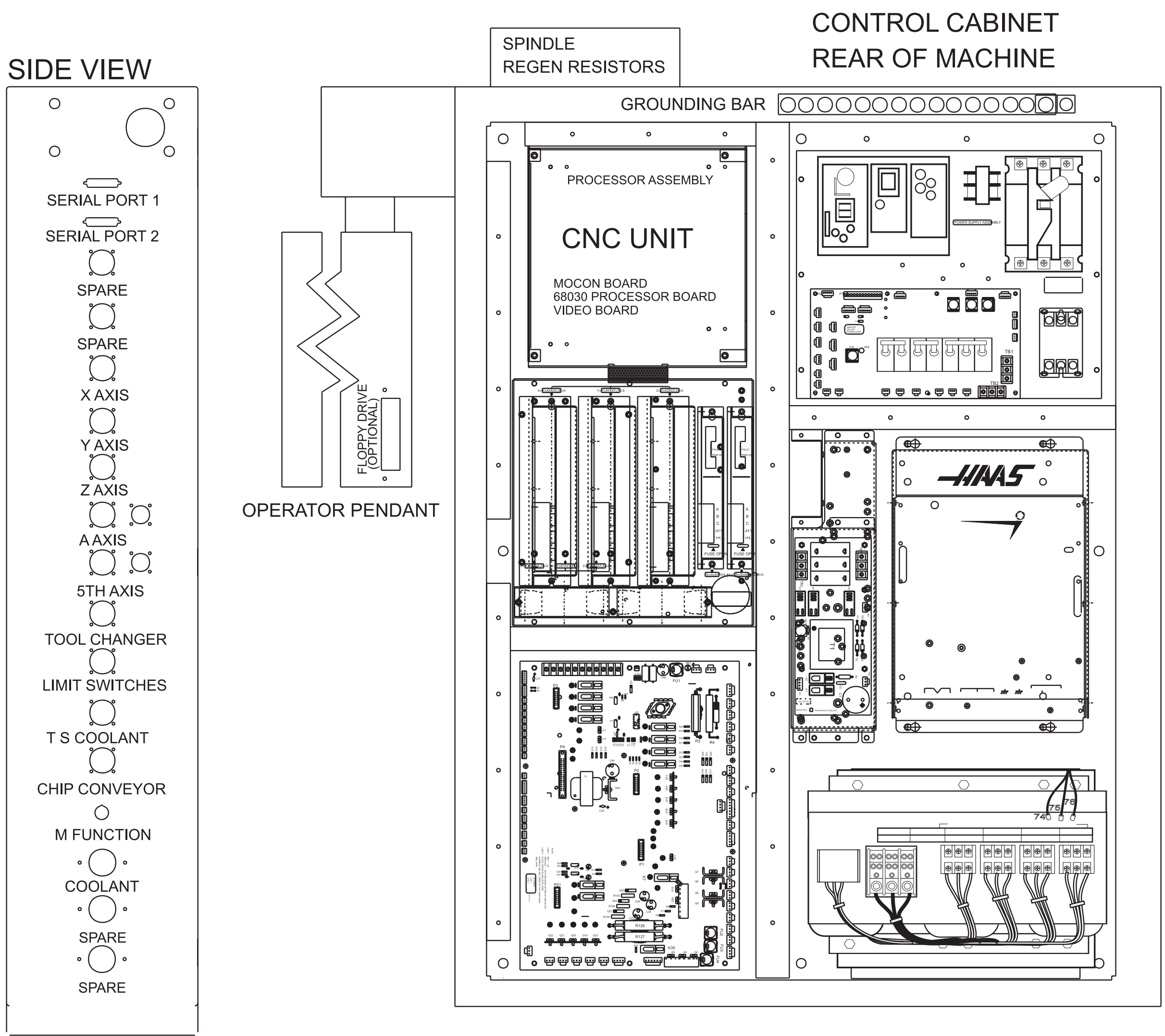
830	OVERHEAT THERMOSTAT - (2 + SHIELD)
831	OVERHEAT SIGNAL (INPUT 14) #20
832	OVERHEAT RETURN (D GROUND) (65) #20
833	SHIELD DRAIN
840	CIRCUIT BREAKER FOR 160 VDC - SHIELD +2
841	LEG 1 (TO 81) #14
842	LEG 2 #14
843	SHIELD DRAIN
850	SERIAL PORT #1 TO SERIAL KEYBOARD INTERFACE CABLE (16 WIRE RIBBON #24)
850A	SERIAL PORT #2 INTERFACE CABLE (16 WIRE RIBBON #24)
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 (6 + SHIELD)
891	SIGNAL RETURN (D GROUND) (65) #24
892	HIGH GEAR (INPUT 6) #24
893	LOW GEAR (INPUT 7) #24
894	TOOL UNCLAMPED (INPUT 15) #24
895	TOOL CLAMPED (INPUT 16) #24
896	SPINDLE LOCKED (INPUT 17) #24
897	SHIELD DRAIN
900	LOW COOLANT STATUS - (2 + SHIELD)
901	LOW COOLANT SIGNAL (INPUT 4 TO P7-C) #20
902	LOW COOLANT RETURN (D GROUND) (65 TO P7-D) #20
903	SHIELD DRAIN
910	115 VAC CIRCUIT BREAKER TO SOLENOIDS - (2 + SHIELD)
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 - (2 + SHIELD) (BRUSH SYSTEMS)
921	LEG 1 #18
922	LEG 2 #18
923	SHIELD DRAIN
930	FUSED 230 VAC FOR COOLANT PUMP - (2 + SHIELD)
931	LEG 1 #14
932	LEG 2 #14
933	SHIELD DRAIN
940	230 VAC TO COOLANT PUMP - (2 + SHIELD)
941	LEG 1 (P7-A) #14
942	LEG 2 (P7-F) #14
943	SHIELD DRAIN
950	LOW AIR PRESSURE SENSOR - (3 + SHIELD)
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 - (2 + SHIELD)
952	LOW HYDRAULIC RETURN (D GROUND) (65) #20
953	LOW HYD PRESSURE SWITCH FOR VERTICAL TRANSMISSION #20
954	SHIELD DRAIN

960	LOW LUB/DOOR OPEN SENSORS - (4 + SHIELD)
961	LOW LUB SIGNAL (INPUT 13) #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 - (2 + SHIELD)
971	LOW VOL SIGNAL (INPUT 11 FROM PMON P9-3) #24
972	LOW VOL RETURN (D GROUND) (PMON P9-4) #24
973	SHIELD DRAIN
980	VOLTAGE MONITOR - (2 + SHIELD)
981	VOLTAGE MONITOR 0 TO +5 (PMON P9-1 / MOTIF P17-1) #24
982	VOLTAGE MON RET (A GND) (PMON P9-2 / MOTIF P17-2) #24
983	VOLTAGE MON RET (A GND) (PMON P9-2 / MOTIF P17-2) #24
990	HOME SENSORS - (4 + SHIELD)
991	X HOME SWITCH (MOTIF P24-2 TO P5-B) #24
992	Y HOME SWITCH (MOTIF P24-3 TO P5-D) #24 (LATHE TAIL STOCK)
993	Z HOME SWITCH (MOTIF P24-4 TO P5-L) #24
994	HOME SWITCH RETURN (MOTIF P24-1 TO P5-C) #24
995	SHIELD DRAIN
1000	SPINDLE ENCODER CABLE - (5 + SHIELD) (LATHE TAIL STOCK)(BRUSH SYSTEMS)
1001	LOGIC RETURN (D GROUND) (TO MOTIF P20-1) #24
1002	ENCODER A CHANNEL (TO MOTIF P20-2) #24
1003	ENCODER B CHANNEL (TO MOTIF P20-3) #24
1004	+5 VDC (TO MOTIF P20-4) #24
1005	ENCODER Z CHANNEL (TO MOTIF P20-5) #24
1006	SHIELD DRAIN
1020	SPINDLE TEMPERATURE SENSOR CABLE - (3 + SHIELD)
1021	SIGNAL
1022	ANALOG RETURN
1023	+5 VOLTS TO SENSOR
1024	SHIELD GROUND
1030	SPINDLE LOAD RESISTOR - (2 + SHIELD)
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 - (2 + SHIELD)
1051	DOOR OPEN SIGNAL (INPUT 9) #24
1052	DOOR OPEN RETURN (D GROUND) (65) #24
1053	SHIELD DRAIN

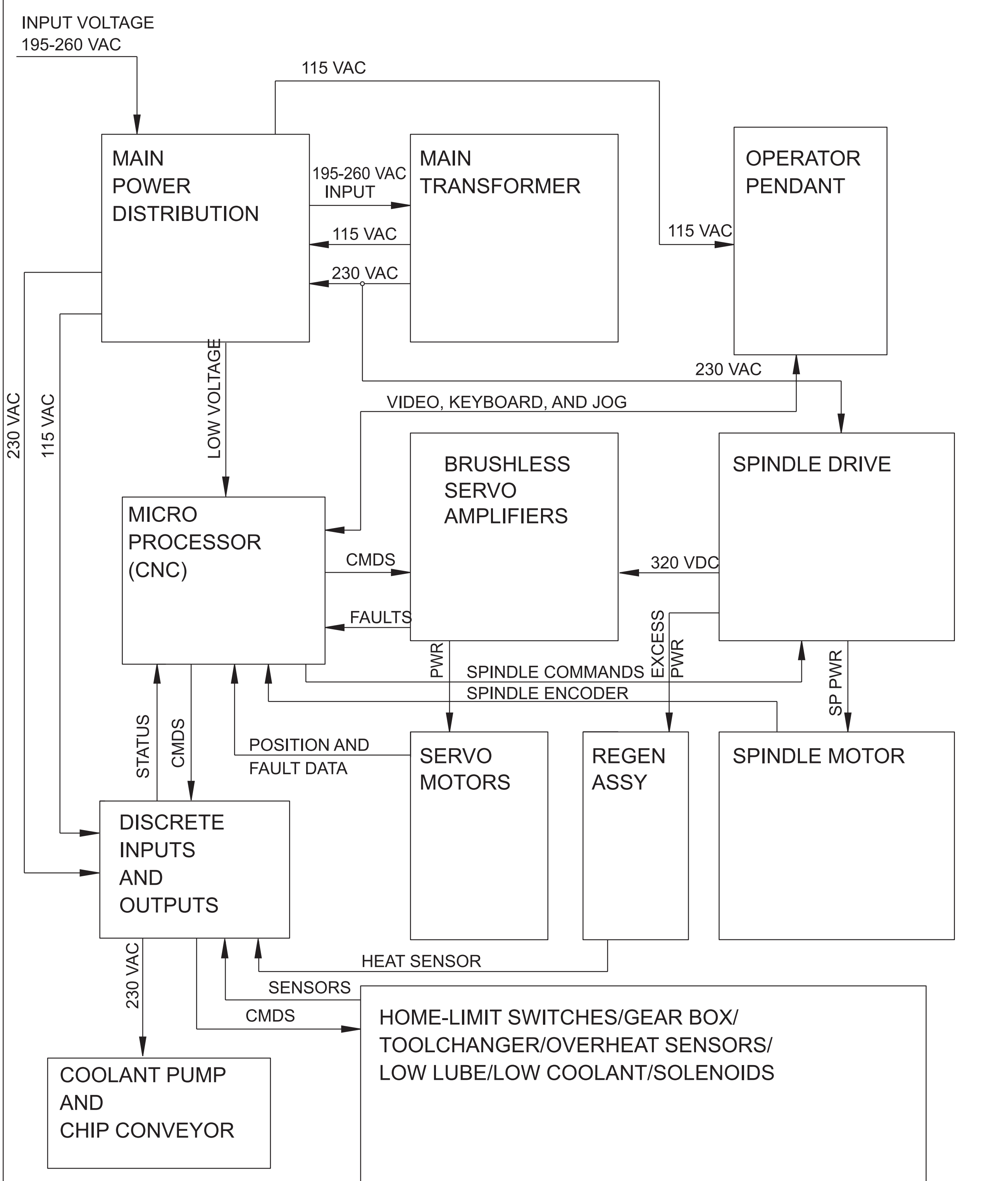
1060	GROUND FAULT DETECTION SENSE INPUT
1061	+ INPUT FROM SENSE RESISTOR
1062	- INPUT FROM SENSE RESISTOR
1070	SKIP INPUT FROM SENSOR - (2 + SHIELD)
1071	LOGIC COMMON
1072	SKIP SIGNAL
1073	SHIELD DRAIN

ELECTRICAL
WIRING DIAGRAMS



CONTROL LAYOUT DIAGRAM

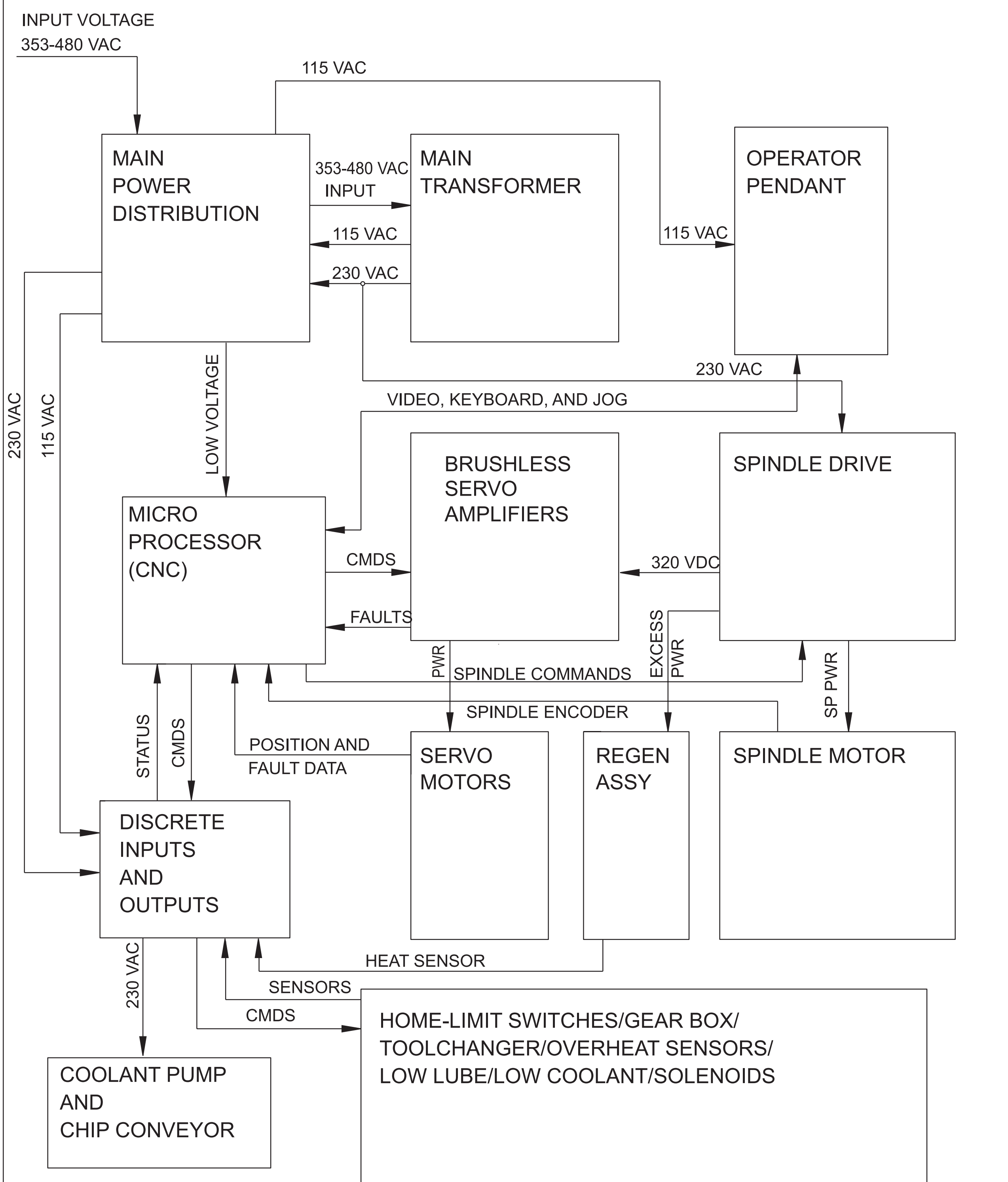
HAAS AUTOMATION VF SERIES PAGE A



NOTE FOR HIGH VOLTAGE IN, SEE PAGE C.

SYSTEM BLOCK DIAGRAM - LOW VOLTAGE

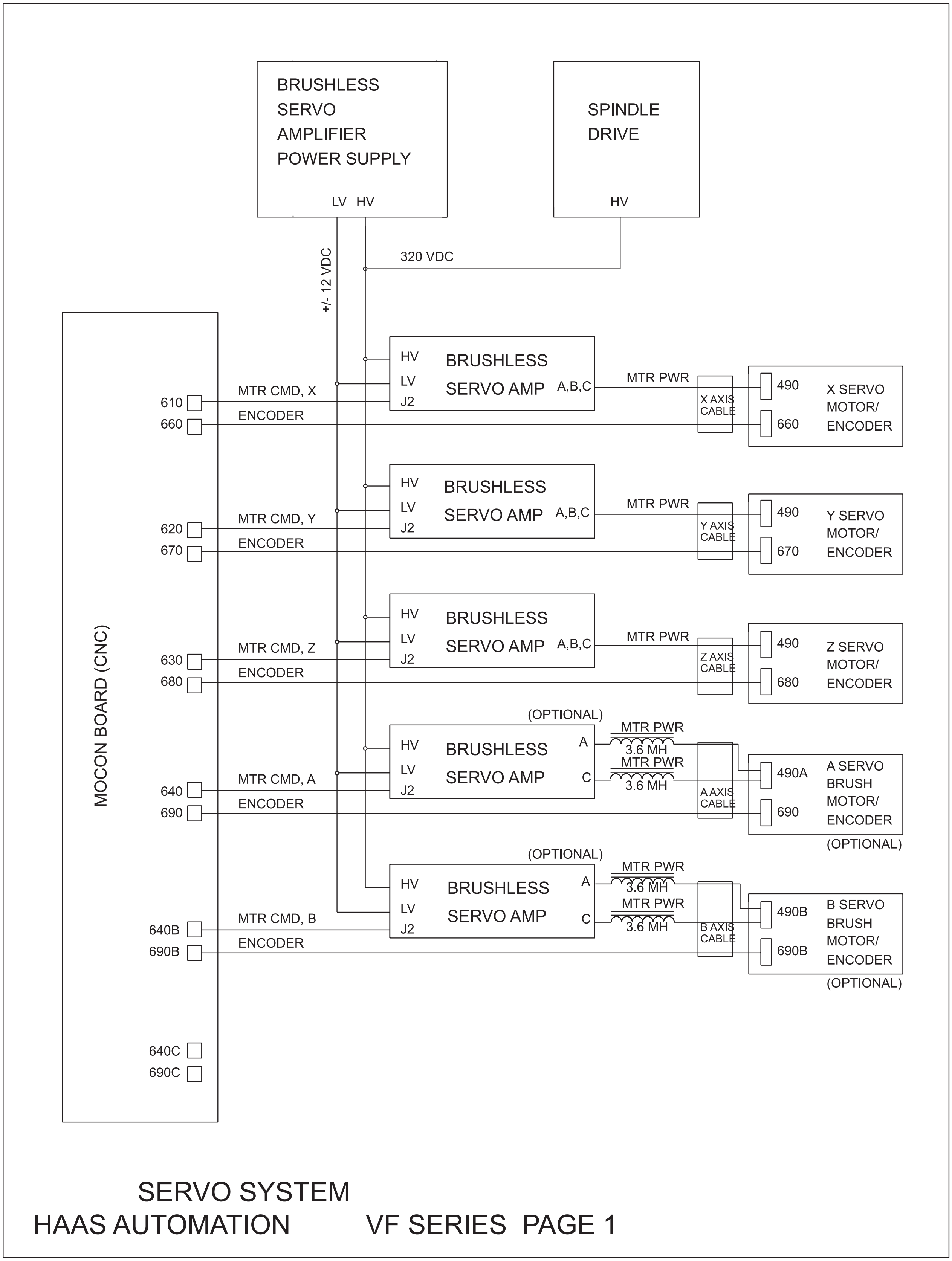
HAAS AUTOMATION VF SERIES PAGE B

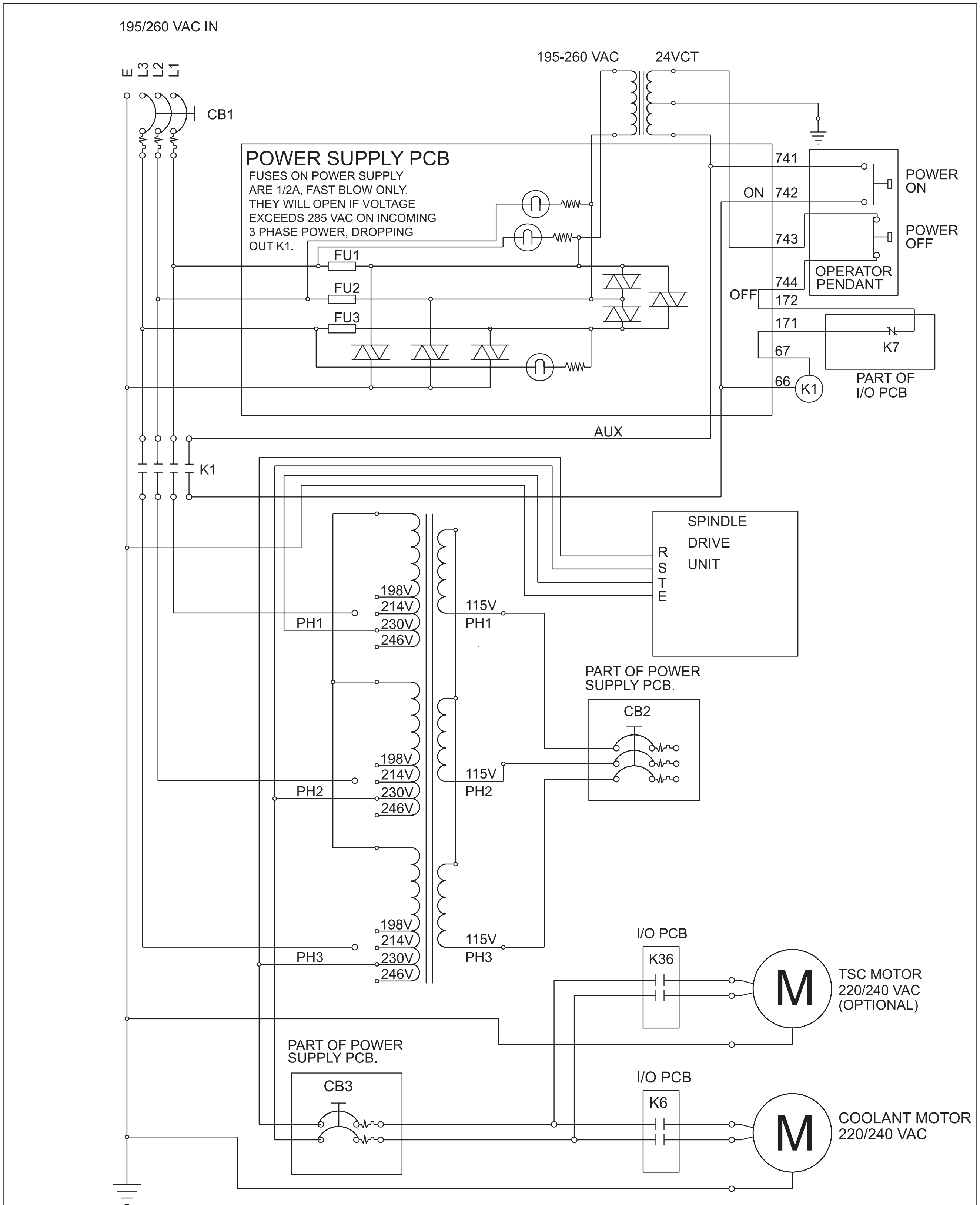


NOTE FOR LOW VOLTAGE IN, SEE PAGE B.

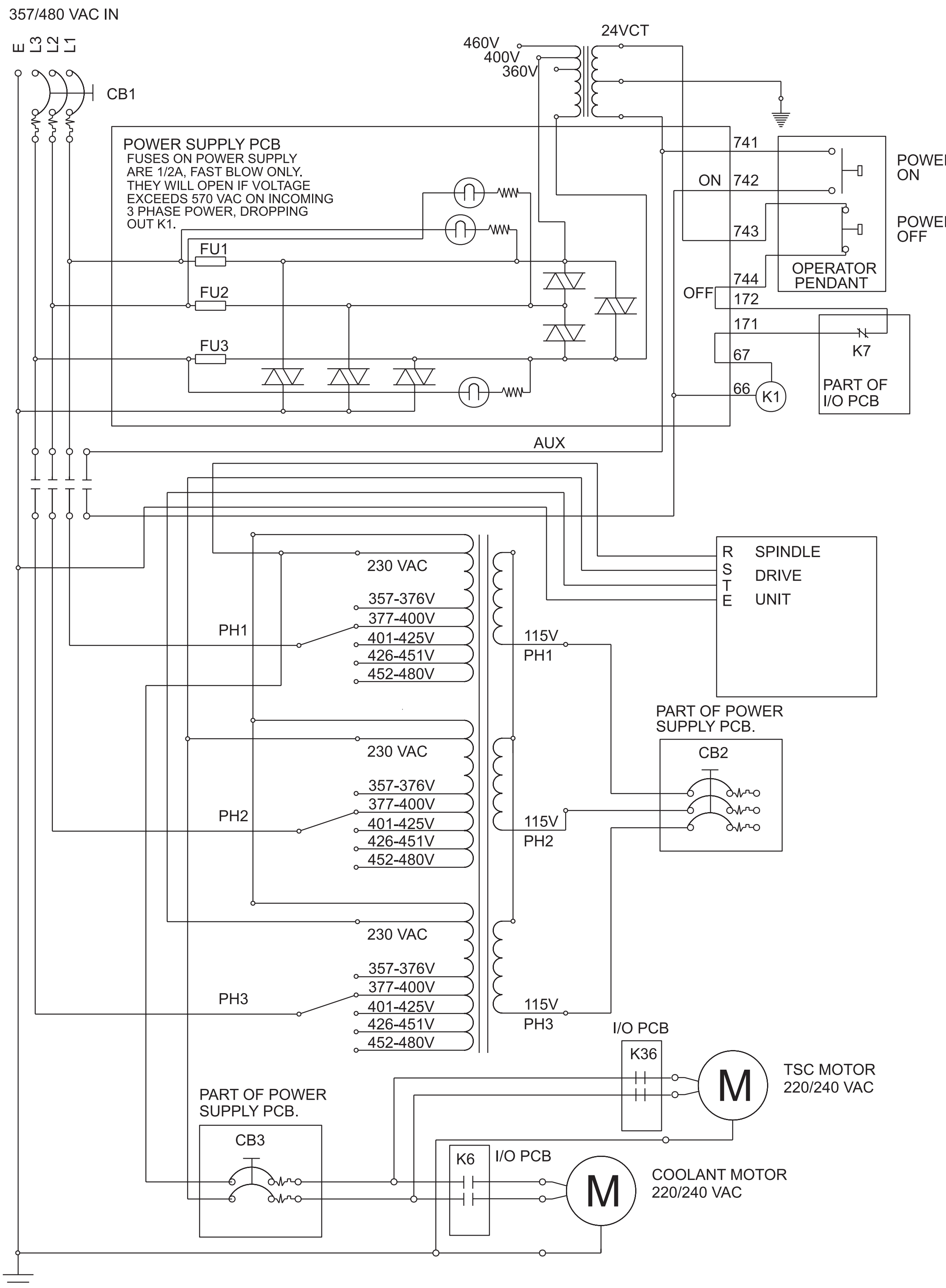
SYSTEM BLOCK DIAGRAM - HIGH VOLTAGE

HAAS AUTOMATION VF SERIES PAGE C

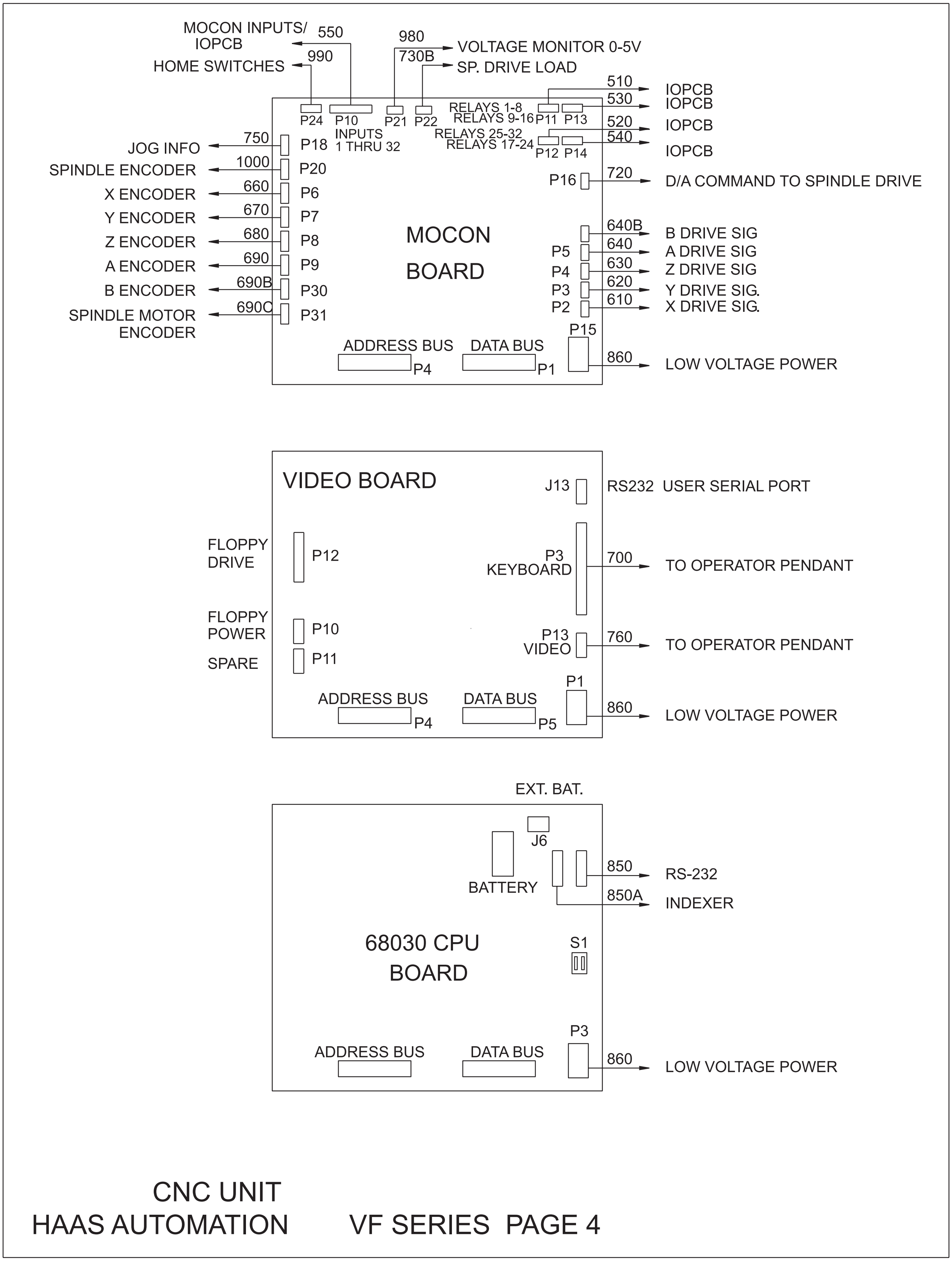

BRUSHLESS SERVO AMPLIFIER POWER SUPPLY
LV HV
SPINDLE DRIVE
HV
320 VDC
+/- 12 VDC
MOCON BOARD (CNC)
610
660
620
670
630
680
640
690
640B
690B
640C
690C
MTR CMD, X
ENCODER
MTR CMD, Y
ENCODER
MTR CMD, Z
ENCODER
MTR CMD, A
ENCODER
MTR CMD, B
ENCODER
HV
LV
J2
BRUSHLESS SERVO AMP
A,B,C
A
C
(OPTIONAL)
MTR PWR
3.6 MH
X AXIS CABLE
Y AXIS CABLE
Z AXIS CABLE
A AXIS CABLE
B AXIS CABLE
490
660
X SERVO MOTOR/ ENCODER
670
Y SERVO MOTOR/ ENCODER
680
Z SERVO MOTOR/ ENCODER
490A
690
A SERVO BRUSH MOTOR/ ENCODER
490B
690B
B SERVO BRUSH MOTOR/ ENCODER
SERVO SYSTEM
HAAS AUTOMATION
VF SERIES PAGE 1

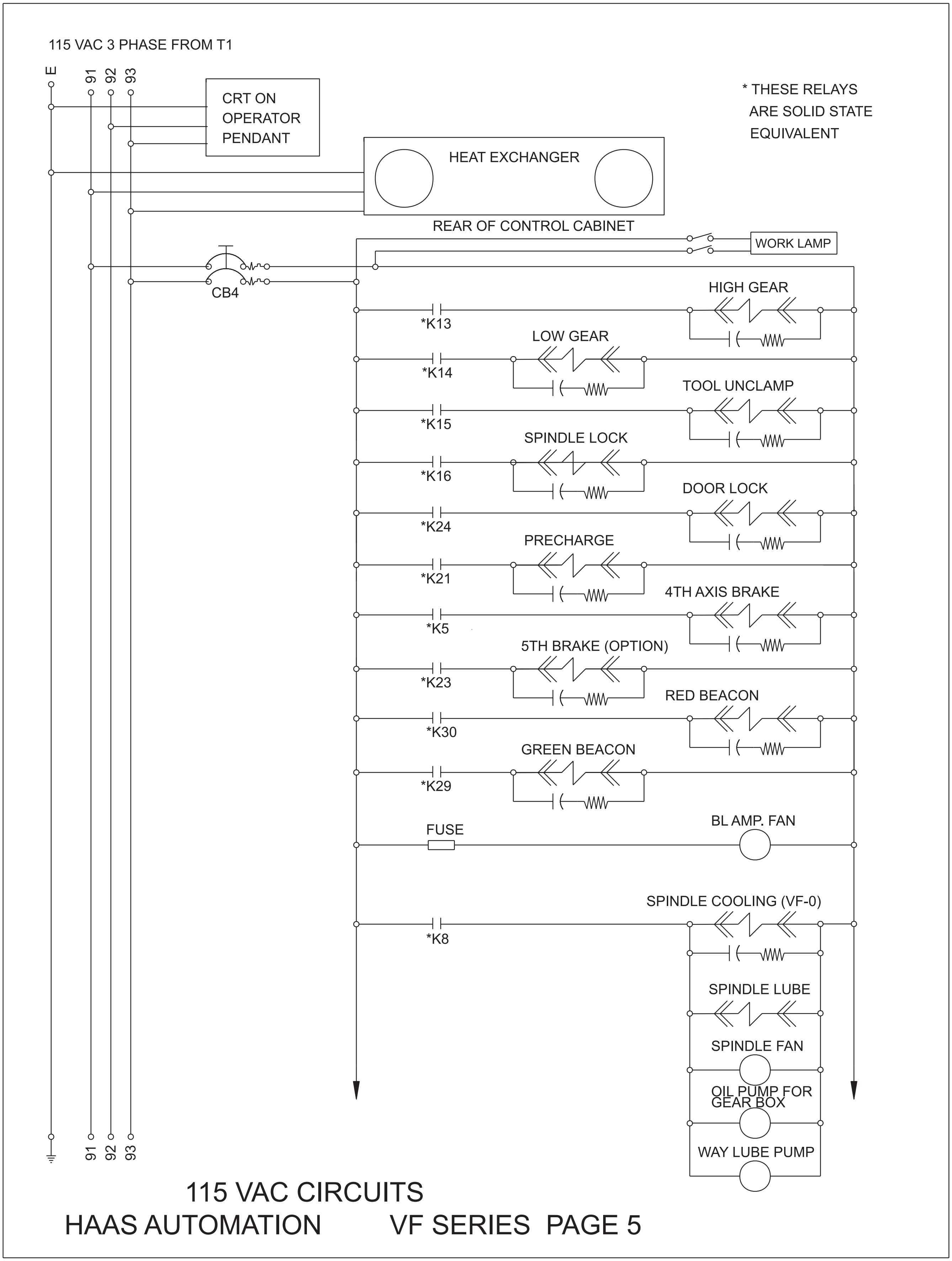


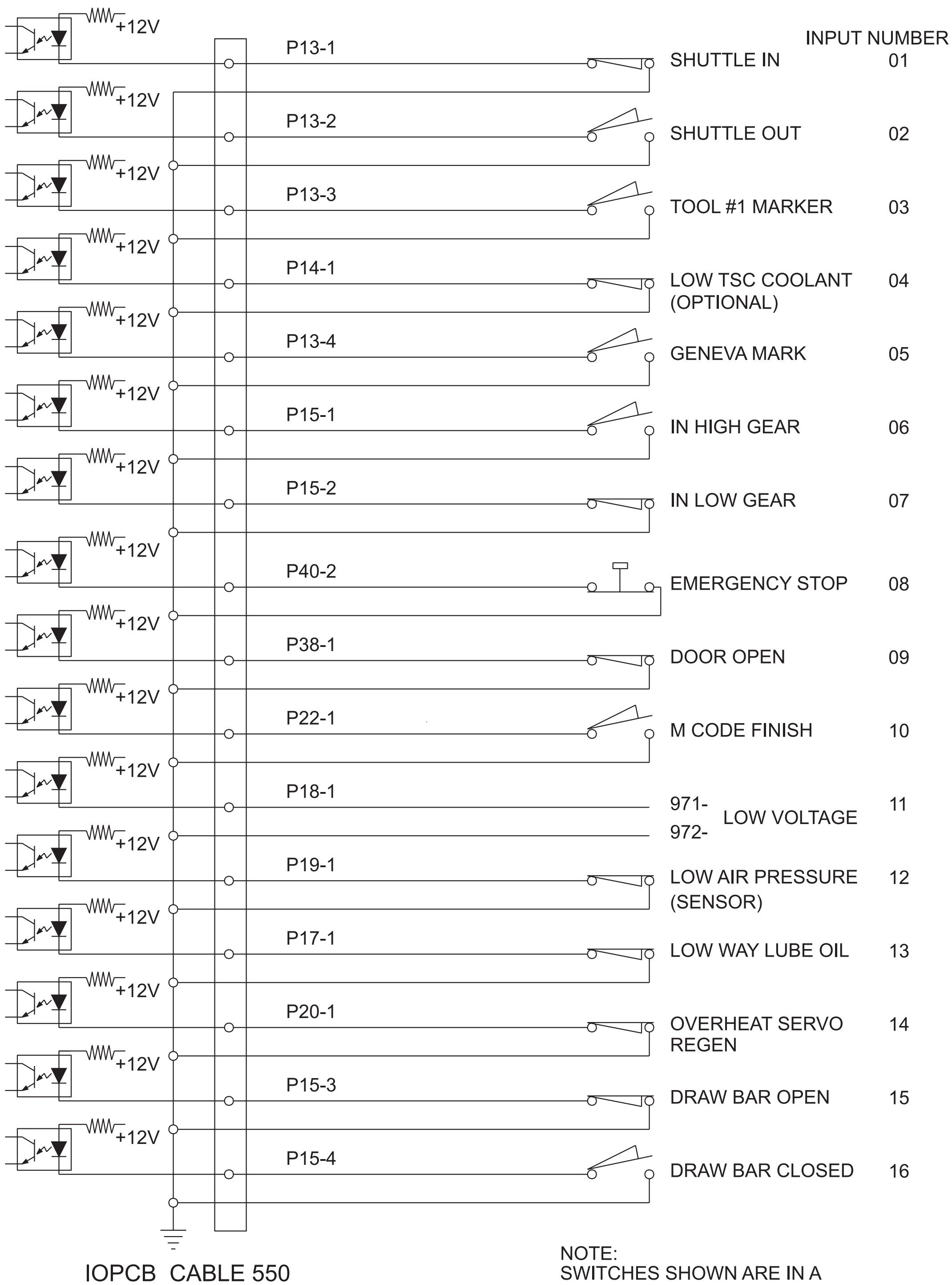
MAIN TRANSFORMER - LOW VOLTAGE
HAAS AUTOMATION VF SERIES PAGE 2



MAIN TRANSFORMER - HIGH VOLTAGE
HAAS AUTOMATION VF SERIES PAGE 3

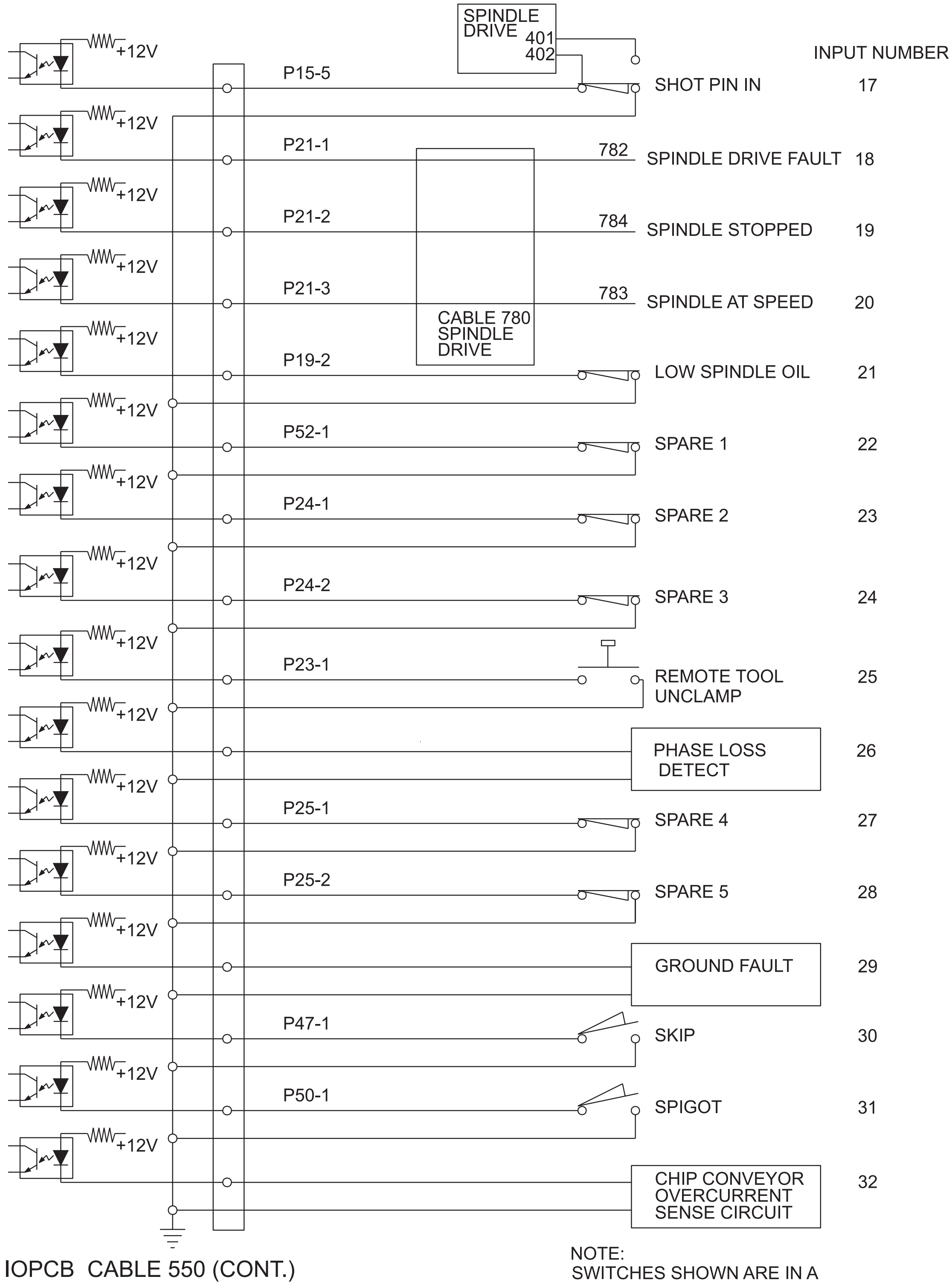

MOCON INPUTS/
IOPCB
HOME SWITCHES
550
990
980
730B
VOLTAGE MONITOR 0-5V
SP. DRIVE LOAD
510
530
520
540
IOPCB
IOPCB
IOPCB
IOPCB
P24
P10
P21
P22
RELAYS 1-8
RELAYS 9-16
RELAYS 25-32
RELAYS 17-24
P11
P13
P12
P14
INPUTS
1 THRU 32
JOG INFO
SPINDLE ENCODER
X ENCODER
Y ENCODER
Z ENCODER
A ENCODER
B ENCODER
SPINDLE MOTOR
ENCODER
750
1000
660
670
680
690
690B
690C
P18
P20
P6
P7
P8
P9
P30
P31
MOCON
BOARD
P16
720
D/A COMMAND TO SPINDLE DRIVE
640B
640
630
620
610
P5
P4
P3
P2
B DRIVE SIG
A DRIVE SIG
Z DRIVE SIG
Y DRIVE SIG.
X DRIVE SIG.
P15
ADDRESS BUS
DATA BUS
P4
P1
860
LOW VOLTAGE POWER
VIDEO BOARD
J13
RS232 USER SERIAL PORT
FLOPPY
DRIVE
P12
P3
KEYBOARD
700
TO OPERATOR PENDANT
FLOPPY
POWER
P10
SPARE
P11
P13
VIDEO
760
TO OPERATOR PENDANT
P1
ADDRESS BUS
DATA BUS
P4
P5
860
LOW VOLTAGE POWER
EXT. BAT.
J6
BATTERY
850
850A
RS-232
INDEXER
68030 CPU
BOARD
S1
P3
ADDRESS BUS
DATA BUS
860
LOW VOLTAGE POWER
CNC UNIT
HAAS AUTOMATION
VF SERIES PAGE 4


115 VAC 3 PHASE FROM T1
E
91
92
93
CRT ON
OPERATOR
PENDANT
* THESE RELAYS
ARE SOLID STATE
EQUIVALENT
HEAT EXCHANGER
REAR OF CONTROL CABINET
WORK LAMP
CB4
HIGH GEAR
*K13
LOW GEAR
*K14
TOOL UNCLAMP
*K15
SPINDLE LOCK
*K16
DOOR LOCK
*K24
PRECHARGE
*K21
4TH AXIS BRAKE
*K5
5TH BRAKE (OPTION)
*K23
RED BEACON
*K30
GREEN BEACON
*K29
FUSE
BL AMP. FAN
SPINDLE COOLING (VF-0)
*K8
SPINDLE LUBE
SPINDLE FAN
OIL PUMP FOR
GEAR BOX
WAY LUBE PUMP
91
92
93
115 VAC CIRCUITS
HAAS AUTOMATION VF SERIES PAGE 5



NOTE:
SWITCHES SHOWN ARE IN A NON - ALARM STATE / HIGH GEAR / SHUTTLE OUT / TURRET AT TOOL 1 POSIT.

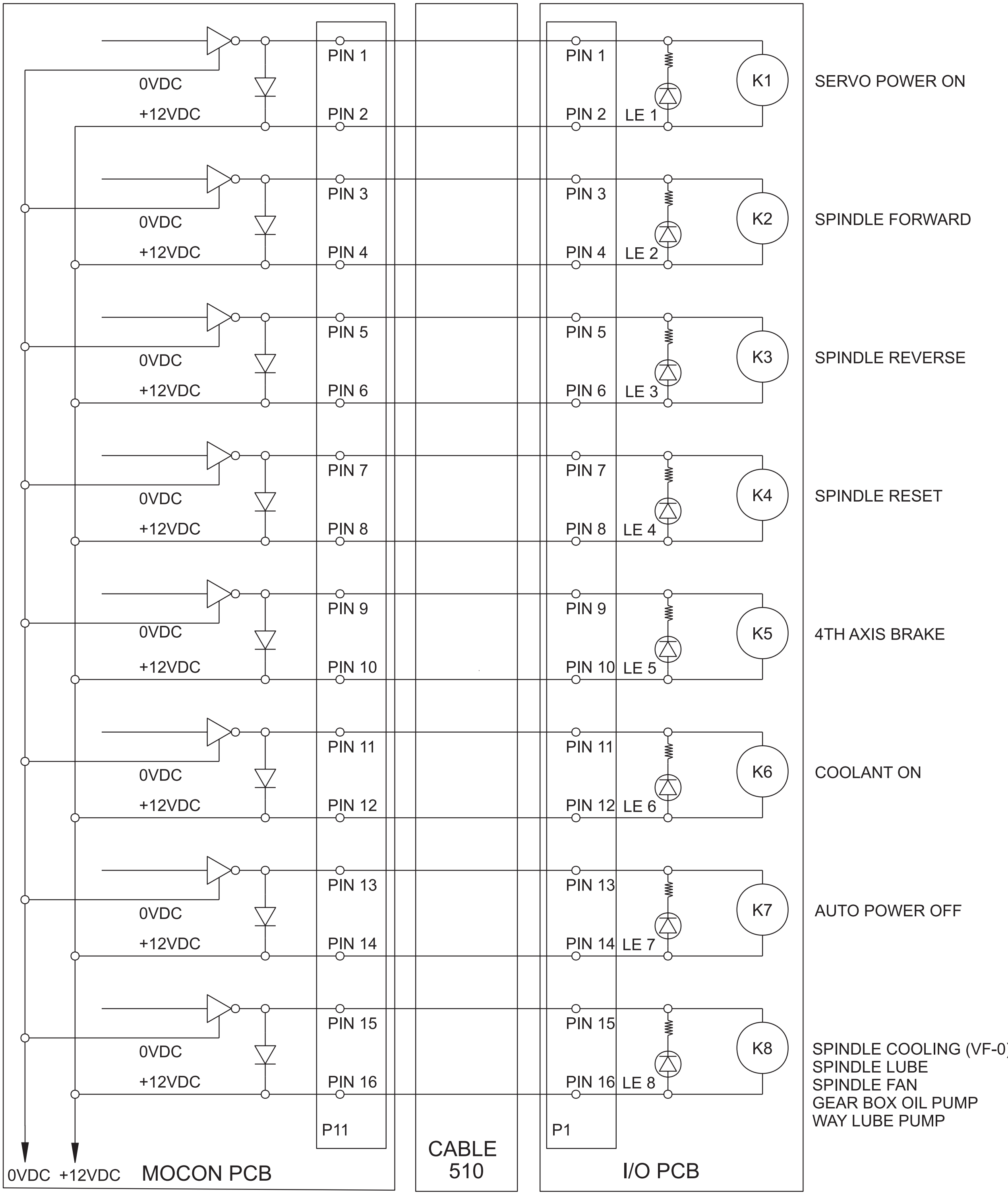
DISCRETE INPUTS 1 THROUGH 16
HAAS AUTOMATION VF SERIES PAGE 6



NOTE:
SWITCHES SHOWN ARE IN A NON - ALARM STATE / HIGH GEAR / SHUTTLE OUT / TURRET AT TOOL 1 POSIT.

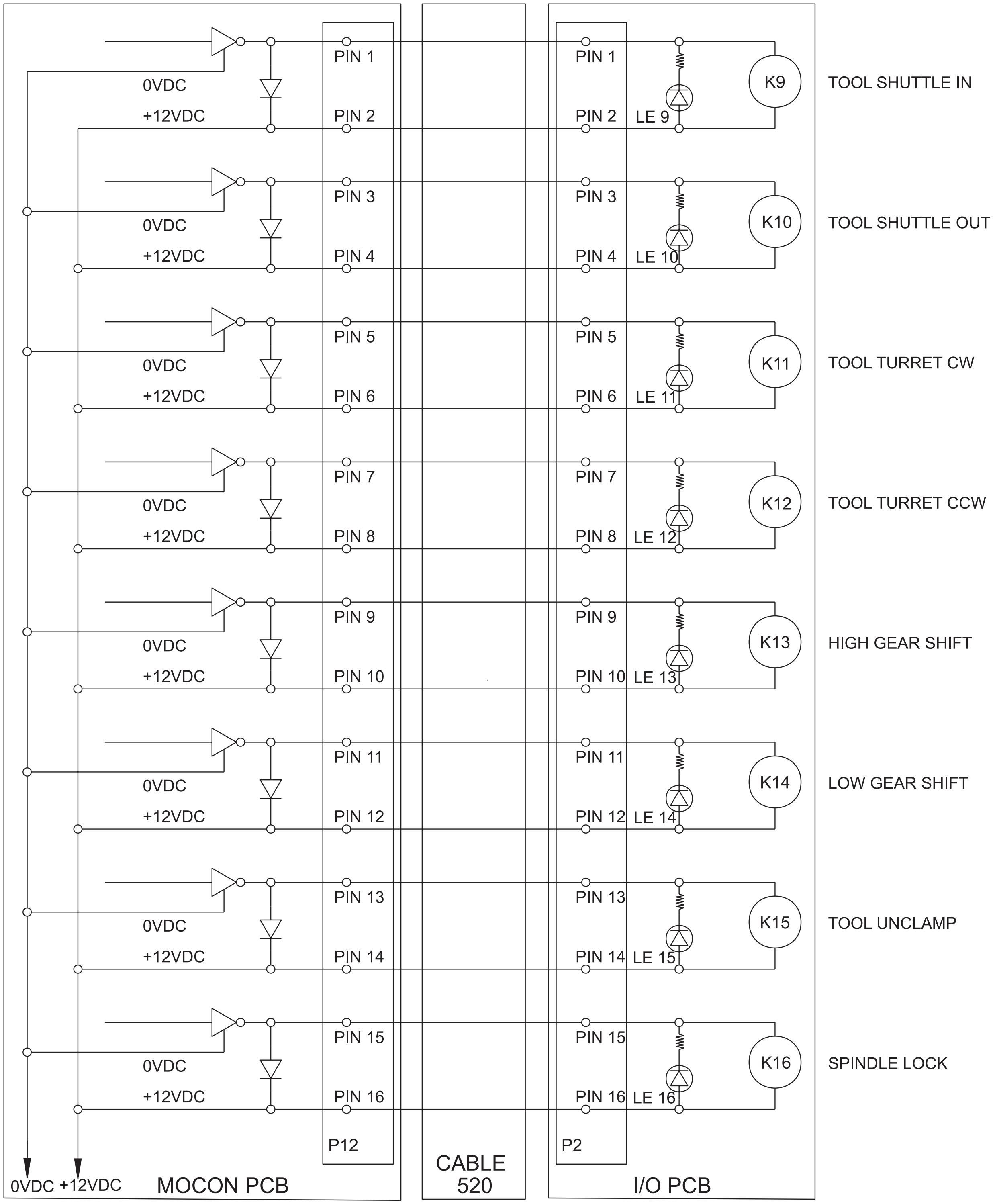
DISCRETE INPUTS 17 THROUGH 32

HAAS AUTOMATION VF SERIES PAGE 7



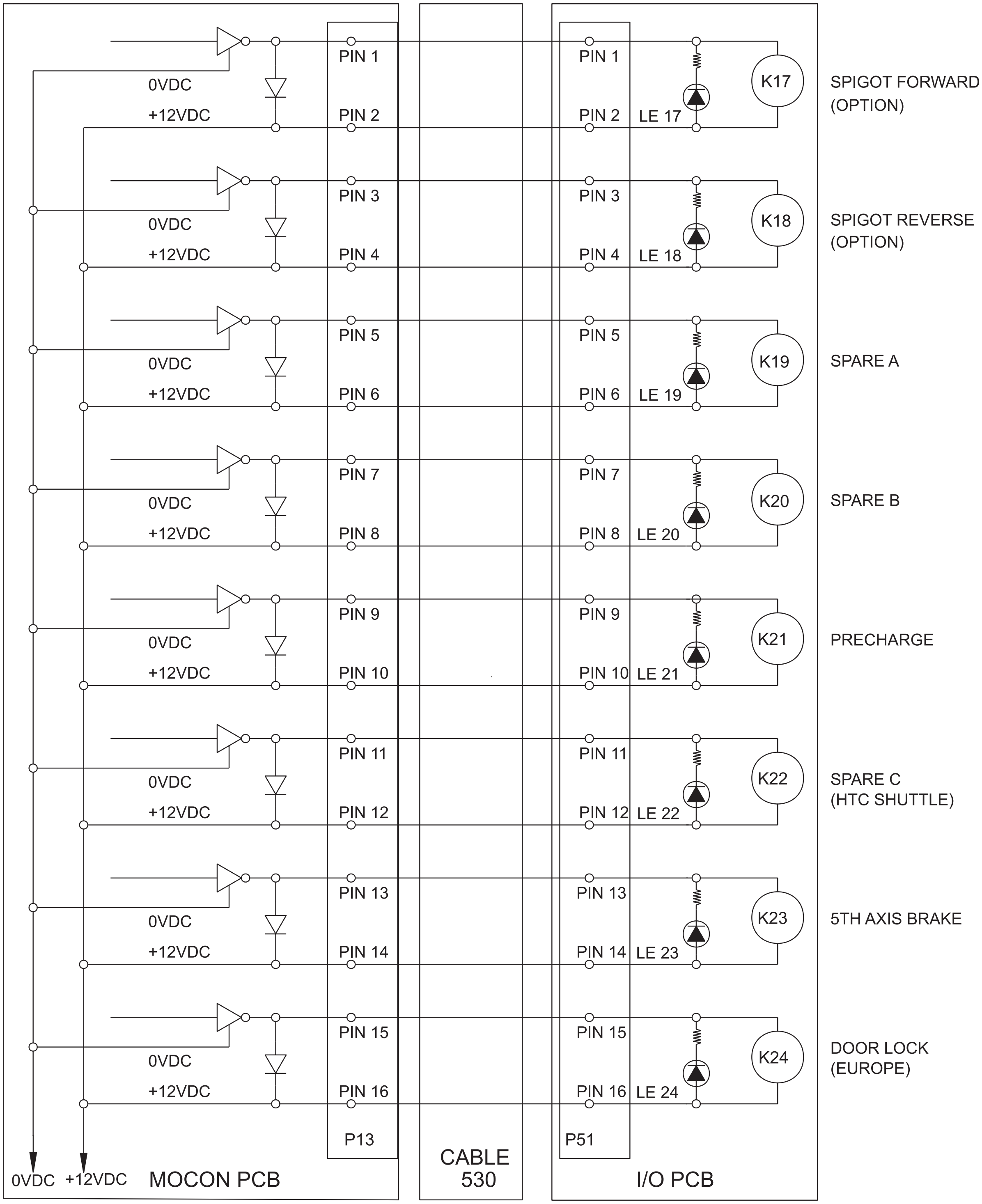
NOTE: ANY RELAY K1 ....K35 CAN BE REPLACED
WITH A SOLID STATE EQUIVALENT

RELAY COIL DRIVERS, K1 THROUGH K8
HAAS AUTOMATION VF SERIES PAGE 8



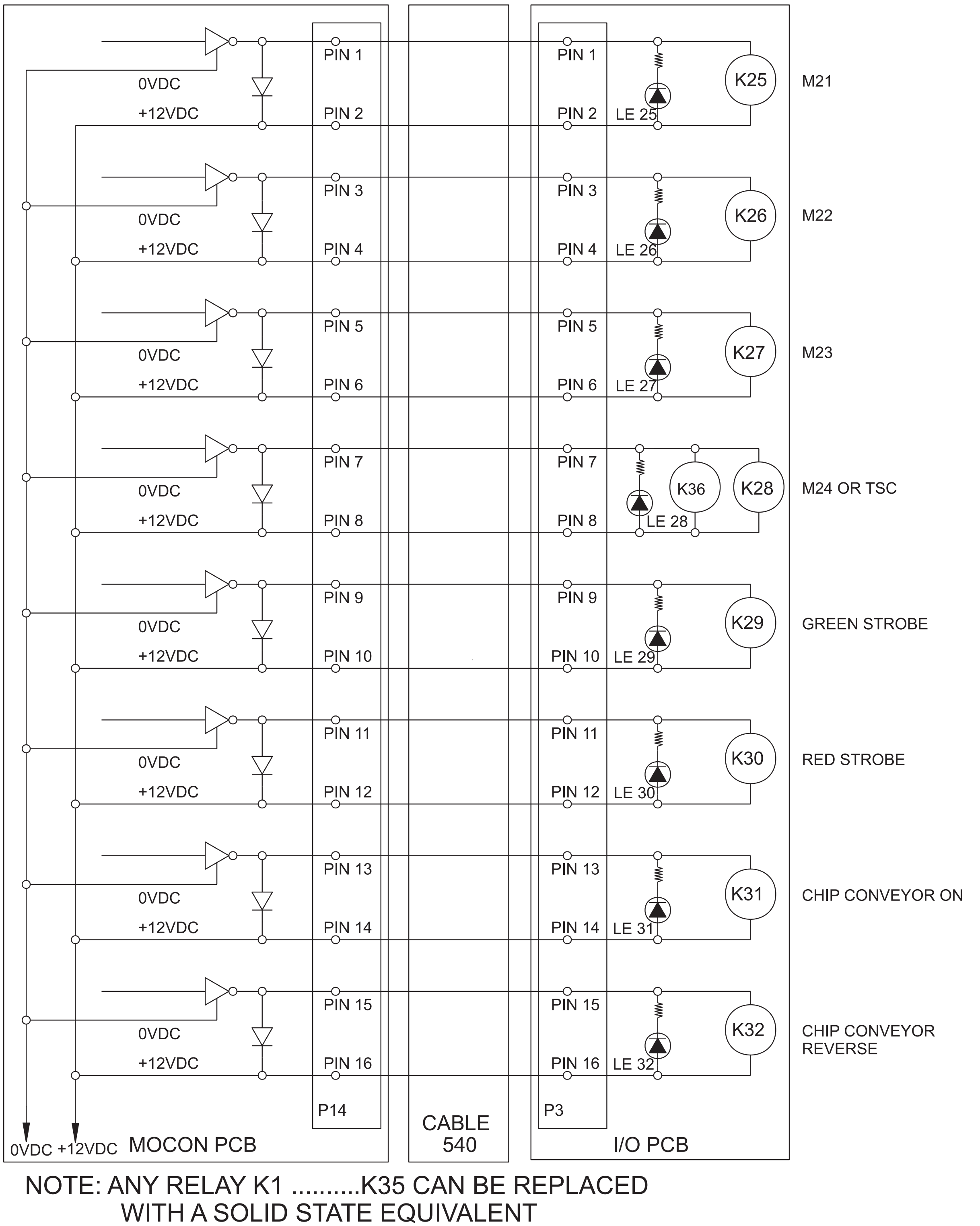
NOTE: ANY RELAY K1 ....K35 CAN BE REPLACED WITH A SOLID STATE EQUIVALENT

RELAY COIL DRIVERS, K9 THROUGH K16
HAAS AUTOMATION VF SERIES PAGE 9

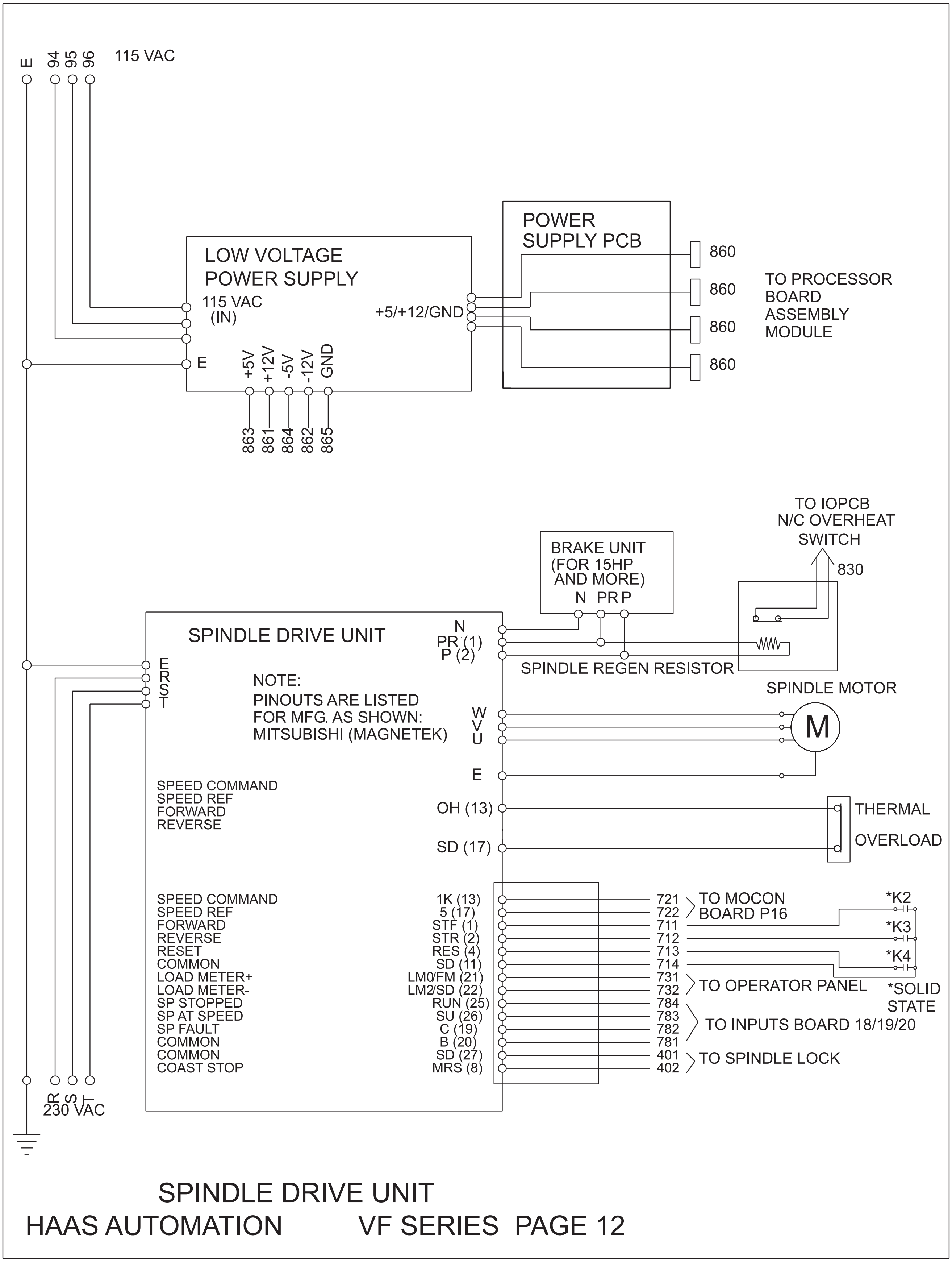


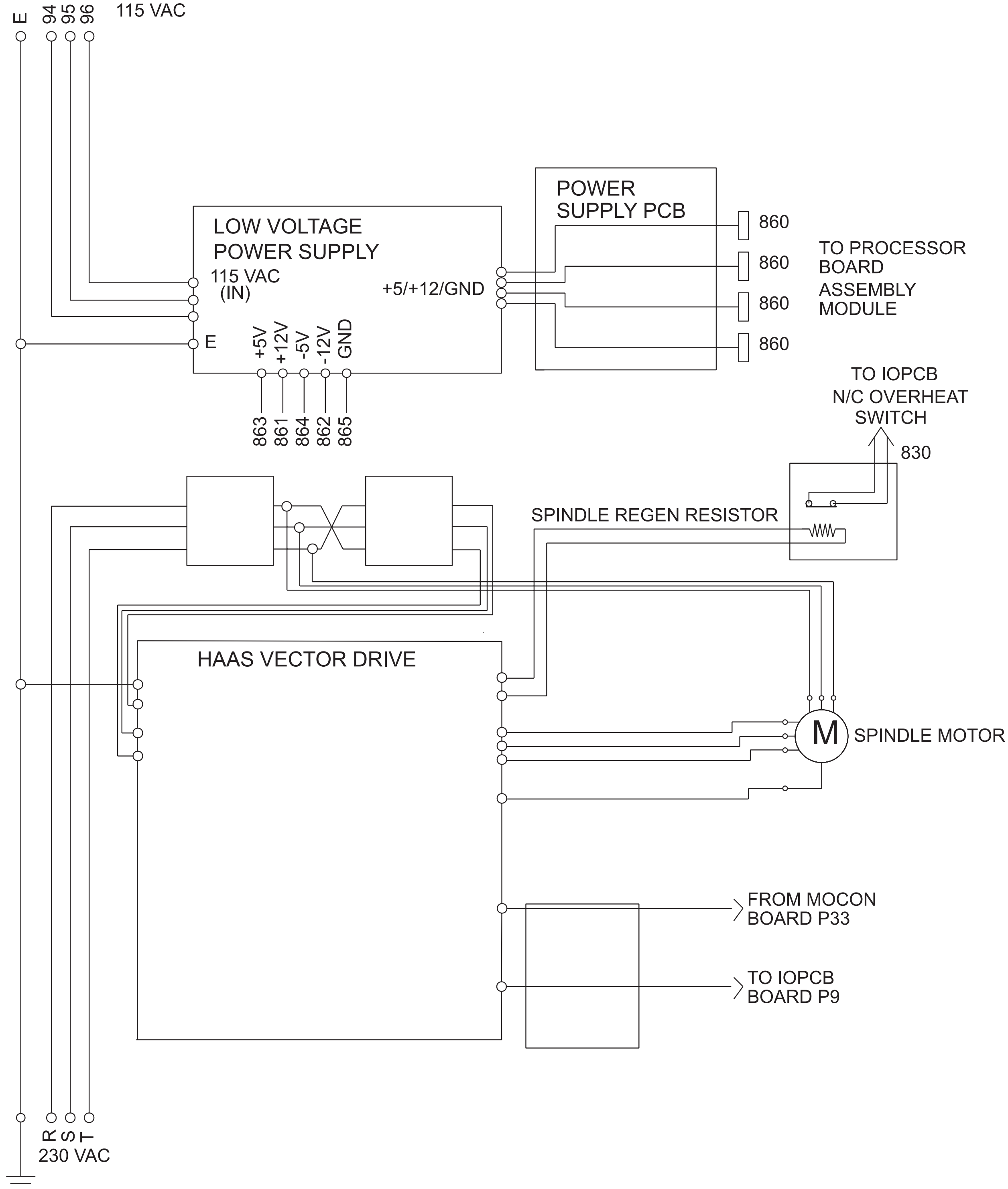
NOTE: ANY RELAY K1 ....K35 CAN BE REPLACED
WITH A SOLID STATE EQUIVALENT

RELAY COIL DRIVERS, K17 THROUGH K24
HAAS AUTOMATION VF SERIES PAGE 10



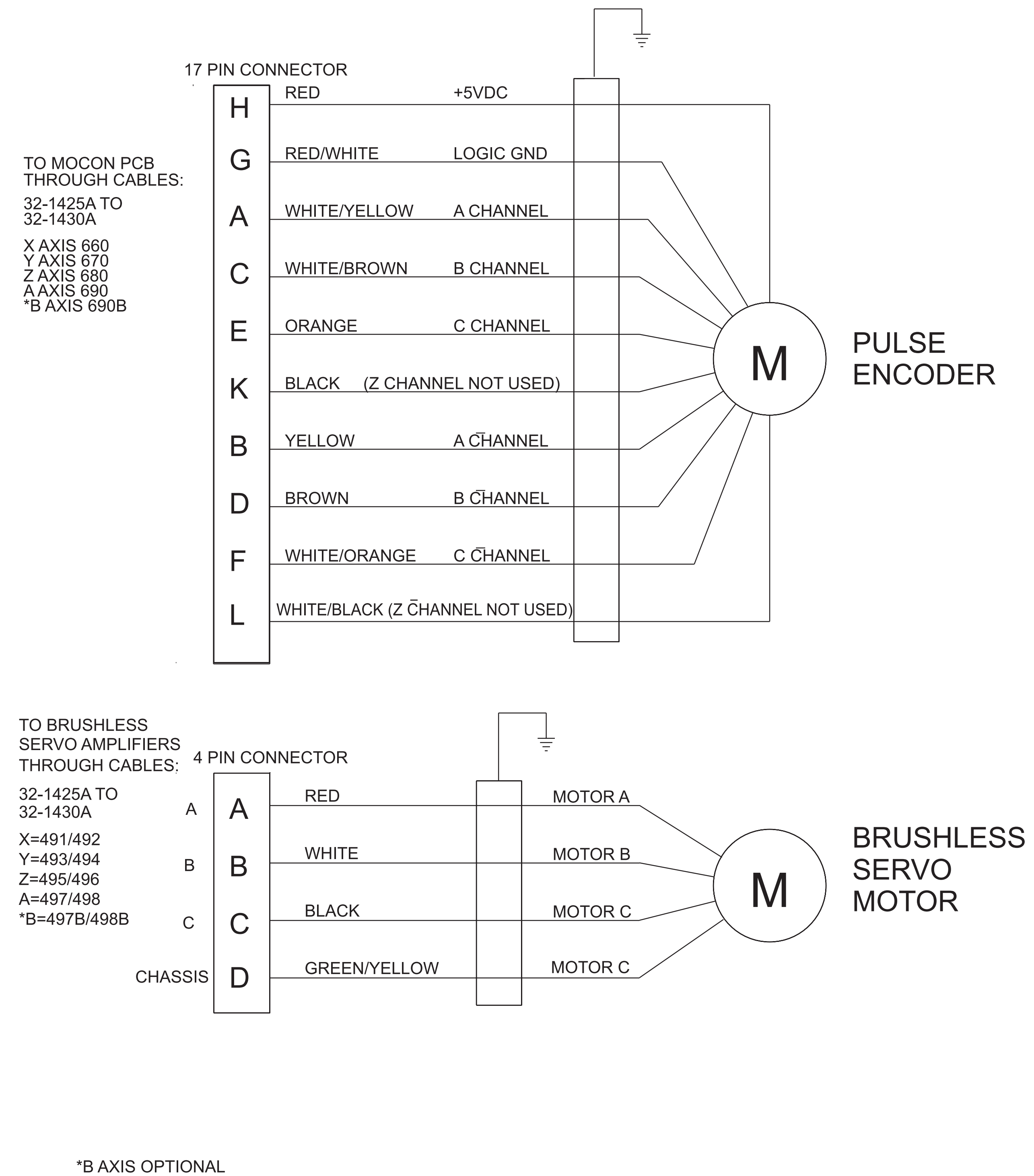
RELAY COIL DRIVERS, K25 THROUGH K32
HAAS AUTOMATION VF SERIES PAGE 11


E
94
95
96
115 VAC
LOW VOLTAGE
POWER SUPPLY
115 VAC
(IN)
E
+5/+12/GND
+5V
+12V
-5V
-12V
GND
863
861
864
862
865
POWER
SUPPLY PCB
860
860
860
860
TO PROCESSOR
BOARD
ASSEMBLY
MODULE
TO IOPCB
N/C OVERHEAT
SWITCH
830
BRAKE UNIT
(FOR 15HP
AND MORE)
N PR P
SPINDLE DRIVE UNIT
N
PR (1)
P (2)
SPINDLE REGEN RESISTOR
E
R
S
T
NOTE:
PINOUTS ARE LISTED
FOR MFG. AS SHOWN:
MITSUBISHI (MAGNETEK)
W
V
U
SPINDLE MOTOR
M
E
SPEED COMMAND
SPEED REF
FORWARD
REVERSE
OH (13)
SD (17)
THERMAL
OVERLOAD
SPEED COMMAND
SPEED REF
FORWARD
REVERSE
RESET
COMMON
LOAD METER+
LOAD METER-
SP STOPPED
SP AT SPEED
SP FAULT
COMMON
COMMON
COAST STOP
1K (13)
5 (17)
STF (1)
STR (2)
RES (4)
SD (11)
LM0/FM (21)
LM2/SD (22)
RUN (25)
SU (26)
C (19)
B (20)
SD (27)
MRS (8)
721
722
711
712
713
714
731
732
784
783
782
781
401
402
TO MOCON
BOARD P16
*K2
*K3
*K4
TO OPERATOR PANEL
*SOLID
STATE
TO INPUTS BOARD 18/19/20
TO SPINDLE LOCK
R
S
T
230 VAC
SPINDLE DRIVE UNIT
HAAS AUTOMATION
VF SERIES PAGE 12

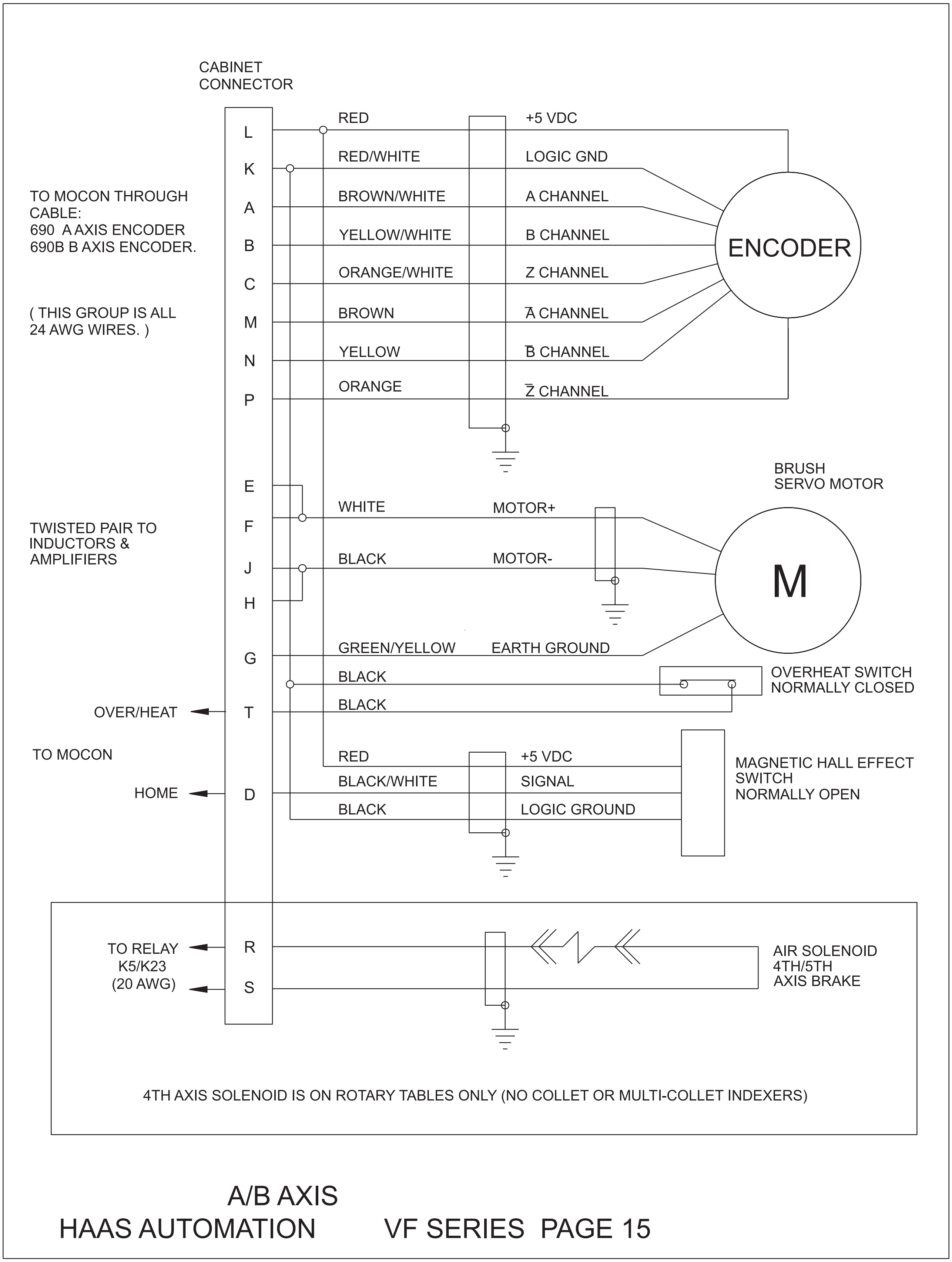


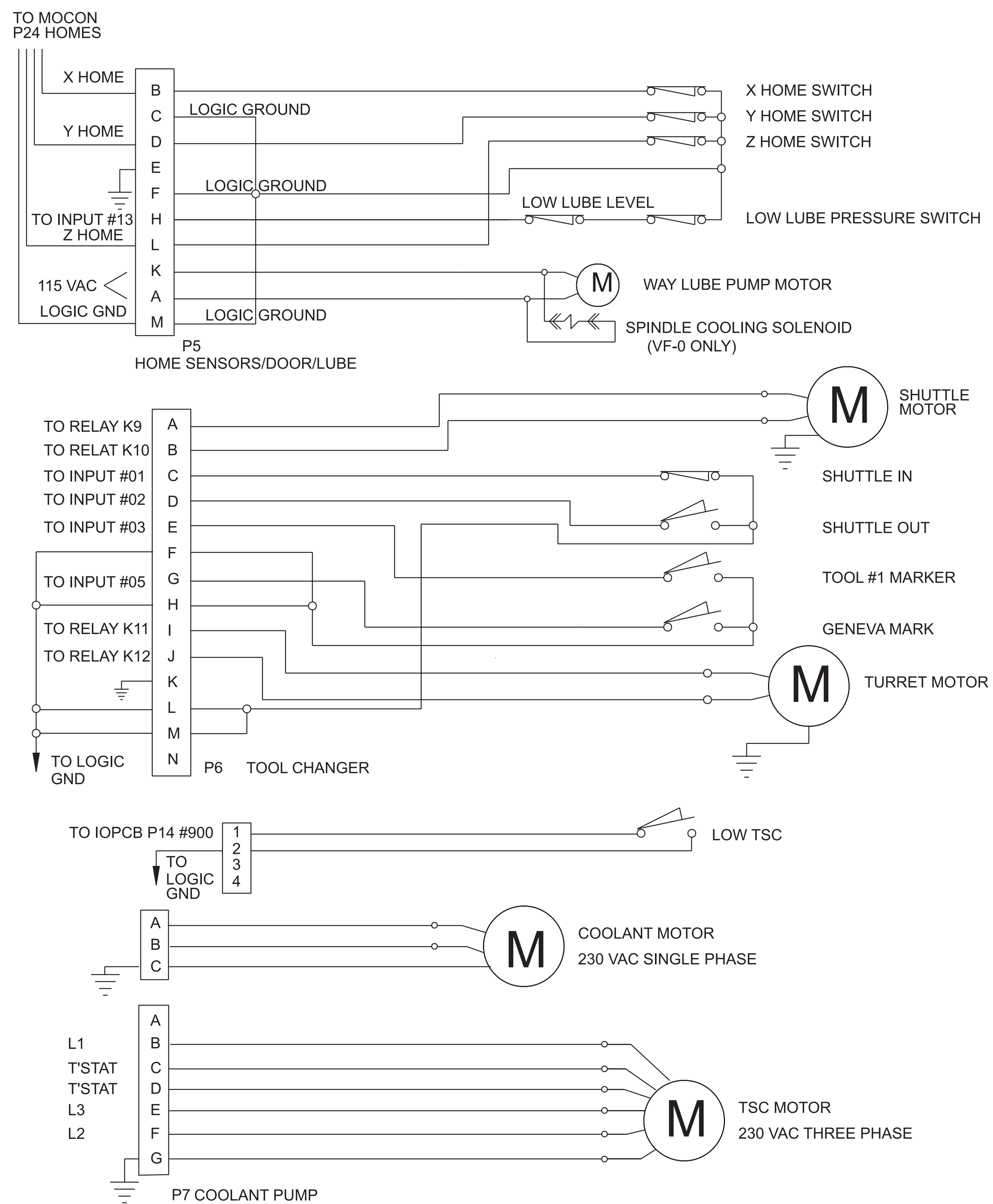
VECTOR SPINDLE DRIVE UNIT

HAAS AUTOMATION VF SERIES PAGE 13



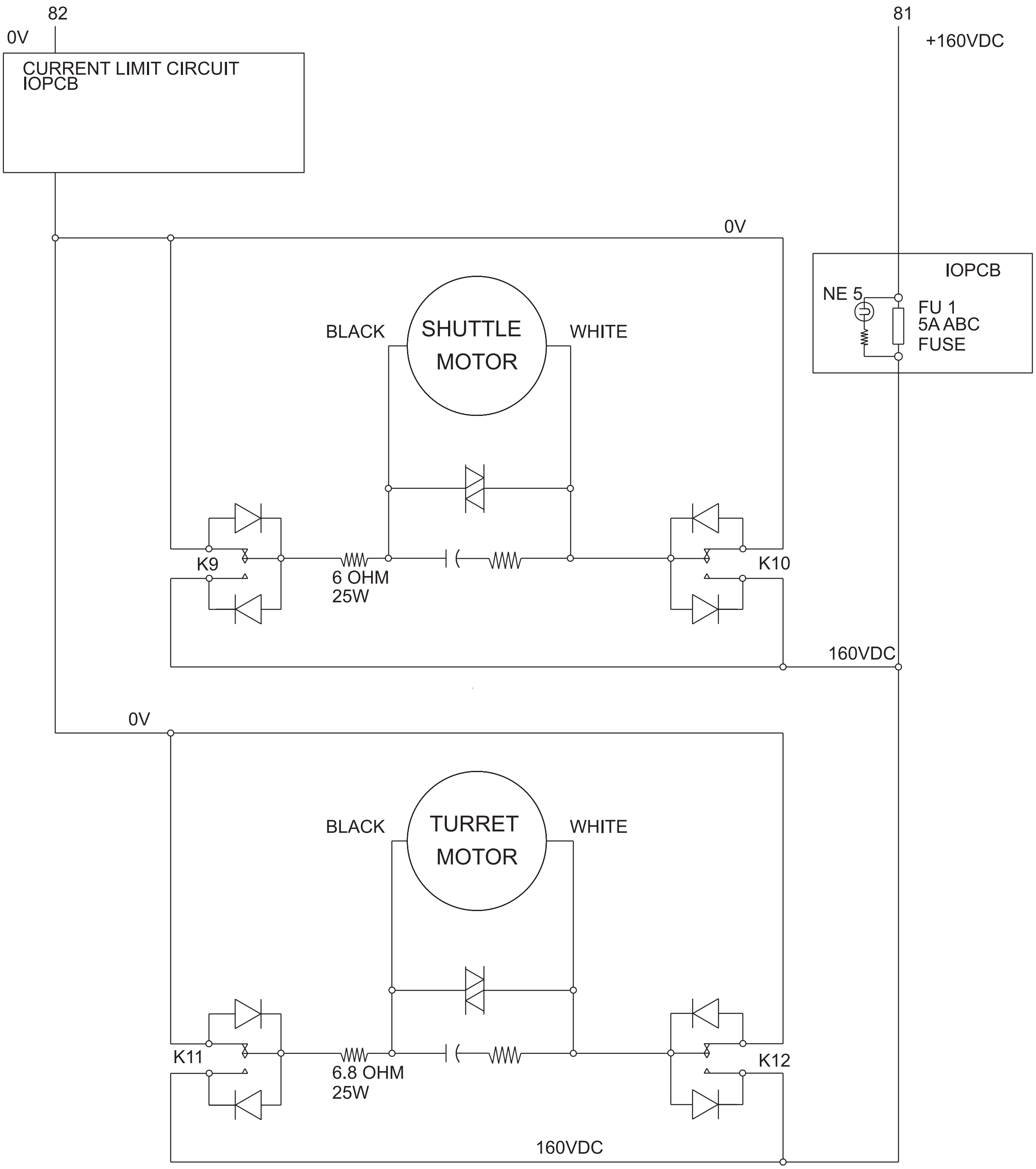
X/Y/Z AXIS MOTOR & ENCODER
HAAS AUTOMATION VF SERIES PAGE 14


CABINET
CONNECTOR
TO MOCON THROUGH
CABLE:
690 A AXIS ENCODER
690B B AXIS ENCODER.
(THIS GROUP IS ALL
24 AWG WIRES.)
L
K
A
B
C
M
N
P
RED
RED/WHITE
BROWN/WHITE
YELLOW/WHITE
ORANGE/WHITE
BROWN
YELLOW
ORANGE
+5 VDC
LOGIC GND
A CHANNEL
B CHANNEL
Z CHANNEL
A CHANNEL
B CHANNEL
Z CHANNEL
ENCODER
BRUSH
SERVO MOTOR
TWISTED PAIR TO
INDUCTORS &
AMPLIFIERS
E
F
J
H
G
WHITE
MOTOR+
BLACK
MOTOR-
M
GREEN/YELLOW
EARTH GROUND
BLACK
OVERHEAT SWITCH
NORMALLY CLOSED
OVER/HEAT
T
BLACK
TO MOCON
RED
+5 VDC
BLACK/WHITE
SIGNAL
HOME
D
BLACK
LOGIC GROUND
MAGNETIC HALL EFFECT
SWITCH
NORMALLY OPEN
TO RELAY
K5/K23
(20 AWG)
R
S
AIR SOLENOID
4TH/5TH
AXIS BRAKE
4TH AXIS SOLENOID IS ON ROTARY TABLES ONLY (NO COLLET OR MULTI-COLLET INDEXERS)
A/B AXIS
HAAS AUTOMATION
VF SERIES PAGE 15

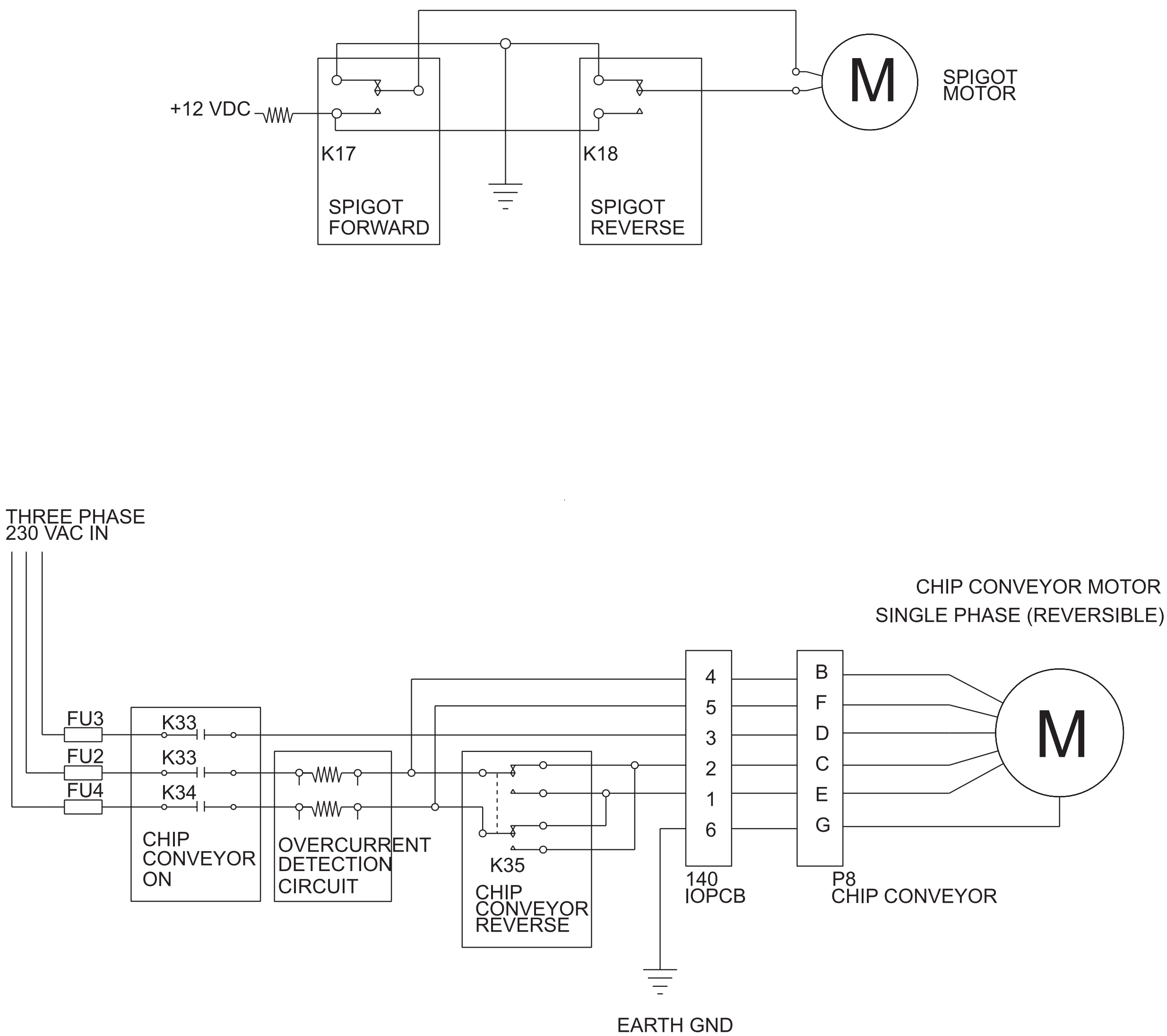


NOTE: CONNECTORS ARE LOCATED ON SIDE OF CONTROL CABINET.

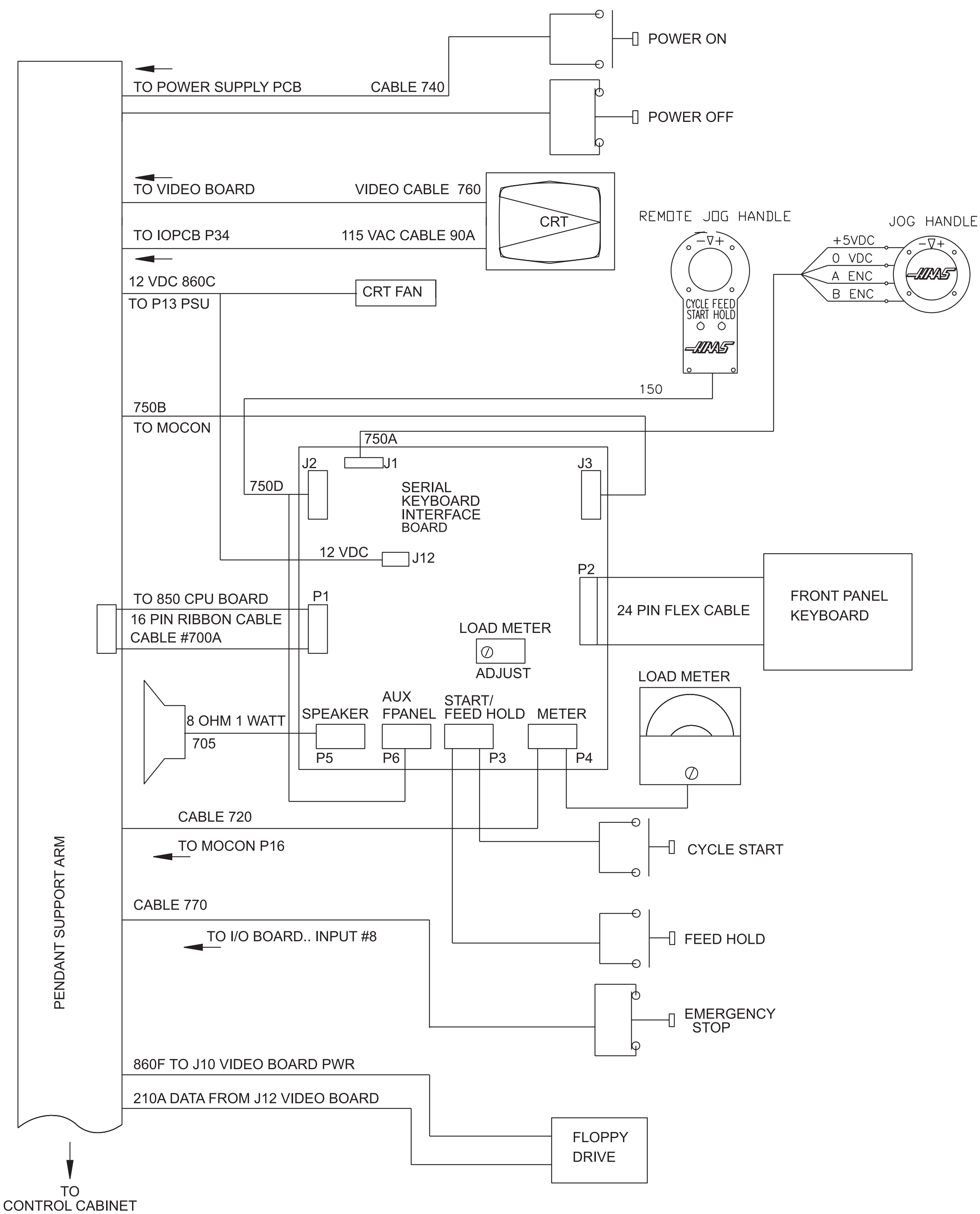
CABINET CONNECTORS
HAAS AUTOMATION VF SERIES PAGE 16



TOOL CHANGE MOTORS
HAAS AUTOMATION VF SERIES PAGE 17

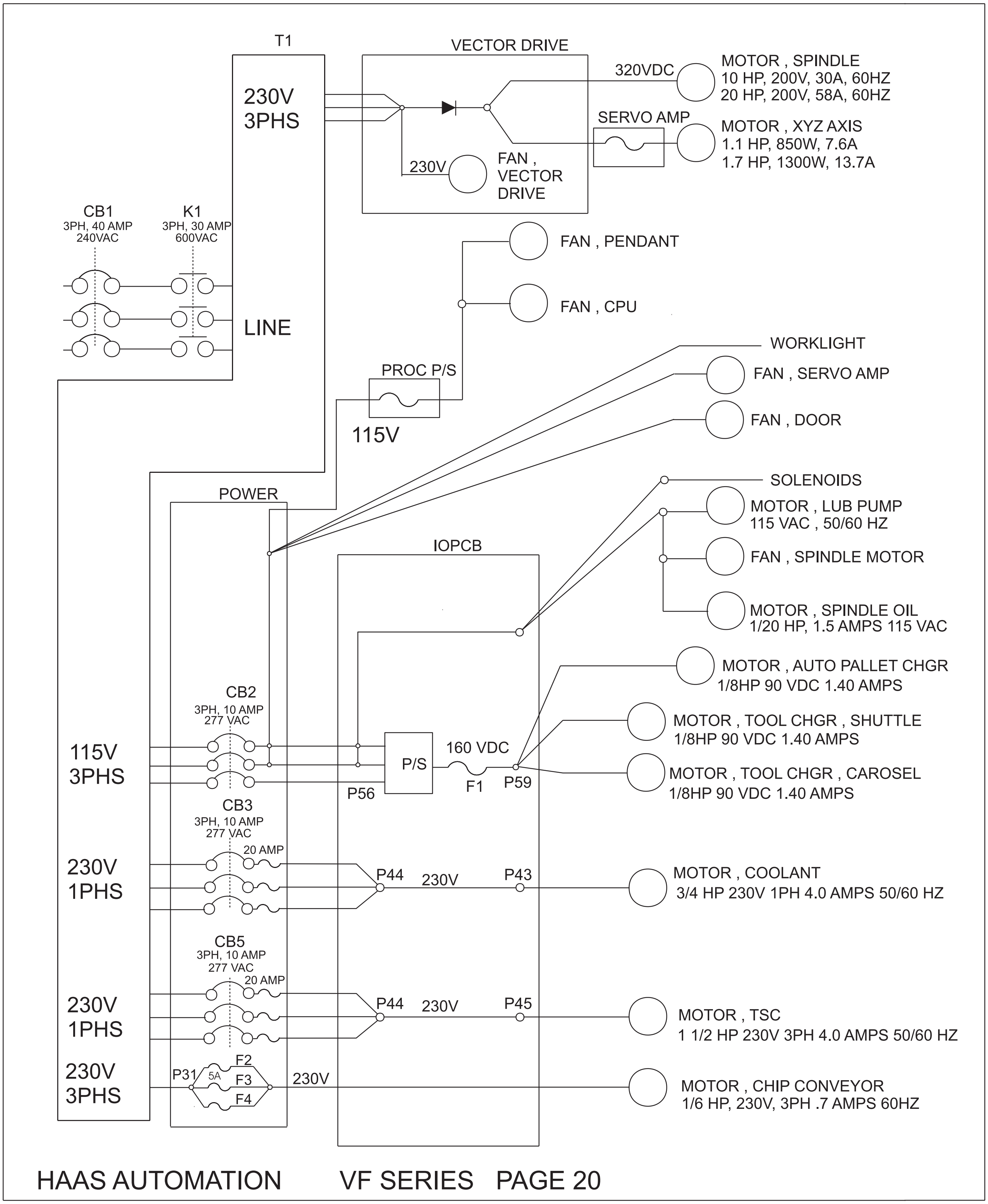


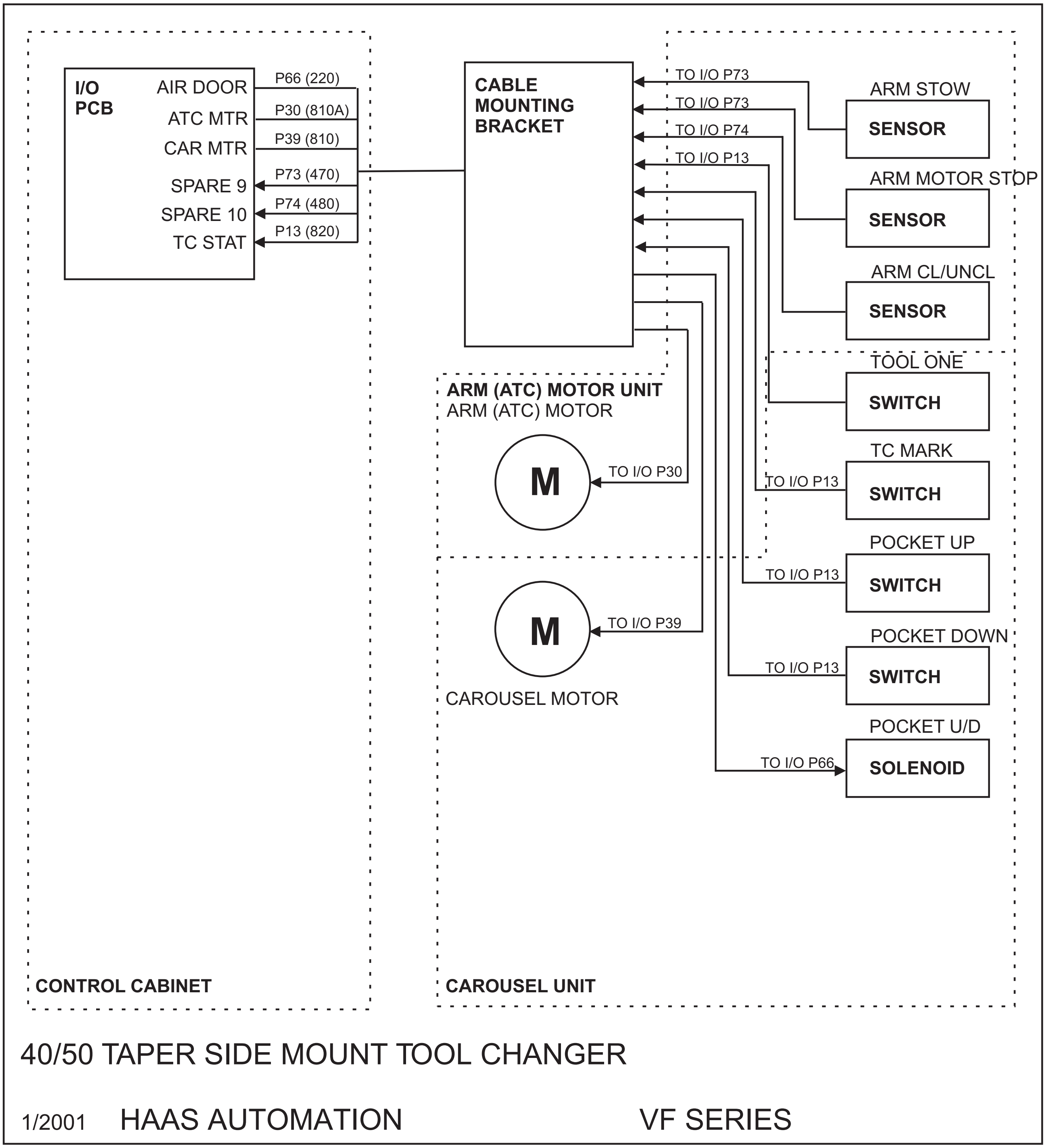
CHIP CONVEYOR AND SPIGOT MOTORS
HAAS AUTOMATION VF SERIES PAGE 18



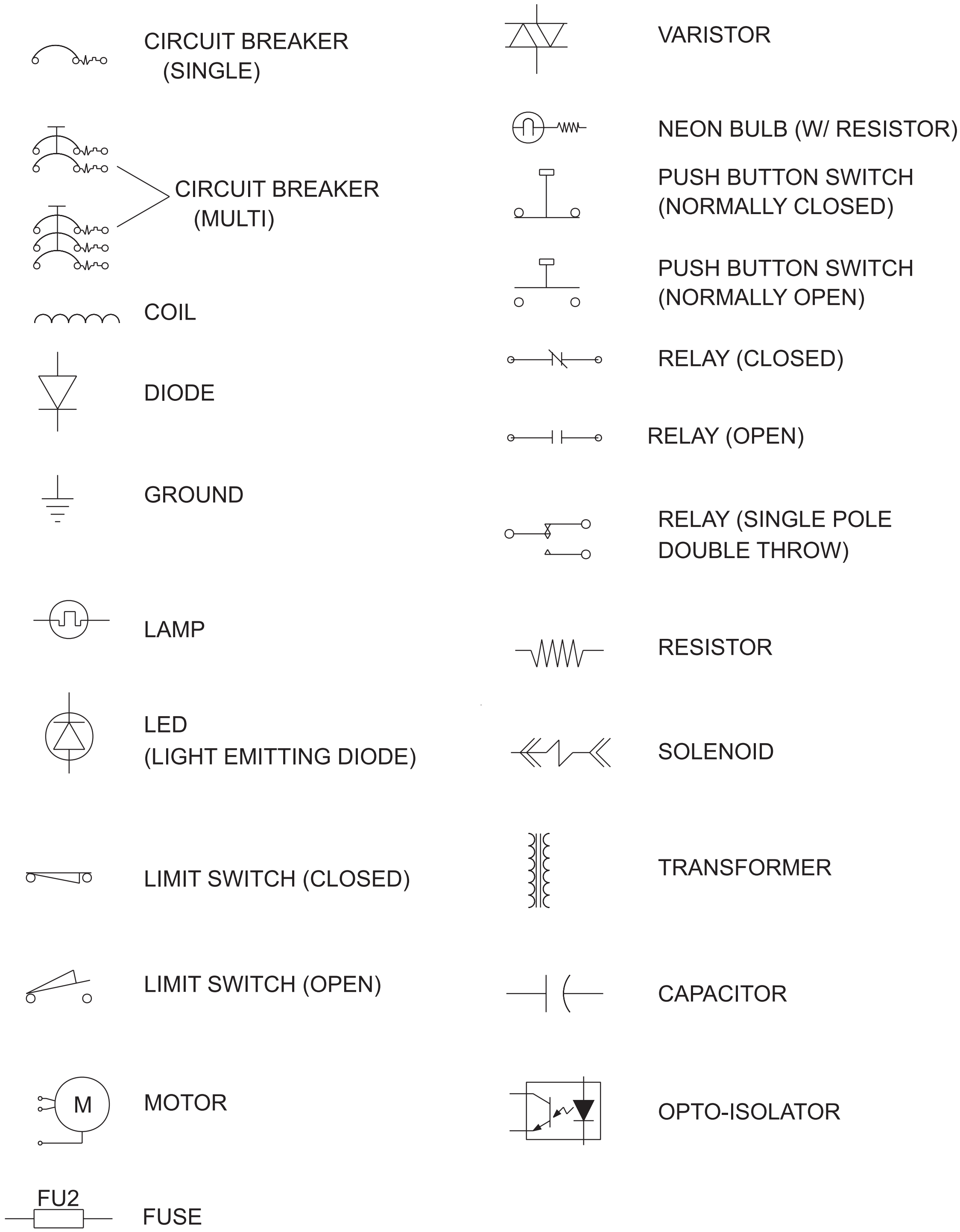
OPERATOR PENDANT

HAAS AUTOMATION VF SERIES PAGE 19


T1
VECTOR DRIVE
230V
3PHS
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
FAN , PENDANT
FAN , CPU
LINE
WORKLIGHT
PROC P/S
FAN , SERVO AMP
115V
FAN , DOOR
POWER
SOLENOIDS
MOTOR , LUB PUMP
115 VAC , 50/60 HZ
IOPCB
FAN , SPINDLE MOTOR
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
MOTOR , TOOL CHGR , SHUTTLE
1/8HP 90 VDC 1.40 AMPS
115V
3PHS
160 VDC
P/S
F1
P59
P56
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 PAGE 20

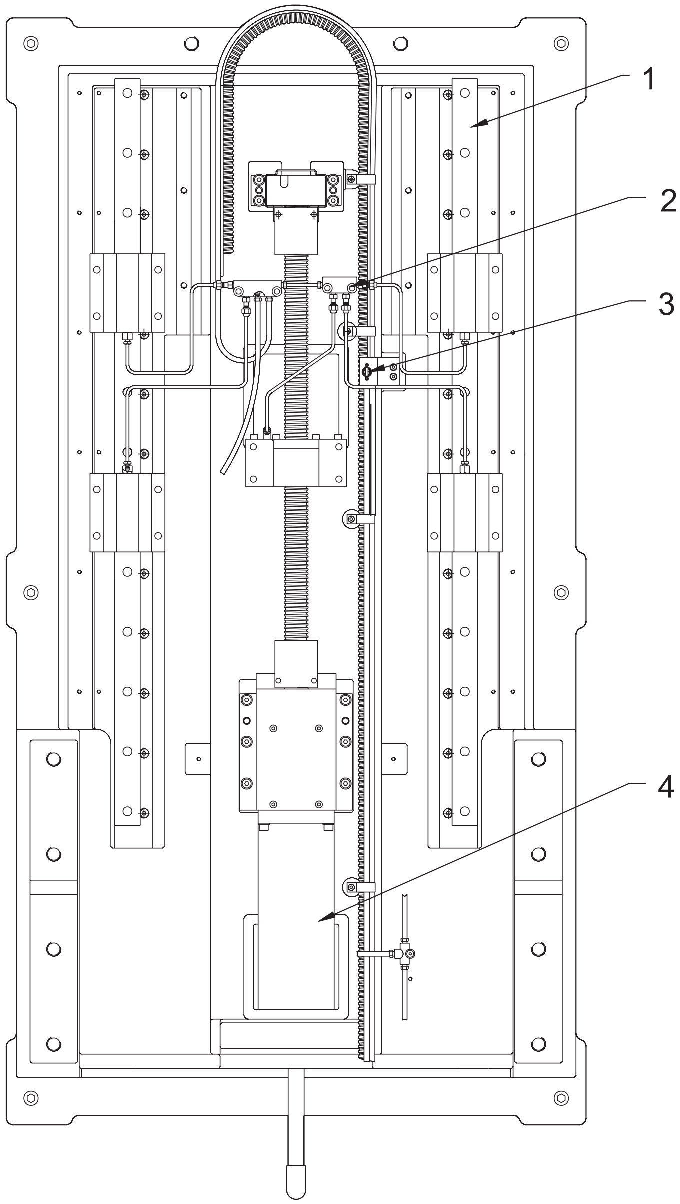


I/O PCB
AIR DOOR
ATC MTR
CAR MTR
SPARE 9
SPARE 10
TC STAT
P66 (220)
P30 (810A)
P39 (810)
P73 (470)
P74 (480)
P13 (820)
CONTROL CABINET
CABLE MOUNTING BRACKET
TO I/O P73
TO I/O P73
TO I/O P74
TO I/O P13
ARM STOW
SENSOR
ARM MOTOR STOP
SENSOR
ARM CL/UNCL
SENSOR
TOOL ONE
SWITCH
TC MARK
TO I/O P13
SWITCH
POCKET UP
TO I/O P13
SWITCH
POCKET DOWN
TO I/O P13
SWITCH
POCKET U/D
TO I/O P66
SOLENOID
ARM (ATC) MOTOR UNIT
ARM (ATC) MOTOR
M
TO I/O P30
M
TO I/O P39
CAROUSEL MOTOR
CAROUSEL UNIT
40/50 TAPER SIDE MOUNT TOOL CHANGER
1/2001 HAAS AUTOMATION VF SERIES



ELECTRICAL SYMBOLS
HAAS AUTOMATION VF SERIES

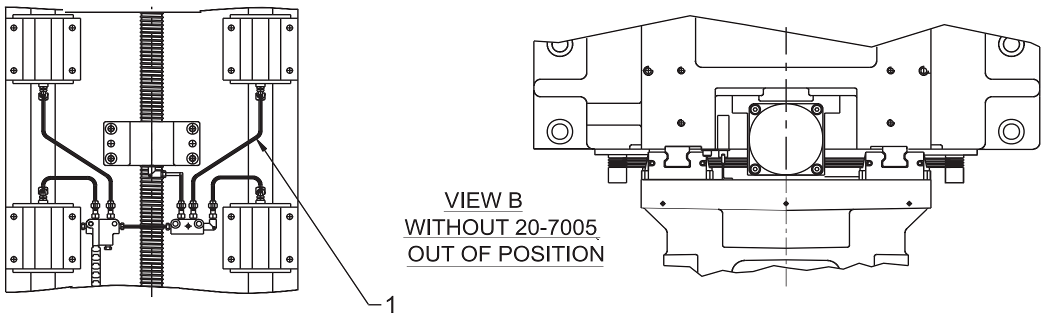
ASSEMBLY DRAWINGS

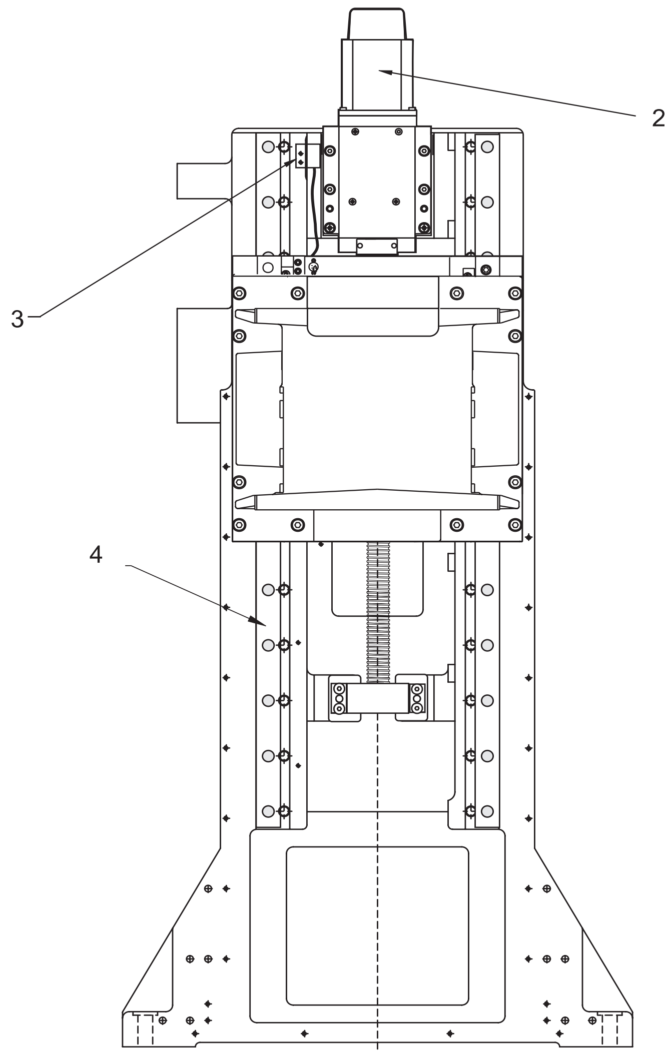


1. 50-3300 Linear guide
2. 30-0171 Oil line assembly
3. 32-2030 Telemechanique switch assembly
4. 62-0014 Yaskawa sigma 09 motor*

*Except XRT

VF-1 Base

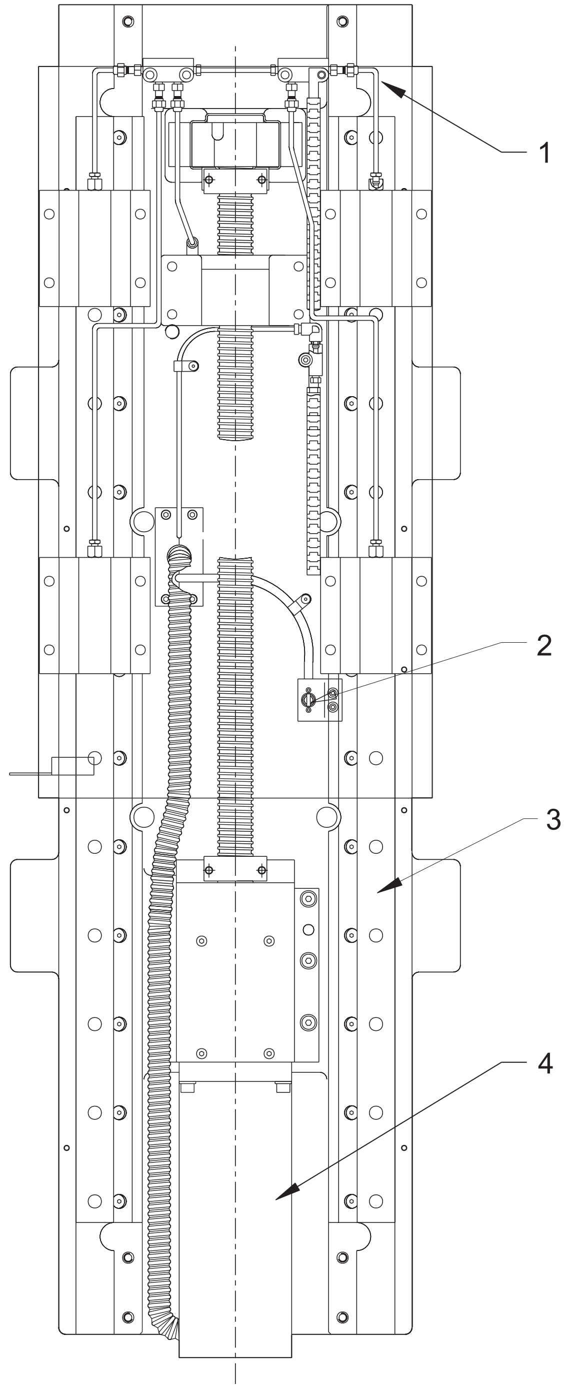




1. 30-0170 Oil line assembly
2. 62-0009 Yaskawa Sigma 09 motor*
3. 32-2040 telemechanique switch assembly
4. 50-3300 Linear guide

*Except XRT

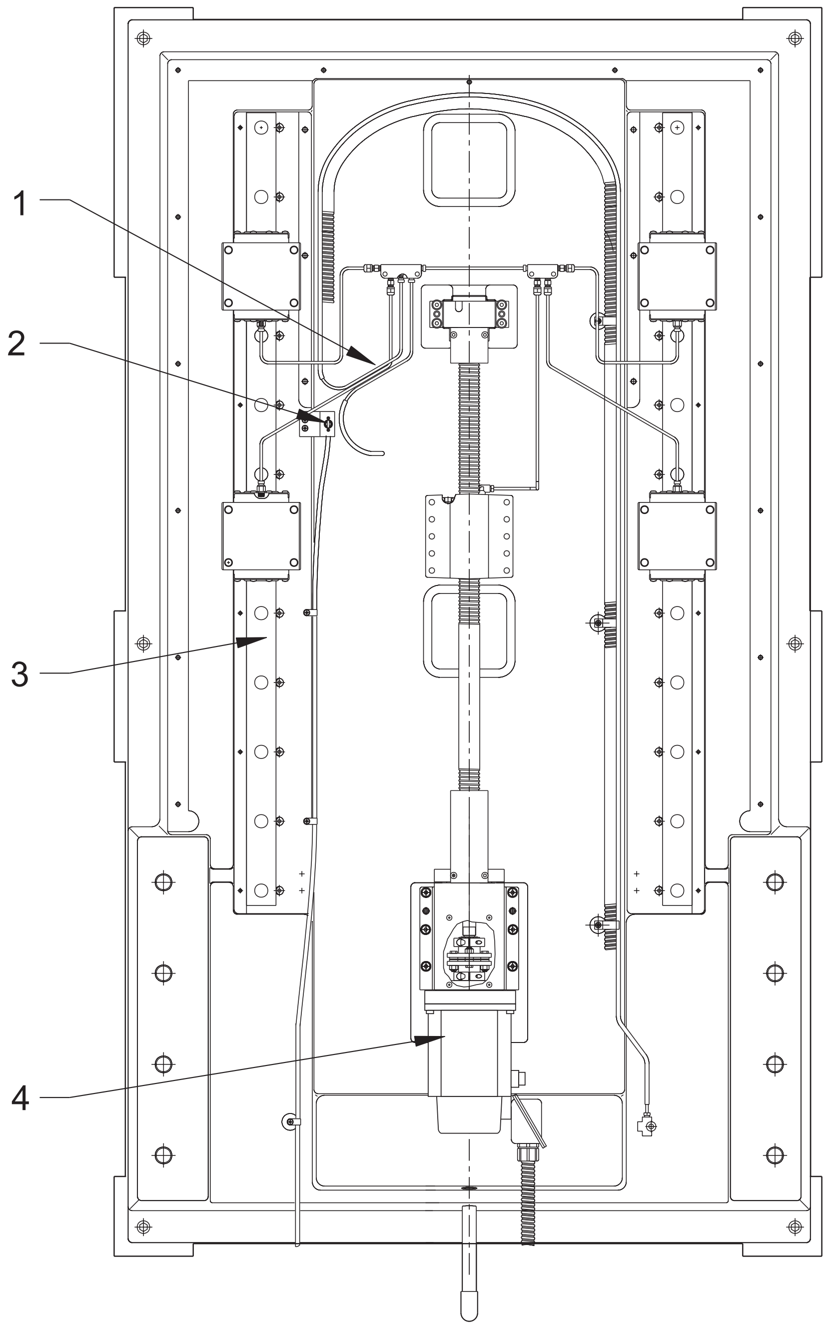
VF-1 Column



1. 30-0173 Oil line assembly
2. 32-2050 Telemechanique switch
3. 50-3300 Linear guide
4. 62-0014 Yaskawa sigma 09 motor*

*Except XRT

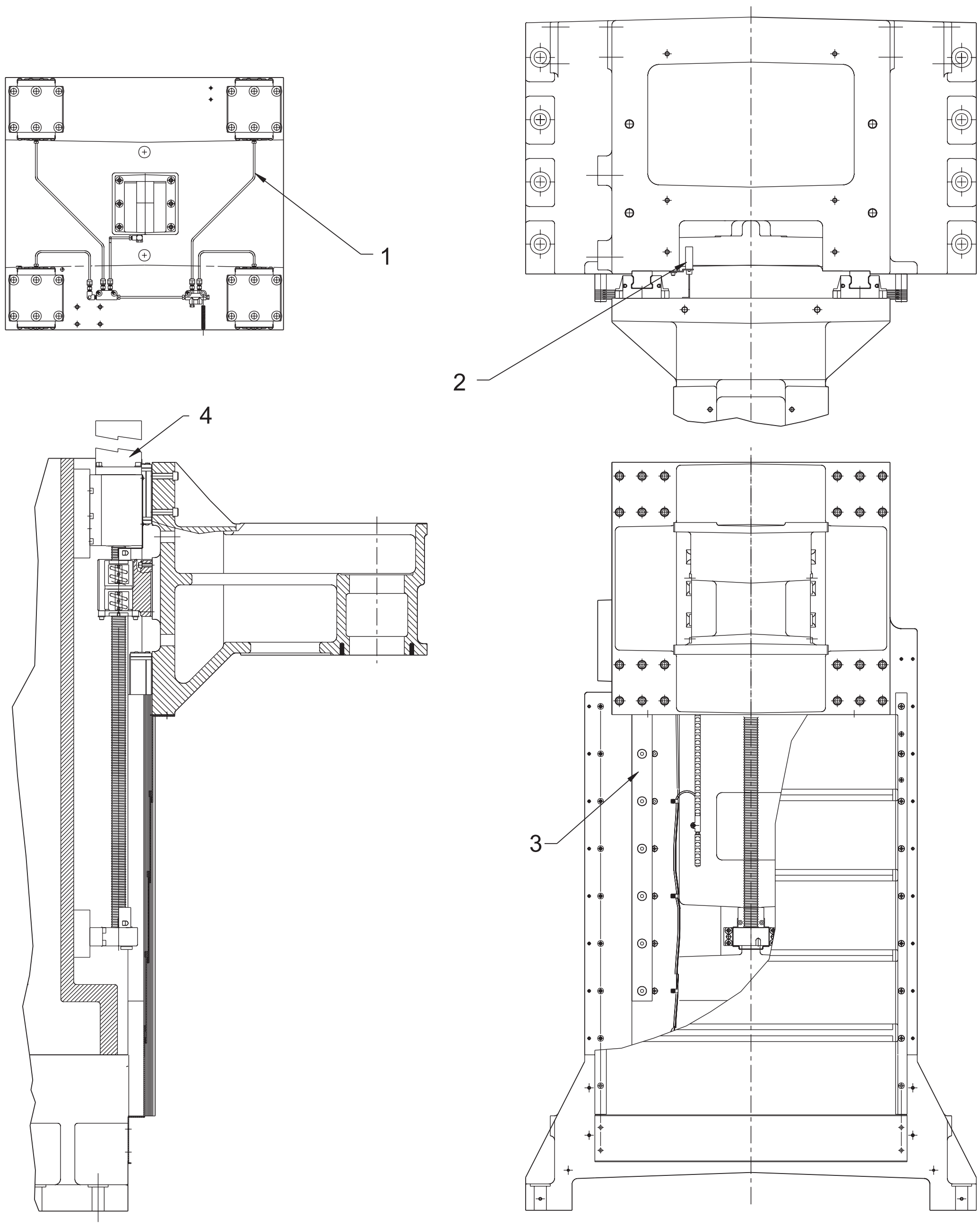
VF-1 Saddle



1. 30-0221 Oil line assembly
2. 32-2031 Telemechanique switch assembly
3. 50-9011 Linear guide
4. 62-0014 Motor assembly*

*Except XRT

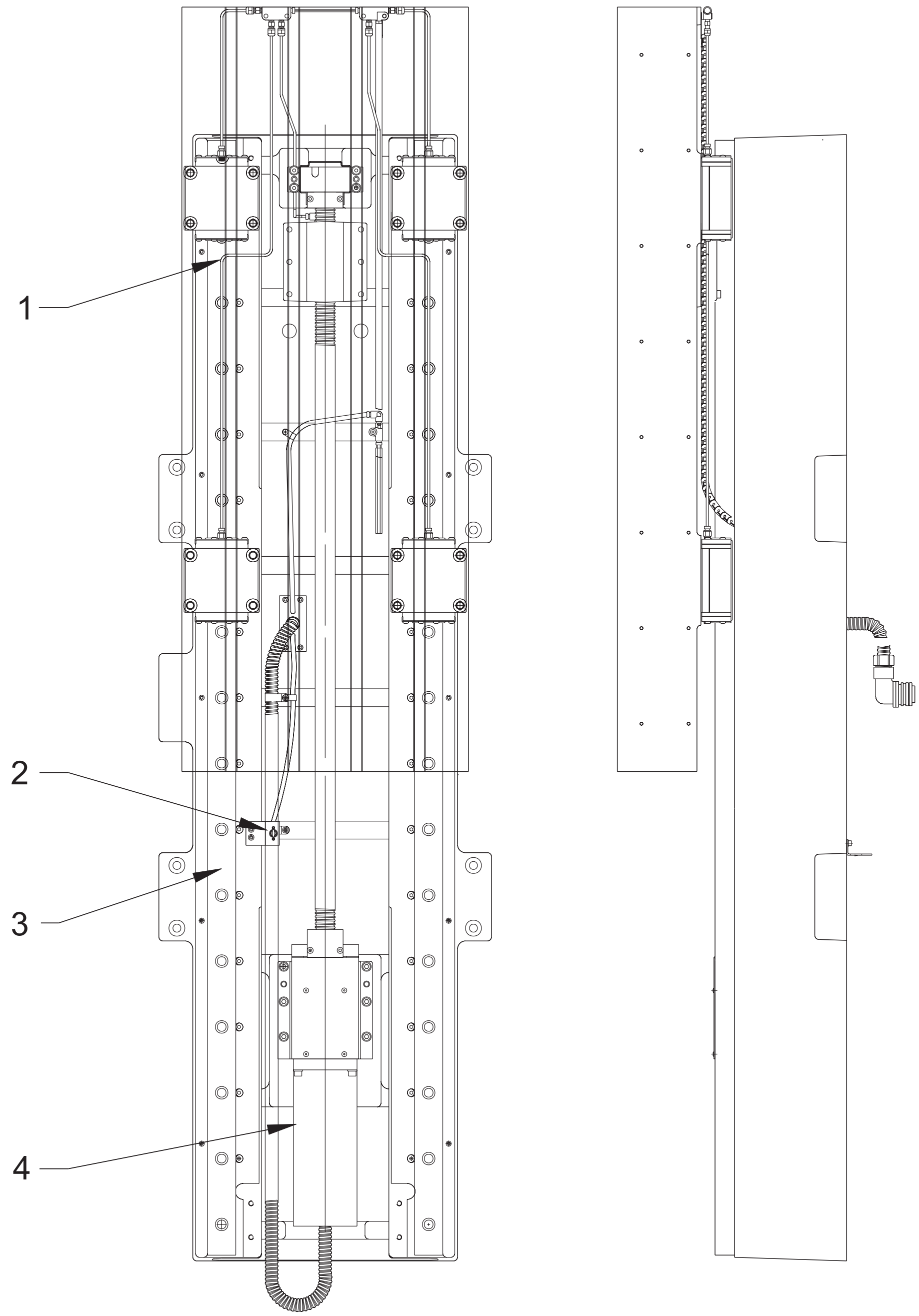
VF-3 Base



1.30-0687 Oil line assembly
2. 32-2041 Telemechanique switch assembly
3. 50-9011 Linear guide
4. 62-0014 Yaskawa Sigma 09 motor*

*Except XRT

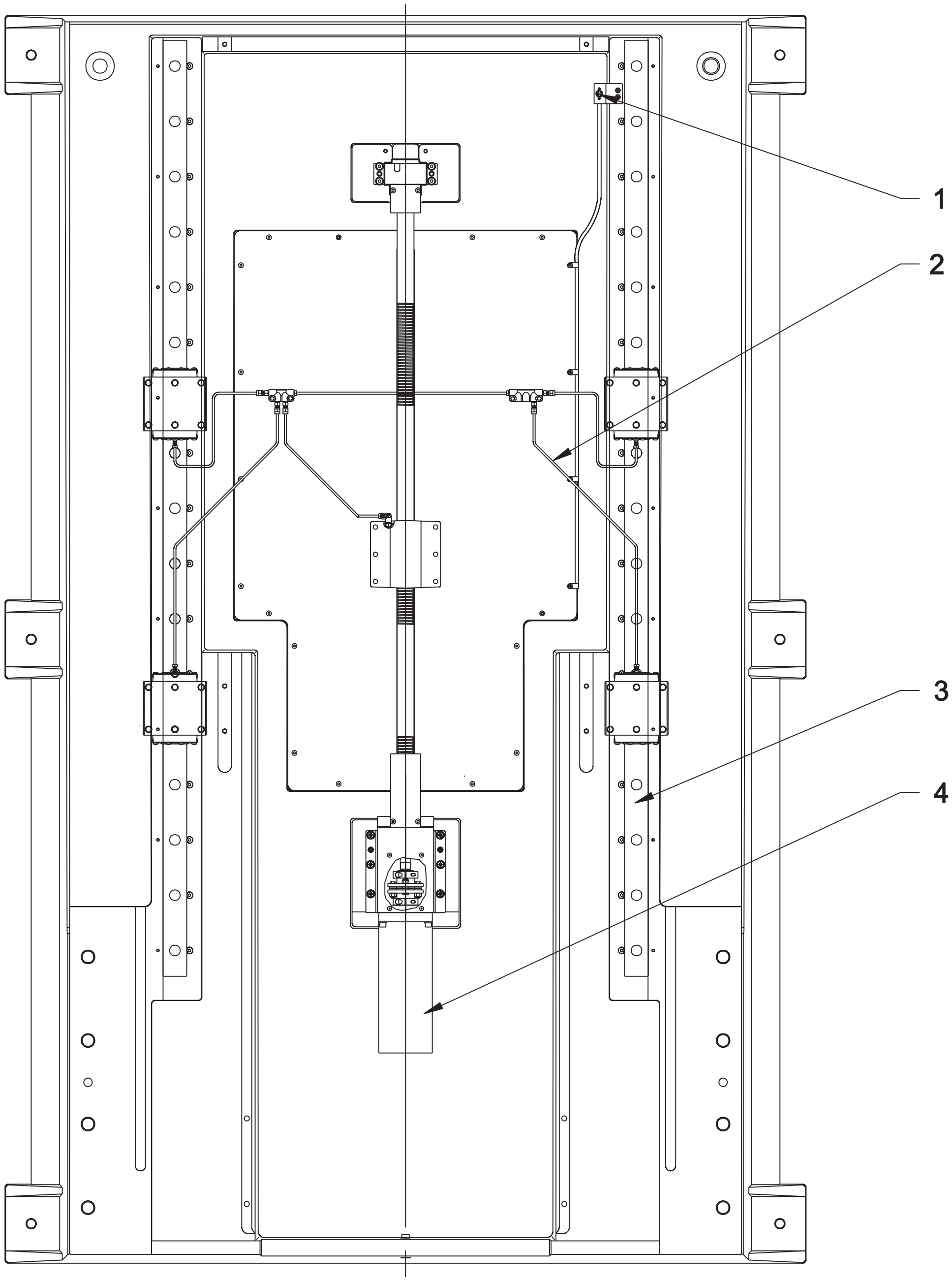
VF-3 Column



1. 30-0223 Oil line assembly
2. 32-2050 Telemechanique switch assembly
3. 50-9010 Linear guide
4. 62-0014 Yaskawa sigma 09 motor*

*Except XRT

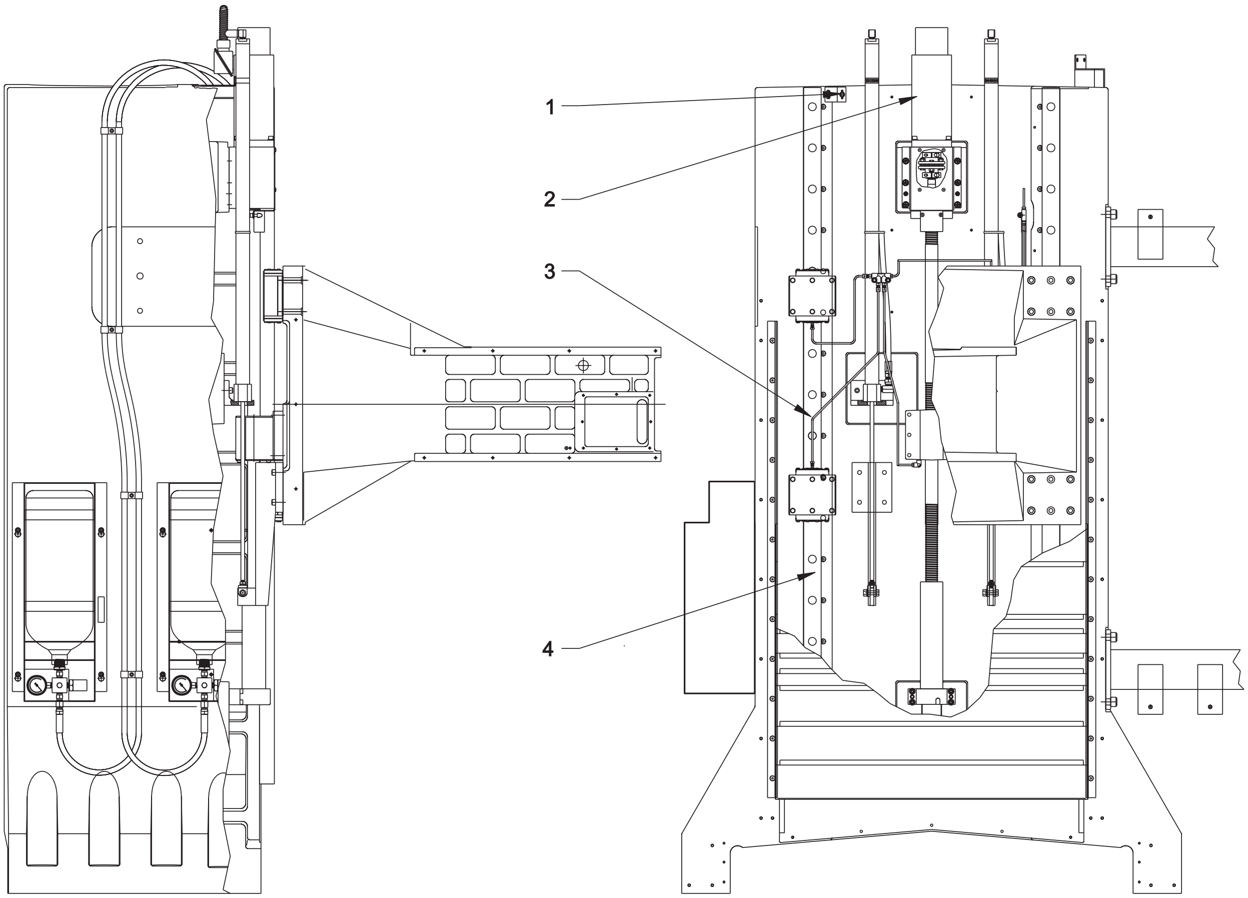
VF-3 Saddle



1. 32-5056 Telemechanique limit switch assembly
2. 30-0221 OIl line assembly
3. 50-9010 Linear guide
4. 62-0014 Yaskawa sigma 09 motor*

*Except XRT

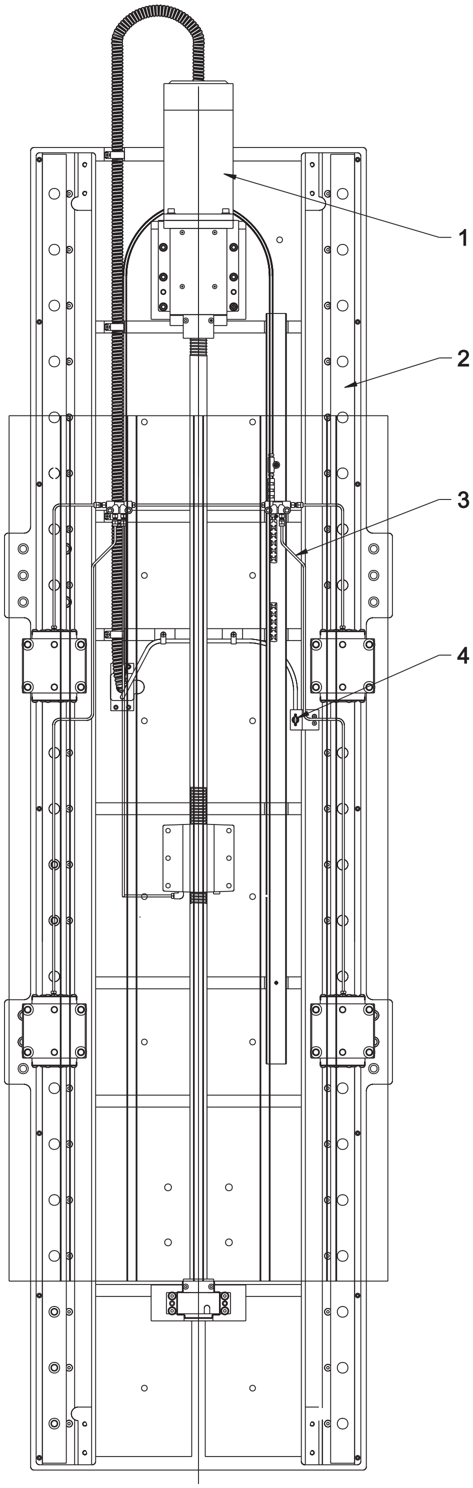
VF-6 Base



1. 32-2050 Telemechanique limit switch assembly
2. 62-0014 Yaskawa sigma 09 motor*
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide

*Except XRT

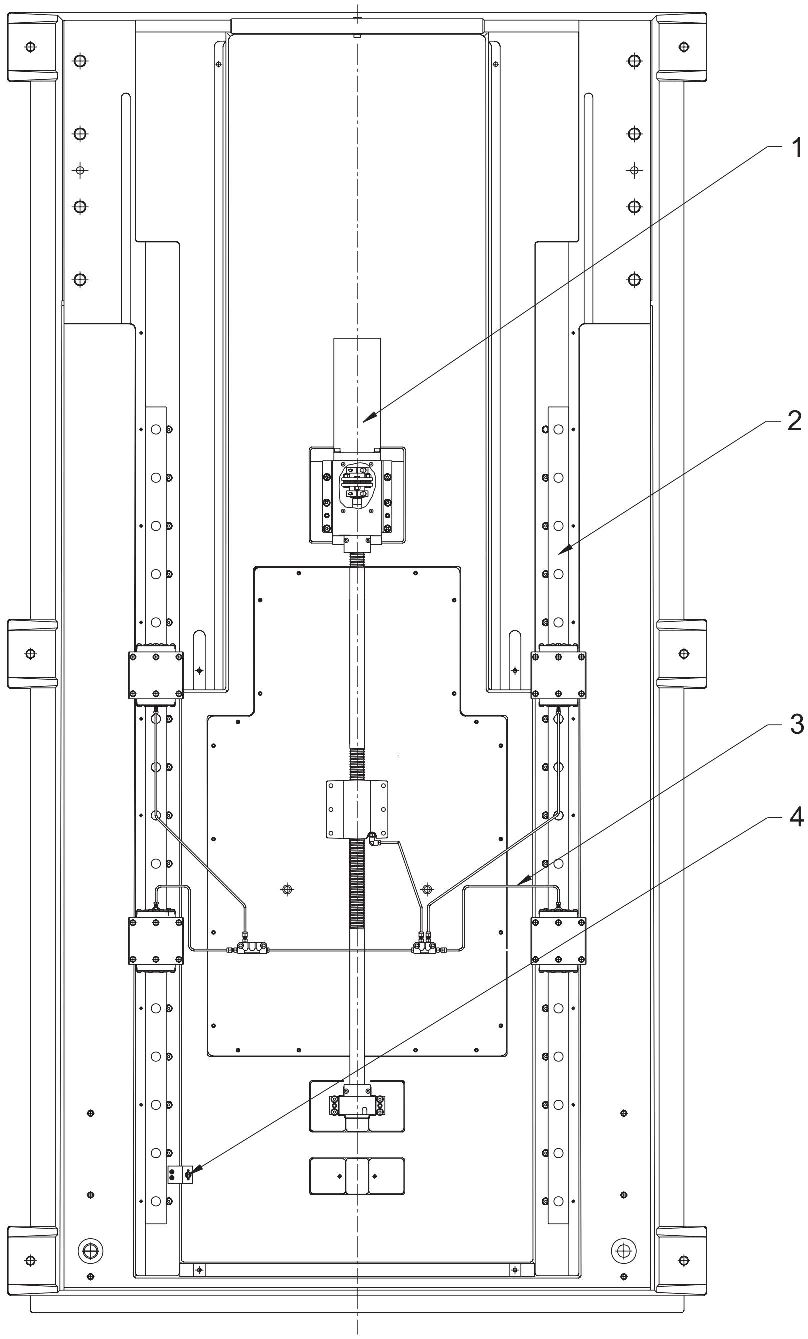
VF-6 Column



1. 62-0014 Yaskawa sigma 09 motor*
2. 50-9806 Linear guide
3. 30-0463 Oil line assembly
4. 32-2051 Telemechanique limit switch assembly

*Except XRT

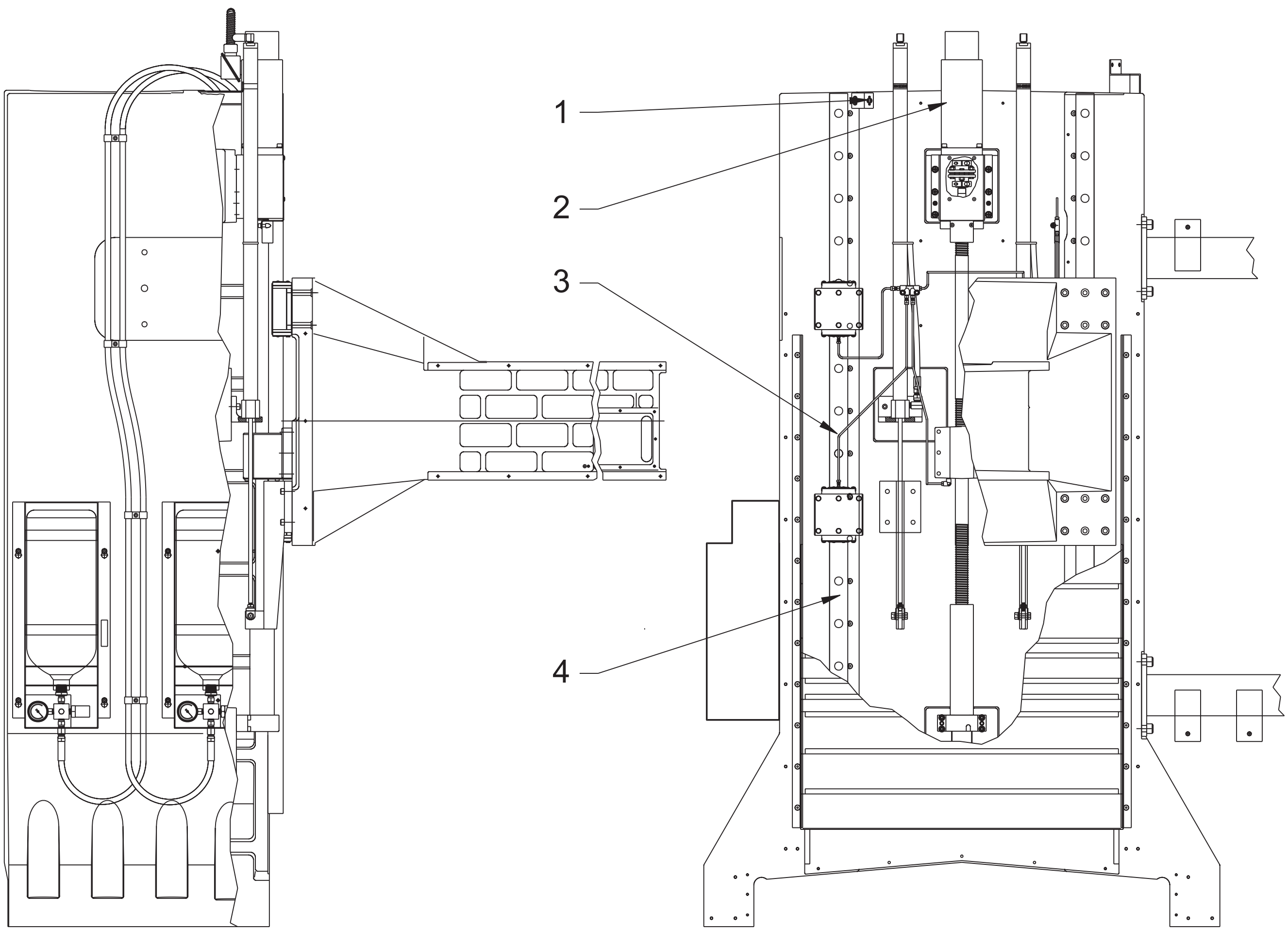
VF-6 Saddle



1. 62-0014 Yaskawa sigma 09 motor*
2. 50-9010 Linear guide
3. 30-0461 Oil line assembly
4. 32-5056 Telemechanique limit switch assembly

*Except XRT

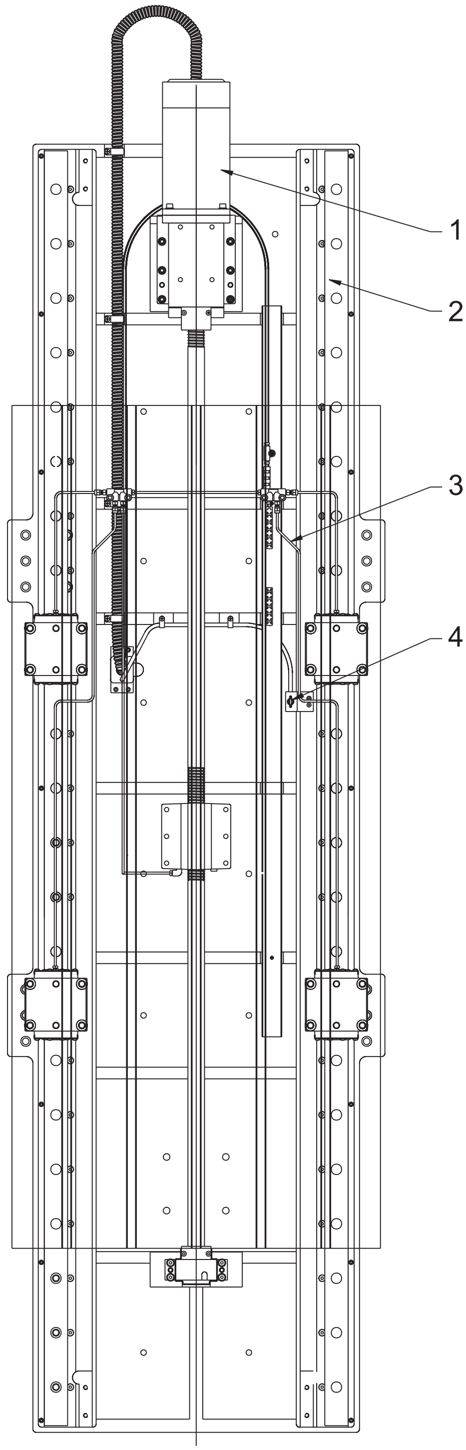
VF-8 Base



1. 32-2050 Telemechanique limit switch assembly
2. 62-0014 Yaskawa sigma 09 motor*
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide

*Except XRT

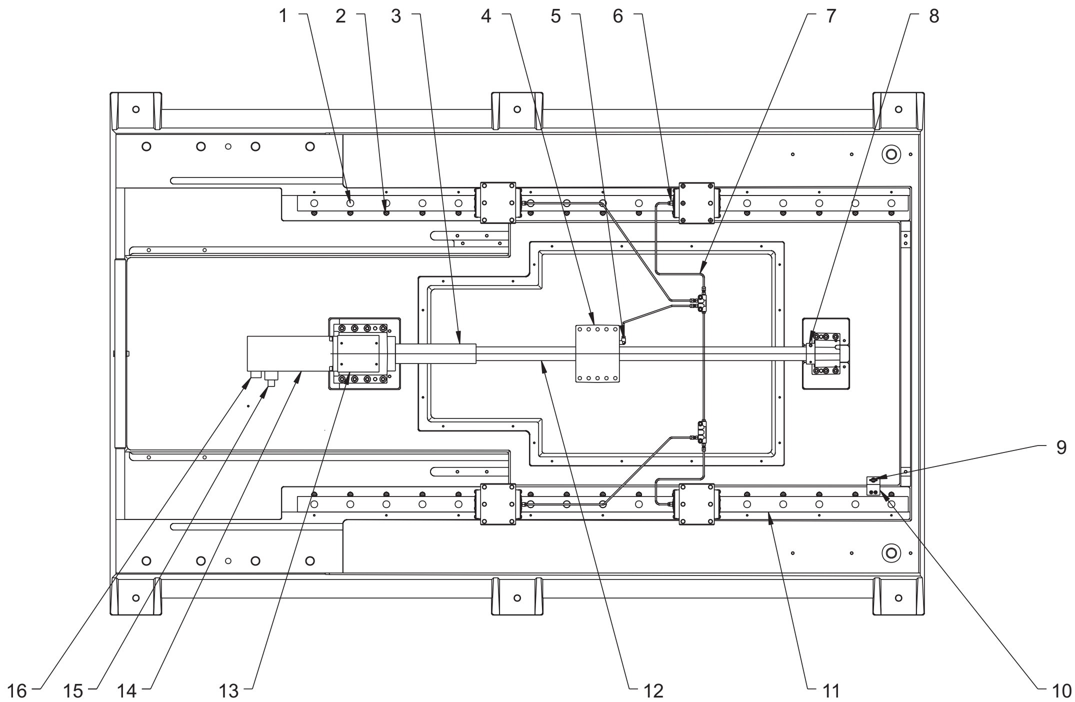
VF-8 Column



1. 62-0014 Yaskawa sigma 09 motor*
2. 50-9806 Linear guide
3. 30-0463 Oil line assembly
4. 32-2051 Telemechanique limit switch assembly

*Except XRT

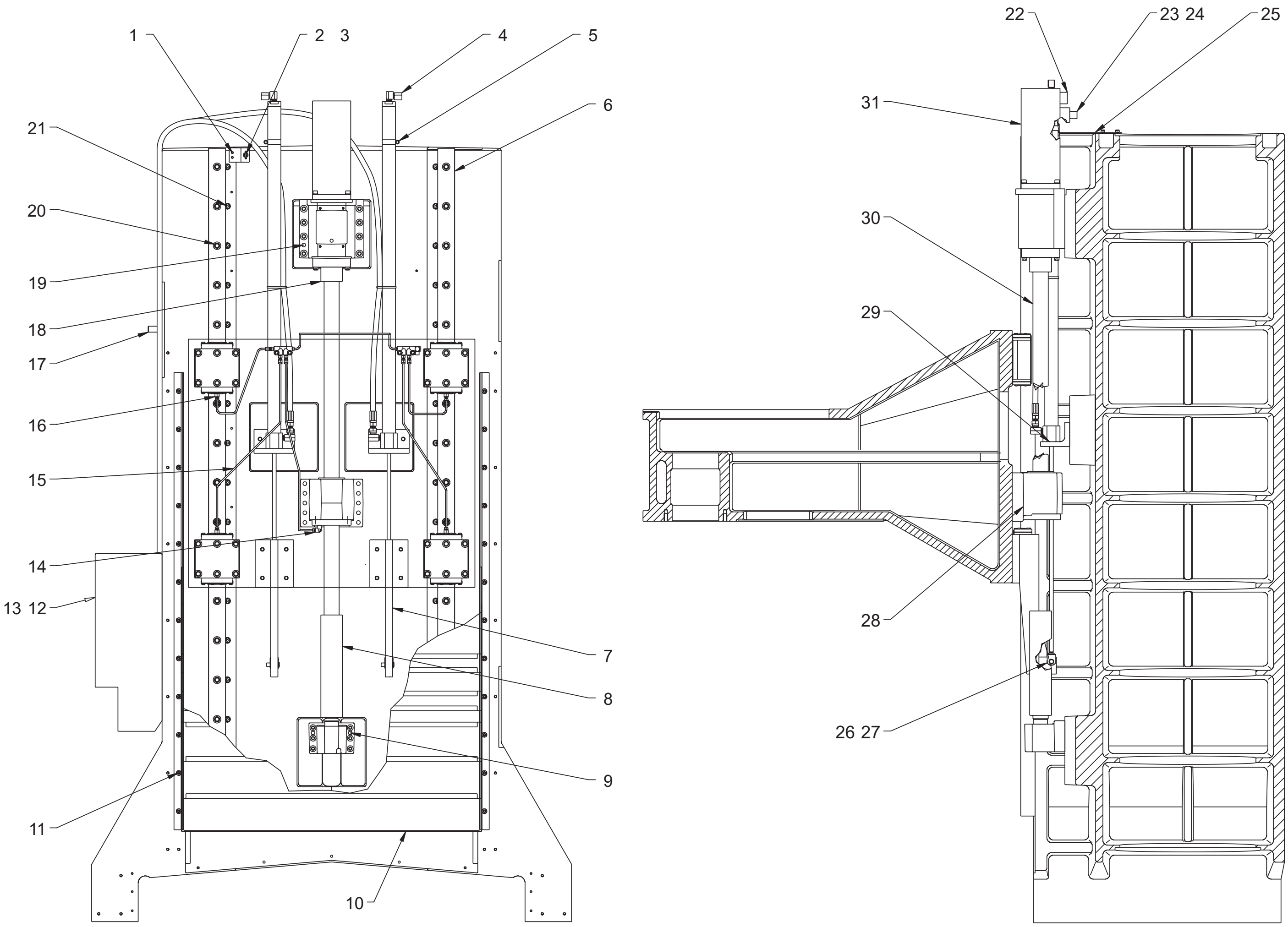
VF-8 Saddle



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*
13. 25-9203 Cover plate motor mount
14. 62-0014 servo motor (40 taper) 62-0016 servo motor (50 taper)*
15. N/A
16. N/A

*Except XRT

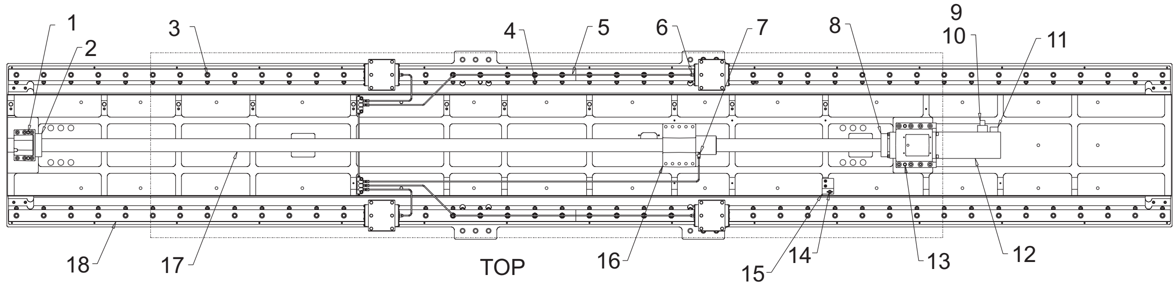
VF-10 Base

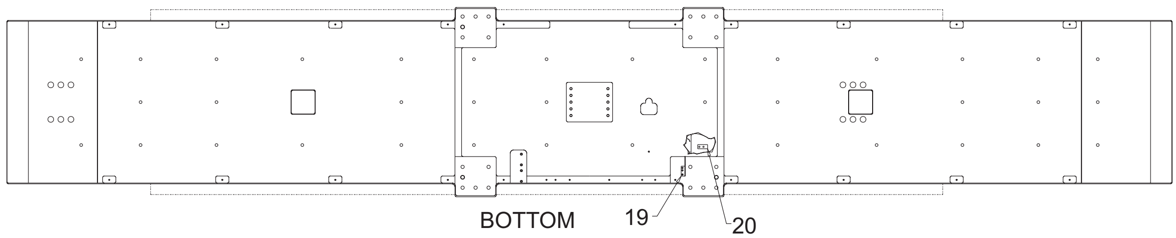


1. 25-7267 Bracket mounting Y-axis
2. 25-9929 Stabilizer bracket hyd. cyl.
3. 32-2050 Limit switch Z-axis
4. N/A
5. 59-4002 Hose clamp 13/16 x 1 3/4
6. 50-9010 Linear guide
7. 22-9826A Counterweight head bracket
8. 20-9217 Z-axis bumper, support end
9. 48-0045 Dowel pin 3/8 x 1 1/2 pull
10. 25-9813 Z-axis waycover
11. 40-2021 FHCS 1/4-20 x 3
12. 25-7560B tank cover
13. 30-1420 (40 taper) 30-1421 (50 taper) Counterbalance tank assembly
14. 58-3031 Banjo elbow 5/16 F x M6 M
15. 30-0464 Oil line assembly
16. 58-1560 Linear guide adaptor 1/8m (NSK and THK) 59-0001 (Star)
17. 48-1699 Dowel pin 5/8 x 2 1/4
18. 20-9216 Z-axis bumper, motor end
19. 48-10045 Dowel pin 3/8 x 1 1/2
20. 59-6655 Rubber plug
21. 22-7458 Cam
22. N/A
23. N/A
24. N/A
25. 25-9929 Stabilizer bracket
26. 20-0365 Clevis counter balance
27. 48-0017 Clevis pin 3/8 dia. x 1 1/4 and 49-0026 Cotter pin 1/8 x 1 1/4
28. 20-0150 Nut housing
29. 22-9927 Bracket cylinder counter
30. 24-9960 40mm ballscrew*
31. 62-0014 Yaskawa sigma 09 motor*

*Except XRT

VF-10 Column

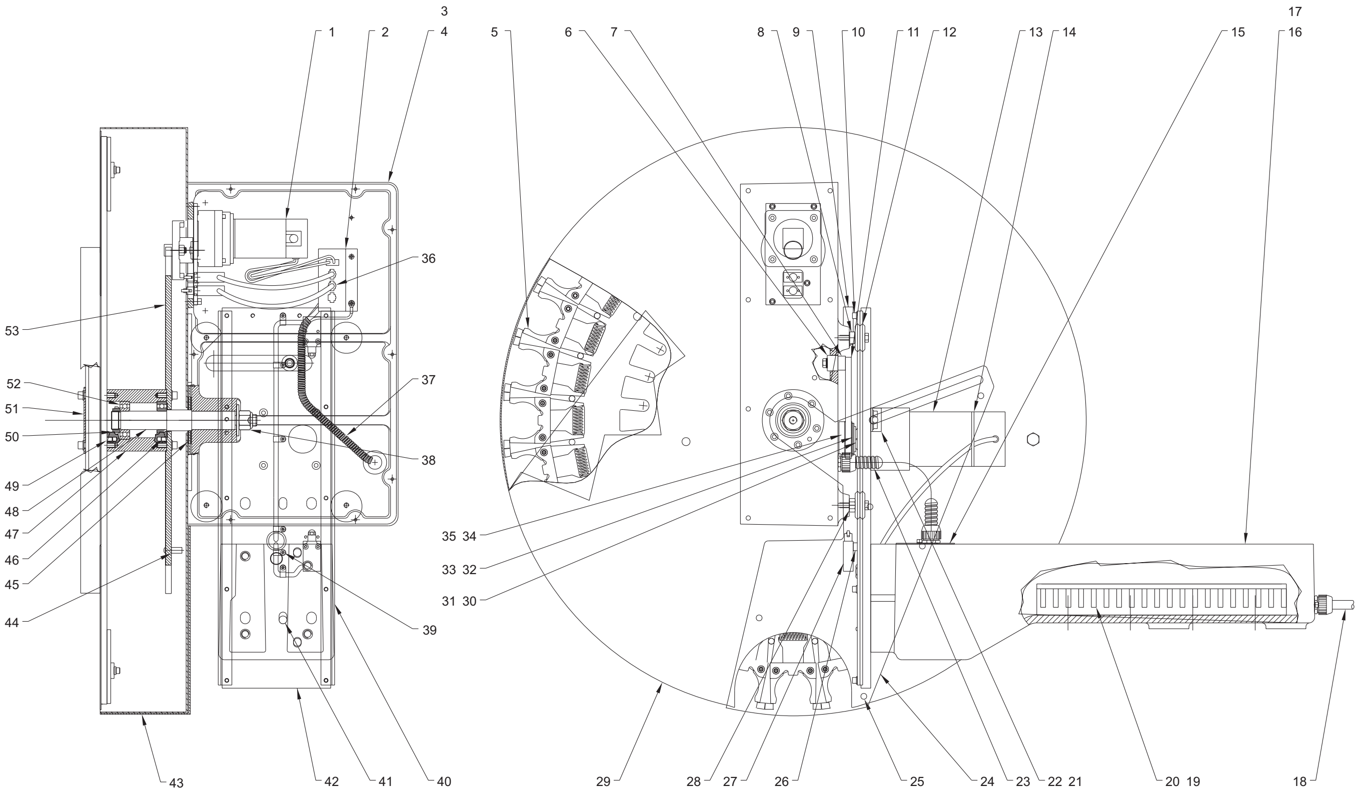




1. 20-0152 Bearing housing 40mm and 50mm ballscrew
2. 20-0156 Bumper
3. 59-6655 rubber plug
4. 22-7458 Cam, linear guide
5. 30-0534 Oil line assembly
6. 58-1560 Linear guide adaptor 1/8m (NSK and THK) 59-0001 (Star)
7. 58-3031 Banjo elbow 5/16 F x M6 M
8. 20-0156 Bumper 40 and 50mm ballscrews
9. N/A
10. N/A
11. N/A
12. 62-0016 Yaskawa sigma 13 motor*
13. 48-0045 Dowel pin 3/8 x 1 1/2 pull
14. 32-2055 X-axis limit switch
15. 25-9219 Bracket, limit switch
16. 20-0150 Nut housing
17. 24-0002C Ballscrew 50mm*
18. 50-0001 Linear guide
19. 25-7459 Bracket trip table
20. 25-9220 Bracket, trip X-axis

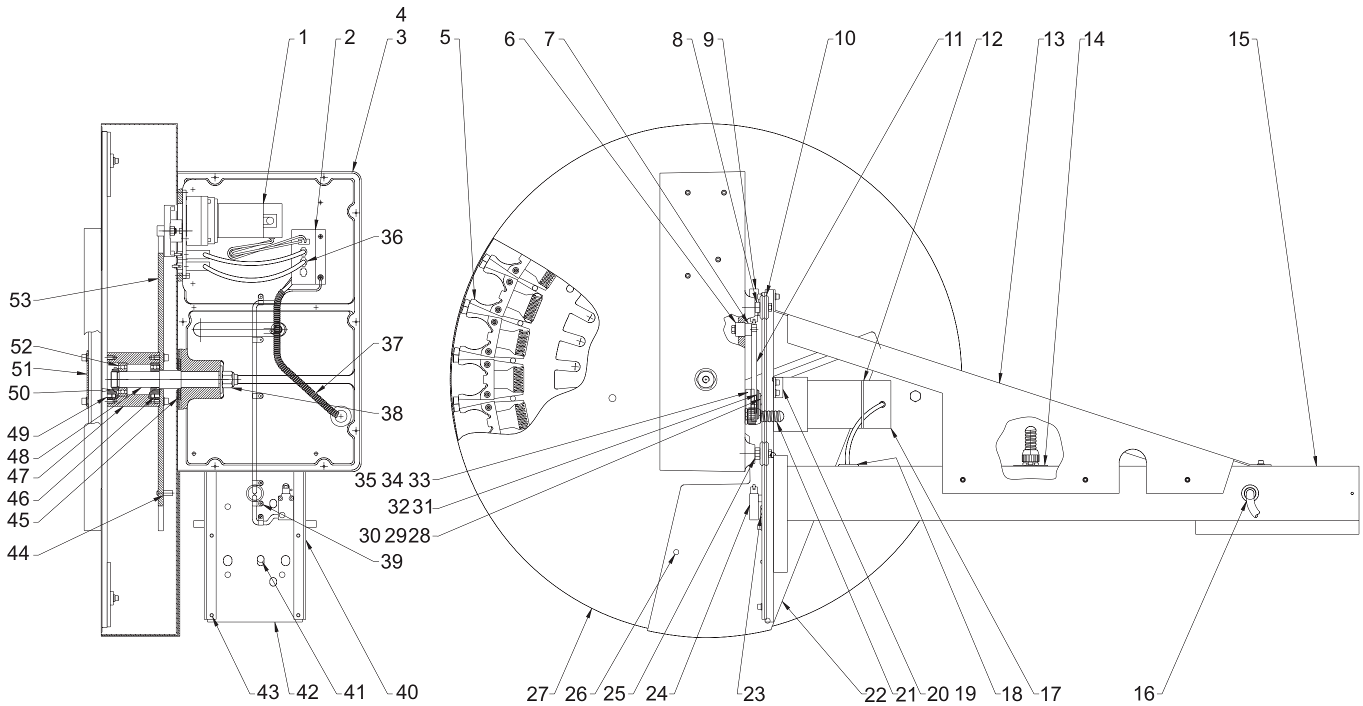
*Except XRT

VF-10 Saddle



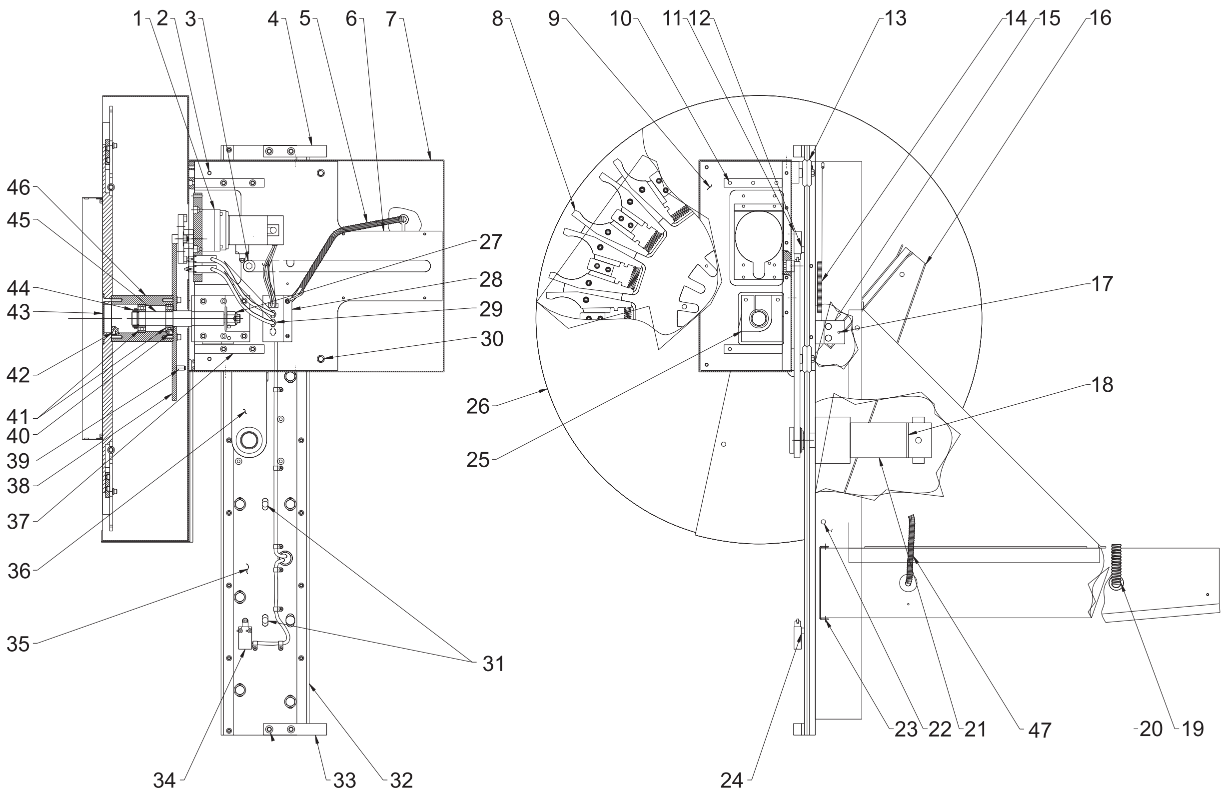
1. 30-0005 Turret motor assembly
2. 25-7162 Connector bracket
3. 57-9335 Shuttle cover gasket
4. 25-9334 Shuttle cover plate
5. 30-0006 Carousel assembly
6. 54-0010 Cam follower, T/C
7. 22-7034 Spacer, cam follower
8. 54-0040 Standard bushing guide wheel
9. 22-7106 V track, T/C
10. N/A
11. 20-7475 Arm, slip clutch
12. 54-0030 Guide wheel
13. 32-1800 Motor assembly shuttle
14. 70-0050 PLT4S-M cable ties
15. 25-9085 Conduit mounting plate
16. 20-9008 Holding arm
17. 57-9139 Tool holding arm gasket
18. 32-7011A Molded T/C cable assembly
19. 79-1000 Wire channel 1 in x 2in
20. 79-1001 Cover wire channel 1"
21. 25-7168 Bracket, door opener
22. 22-2065 Locating pin
23. 32-7614 TL carriage cable (VF 3-11)
24. 25-9329 Door, T/C cover
25. 22-7163 Rider trap door
26. 22-7263 Block switch MTG
27. 32-2010 Limit switch shuttle in/out
28. 54-0020 Bushing guide wheel
29. 25-9331 Tool changer cover TC32
30. 55-0010 Spring washer B2500-80
31. N/A
32. 22-7477 Pressure plate
33. 51-6000 Bearing locknut NT-05
34. 20-7476 Hub, slip clutch
35. 44-1710 SSS 1/4-20 x 3/8 cup with nylock
36. 75-15721 MLX 2 pin M 7.11LSW/earmolex
37. 78-1996 Split flex tubing 1/2 ID
38. 46-1705 Nut 3/4-10 nylon lock
39. 63-1031 Cable clamp 1/4
40. 22-7106 V-track tool changer
41. 48-1750 Dowel pin
42. 20-9330 32 T/C holding plate
43. 25-9331 TC cover
44. 22-7255A Tool #1 standoff
45. 26-7239 Spacer ring, tool changer
46. 48-0020 Dowel pin 1/4 x 1
47. 20-7038A Bearing housing
48. 20-7035G Vertical axle
49. 48-0019 Dowel pin 1/4 x 5/8
50. 51-0012 Bearing locknut BH-06
51. 25-7036 Cap, tool changer
52. 51-0010 Bearing deep groove
53. 20-9325 Geneva star

32 Tool Changer Assembly VF-3/4



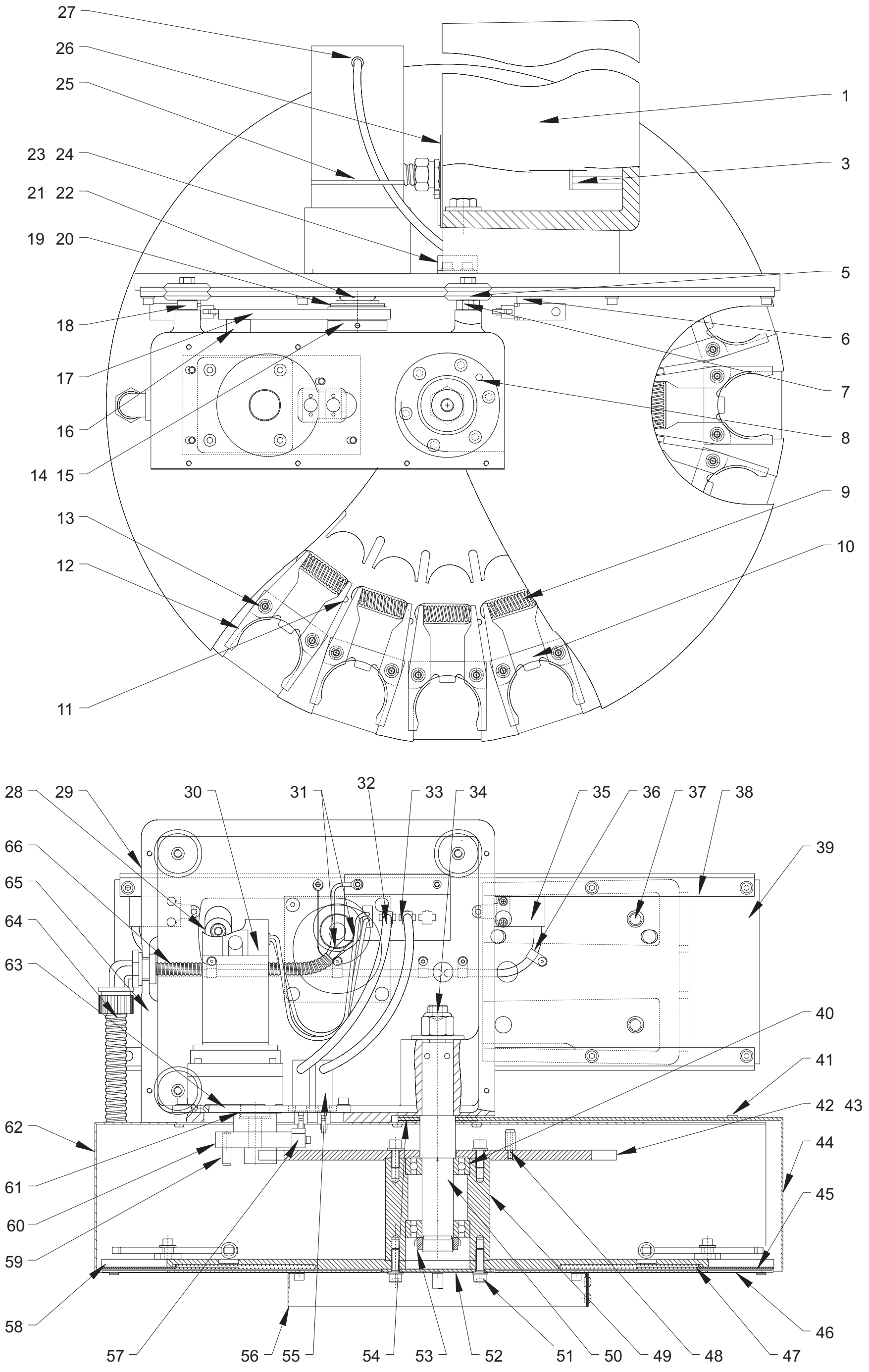
1. 30-1967 Turret motor assembly
2. 25-7162 Connector bracket
3. 25-9334 Shuttle cover plate
4. 57-9335 Shuttle cover gasket
5. 30-0006 Carousel assembly
6. 54-10010 Cam follower T/C
7. 22-7034 Spacer, cam follower
8. 54-0040 Standard bushing guide wheel
9. 32-2013 Limit switch shuttle assembly
10. 54-0030 Guide wheel
11. 20-9834 Tool changer clutch arm
12. 30-1875 Motor assembly carousel/shuttle
13. 25-0014 Brace
14. 25-9912 Conduit mounting plate
15. 22-9805 Holding arm
16. 32-7012B Molded T/C cable assembly
17. 25-0014Brace VF-6/8 32 tools
18. 59-7222 Grommet 1 1/2
19. 25-7168 Bracket, door opener
20. 22-2065 Locating pin
21. 32-7614 TL carriage cable (VF 3-11)
22. 25-9329 Door T/C cover
23. 25-9334 Shuttle cover plate
24. 32-2013 Limit switch shuttle assembly
25. 54-0020 Bushing guide wheel
26. 22-7163 Rider trap door
27. 25-9331 Tool changer cover
28. 45-2020 Washer 1 1/4 nylon
29. 55-0010 Spring washer B2500-080
30. 45-0050 Washer steel
31. 22-7477 Pressure plate
32. 51-6000 Bearing locknut NT-05
33. 20-7476 Hub slip clutch
34. 44-1710 SSS 1/4-20 x 3/8 with nylock
35. 48-0005 Dowel pin 3/16 x 3/8
36. 75-15721 MLX 2 pin M 7.11LSW/earmolex
37. 78-1996 Split flex tubing 1/2ID
38. 46-1705 Nut 3/4-10 nylon lock
39. 75-15721 MLX 2 pin M 7.11LSW/earmolex
40. 22-7106 V-track, tool changer
41. 48-1750 Dowel pin 1/2 x 1 1/2
42. 20-9330 32 T/C holding plate
43. 40-1697 SHCS 1/4-20 x 3/4
44. 22-7255A Tool #1 standoff
45. 26-7239 Spacer ring, tool changer
46. 48-0020 dowel pin 1/4 x 1
47. 20-7038A Bearing housing
48. 20-7035G Vertical axle
49. 48-0019 Dowel pin 1/4 x 5/8
50. 51-0012 Bearing locknut BH-06
51. 25-7036 Cap, tool changer
52. 51-0010 Bearing deep groove
53. 20-9325 Geneva star 32 tool 2 pin

32 Tool Changer Assembly VF-6..10



1. 30-0016 Geneva driver assembly
2. N/A
3. 54-0010 Cam follower T/C
4. 20-9289 Shuttle stop block
5. 78-1996 Split flex tuning 1/2 I.D.
6. 20-9291 Shuttle vertical plate
7. 25-9342 Shuttle cover
8. 30-0017A carousel assembly
9. 20-9290 Shuttle base plate
10. 20-9293 Shuttle gusset
11. 32-2030 Limit switch Y-axis
12. 22-7263 Block switch mounting
13. 51-0002 V-roller W-4
14. 59-9340 Spring, tool door
15. 22-9344 Tool door trip bracket
16. 25-9343 Tool door
17. 22-2065 Locating pin
18. 70-0050 PLT4S-M cable ties
19. 32-7014 Molded T/C Cable Assembly (VF 5/50)
    32-7012B molded T/C cable assembly (VF 6-11)
20. 22-9287 Tool changer mounting arm
21. 32-0011 Motor shuttle assembly
22. 22-7163 Rider trap door
23. 25-9345 Holding arm cover plate
24. 22-7263 Switch mounting block
25. 20-9292 Shuttle hub block
26. 25-9341 Tool changer cover
27. 46-1720 Nut 1/2-13 hex plt
28. 25-7162 Connector bracket
29. 75-15721 MLX 2 pin M 7.11 LSW/earmolex
30. 51-0003 Adj ecentric model BX-4
31. 48-0020 Dowel pin 1/4 x 1
32. 20-9295 V-track
33. 20-9289 Shuttle stop block
34. 32-2010 Limit switch shuttle in/out 24"
35. 20-9288 Shuttle plate
36. 30-0019B Slip clutch assembly
37. 20-9393 Shuttle gusset
38. 20-9336 20 pocket geneva star
39. 22-7255A Tool #1 standoff
40. 48-0020 Dowel pin 1/4 x 1
41. 51-0010 Bearing, deep groove
42. 48-0019 Dowel pin 1/4 x 5/8
43. 25-7036 Cap, tool changer
44. 51-0012 Bearing locknut BH-06
45. 20-7035G Vertical axle
46. 20-9283 Bearing housing T/C hub
47. 32-7616 TL Carriage Cable 50T (VF 5-11)

50 Taper Tool Changer Assembly



20 Pocket Tool Changer

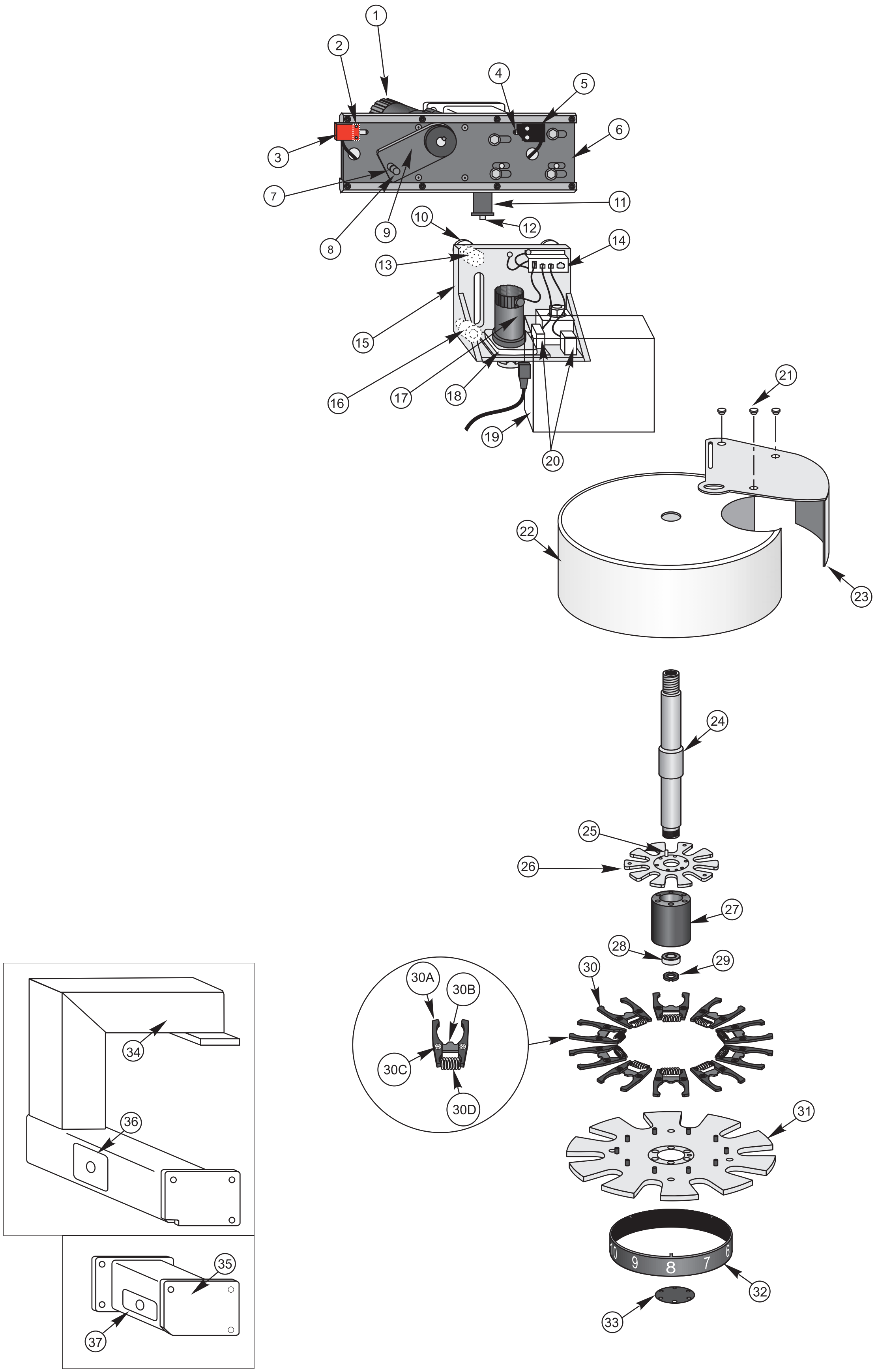
20 Pocket Tool Changer

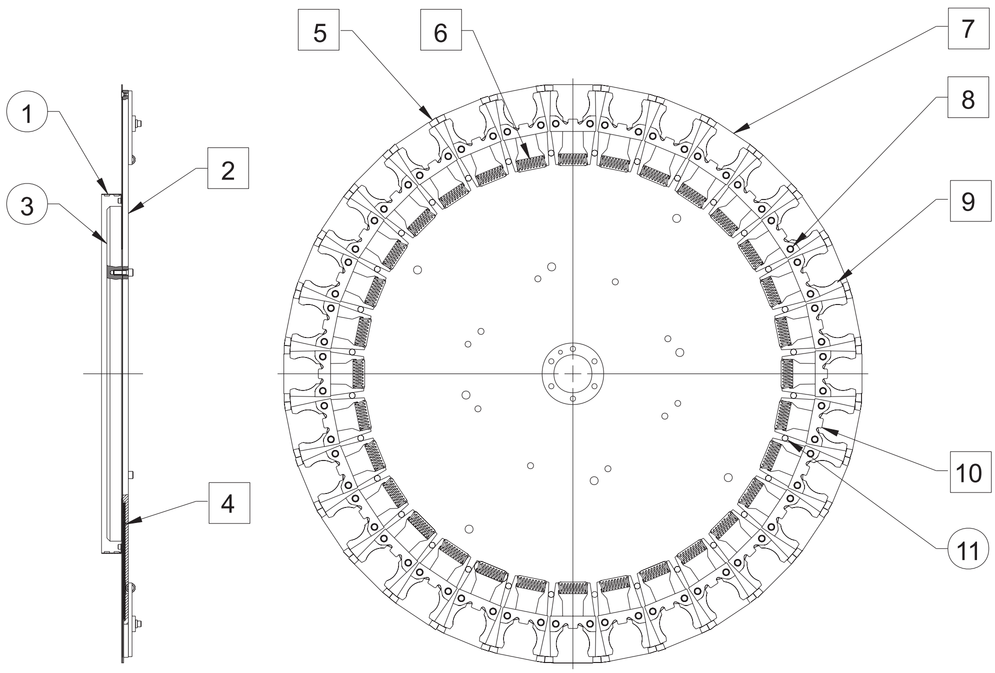
1. 20-7029B Holding arm
2. 57-7379 Tool holding arm gasket
3. 79-1000 Wire channel 1in. x 2in.
4. 79-1001 Cover wire channel 1"
5. 54-0030 Guide wheel
6. 22-7263 Block switch mounting
7. 54-0020 Bushing guide wheel
8. 48-0019 Dowel pin 1/4 x 5/8
9. 24-9257 Spring, extractor
10. 22-7067F Key extractor spring
11. 48-0002 Roll pin 7/32 x 7/8
12. 22-9574A CT extractor spring load
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. 51-0010 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
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.

MINI-MILL AND TRM TOOL CHANGERS

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	20-0079	T/C Link
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)

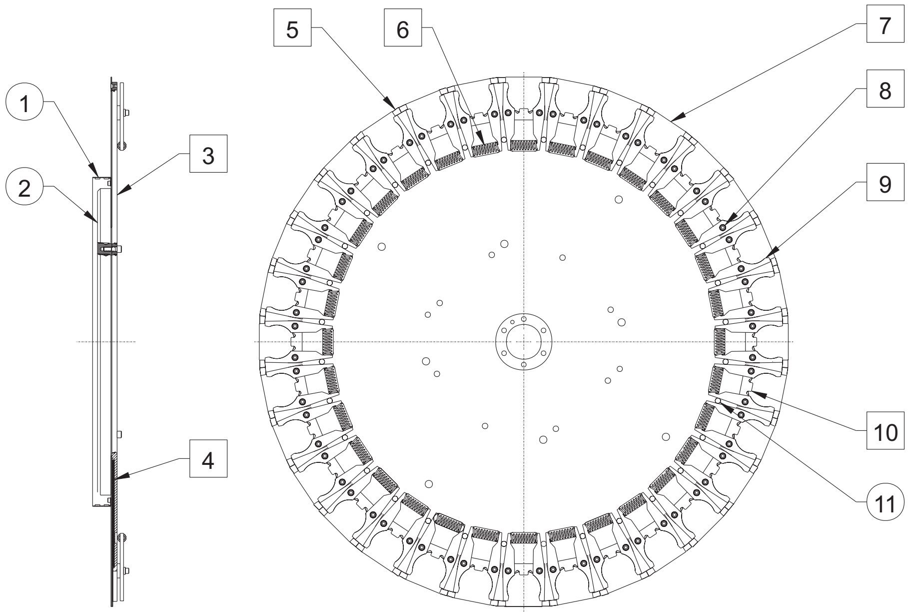
I\G\TRM\TC List.cdr


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
30A
30B
30C
30D
31
32
33
34
35
36
37



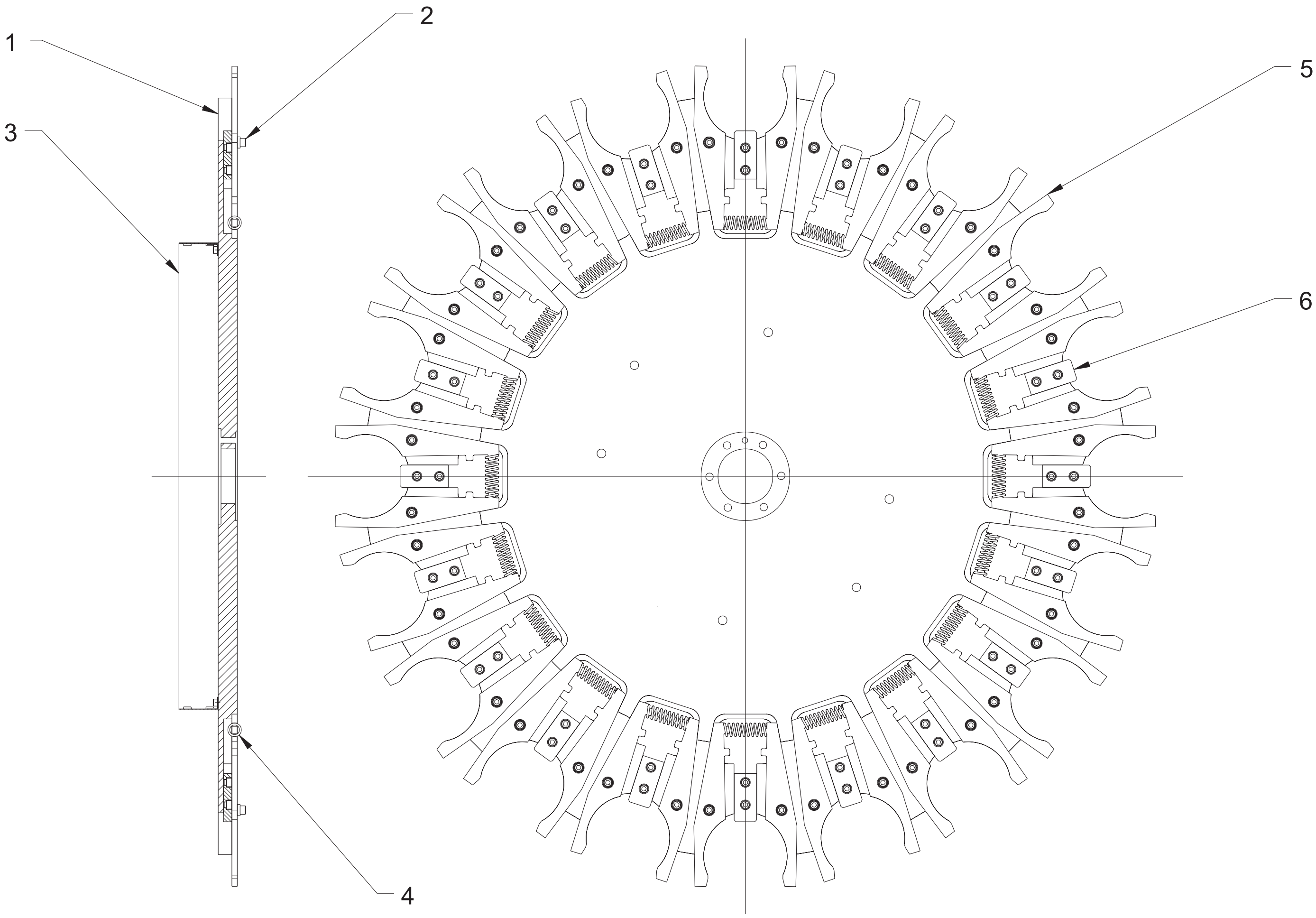
1. 25-9333 Number ring
2. 20-9324 Carousel 32 tool
3. 20-9193 Carousel support plate
4. 24-2010A Compression spring
5. 25-9328 Sliding panel cover
6. 24-9257 Spring extractor
7. 25-7249 Sliding panel
8. 22-9256 Bushing extractor
9. 22-7166A Extractor BT-40 T/C
10. 22-7067F Key extractor spring
11. 48-0004 Roll pin 3/8 x 1

32 Tool Carousel Assembly (BT) VF 3-10



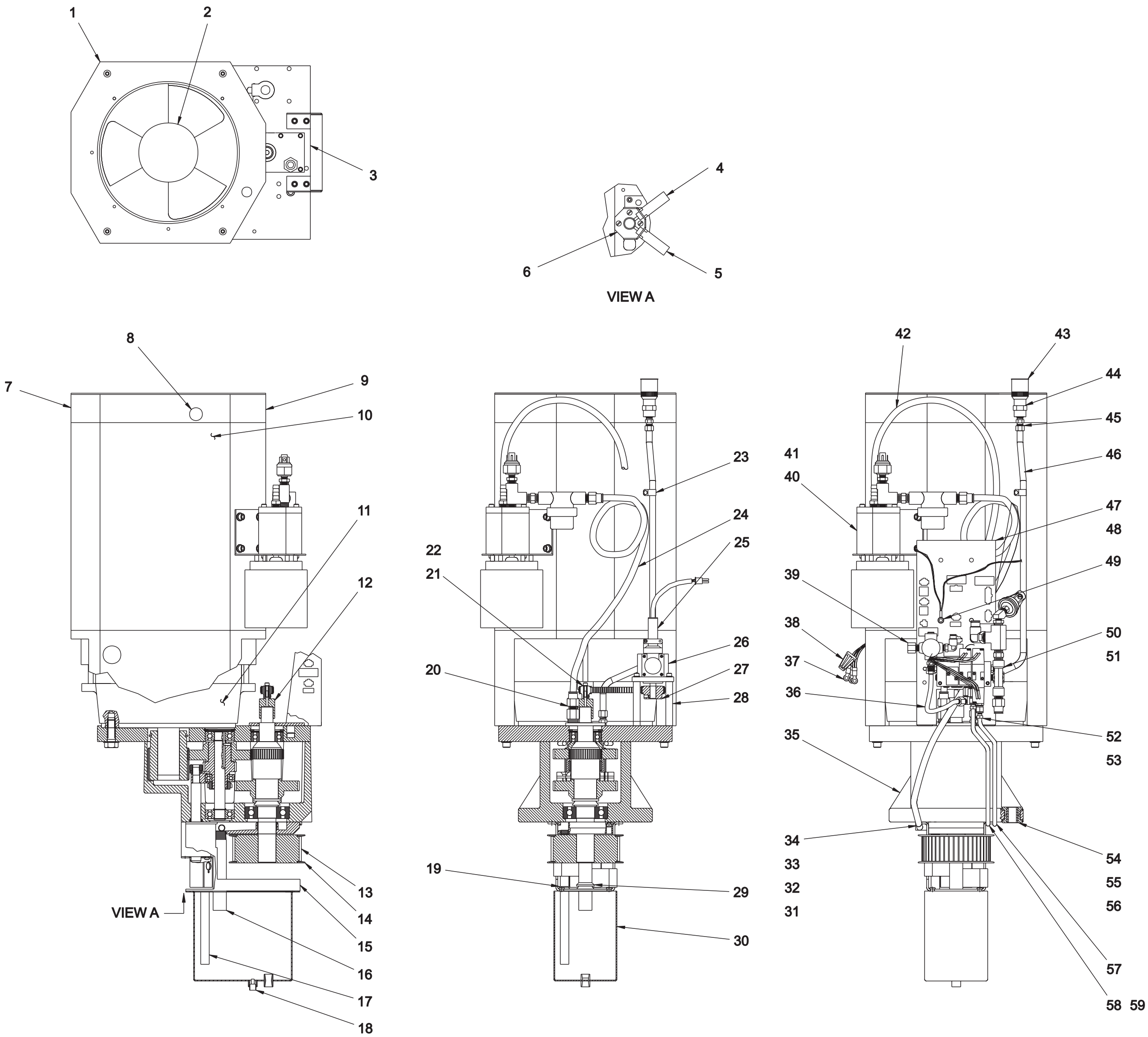
1. 25-9333 Number ring
2. 20-9193 Carousel support plate
3. 20-9324 Carousel 32 tool
4. 24-2010A Compression spring
5. 25-9328 Tool sliding panel cover
6. 24-9257 Spring extractor
7. 25-7249 Slider panel
8. 22-9574A CT extraxctor spring
9. 22-9256 Bushing extractor
10. 22-7067F Key extractor spring
11. 48-0004 Roll pin 3/8 x 1

32 Tool Carousel Assembly Assembly (CT) VF 3-10



1. 20-9296 50 Taper carousel
2. 22-9256 Bushing extractor
3. 25-9349 Number ring
4. 24-9257 Spring extractor
5. 22-9297 Extraction finger
6. 20-9298 Alignment key

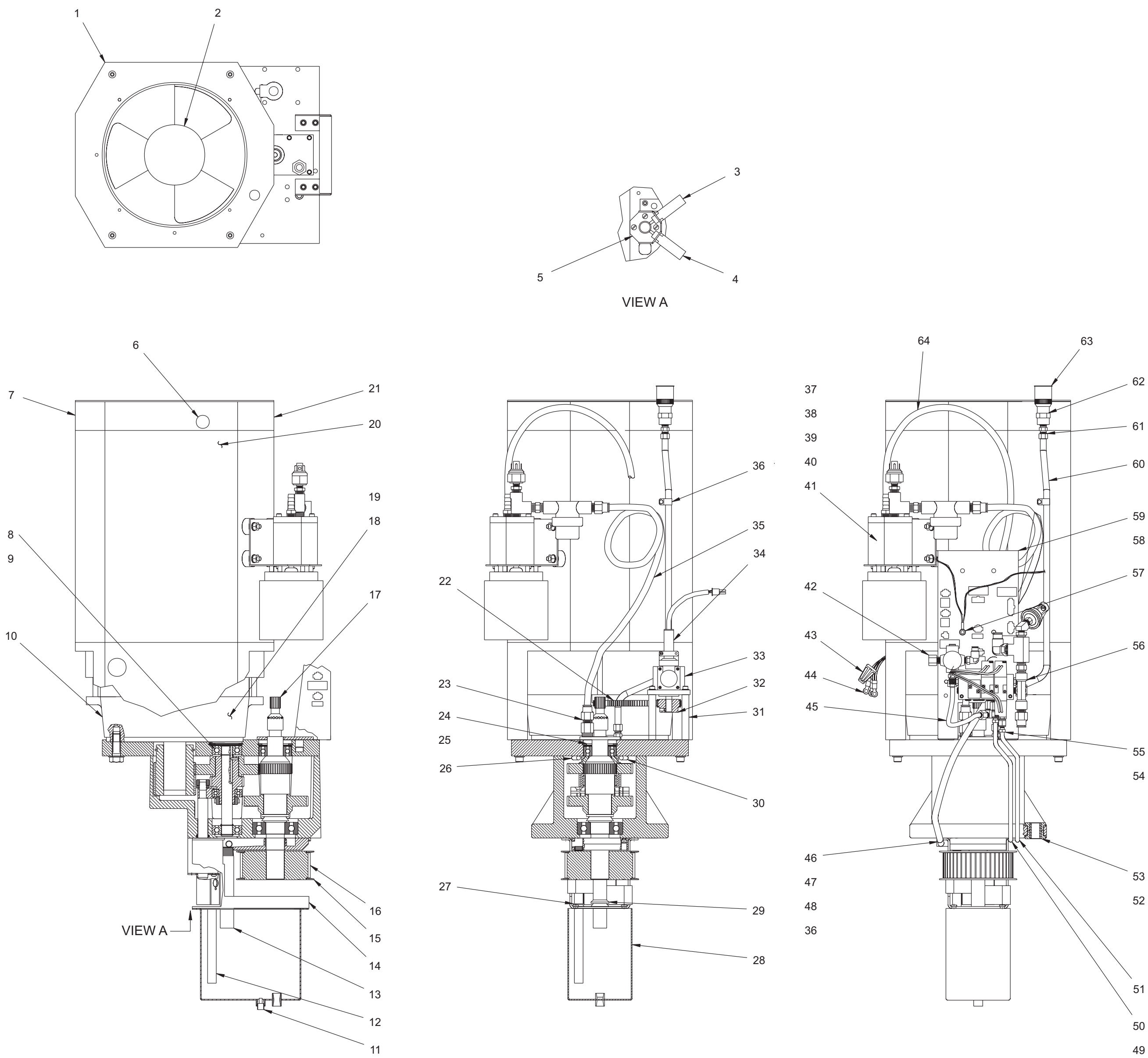
50 Taper Carousel Assembly (CT) VF 6-10



VF 1-11 Gearbox Assembly 15 HP

VF 1-11 Gearbox Assembly 15 HP

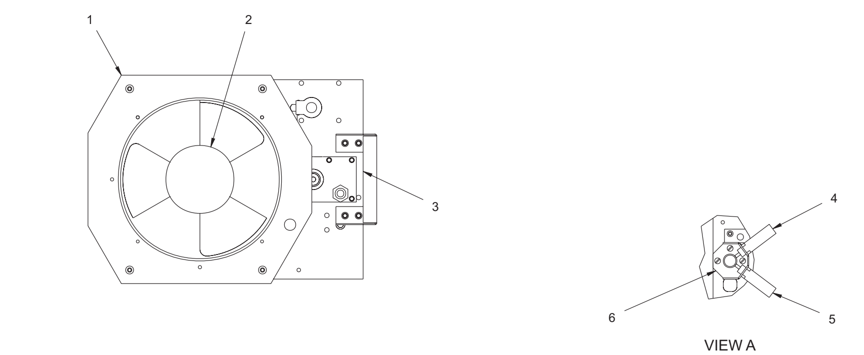
1. 25-0108 Fan bracket motor shroud
2. 36-3035 Spindle fan assembly
3. 59-7130 Protective strip
4. 32-2011Telmech. 30" cable assembly
5. 32-2010 24" limit switch
6. 25-7264 Switch mounting bracket
7. 29-0022 Shroud caution decal
8. 59-1482 Nylon finish plug, 13/16
9. 25-01074 Motor shroud
10. 20-0064 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

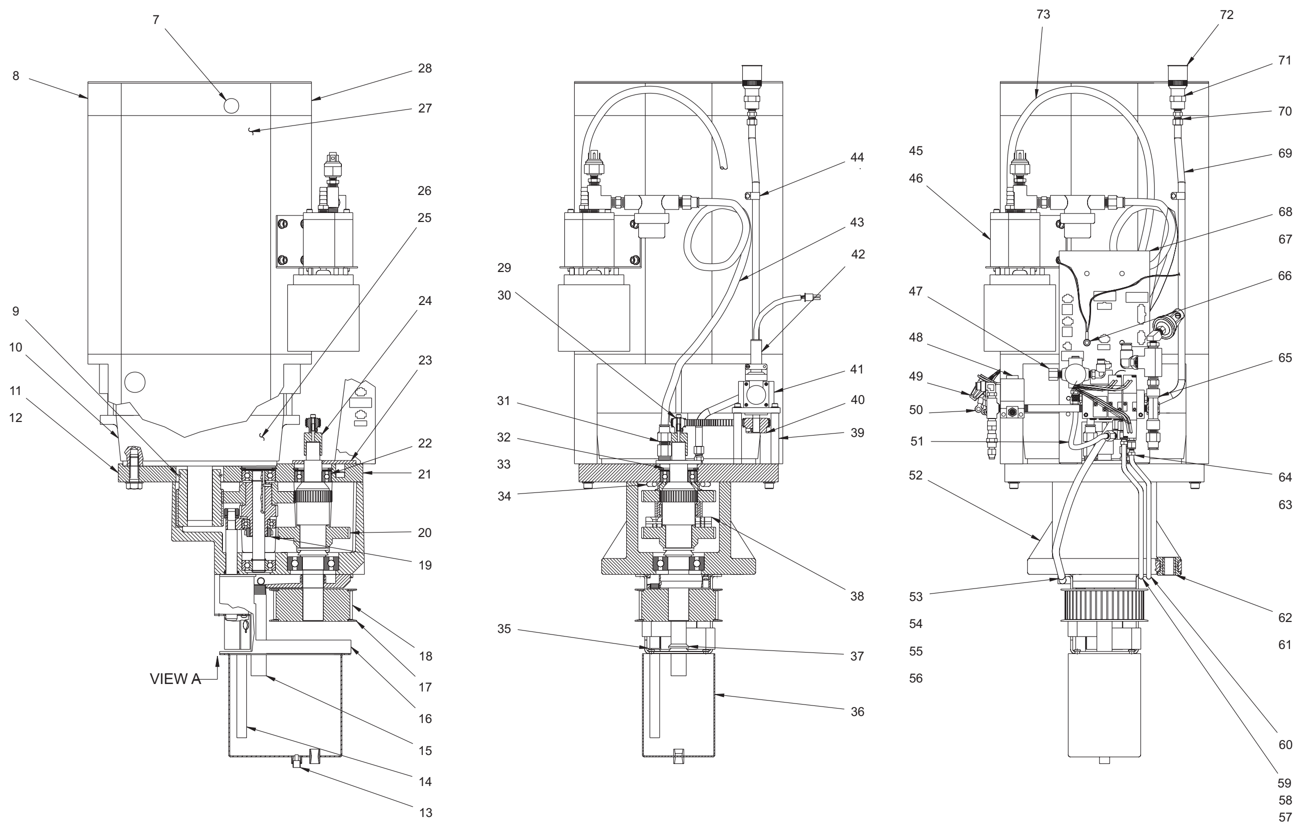


VF 1-11 Gearbox Assembly HT10K

VF 1-11 Gearbox Assembly HT10K

1. 25-0108 Fan bracket motor shroud
2. 36-3035 Spindle fan assembly
3. 32-2011 Telmech 30" cable assembly
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

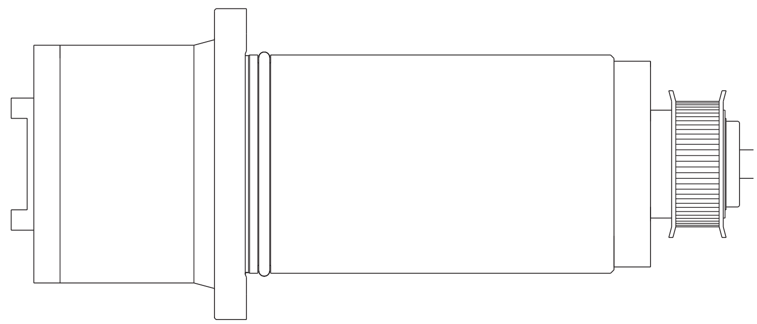




VF 1-11 Gearbox Assembly HT10K TSC

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 Telmech 30" cable assembly
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

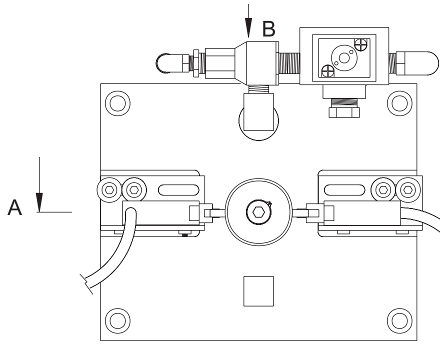


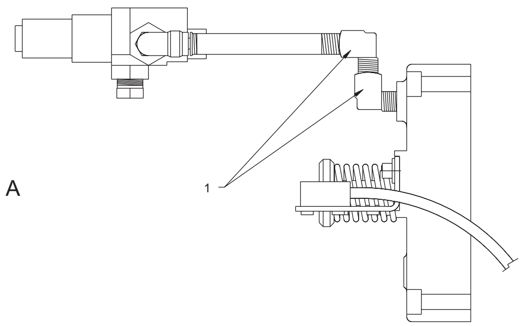
SPINDLES
30-0319A 7.5 Spindle Assembly
30-2132 10K Spindle Assembly
30-1360 15K Spindle Assembly
30-1468 15K spindle assembly VF5-11

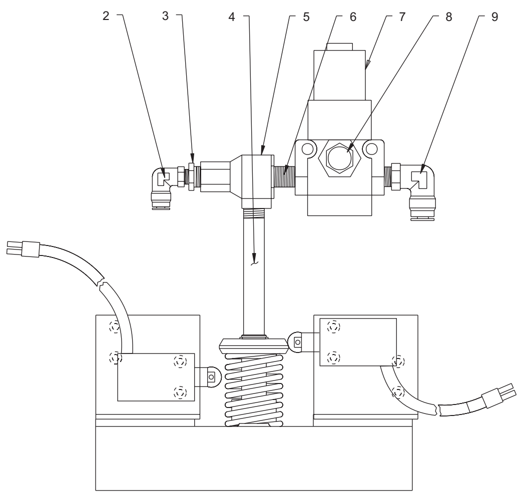
30-0449 50 Taper Spindle Assembly

DRAWBAR
30-3410E 7.5k spindle with or without TSC
30-0067 50 Taper

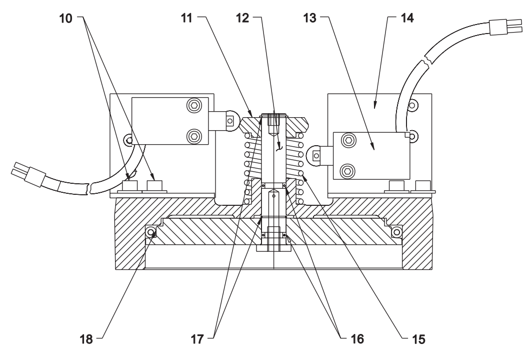
Spindle Assemblies







VIEW B
OUT OF POSITION



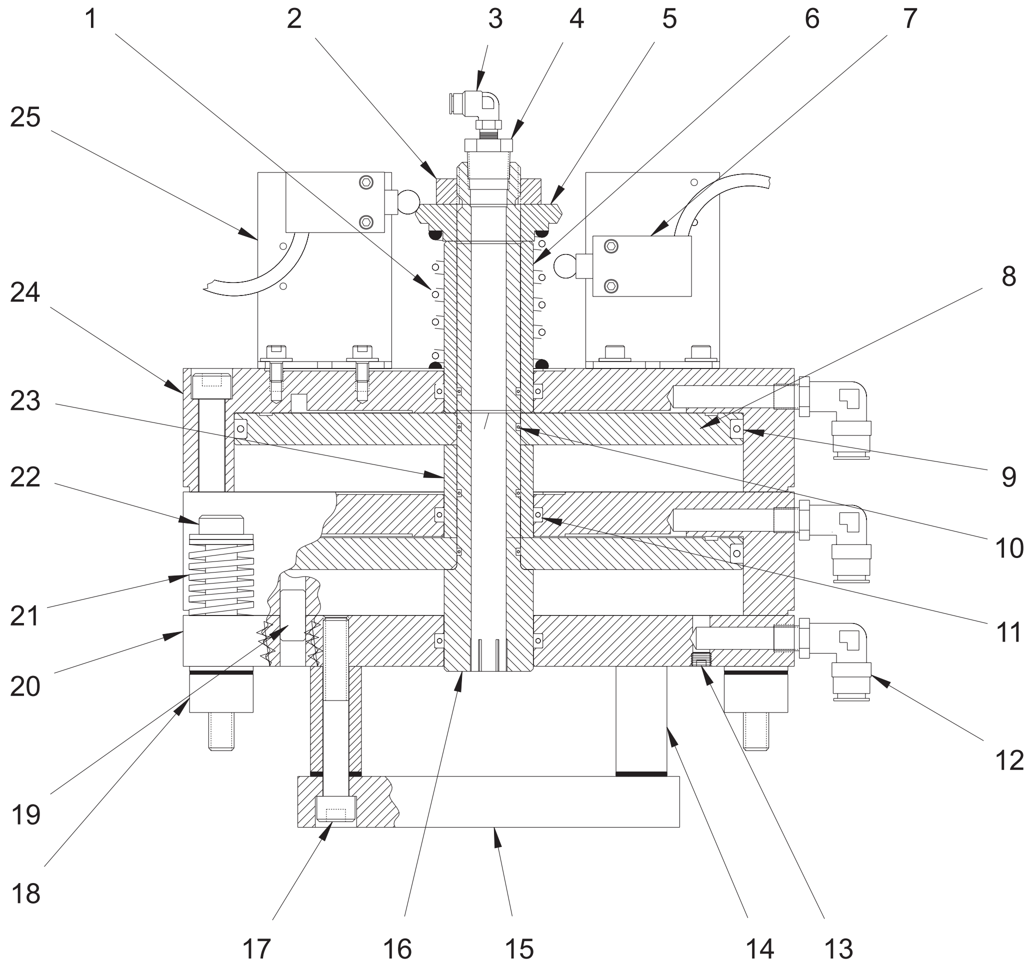
SECTION A-A
OUT OF POSITION

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

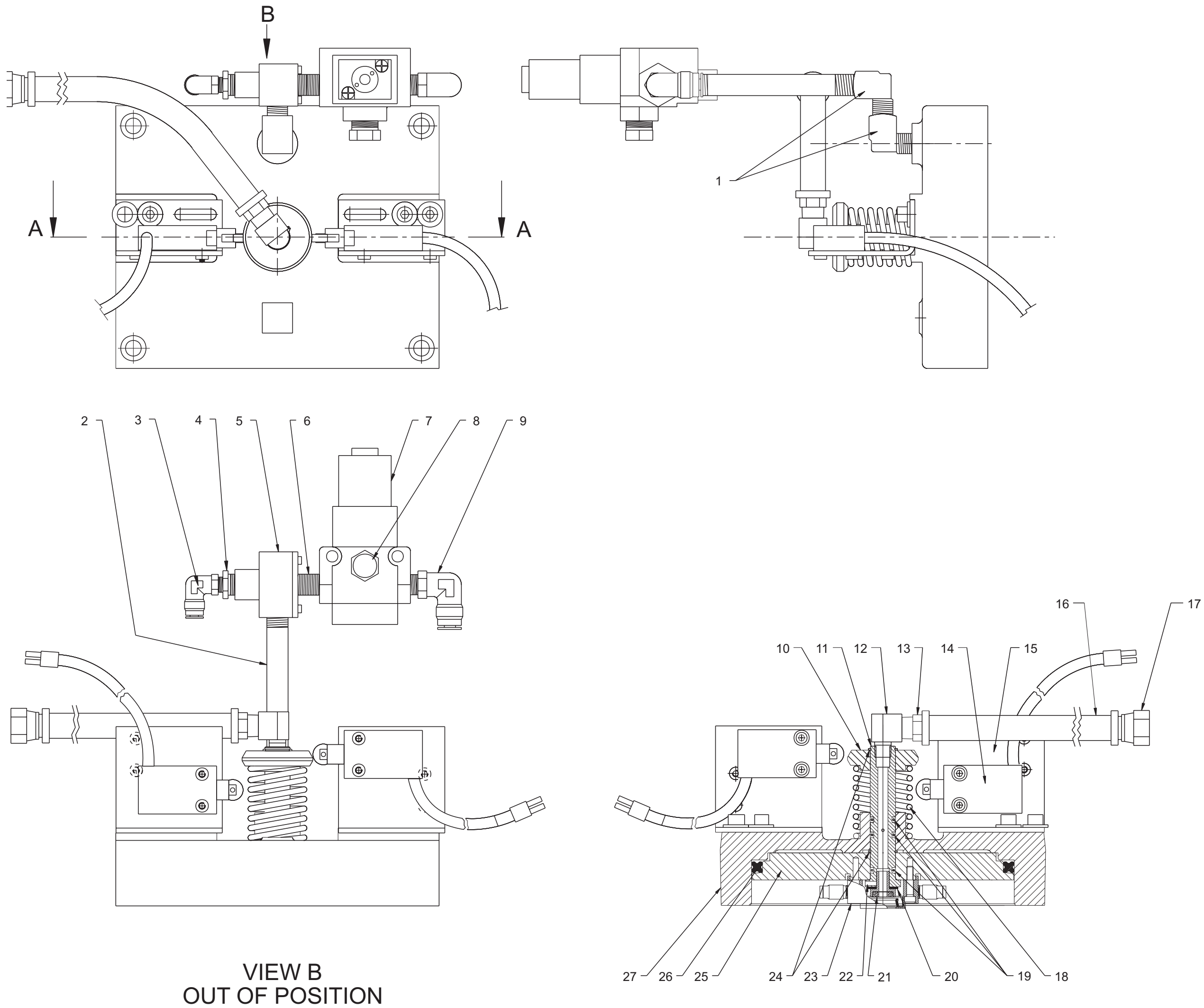
Tool Release Piston Assembly



1. 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

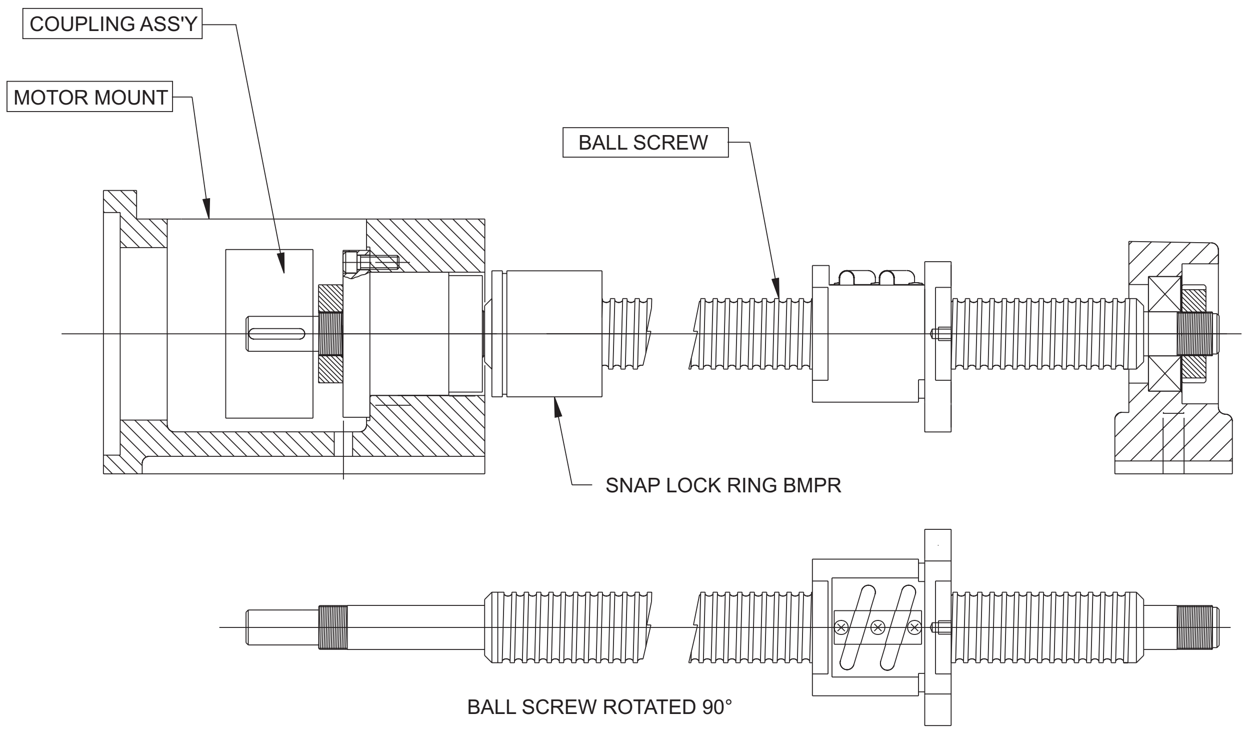
50 Taper Tool Release Piston



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. N/A
19. N/A
20. N/A
21. 20-7627B Coolant tip carbide
22. N/A
23. 30-3298
24. 56-0040 Retaining ring N5100-62
25. 20-7630A TRP rectangle TSC
26. 57-2156 Quad-ring Q4-440 buna
27. 20-7007A Cylinder housing

93-30-3206 Complete assembly

TSCHP Tool Release Piston Assembly



	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

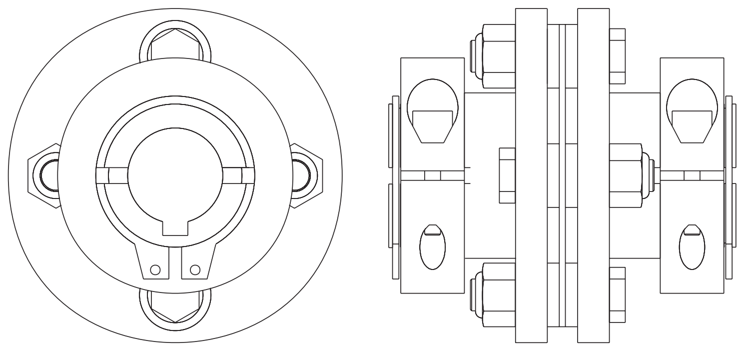
	VF-6/8	VF-7/9	VF-10/11
Base	30-0474	30-0474	30-0474
Saddle	30-0470	30-0473	30-0516
Column	30-0474	30-0474	30-0474

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



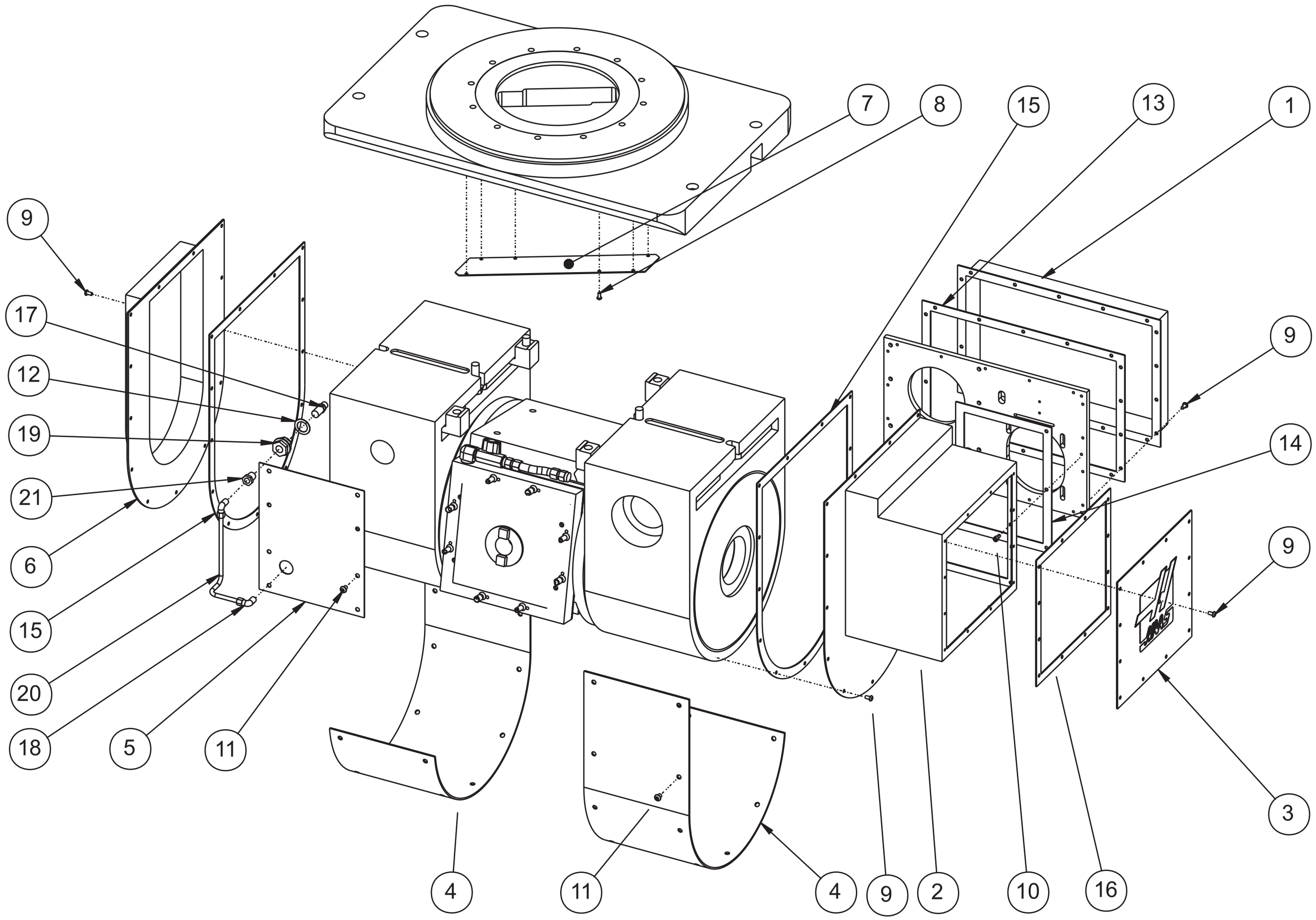
	VF 0-5 & Mini-Mill	VF-5XT	VF 6/8	VF 7/9	VF10/11
Base	30-0211 (30-1220A)	30-1215	30-1219	30-1219	30-1219
Saddle	30-0211 (30-1220A)	30-1219	30-1225A	30-0516	
Column	30-0211 (30-1220A)	30-1219	30-1219	30-1219	

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

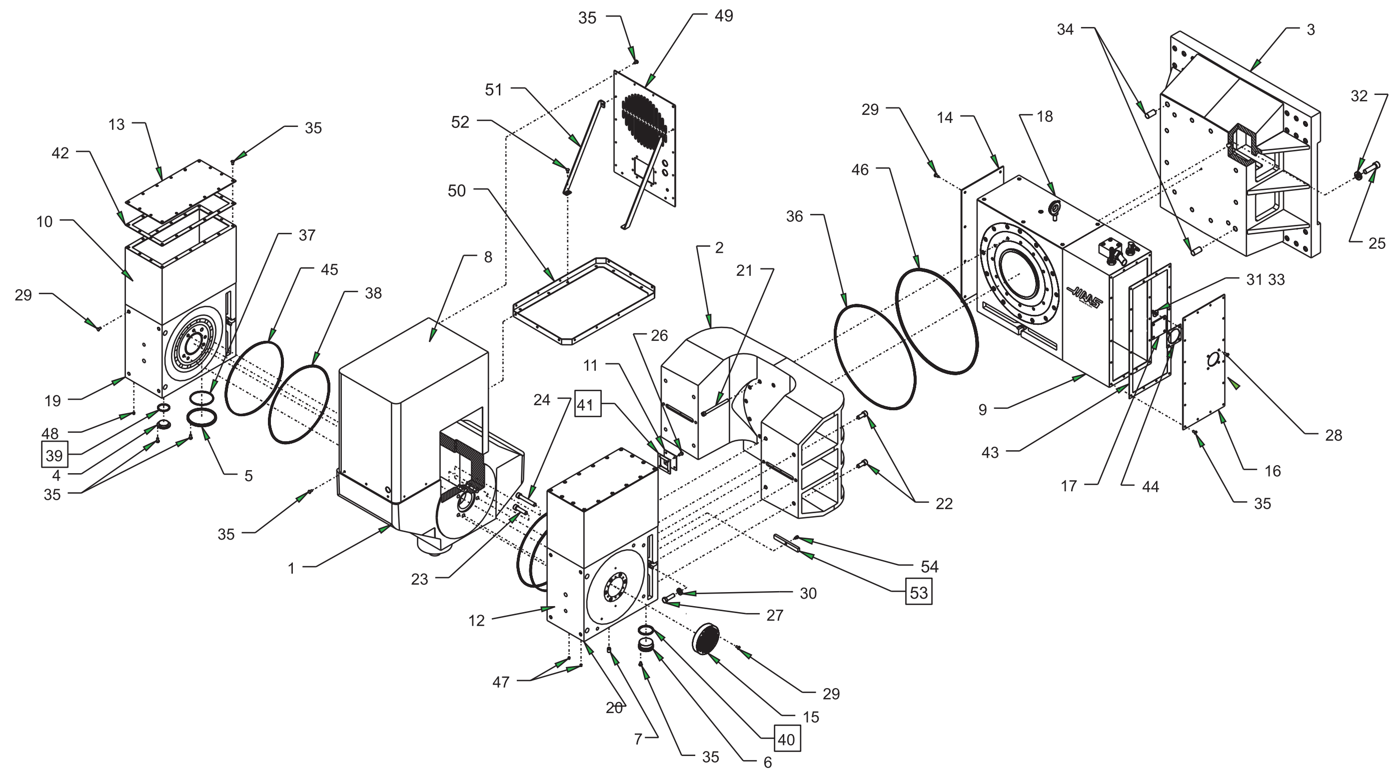
Bridge Mill Head Assembly



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

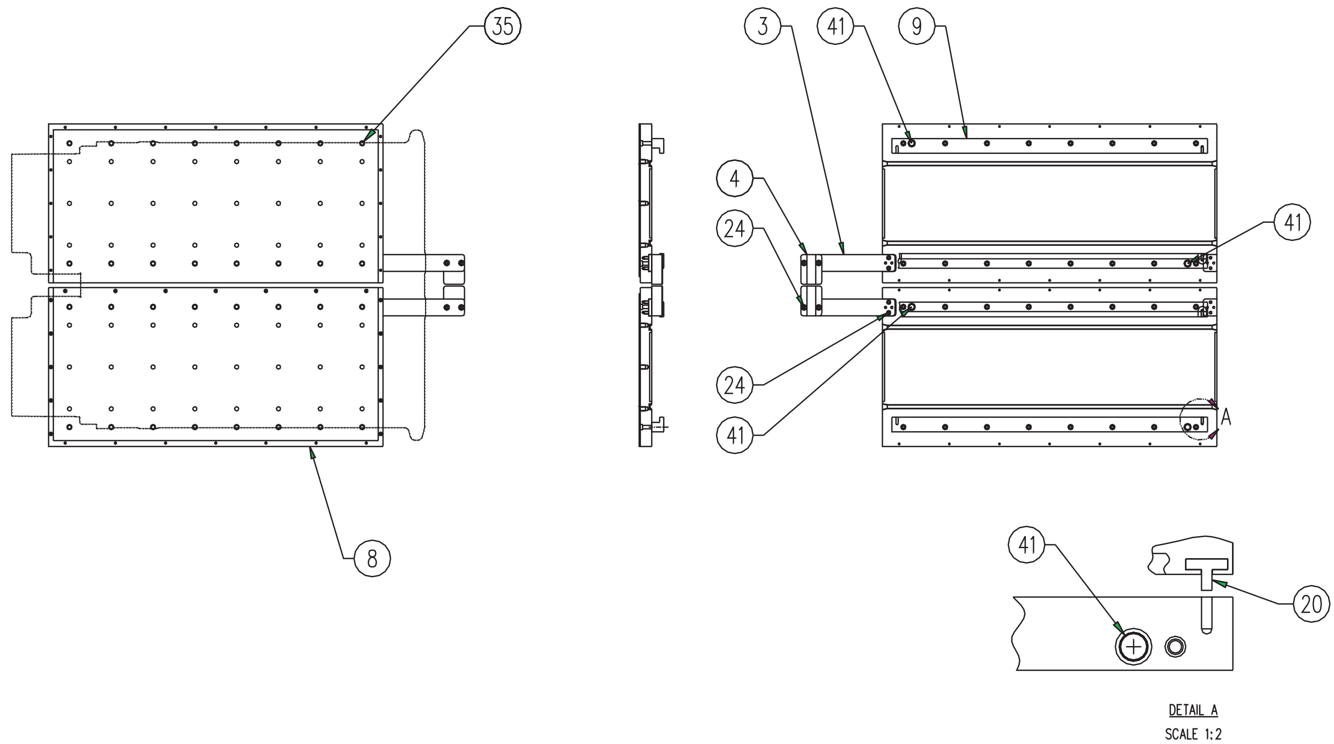
VR-Series Head Assembly



TORQUE SETTINGS	
ITEM	VALUE
21	45 FT LBS
22	88 FT LBS
23	100 FT LBS
24	100 FT LBS
25	160 FT LBS

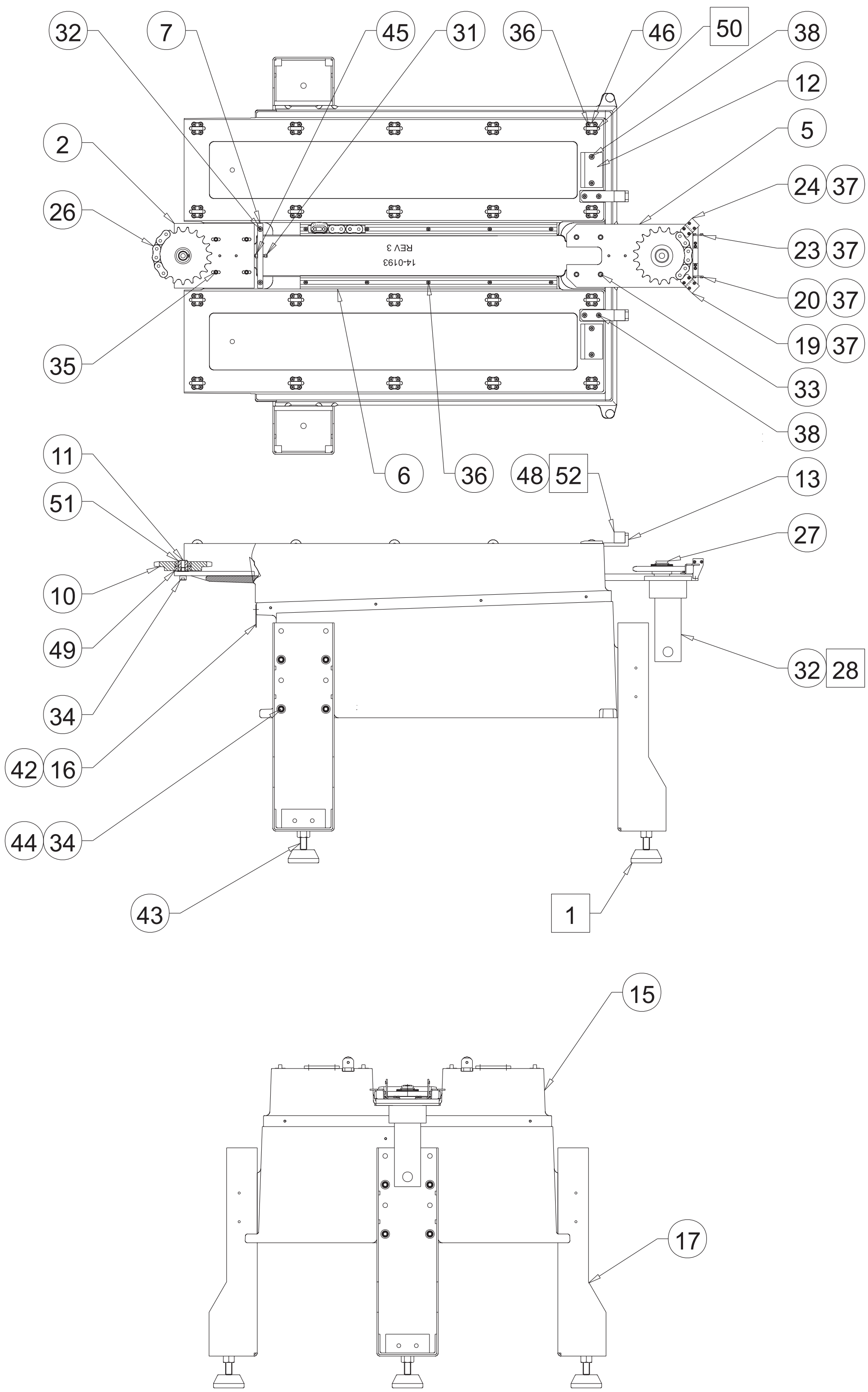
VR-Series Head Assembly

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



APC Assembly

sheet 1 of 2

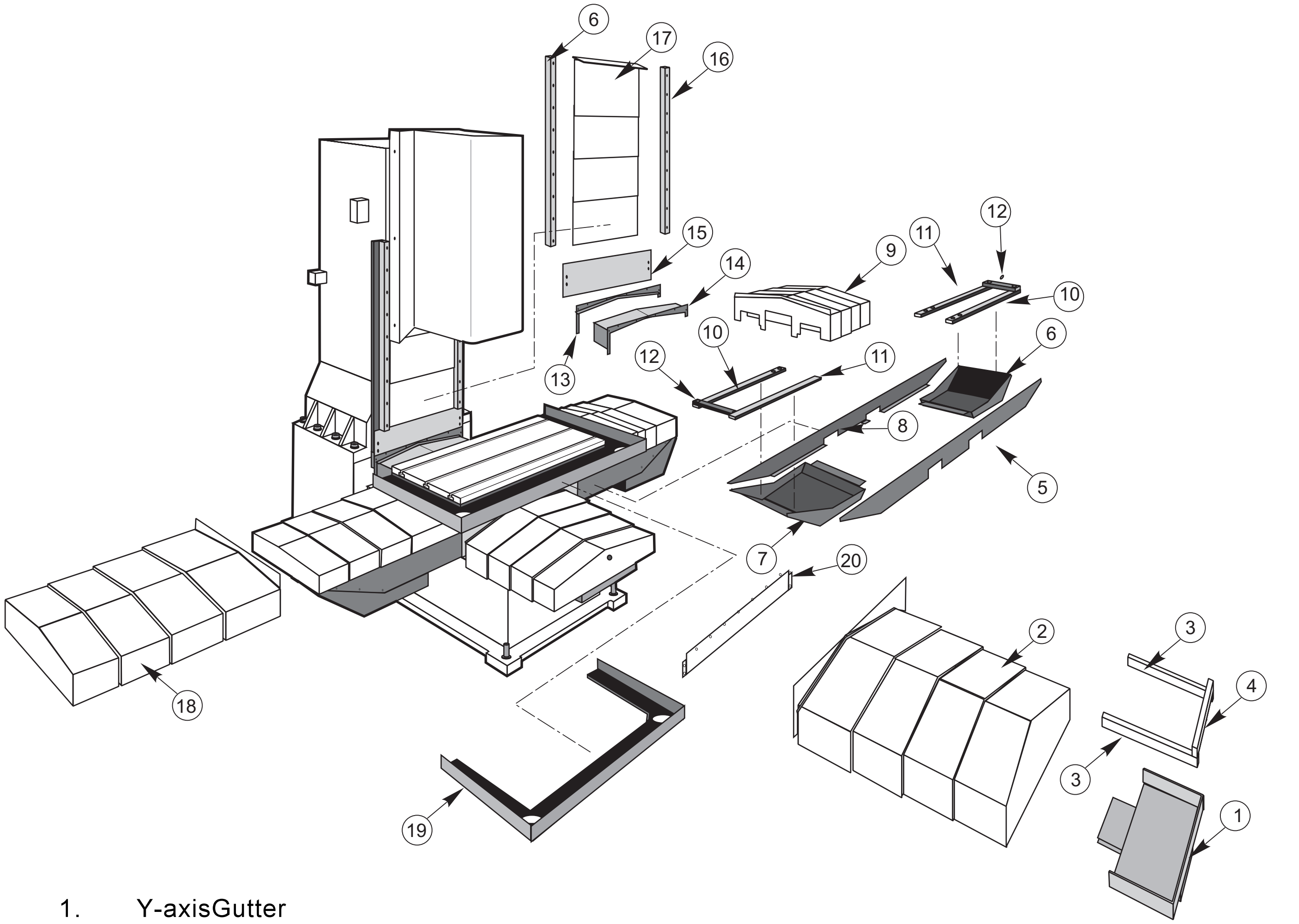


APC Assembly

sheet 2 of 2

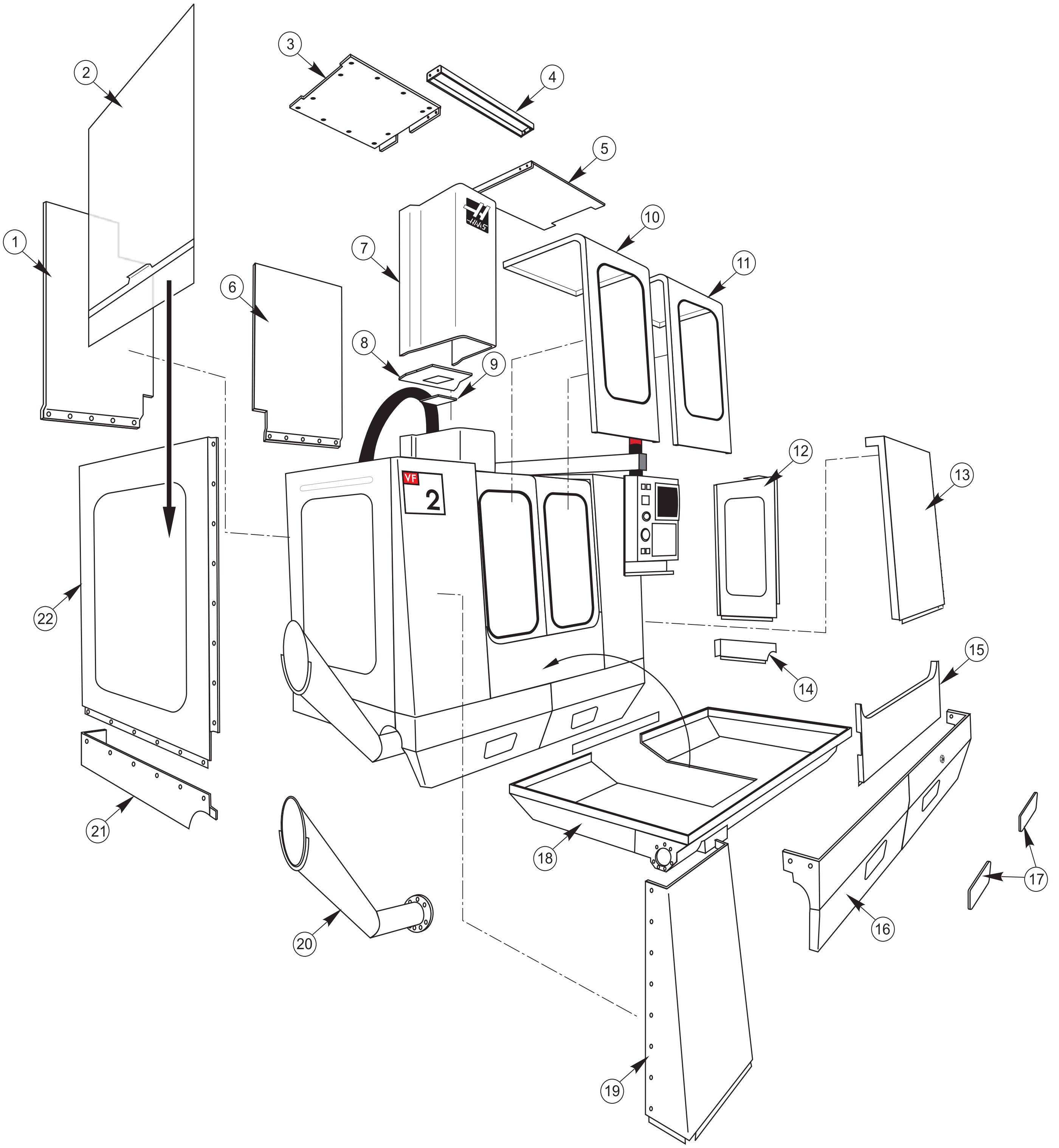
APC Assembly

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.	4	20-0071	WIPER, APC
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.	1	25-0085	SWITCH BRACKET, ARM #1
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



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

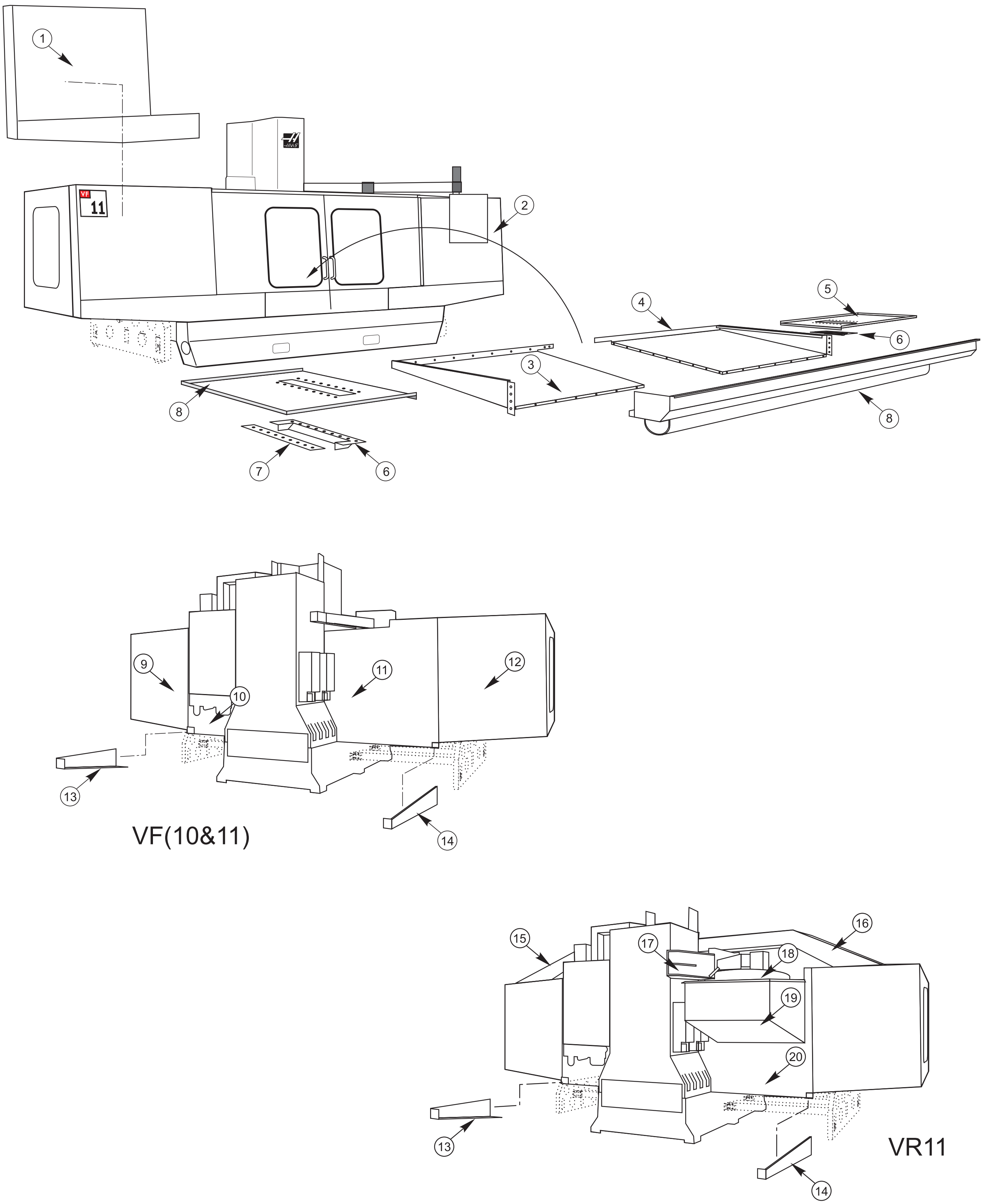
VF Interior Replaceable Parts



VF Exterior Sheet Metal

VF Exterior Sheet Metal

1. Back Panel, Left
2. Side Window (handle not included)
3. Roof
4. Bridge
5. Roof
6. Back Panel, Right
7. Spindle Head Cover
8. Bottom Head Cover
9. Bottom Head Cover Inspection Panel
10. Left Door
11. Right Door
12. Right Side Panel
13. Front Right Panel
14. Apron Extension
15. Middle Front Panel
16. Front Apron
17. Access Panel
18. Pan
19. Front Left
20. Chip Chute
21. Left Side Apron
22. Left Side Panel

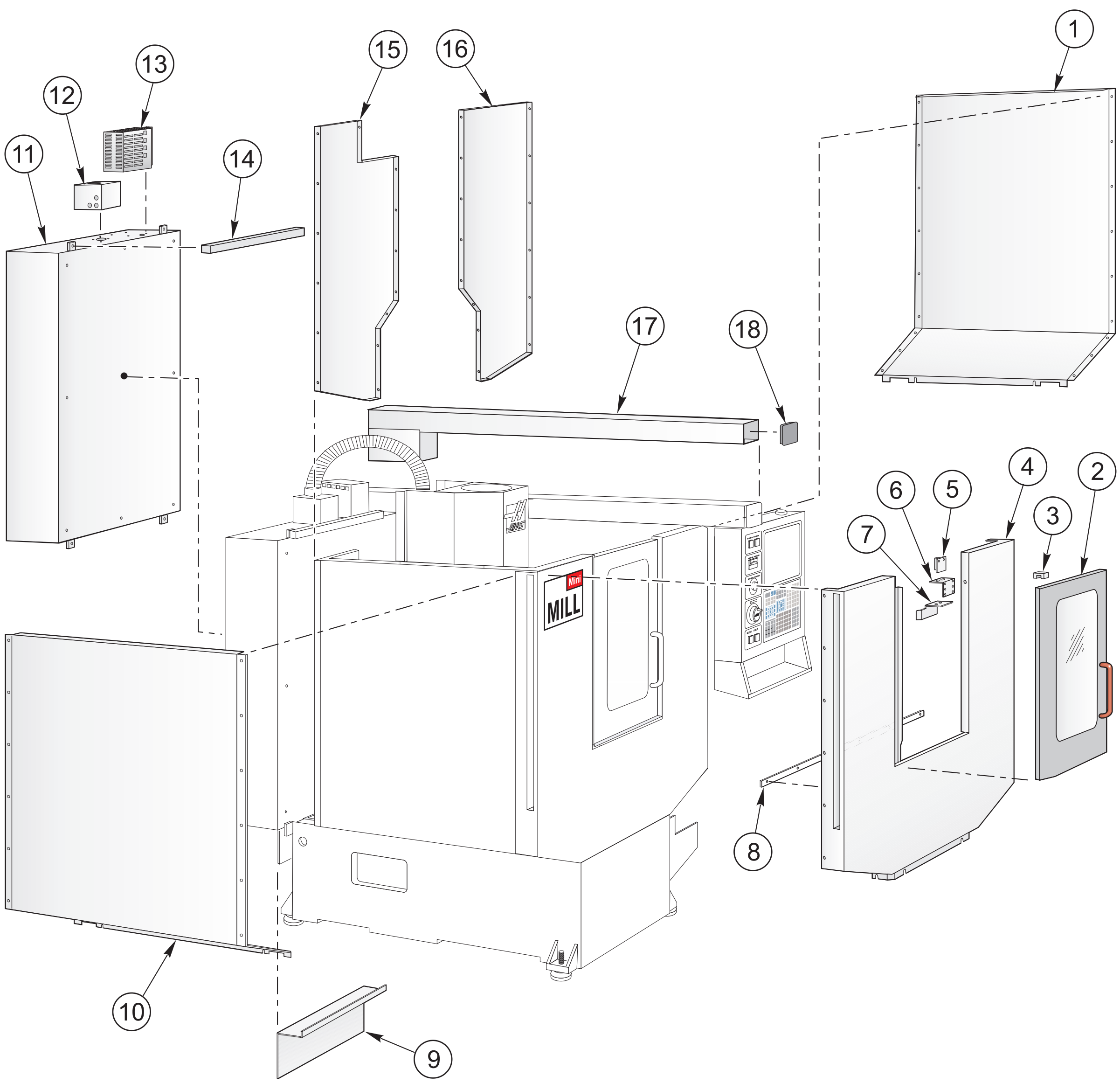


VF Exterior Sheet Metal

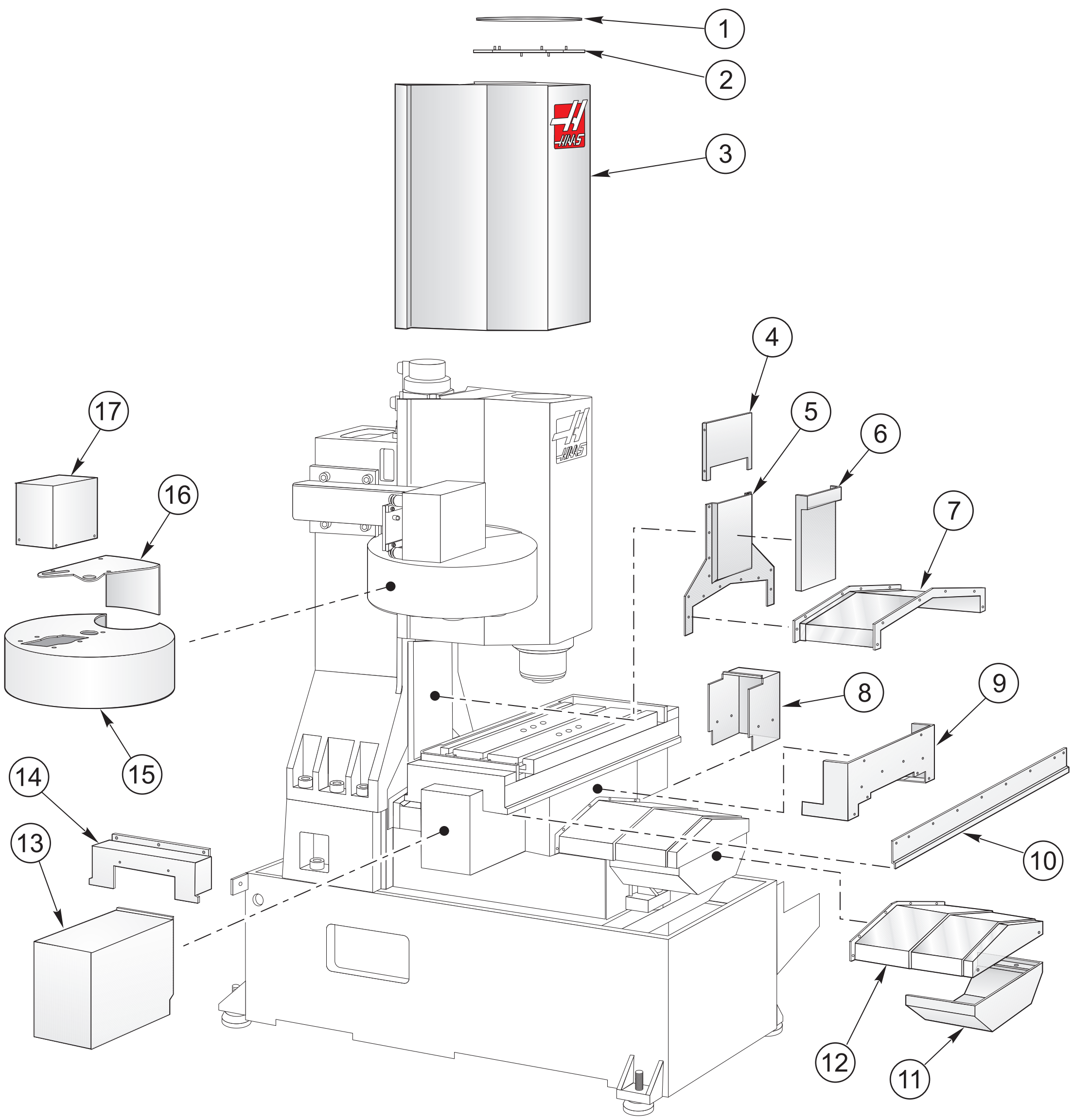
VF Exterior Sheet Metal

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

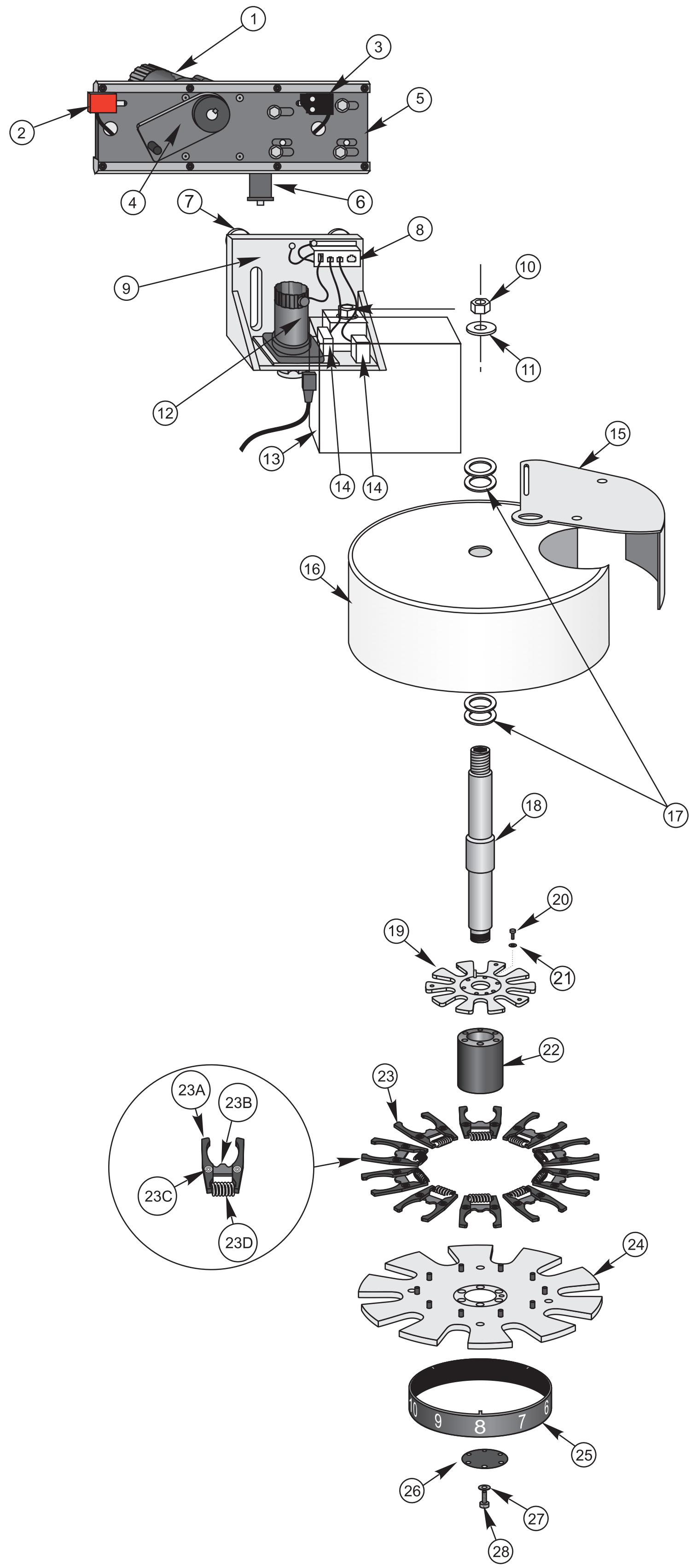
1. Enclosure Side	25-0754
2. Door Assembly	25-0386 (Window 28-0011)
3. Guide Block	20-0712
4. Panel Front Enclosure	25-0753
5. Keybracket	25-0958
6. Switch Mounting Bracket	25-7050C
7. Door Keeper	25-0757
8. Lower Door Rail	22-7616
9. Lube Panel Mounting	25-7195K
10. Enclosure Side Mirror	25-0754
11. Main Electric Control Box	25-0025D
12. Junction Box	25-7198B
13. Regen Cover	25-0461 (front) 25-0462 (back)
14. Box Bar	20-3009
15. Back Panel Left	25-0384A
16. Back Panel Right	25-0385A



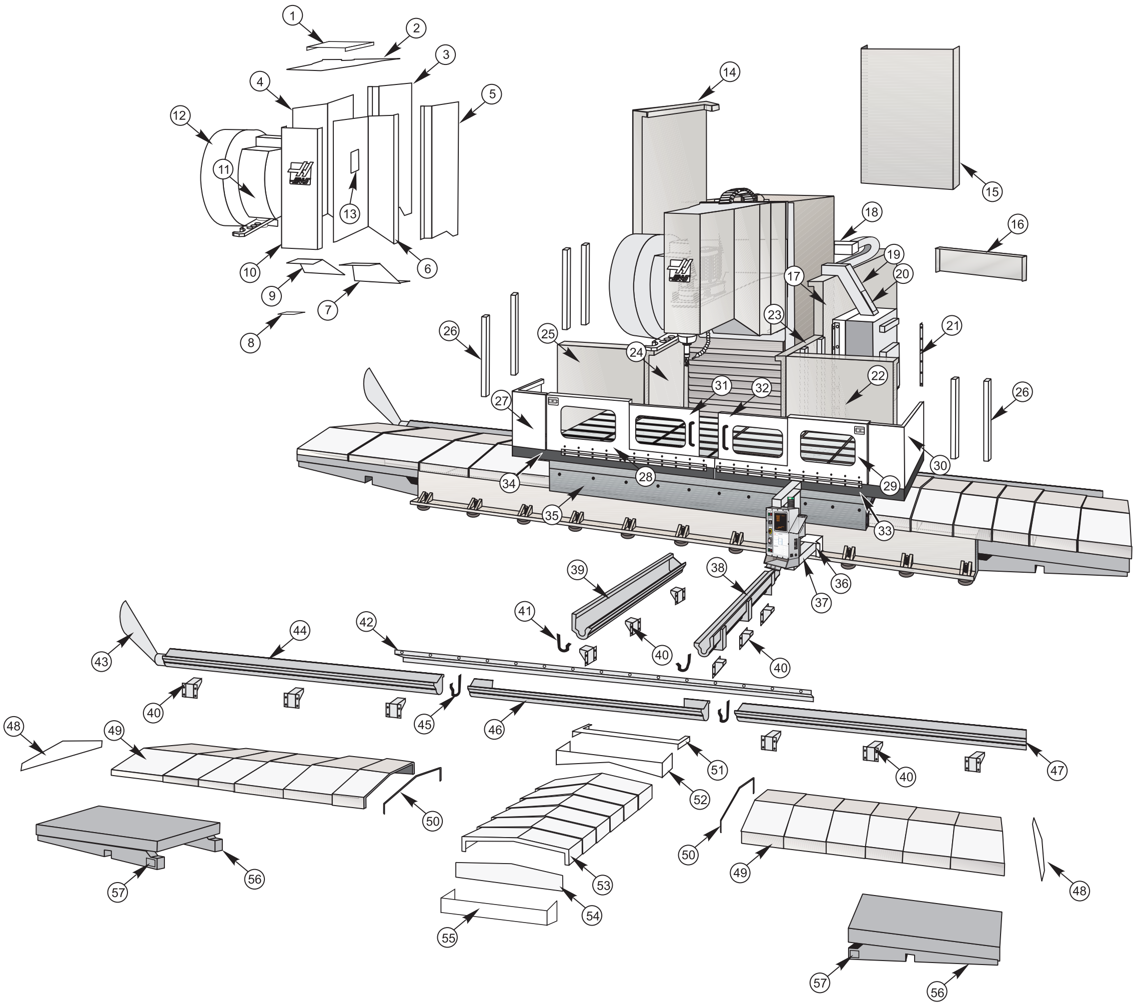
1. Fan guard	59-0144
2. Fan bracket top	25-0389
3. Head Cover	25-0382
4. Back Head Cover	25-0388
5. Z lower cover	25-0381
6. Z upper cover	25-0380
7. Y-axis way cover, rear	25-0373
8. Support Cover	25-0377
9. Saddle cover (2)	25-0375
10. Tab side cover (2)	25-0378
11. Front Y-axis motor cover	25-0374
12. Y-axis Waycover, Front	25-0372
13. Motor Cover, X-axis	25-0376
14. Table End Cover (2)	25-0379
15. Tool Changer Shroud	25-0633
16. Trap Door	25-0636A
17. Tool Changer Cover	25-0634



1.32-1875 Motor Assembly
2. 32-2010 Limit Switch
3. 32-2000 Limit Switch
4. 30-7200A Actuating Arm
5. 20-0682 Tool Holding plate
6. 25-0466 Door Opener Bracket
7. 54-0030 Guide Wheel
8. 25-7162 Connector Bracket
9. 20-1354A T/C Carriage
10. 46-1705 Lock nut
11. 45-1725 3/4" Flat Washer
12. 30-1679 Turret Motor Assembly
13. 25-0634 T/C Cover
14-32-1999 Limit Switch
15. 25-0636A Trap Door
16. 25-0633 T/C Shroud
17. 45-2020 Nylon Washer
18. 20-0681 Vertical Axle
19. 20-0678 Geneva Star
20. 40-16385 SHCS 5/16-18x3/4
21. 45-1600 Washer 5/16 Split Lock
22. 20-0079 T/C Link
23 a) 22-9574A CT Extractor
b) 22-7067F Extractor Key
c) 22-9256 Extractor Bushing
d) 24-9257 Extractor Spring
24. 20-0670 Carousel
25. 25-0638 Number Ring
26. 25-0635 Bearing Cover
27. 45-1600 Washer 5/16 Split Lock
28. 40-1500 SHCS 5/16-18x1



VS-3 Sheet Metal Assembly



VS-3 Sheet Metal Assembly Parts List

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