HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

Horizontal Service Manual 96-0189 RevL English June 2005

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

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

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

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

COMMON ABBREVIATIONS

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

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

1. TROUBLESHOOTING

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

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

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

BEFORE YOU BEGIN:
USE COMMON SENSE

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

FIND THE PROBLEM FIRST

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

DON'T TINKER WITH THE MACHINE

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

1.1 General Machine Operation

Machine Not Running

Machine cannot be powered on

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

Machine can be powered on, but turns off by itself

- Check Settings #1 and #2 for Auto Off Timer or Off at M30.
- Check AC power supply lines for intermittent supply.
- Check low voltage power supply for intermittent supply.
- Check wiring to POWER OFF button on front control panel.
- Check connection between 24V transformer and K1 contactor.
- Check Parameter 57 for Power Off at E-STOP.

Machine turns on, keyboard beeps, but no LCD display

- Check for power connections to LCD from IOPCB.
- Close doors and Zero Return machine (possible bad monitor).
- Check video cable from VIDEO PCB to LCD.
- Check for lights on the processor.
- Replace LCD (see "Electrical Service").

Machine turns on, LCD works, but keyboard keys do not work

- Check keyboard cable (700) from VIDEO to KBIF PCB.

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. 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. 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 can be caused by a number of factors as 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/Ball Screws", and "Gearbox and Spindle Motor" sections.

Accuracy

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

- Ensure that the machine has been sufficiently warmed up before cutting parts. This will eliminate mispositioning errors caused by thermal growth of the ballscrews (see "Thermal Growth" section).
- *Don’t* ever use a wiggler test indicator for linear dimensions. They measure in an arc and have sine/cosine errors over larger distances.
- *Don’t* use magnetic bases as accurate test stops. The high accel/decel of the axis can cause them to move.
- *Don’t* attach magnetic base to the sheet metal of the machine.
- *Don't* mount the magnetic base on the spindle dogs.
- *Don’t* 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).
- *Don't* 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 of the Reference manual).
• Check for backlash ("Servo Motors/Ballscrews" section).

Bored holes do not go straight through the workpiece.

• Check that the machine is level (see "Installation" section of the Reference manual).
• Check for squareness in the Z axis.

Machine bores holes out-of-round.

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

Bored holes are out of round or out of position.

• Check for thermal growth of the ballscrew (see "Thermal Growth" section).
• The spindle is not parallel to the Z axis. Check the sweep of the machine (see "Spindle Sweep Adjustment")

Machine mis-positions holes.

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

Machine leaves large steps when using a shell mill.

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

Finish

Machining yields a poor finish

• Check for gearbox vibration.
• Check for backlash ("Accuracy/Backlash")
• Check the condition of the tooling and the spindle.
• Check for spindle failure.
• Check the condition of the axis motors.
• Check that the machine is level (See the Installation section of the Reference manual).

Thermal Growth

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

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

VERIFY THERMAL GROWTH

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

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

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

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

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

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

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

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

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

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

SOLUTIONS

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

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

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.
- Command spindle to turn at 1800 RPM and check spindle drive display. If display blinks “bb”, check spindle orientation switch ("Spindle Orientation"). 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").

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

Noise

Check the tooling; balanced tooling will run smoother; possible reducing the noise.

Check for misalignment between the motor and the spindle. If misalignment is noted, loosen the motor mounting bolts, run the spindle at 1000 rpm and then tighten the mounting bolts.

Remove the coolant union and run the spindle, if the spindle runs quiter the coolant union may need replacing.

Overheating

Run program #O02021 with the air pressure to the spindle at 30 psi. 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 at 100% for 8,000 RPM machines; Set at 120% for 12,000 RPM machines.

N100	N200	N1000	N2000
S750M3	M97 P1000 L15	S7500M3;	S10000M3;
G04 P600.;	M97 P2000 L15	G04 P30.;	G04 P30.;
S2500M3;	M30;	S500 M3;	S500M3;
G04 P600.;		G04 P150.;	G04 P150.;
S5000M3;		M99;	M99;
G04 P900.;			%

- If at any time during this procedure the spindle temperature rises above 150 degrees, start the procedure over from the beginning and follow the steps below. If the temperature rises above 150° a second time, contact your dealer.

NOTE: Once run-in program is complete **reset** the air pressure back to **25psi**. 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.

- 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, and run very hot and very loud. Investigate machining problems before concluding that the problem exists with the spindle or spindle drive.

Spindle Drive

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 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 8.6 ohms between the leads.

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

Orientation

Spindle loses correct orientation

- 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 encoder.

Tools Sticking In Taper

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 is normal provided it does not create flex in the double arm 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 to release the tool using the tool release button. 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°F [60°C] or above).
- Check air supply. Max air pressure drop of 10 psi [69 kilopascals] during a tool change is allowed.
- 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 / Ball Screws

Not Operating

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

Servo motor is not functioning

- Check the power cable from electrical cabinet to ensure connection is tight.
- Encoder is faulty or contaminated (Alarms 139-142, 153-156). Replace motor assembly on brushless machines.
- Open circuit in motor (Alarms103-106). Replace motor assembly ("Axis Motor").
- Motor has overheated, resulting in damage to the interior components (Alarms 135-138, 176). Replace motor assembly ("Axis Motor").
- Wiring is broken, shorted, or missing shield (Alarms 153-156, 175, 182-185).
- Check for broken or loose coupling between the servo motor and the ball screw. Replace or repair the coupling ("Axis Motor")
- Check for a damaged ball screw, and replace if necessary ("Ball Screw" section).

Noise

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

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

Servo motor noise

- Disconnect the servo motor from the ball screw and rotate by hand. If the noise persists, replace the motor assembly ("Axis Motor" section).
- Noise is caused by bearings. Rolling, grinding sound is heard coming from the motor. If bearings are making a consistently loud sound, replace the motor.

Ball screw noise

- Ensure oil is getting to the ball screw through the lubrication system. Check for a plugged metering valve.
- Check for damage to the bearing sleeve.

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

- Run the axis back and forth. The motor will get very hot if the bearing sleeve is damaged. If so, turn the axis by hand and feel for roughness in the ball screw. Loosen the clamp nuts at both ends of the ball screw. If the symptom disappears, replace the bearing sleeve. Be certain to check for damage to the ball screw shaft where the bearing sleeve is mounted.
  If the noise persists, the ball screw is damaged and must be replaced. When replacing the ball screw in an older machine, always replace the bearing sleeve with the an angular contact design bearing sleeve.

- Check the ball screw for misalignment. If incorrect, perform alignment procedure in "Ball Screw" section.
- Misalignment in the ball screw itself will tend to cause the ball screw to tighten up and make excessive noise at both ends of the travel. The ballnut may get hot. Misalignment radially at the yoke where the ball screw ball nut mounts is indicated by heating up of the ball nut on the ball screw, and noise and tightness throughout the travel of the ball screw. Misalignment at the yoke where the ball nut mounts is indicated by noise and tightness at both ends of the travel of the ball screw. The ball nut may get hot.

NOTE: Customer complaints of Ball Screw noise may not indicate a bad ball screw. Ball screws from different manufacturers produce varying levels of noise. Often machines are built with two or more different brands of ball 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 positioning accuracy

- Check parameters for that axis.
- Check for backlash in the ball screw; see the following steps.

INITIAL PREPARATION -

Turn the machine ON. Zero return the machine and jog the column to the approximate center of its travel in the X and Y directions. Move the Z-axis to its full travel forward.

CHECKING X-AXIS:

1. Set up a dial indicator and base on the mill table as shown in Fig. 1.3-1.

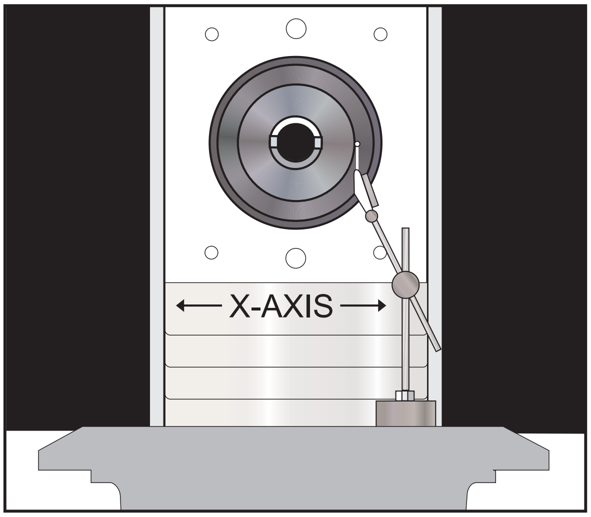

Figure 1.3-1. Dial indicator in position to check X-axis.

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 key on the control panel.
   - Press the HANDLE JOG key on the control panel.

The “Distance to go” display in the lower right hand corner of the screen 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. 1.3-1 and manually push the mill column to the left and right while listening for a 'clunk'. The dial indicator should return to zero after releasing the column.

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

5. If backlash is found, refer to "Backlash - Possible Causes" in this section.

CHECKING Y-AXIS:

1. Set up a dial indicator and base on the mill table as shown in Fig. 1.3-2.

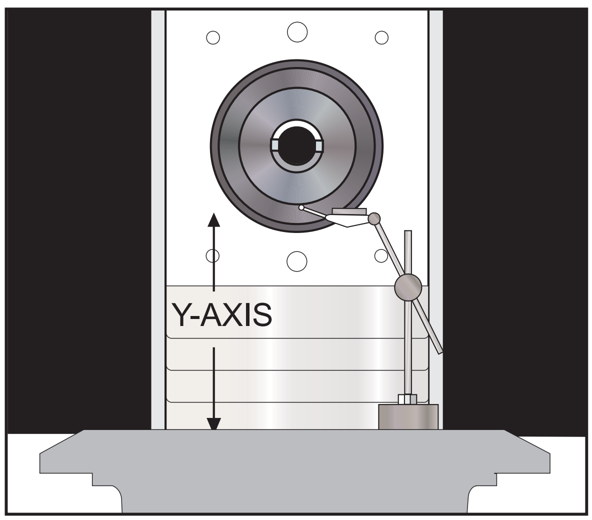

Figure 1.3-2. Dial indicator in position to check Y-axis.

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 key on the control panel.
   - Press the HANDLE JOG key on the control panel.

The “Distance to go” display in the lower right hand corner of the screen 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. 1.3-2 and manually push up and down on the spindle head while listening for a 'clunk'. The dial indicator should return to zero after releasing the spindle head.

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

5. If backlash is found, refer to "Backlash - Possible Causes" in this section.

CHECKING Z-AXIS:

1. Set up a dial indicator and base on the mill table as shown in Fig. 1.3-3.

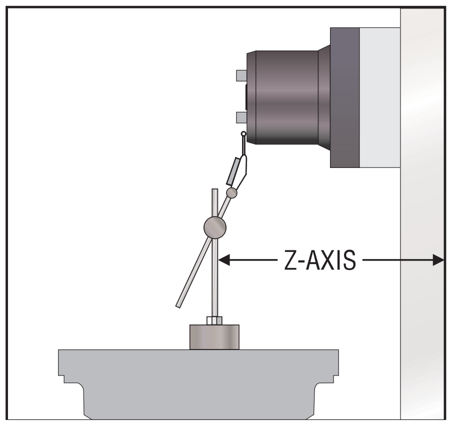

Figure 1.3-3. Dial indicator in position to check Z-axis.

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 key on the control panel.
   - Press the HANDLE JOG key on the control panel.

The “Distance to go” display in the lower right hand corner of the screen 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 (+) Z 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.

An alternate method for checking backlash is to place the dial indicator as shown in Fig. 1.3-3 and manually push the Z-Axis forward and back while listening for a ‘clunk’. The dial indicator should return to zero after releasing the axis.

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

5. If backlash is found, refer to "Backlash - Possible Causes" in this section.

BACKLASH - POSSIBLE CAUSES:

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" section.
- Loose SHCS attaching the nut housing to the column, 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 or top of column. Tighten as described in "Ball Screw" section.
- Defective thrust bearings in the bearing sleeve. Replace the bearing sleeve as outlined in "Bearing Sleeve" section.
- Loose SHCS attaching the axis motor to the motor housing. If the SHCS are found to be loose, inspect the motor for damage. If none is found, tighten as described in "Axis Motor" section. If damage is found, replace the motor.
- Incorrect backlash compensation number in Parameter 13, 27, or 41.
- Worn ball screw.

EC-400 A-Axis Backlash Adjustment (Full Forth)

1° indexer instructions are different, see the instructions at the end of this section.

1. Remove all parts and fixtures from the platter.

2. Check and record backlash near the outer edge of the platter face, using approximately 15-20 ft./lbs. The factory specification is 0.0003” to 0.0007”.

NOTE: Check backlash in each of the four quadrants (every 90°).

3. Remove the (4) 10-32 BHCS that retain the worm housing cover. Place a drip pan beneath the black bearing housing cover to catch any gear oil (keep this pan in place for Step 4). Remove the bearing housing cover. It may be necessary to apply channel lock pliers to the bearing housing in order to remove it; if this is necessary, use a rag to prevent marring.

4. Note the position of the dimple located on the flange of the bearing housing. Mark this position on an adjacent part of the casting for reference. Remove the four 5/16-18 cap screws. Do not pull the housing out or gear oil will pour out of the housing. Put two (2) screws part way in housing holes and turn housing with lever.

5. Index the bearing housing one set of holes. Move to the next set of holes by rotating the hole set upwards (towards the platter) - This may be CC or CCW. Bolt the bearing housing flange down. Torque the bolts to 25 ft./lbs. Check the backlash in each of the four quadrants. The factory specification is 0.0003” to 0.0007”.

   If necessary, repeat Steps 4 and 5.

6. Replace the bearing housing cover. Replace the side cover sheetmetal and reattach with the (4) BHCS removed in Step 3.

7. Remove the oil filler pipe plug. If the oil level covers less than half of the sight glass, then add as follows in step 8.

8. Refill the gear case with Mobil SHC-630 gear oil to the midpoint of the oil level eye.

9. Reinstall the oil fill pipe plug form step 7.

A-axis backlash adjustment for optional 1° indexer:

The facegear must be disengaged before checking backlash. First raise the platter by applying air to the lift piston with Haas tool number T-2150. Disconnect the A-axis and connect tool T-2150 as shown on drawing T-2150. Toggle air to the lift piston with the regulator set between 20 to 40 PSI [138-276 kilopascals]. Check backlash at each quadrant (every 90°). Backlash on the 1° indexer option is .0007”-.0015” (nonstandard). Adjust as necessary. See the previous adjustment description.

Vibration

Excessive Servo Motor Vibration

- If no “A” axis is present, swap the suspected bad servo motor with the “A” driver and check to see if there is a driver problem. If needed, replace the DRIVER PCB ("Electrical Service").
- Check all parameters of the suspected axis against the parameters as shipped with the machine. If there are any differences, correct them and determine how the parameters were changed. PARAMETER LOCK should normally be ON.
- 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 ground. If the motor is open or shorted, replace.

Overheating

Servo motor overheating

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

Following Error

Following Error alarms occur on one or more axes sporadically

- Check DC bus voltage on "Diagnostics" page 2. 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 section of the Reference manual.
- Check motor wiring for shorts.
- Replace driver card ("Electrical Service").
- Replace servo motor ("Axis Motor").

Ball Screws - Visual Inspection

The three main causes of Ball Screw failure are:

Loss of Lubrication
Contamination
Machine Crash

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

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

Loss of Lubrication:

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

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

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

Contamination:

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

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

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

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

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

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

Machine Crash:

A hard machine crash can cause a Ball Screw to lock up. The static overload created during a machine crash can break apart the ball-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 ball nut, creating impressions on the screw surface.

Ball Screw Cleaning

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

1. Manually jog the ball 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 the “Ball Screws - Visual Inspection - Contamination” section.
3. Use alcohol, or other approved cleaning agents, to wash the screw.

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

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4. Jog the ball 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.

Drive Fault / Overcurrent

Y-axis motor overcurrent.

- Alarm not cleared
- Check Y axis parameters
- Check the ball screw for binding
- Check motor and cable for shorts
- Check amplifier

1.4 Pallet Changer

EC-400 Pallet Changer Overview

When the automatic pallet changer (APC) is at rest, the pallet is clamped, the pallet at the load station is at home position, and the APC door is closed. The H-frame "Down" solenoid is on, the safety solenoid is on, and the H-frame is down with the H-frame lock pin engaged in the bumper mount. The APC servo has been zero returned, using the APC home sensor.

When a pallet change is commanded the following events occur in this order:

1. H-frame down switch is checked to verify down status.

2. Z-axis rapids, if necessary, to a position specified by the grid offset & parameter 64.

3. A-axis rapids, if necessary, to position specified by grid offset & parameter 224 (this may involve a raise & lower of the pallet).

4. The lifting and lowering of the A-axis platter is monitored by a sensor assembly located on the bottom of the A-axis, on indexer style machines. There are no sensors monitoring the A-axis platter position on machines with the full 4^{th} axis option.

5. The A-axis is allowed to rotate, once the platter lift sensor is triggered.

6. When the A-axis moves to the home position and lowered, the platter down sensor is triggered and the platter lift sensor is turned off.

7. Power is turned on to the pallet clamp/unclamp solenoid located at the rear of the machine.

8. The clamp air pressure is released from the clamp side of the receiver piston and 100 PSI of air is applied to the unclamp side of the receiver piston.

9. The clamp plate rises.

10. When the clamp plate moves approximately .400" it will trigger the pallet unclamp sensor. The sensor sends a signal to the CNC control, that the clamp plate is in the unclamp position. A sensor assembly located on the bottom of the A-axis monitors the clamp plate position.

11. APC door switch & load station lock switch are checked.

12. The H-frame down solenoid & safety solenoid turn off.

13. The H-frame up solenoid turns on.

14. Air pressure in the air cylinder rotates the top cam, by rotating the seal housing. The bottom cam does not rotate.

16. The cage & 3 balls rotate at half speed of the cam, forcing the cams to separate.

17. The top cam raises the H-frame by lifting upward on the hub, using the tapered bearing as a thrust bearing.

18. The H-frame engages and raises both pallets as it is raised.

19. The APC shaft does not rise. The hub slides up the shaft on the 4 ball bearings. The flat tang of the apc shaft slides inside a slot in the cycloid hub.

20. The H-frame Up-switch checks H-frame up status. As the H-frame rises, the lock pin comes out of the hole in the bumper mount, so the H-frame can rotate.

21. Once the H-frame up switch indicates up, the air blast solenoid is turned on, and sends air blowing thru the air blast assembly at the top of the receiver.

22. The servomotor rotates the H-frame and pallets 180 deg., by driving through the gearbox, torque tube, & hub, while the apc shaft, cycloid hub, and part of the gearbox remain stationary.

The servomotor rotates with the assembly.

23. The H-frame down switch gets a momentary false signal as it rotates past the tang on the APC shaft approximately mid stroke, which the software ignores.

24. The safety solenoid, which is off, prevents the H-frame from suddenly lowering in the event of a power failure by blocking the vent port of the h frame up solenoid.

25. When it has rotated 180 degrees, the servomotor stops, and holds position. The encoder on the servomotor determines the rotational position.

26. The H-frame up solenoid is turned off.

27. The H-frame down solenoid and safety solenoids are turned on, pressurizing the other side of the air cylinder while venting the side previously pressurized.

28. The top cam is rotated back to its original position, allowing the H-frame and pallets to lower.

As the H-frame lowers, a lock pin under the H-frame drops into a hole in the bumper mount. It keeps the H-frame from being moved while the servo power is off.

29. The pallet in the machine is lowered onto the receiver and the pallet on the load station is lowered onto the index-disc pallet-pins.

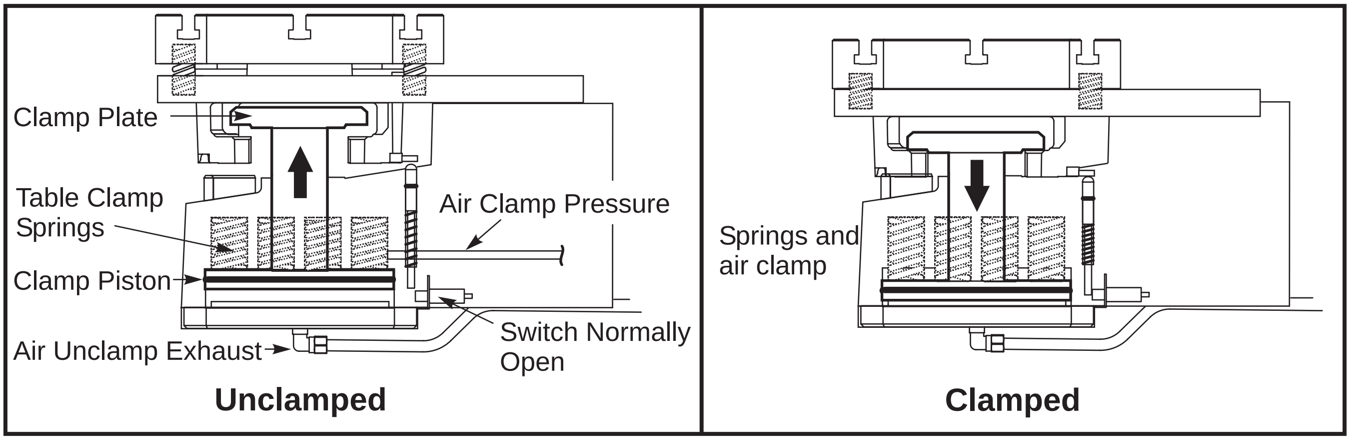
30. Power is turned off to the clamp/unclamp solenoid and air blast solenoids located at the rear of the machine.

31. The unclamp air pressure is exhausted from the unclamp side of the receiver piston and air blast is turned off while simultaneously applying 100 PSI of air pressure to the clamp side of the receiver piston.

32. The clamp plate moves down to clamp the pallet. The clamp plate will move approximately .400" and clamp the pallet. It will trigger the pallet clamp sensor, indicating that the pallet is clamped. The clamp plate position is monitored by a sensor assembly located on the bottom of the A axis.

33. The load station lock plate prevents the load station pallet from falling off if it is rocked severely while loading parts.

Introduction



Operation

Note: Pallet is pulled down by clamp plate.

The table trips the clamp switch, not the clamp plate

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

2. When ta0ble is in position, the solenoid valve actuates to pressurize the clamp side of the piston. A combination of air pressure and spring force combine to clamp the table (approximately 10,000 pounds of clamp force depending on air pressure.
• The table lowers and contacts the clamp status switch plunger. The plunger is pushed down and trips the normally open (NO) status switch to close contacts.

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

Table Clamp Status Under Different Conditions

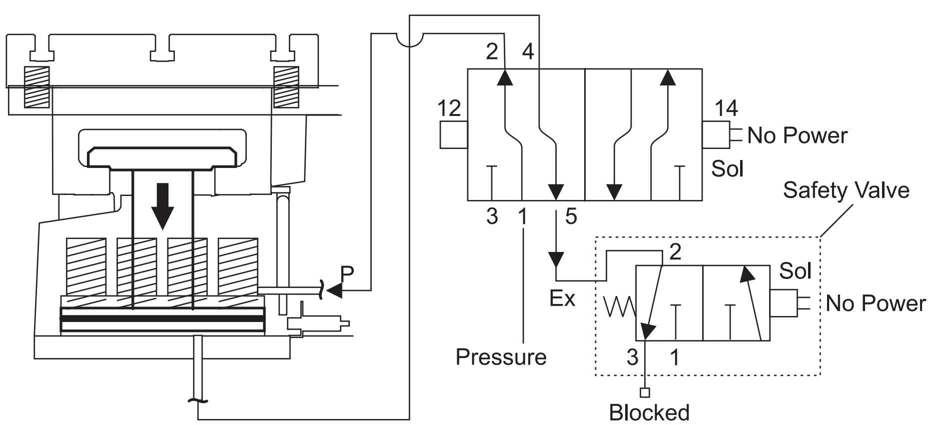
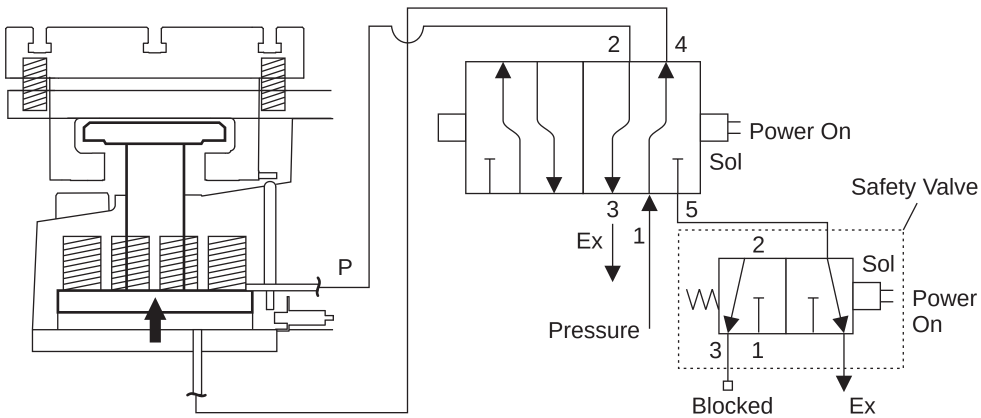


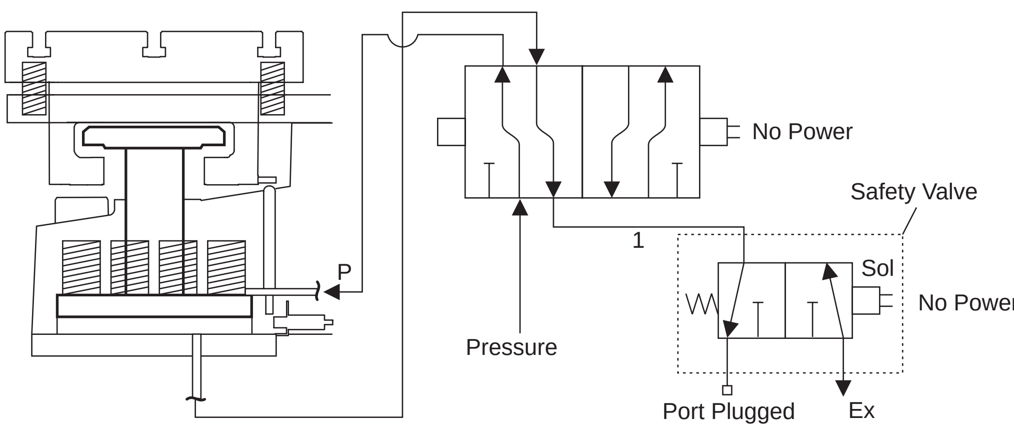
Table Clamp

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



B. Condition when machine is unclamped

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



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

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

Troubleshooting

1. Failure - Clamp switch wires cut

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

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

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

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

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

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

Result the clamp plate remains in the unclamp position.

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

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

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

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

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

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

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

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

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

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

7. Failure Table clamped and machine loses air pressure

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

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

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

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

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

1.5 Automatic Tool Changer (ATC)

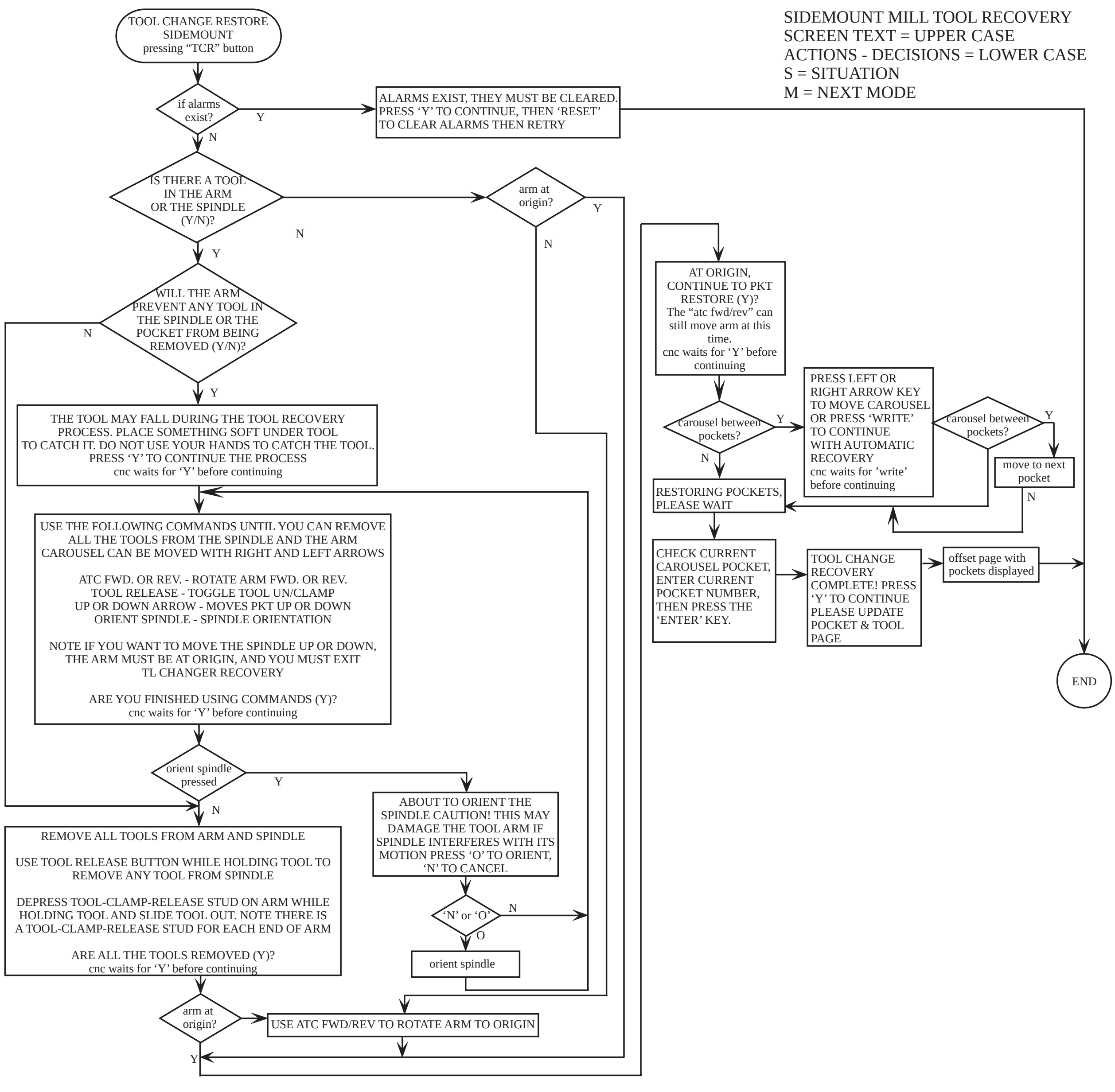
Refer to the alarm description when problems arise with the ATC
See "Spindle" section for additional trouble shooting information.

Crashing

Crashing of the ATC is usually a result of operator error. The most common ATC crashes is the part or fixture on the mill table crashes into long tooling or into the ATC double arm during a tool change

- Inspect the pocket involved in the crash for damage and replace parts as necessary.
- The machine will normally home the Z-axis as part of the tool change sequence. Check Parameter 209 bit "TC Z NO HOME", and ensure it is set to zero.

Side Mount Tool Changer Recovery Flow Chart



1.6 Through the Spindle Coolant

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 warranty on new machines. Notify HAAS Service Department if machine is being used for this application.

Coolant Overflow

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

Coolant pouring out of spindle head

- Check the customer's tooling for through holes in the pull stud, holder and tool.
- Check the purge and drain lines connected to the seal housing are intact; if not replace.
- Check the TSC coolant union. If failure is found, replace the coolant union.
- Check pre-charge pressure in accordance with TSC "Precharge Regulator Adjustment' section and reset if necessary. Low pre-charge pressure can cause coolant to dump into the spindle head.
- Ensure the coolant pump relief valve has not been tampered with (yellow paint band is intact). Check the coolant pump pressure (should be 300 psi [2068 kilosascals]), with a standard (non-TSC) tool holder in spindle. If pump pressure is above 310 psi, reset the pump relief valve.

Excessive coolant flow out of drain line or pulsating flow through tool and drain line

- Check pre-charge pressure in accordance with TSC "Precharge Regulator Adjustment" section. Reset precharge pressure if necessary. Low pre-charge pressure will cause heavy or pulsating flow from the drain line. Check main air pressure regulator for 85 psi [241 kilopascals]. A higher supply pressure will reduce precharge pressure. Lower supply pressure will increase precharge pressure.
- Ensure the coolant pump relief valve has not been tampered with (yellow paint band is intact). Check the coolant pump pressure (should be 300 psi [2068 kilosascals]), with a standard tool holder in spindle. If pump pressure is above 310 psi [2137 kilopascals], reset the pump relief valve.

Low Coolant

Alarm 151, "Low Thru Spindle Coolant"

- Check coolant tank level. Check for slow coolant drainage from the machine enclosure.
- Check the filter and intake strainer for any clogging. Read filter gauges with TSC running with no tool in spindle. Check coolant lines for any clogging or kinking. Clean or replace as needed.
- Check for overheating TSC pump motor. Three phase motors have a thermal circuit that will interrupt power to the relay coil.
- If received at start-up, check that the breaker has not tripped and that the pump is turning. Check the electrical continuity of cables.
- Check for pressure switch failure (refer to "Testing the Coolant Pressure Switch" section), and replace if necessary. Check the electrical continuity of the switch cable and the control function by monitoring the "LO CLNT" bit on the Diagnostics page (0 = pressure on, 1= pressure off). Shorting the leads should cause the bit to switch from 1 to 0. Check this before replacing the pressure switch. Leaking switches can give intermittent alarms.
- Check pump pressure with no tool in the spindle. If the pressure is less than 60 psi, replace the pump.
- May be generated if another machine alarm occurs during TSC operation.

Pre-Charge Failure

Alarm 198, "Precharge Failure"

NOTE: This alarm only applies to the TSC system.

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

1.7 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.

- 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.

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.

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.

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.

Saving the Machine Information

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

2. ALARMS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

112 NO INTERRUPT Electronics fault. Call your dealer.

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

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

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

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

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

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

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

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

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

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

123 SPINDLE DRIVE FAULT Failure of spindle drive, motor or regen load. This can be caused by a shorted motor, overvoltage, overcurrent, 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 about 30 days, you may lose your stored programs, parameters, offsets, and settings.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

148 A LIMIT SWITCH Normally disabled for rotary axis.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

191 B LIMIT SWITCH Normally disabled for rotary axis.

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

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

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

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

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

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

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

199 NEGATIVE RPM A negative spindle RPM was sensed.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

216 EPROM SPEED FAILURE Possible processor board problem

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

236 SPINDLE MOTOR OVERLOAD The spindle motor is overloaded.

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

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

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

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

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

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

243 BAD NUMBER Data entered is not a number.

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

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

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

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

248 NUMBER RANGE ERROR Number entry is out of range.

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

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

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

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

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

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

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

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

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

258 INVALID DPRNT FORMAT Macro DPRNT statement not structured properly.

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

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

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

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

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

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

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

266 TOOL CHANGER FAULT Run Tool Changer recovery.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

309 EXCEEDED MAX FEEDRATE Use a lower feed rate.

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

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

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

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

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

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

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

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

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

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

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

321 AUTO OFF ALARM Occurs in debug mode only.

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

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

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

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

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

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

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

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

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

331 RANGE ERROR Number too large.

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

333 X AXIS DISABLED Parameter has disabled this axis.

334 Y AXIS DISABLED Parameter has disabled this axis.

335 Z AXIS DISABLED Parameter has disabled this axis.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

357 AUX AXIS DISABLED Aux axes are disabled.

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

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

360 TOOL CHANGER DISABLED Check Parameter 57.

361 GEAR CHANGER DISABLED Check Parameter 57.

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

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

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

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

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

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

368 GROOVE TOO SMALL Tool too big to enter cut.

369 TOOL TOO BIG Use a smaller tool for cut.

370 POCKET DEFINITION ERROR Check geometry for G150.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

421 NO VALID POCKETS Pocket Table is full of dashes.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

539 ILLEGAL GOTO Expression after GOTO not valid.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

620 C AXIS DISABLED Parameters have disabled this axis

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

664 U AXIS DISABLED Parameter has disabled this axis.

665 V AXIS DISABLED Parameter has disabled this axis.

666 W AXIS DISABLED Parameter has disabled this axis.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

909 APC-PROGRAM NOT LISTED There is no program name in the Pallet Schedule Table for the loaded pallet. To run a program for the loaded pallet, enter the program name into the Program Name column of the Pallet Schedule Table, for the pallet you want to operate on, or remove the M48 from the subprogram you want to use. Verify that the program and the pallet are compatible.

910 APC-PROGRAM CONFLICT The subprogram you are trying to run is not assigned to the loaded pallet. Another program is assigned to this pallet in the Pallet Schedule Table. Either enter the program name that you want to run into the Program Name column of the Pallet Status Table or, remove the M48 from the subprogram you want to use. Verify that the subprogram and the pallet are compatible.

911 APC-PAL LOAD/UNLOAD AT ZERO One or more of the pallets on the Automatic Pallet Changer has a load or unload position set to zero. This indicates that the APC set up procedure was incomplete. Establish the correct load and unload positions for all pallets and enter the positions in the appropriate settings. See operator's manual for the APC model and its correct setting numbers.

912 APC-NO P CODE OR Q CODE FOR M46 M46 must have a P code and a Q code. The P code must be a line number in the current program. The Q code is the number of the pallet, if loaded, that will cause a jump to the program line number.

913 APC-NO P CODE OR Q CODE FOR M49 M49 must have a Q code. The P code is the pallet number. The Q code is the status to give the pallet.

914 APC-INVALID P CODE The P code must be the name of a program stored in memory. The program name must not have a decimal point. Remove any decimal points from the program name.

915 APC-ILLEGAL NESTING G188 or M48 G188 is only legal in main program. M48 is only legal in a program listed in the Pallet Schedule Table or a first level subprogram.

916 APC-NEGATIVE PAL PRIORITY INDEX Software Error; Call your dealer.

917 APC-NUMBER OF PALLETS IS ZERO Parameter 606 must have a value if parameter 605 is not zero. Set parameter 606 to the number of pallets in your FMS system.

918 APC LOAD-SWITCH MISSED PAL 1 Pallet #1 did not complete its move from the APC to the receiver in the allowable time. Pallet change sequence was halted because receiver switch was not activated. Pallet is either unclamped or not on the receiver. Ensure the pallet is correctly located on receiver (against hard stop) then run M18 to clamp the pallet. After correcting the condition, run an M50 to continue machining.

919 APC LOAD-SWITCH MISSED PAL 2 Pallet #2 did not complete its move from the APC to the receiver in the allowable time. Pallet change sequence was halted because receiver switch was not activated. Pallet is either unclamped or not on the receiver. Ensure the pallet is correctly located on receiver (against hard stop) then run M18 to clamp the pallet. After correcting the condition, run an M50 to continue machining.

920 APC LOAD-SWITCH MISSED PAL 3 Pallet #3 did not complete its move from the APC to the receiver in the allowable time. Pallet change sequence was halted because receiver switch was not activated. Pallet is either unclamped or not on the receiver. Ensure the pallet is correctly located on receiver (against hard stop) then run M18 to clamp the pallet. After correcting the condition, run an M50 to continue machining.

921 APC LOAD-SWITCH MISSED PAL 4 Pallet #4 did not complete its move from the APC to the receiver in the allowable time. Pallet change sequence was halted because receiver switch was not activated. Pallet is either unclamped or not on the receiver. Ensure the pallet is correctly located on receiver (against hard stop) then run M18 to clamp the pallet. After correcting the condition, run an M50 to continue machining.

922 APC-TABLE NOT DECLARED Software calling invalid tables. Software Error; Call your dealer.

923 A INDEXER IS NOT AT THE PROPER INCREMENTAL POSITION The indexer has moved to a position that cannot be seated.

924 B INDEXER IS NOT AT THE PROPER INCREMENTAL POSITION The indexer has moved to a position that cannot be seated.

925 A INDEXER IS NOT FULLY IN THE UP POSITION The indexer is still seated. It is not completely in the up position and cannot be rotated. Reset then rezero the indexer.

926 B INDEXER IS NOT FULLY IN THE UP POSITION The indexer is still seated. It is not completely in the up position and cannot be rotated. Reset then rezero the indexer.

927 ILLEGAL G1 CODE FOR ROTARY INDEXER The rotary indexer only does rapid G0 motion. Feed G1 motion is not allowed.

937 INPUT LINE POWER FAULT This alarm works with the Power Failure Detection Module. This alarm will be generated whenever incoming power to the machine falls below reference voltage value in parameter 730 and duration of time in parameter 731. Cycle the power to continue.

938 LANGUAGES LOADED Foreign languages were recently loaded into the control.

939 LANGUAGES FAILED TO LOAD Foreign languages fails to be loaded into the control. Languages either exceeded total flash memory, or not enough flash memory available. Try deleting a language from disk.

940 SIDE MOUNT CAROUSEL ERROR This alarm is generated by the tool changer if the carousel motor is still running when the tool pocket is unlocked and lowered prior to a tool change. If the carousel does not start to rotate after the allowed time specified by parameter 60 TURRET START DELAY or does not stop rotating after the allowed time specified by parameter 61 TURRET STOP DELAY.

941 POCKET-TOOL TABLE ERROR This alarm is generated by the tool changer if the tool specified by the program is not found in the POCKET-TOOL table, or the searched pocket is out of range.

942 CAROUSEL POSITION TIMEOUT This alarm is generated by the tool changer if the tool carousel has not moved after the allowed time or has not stopped after the allowed time specified by parameter 60 TURRET START DELAY and parameter 61 TURRET STOP DELAY, respectively.

943 UNPROCESSED QUEUE CELL IN TOOL CHANGE There is an unknown command generated in the Tool change. Please save your current program to disk and notify your dealer.

944 INDEXER OUT OF POSITION The A axis indexer is out of position. Jog the A axis to within 1 degree of a clamping position before you run a program.

945 APC-LIFT FRAME DOWN TIMEOUT The pallet changer was commanded to lower but the down position switch was not contacted before the timeout period. Check for foreign objects under the lift frame. Verify there is an adequate supply of air pressure and air volume. Verify that parameter 320 is correct. Check air solenoids for sticking and air release ports for clogging. Check pallet down position switch and wiring for damage, switch connections for positive electrical contact, and the lifting mechanism for proper operation. After determining the cause and correcting the problem, press TOOL CHANGER RESTORE to enter pallet changer recovery, recover the pallet changer, and then continue operation.

946 APC-PALLET CLAMP TIMEOUT The pallet in the mill did not clamp in the time allowed. Check for foreign objects under the pallet and between the pallet and the clamp plate. Verify there is an adequate supply of air pressure and air volume. Check air solenoids for sticking and air release ports for clogging. Check the pallet clamped position switch for correct operation, the switch and wiring for damage, and pallet alignment. Check the pallet clamp mechanism for correct operation. After determining the cause and correcting the problem, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation. Parameter 317 specifies the pallet clamp timeout period.

947 APC-PALLET UNCLAMP TIMEOUT The pallet in the mill did not unclamp in the time allowed. Check for foreign objects between the pallet and the clamp plate. Verify there is an adequate supply of air pressure and air volume. Check air solenoids for sticking and air release ports for clogging. Check the pallet clamped position switch for correct operation, the switch and wiring for damage and pallet alignment. Check the pallet clamp plate for damage. After determining the cause and correcting the problem, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and continue operation. Parameter 316 specifies the unclamp timeout period.

948 APC-SOFTWARE ERROR Fault in pallet changer software. Note the actions that caused this alarm. Also, record the following information: On the control panel, press PARAM DGNOS key to get the DGNOS screen. Then press PAGE UP to the PC INPUTS page. Record the values of PC STATE, ALARM ST and ALARM. If this alarm recurs regularly call your dealer.

949 APC-AXIS VISIBLE The pallet changer axis must be invisible for the pallet changer to operate. Set the parameter bit INVIS AXIS to one for the axis that the pallet changer is installed on.

950 APC-ILLEGAL SWITCH CONDITION, LIFT FRAME The pallet changer lift frame switches indicate that the pallet changer lift frame is up and down at the same time. Verify there is an adequate supply of air pressure and air volume. Check the adjustment of the lift frame position switches and for debris on the switches. Check switch electrical connections and wiring. This may be a false alarm if the pallet changer was out of position by 90 degrees (+/- 20) when a pallet change was in progress. After correcting the cause, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

951 APC-ILLEGAL SWITCH CONDITION, PALLET CLAMP The pallet changer clamp switches indicate that the pallet changer is clamped and unclamped at the same time. Check the adjustment of the pallet clamp switches and for debris on the switches. Check switch electrical connections and wiring. After correcting the cause, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

952 APC-MISLOCATED LIFT FRAME The pallet changer lift frame is not in the expected position. The lift frame was either down when expected to be up, or up when expected to be down. For example, the lift frame must be up while rotating. The lift frame must be down when a pallet change starts, before clamping the pallet, before the A axis or Z axis can be jogged, or before starting a program with CYCLE START. If the pallet began to lower during rotation, check the lift mechanism for proper operation. If this alarm occurred at start of pallet change or when clamping the pallet, check for foreign objects or misalignment that prevent the frame from lowering all the way. Verify there is an adequate supply of air pressure and air volume. After correcting the cause, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

953 APC-MISLOCATED PALLET CLAMP The pallet changer clamp plate is not in the expected position. The clamp plate must be unclamped while the pallet changer is rotating or before the pallet is lifted. Verify there is an adequate supply of air pressure and air volume. Check operation of the clamp mechanism air solenoids. Check the pallet clamped position switch for correct operation, the switch and wiring for damage and pallet alignment. Check the pallet clamp plate for damage. After correcting the cause, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

954 APC-INCOMPLETE PALLET CHANGE The last pallet change did not complete successfully or the mill has been initialized. Press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

955 APC-INVALID PALLET CHANGER TYPE Parameter 605 has an invalid pallet changer type.

956 APC-LIFT FRAME UP TIMEOUT The pallet changer was commanded to lift but the up position switch was not contacted before the timeout period. The primary cause of this alarm is insufficient air pressure or air volume. Also, verify the pallet is unclamped and there are no obstructing objects. Check pallet up switch and wiring for damage, switch connections for positive electrical contact, and the lifting mechanism for proper operation. Verify parameter 321 is correct. After determining and correcting the problem, press Tool Changer Restore to enter pallet changer recovery, recover the pallet changer, and then continue operation.

957 APC-SWITCH FAULT An illegal switch condition was detected. The pallet clamp switch did not function correctly. Use M17 and M18 commands to verify the input switch (input relay 26) changes state when the pallet clamps and unclamps. Check switch adjustment and check wiring for damage or unplugged connectors. The polarity of the clamp switch may be wrong. Parameter 734 is used to invert input switch polarity.

958 TOOL OFS WEAR HAS BEEN CHANGED When tool offsets have been changed, alarm 958 will be added to the alarm history along with the date and time. Note that this is not a resetable alarm; it is for information purposes only.

959 NON-INDEXER POSITION The position commanded for the A axis incremental indexer is a non-indexer position. The indexer positions are multiples of parameter 647. Parameter 647 is in thousandths of a degree. For example, a value of 2500 represents 2.5 degrees.

960 INDEXER SWITCH NOT FOUND IN TIME The A axis indexer down switch was not found within the allowed time specified by parameter 659.

961 FLOPPY OFFSET NOT FOUND This alarm is generated because FNC has lost the offset place mark it needs to correctly advance program. Try to reload program.

962 UNABLE TO RETRIEVE FILE INFORMATION File functions are taking too long to process. Try loading again.

963 UNABLE TO FNC FROM THIS DEVICE This device may not function from FNC. Please change setting 134 connection type to an appropriate FNC device, from the operator's manual.

968 DOOR HOLD OVERRIDE ENGAGED Whenever setting 51 is changed to ON, alarm 968 will be added to the alarm history along with the date and time the change was made. Note that this is not a resetable alarm; it is for information purposes only.

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

The following alarms only apply to HS Series mills with a pallet changer

1001 Index St Unlocked The index station is not in the correct orientation for a pallet change.

1002 Pallet Locked Down The pallet did not begin to lift within two seconds of command, or did not complete lifting within six seconds.

1003 Pallets Jammed The lift cylinder has not moved from the clockwise position within three seconds, or has not reached the counter clockwise position within twelve seconds.

1004 CW/CCW Switch Illegal Condition One or both of the switches that sense the rotational position of the pallet changer has failed its self-test.

1007 Up/Down Switch Illegal Condition One or both of the switches that sense the lifted/lowered position of the pallet changer has failed its self-test.

1008 Main Drawbar Locked In Up Position The main drawbar will not disengage from the pallet nut.

1009 Main Drawbar Locked In Down Position The main drawbar will not move upward to the pallet nut.

1010 Main Drawbar Switch Illegal Condition One or both of the switches that sense the up/down position of the main drawbar has failed its self-test.

1011 Main Drawbar Unclamp Timeout The main drawbar has disengaged from the pallet nut, but did not reach the main drawbar down switch.

1012 Main Drawbar Clamp Timeout The main drawbar has begun to travel upward, but did not reach the fully raised position within 15 seconds.

3. MECHANICAL SERVICE

RECOMMENDED TORQUE VALUES FOR MACHINE FASTENERS

The following chart should be used as a reference guide for torquing machine fasteners where specified.

DIAMETER	***TORQUE***
8-32	30 in. lb.
1/4 - 20	15 ft. lb.
5/16 - 18	30 ft. lb.
3/8 - 16	50 ft. lb.
M10 - 100	50 ft. lb.
M12 - 65	100 ft. lb.
1/2 - 13	80 ft. lb.
3/4 - 10	275 ft. lb.
1 - 8	450 ft. lb.

3.1 Way Covers

X-Axis Way Cover Removal

Left/Right Way Cover Removal

1. Jog the X-axis to the center of travel and POWER OFF the machine.

2. To remove the desired way cover, remove the SHCS that fasten the way covers to the table and remove the SHCS that fasten the way covers to the outside casting.

Y-Axis Way Cover Removal

Removal - Top

1. Jog the X-axis to the center of travel and the Y-axis all the way down.

2. POWER OFF the machine.

3. Remove the BHCS that fasten the waycover to the spindle head and the vertical guides to the column.

5. Remove the top waycover.

Install the way cover in the reverse order above however make sure that all necessary gaskets, and sealants are replaced and repaired as necessary.

Removal - Lower

1. Jog the X-axis to the center of travel and the Y-axis all the way up.

2. POWER OFF the machine.

3. Remove the three (3) BHCS that fasten the waycover to the spindle head.

4. Remove the seven (7) BHCS on each side that fasten the vertical guides to the column.

5. Remove the lower waycover.

Install the way cover in the reverse order above however make sure that all necessary gaskets, and sealants are replaced and repaired as necessary.

Z-Axis Way Cover

Right Way Cover

Removal

1. Jog the Z-axis (receiver) all the way in the +Z direction (away from the spindle).

2. POWER OFF the machine.

3. Remove the 14 BHCS that fasten the front of the waycover to the receiver.

4. Remove the 14 BHCS that fasten the rear of the waycover to the column.

5. Remove the waycover.

Installation

1. POWER ON the machine.

2. Replace the waycover. The end with the smallest section goes toward the receiver.

3. Fasten the column end using fourteen (14) BHCS.

4. Fasten the receiver end using fourteen (14) BHCS.

Left Way Cover

Removal

1. Jog the Z-axis (receiver) all the way in the -Z direction (toward the spindle).

2. Rotate the H-frame 45° counter clockwise.

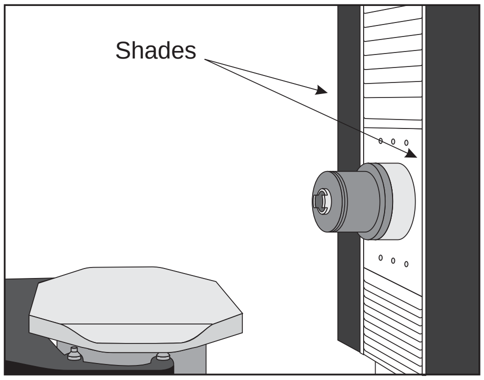
3. Remove the thirteen (13) BHCS that fasten the rear way cover to the receiver assembly.

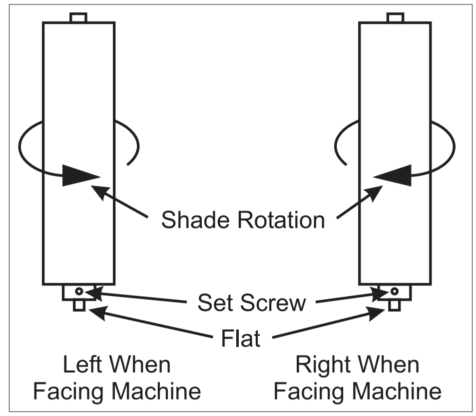
4. Remove the rear waycover through the door.

Install the way cover in the reverse order above however make sure that all necessary gaskets, and sealants are replaced and repaired as necessary.

EC-300 X-Axis Way Cover Adjustment

The front of the column on either side of the spindle, is covered by heavy shades kept taut by spring loaded canisters. If the shades should need adjusting, refer to the following procedure.





1 Clamp the shaft at the flat with clamping pliers or other such clamping device to hold the shaft when adjusting of the spring tension.

2. Loosen the set screw so that the spring tension may be adjusted.

3. Rotate the shaft one complete revolution against the force of the spring (counter clockwise for the left canister and clockwise for the right canister). Retighten the set screw.

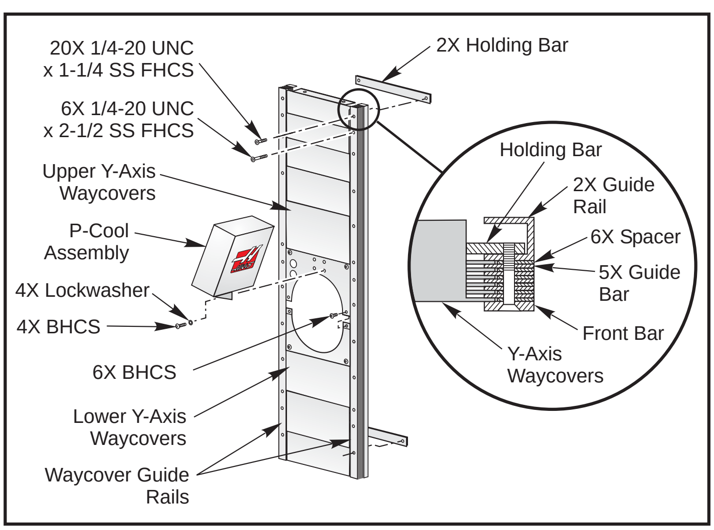
4. Check the tension of the shade. Repeat this process as needed for proper tension one revolution at a time. Do not overtighten the spring.

EC-300 Y-Axis Way Cover

Upper Way Cover

Removal

1. Handle jog the X-axis to center of travel. Handle jog the Y-axis down fully.
2. POWER OFF the machine.
3. Remove the twenty six (26) FHCS that attach the vertical guides to the way cover.
5. Remove the six (6) BHCS that the attach the upper way cover to the spindle head and the lower way cover.



Installation

1. Install the four SHCS at the top of the way cover. Slide the way cover up and down to ensure that it moves freely.
2. Slide the way cover down until the bottom flange goes under the spindle head cover and fasten it with four (4) BHCS.
3. Fasten the left and right vertical guides using twenty six (26) FHCS.

Lower Y-Axis Way Cover

Removal

1. Handle jog the X-axis to center of travel. Handle jog the Y-axis up fully.
2. POWER OFF the machine.
3. Remove the twenty six (26) SHCS that attach the left and right vertical guides and remove.
4. Remove the four (4) FHCS that attach the top of the lower Y-axis way cover to the spindle head casting. Collapse the way cover down fully.
5. Remove the way cover from the bottom.

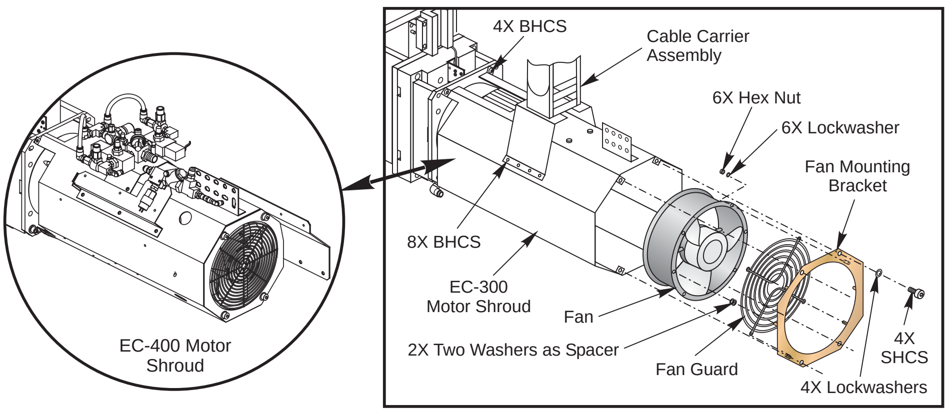
Installation

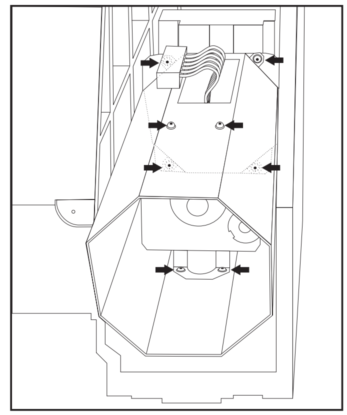
1. Install the four SHCS at the bottom of the way cover, and tighten evenly.
2. Slide the bottom of the way cover up and down to ensure it moves freely.
3. Slide the top flange of the waycover under the spindle head cover plate and fasten it to the spindle head cover and upper waycover using four (4) BHCS.
4. Replace the left and right vertical guides using twenty six (26) BHCS.

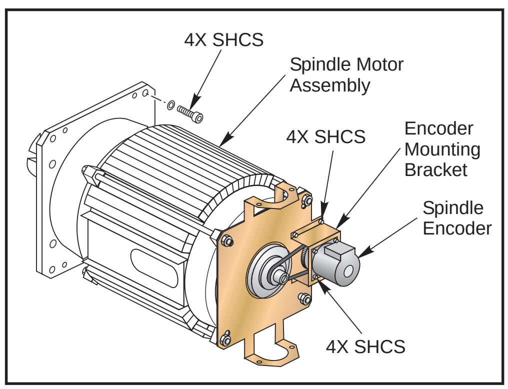
3.2 Spindle Motor Replacement

Removal

1. Remove the rear enclosure panel.
2. Disconnect the electrical cable to the fan.
3. At the rear of the spindle and motor shroud, remove the four (4) SHCS that hold the fan mounting bracket in place. Remove the electrical and pneumatic connections from the solenoid valve assembly.







4. **EC-400** Remove the motor shroud, which is held on with four (4) BHCS. Disconnect the encoder cable.
5. **EC-300** Remove Y-axis cable carrier and bracket. Loosen the X-axis cable carrier and position away from the back of the spindle casting.
6. Remove the four (4) bolts that mount the spindle motor assembly to the column and remove the spindle motor assembly.

Installation

1. Sweep the spindle before the motor installation is started.

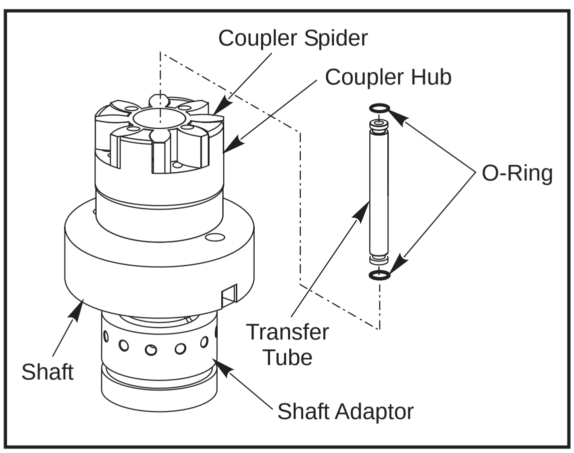
2. Check the condition of the coupler hub on top of the spindle, and the condition of the coupler spider. Lift the motor up and position it just above the TRP using a forklift or hoist. Check the condition of the coupler hub on the motor, and align it with the coupler on the spindle. Inspect the transfer tube for damage and the O-rings for deterioration. Replace, if necessary.

Note: Insure that the transfer tube has been installed prior to motor installation.

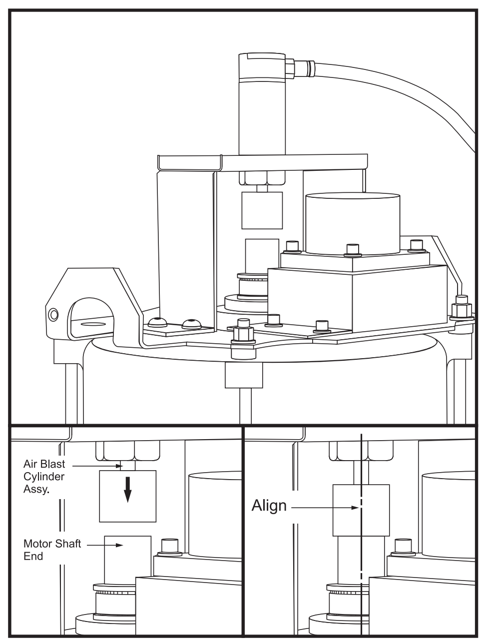
3. Bring the motor towards the TRP. The couplers should engage with very little interference. It may be necessary to rotate the spindle slightly to line up the coupler hubs or rock the motor housing back and forth to square the assemblies. Do this using your hand on the spindle dogs, at the nose of the spindle.

4. Once the coupler hubs are mated, install the bolts in that hold the motor to the spacer blocks; leave them loose. Join all the motor cables to the harness of the machine. Command a spindle speed of 1000 rpm; the motor mounting bolts are to be left loose. Let the spindle run for about 5 minutes, this allows the spindle assembly to seat and will help the final alignment. Snug bolts while spindle is rotating then stop the spindle and torque the bolts.

5. Install the air blast (purge) bracket and solenoid on the back of the motor. Ensure the cylinder is centered over the motor shaft, adjust as necessary. Connect the air line to the solenoid 3.3 Tool Release Piston (TRP)



Transfer Tube and Motor Shaft



Motor and Air Blast Purge Bracket

50 Taper Transmission and Motor Replacement

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). Access the panel on front of the head casting above the spindle.

12. Remove the four large SHCS that attach the transmission mount plate to the spindle head and pull the transmission/motor assembly towards the front of the machine slightly. This proceedure 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.

Tool Release Piston Replacement

Removal

1. Remove the rear enclosure panel.

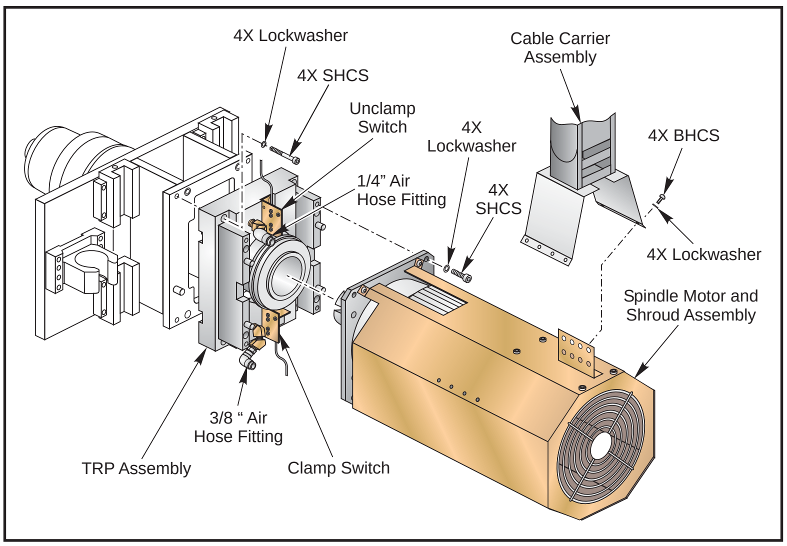
2. Jog the Y-axis all the way to the top. Insert a sturdy piece of wood on the bottom of the column casting. Jog the Y-axis down until the bottom of the spindle head rests on the wood. This will prevent the spindle head from falling in the event of an accident. Power off the machine.

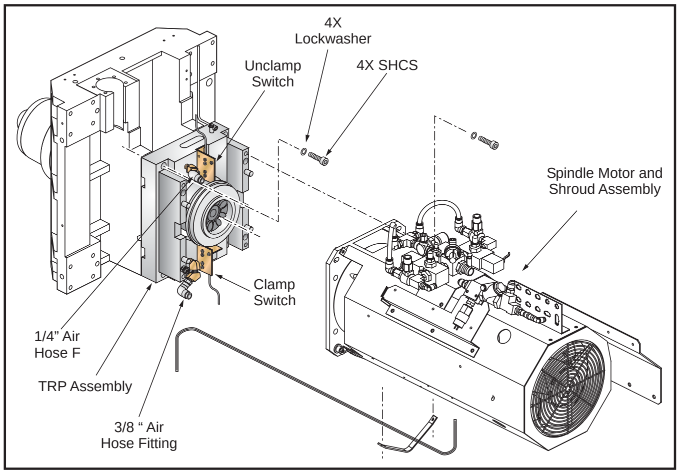
3. Disconnect the main air supply at the lube/air panel.

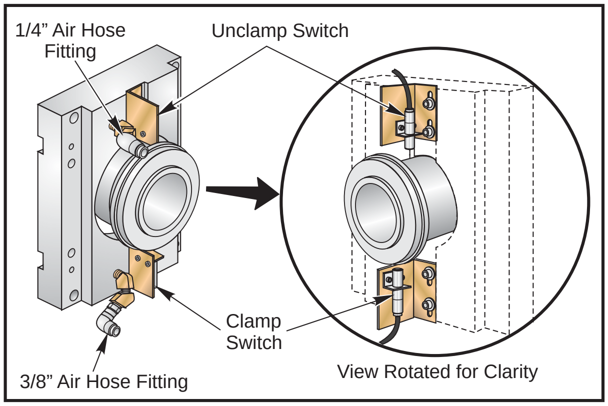
4. Remove the spindle motor as described in the Spindle Motor Removal section.

5. Remove the two (2) SHCS attaching the lower Y-axis way cover to the spindle head casting, and collapse it downward. It is easiest to reach the TRP from the front side of the machine.

6. Disconnect the TRP air lines and switch cables.







EC-Series TRP assembly

7. Remove the four (4) SHCS holding the tool release piston assembly to the head casting.

8. Remove the entire tool release piston assembly.

Installation

1. Loosely reinstall the tool release piston with the four (4) SHCS.

2. Reconnect clamp/unclamp switch cables and TRP air lines

3. Install the motor as described in the Spindle Motor Replacement section.

4. Finish tightening the four SHCS that mount the TRP to the spindle head.

5. **IMPORTANT!** Remove the wood brace from the spindle head.

6. Replace the rear enclosure panel.

Setting Pre-Charge

1. Install an air gauge capable of reading 30 psi to the precharge assembly.

2. Press **MDI DNC** to get to MDI screen.

3. Type in 1120=1 and press **WRITE/ENTER**, and then Press **CYCLE START**.

4. Set the pressure regulator so that 30 psi reads on the gauge. Press the regulator knob in to lock the knob in place.

5. Press **RESET**.

6. Remove the gauge and replace the hose.

3.3 Spindle

Spindle Cartridge

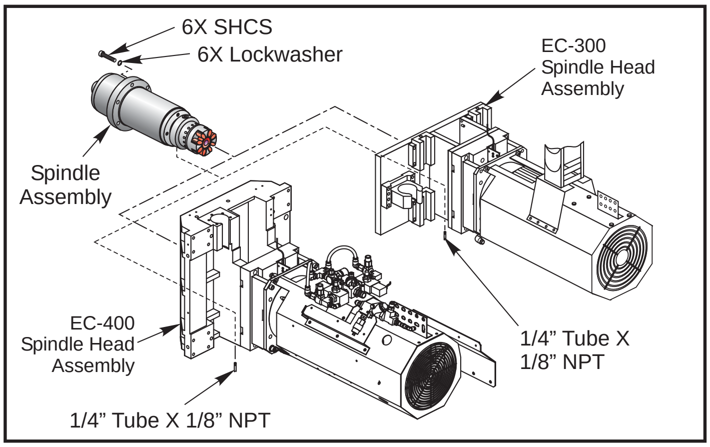
REMOVAL-

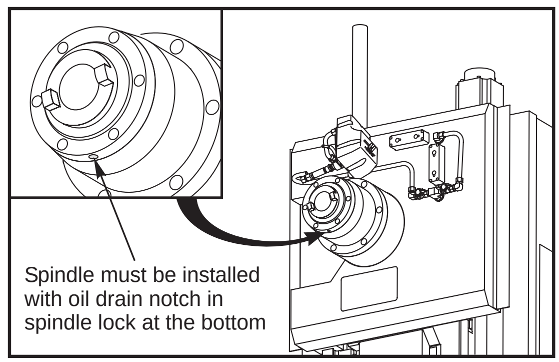
1. Remove the six SHCS that mount the spindle to head casting.
2. Slide the spindle out from the front side of machine.

INSTALLATION-

1. Inspect the mating surface for high spots on the spindle and spindle head casting before installing spindle.

2. Carefully install the new spindle into the bored sleeve of the head casting. Apply grease to the inside of the through bore in the spindle head. **The oil drain hole must point down**. Failure to do so will cause the spindle to overheat, fail, adn will void the warranty.



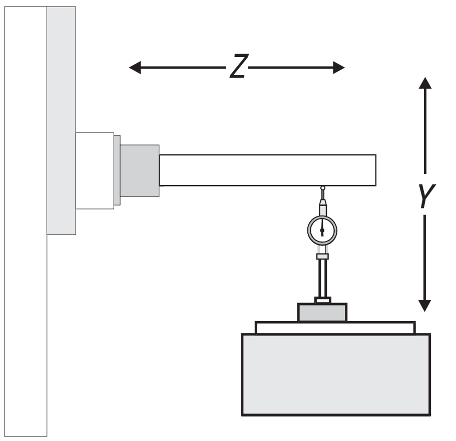


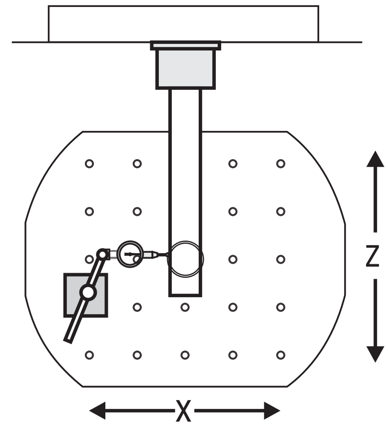
3. Evenly tighten the six mounting SHCS on the front side of the spindle in a cross pattern until all bolts are completely tight.
4. Reset spindle orientation and check the tool changer adjustment.
5. Refer to the "Spindle - Overheating" section of "Troubleshooting" and use the spindle run-in program. Verify that the spindle temperatures are acceptable.

Spindle Sweep Adjustment

NOTE: The machine must be properly leveled for the spindle sweep adjustment to be accurate.

1. Place an indicator on the table and insert a 6" precision test bar into the spindle.
2. Jog the Z-axis while indicating the bottom, and then the side, of the test bar. The readings must be within 0.0005/10" in both the Y/Z and X/Z planes, as stated in the inspection report supplied with the machine.
3. Shim the spindle, if necessary, to correct the spindle sweep to specifications. Recheck spindle sweep.





3.4 Drawbar Replacement

Drawbar Replacement - In-Line Drive

The drawbar is only replaceable on the 8000 RPM spindle. The 12000 RPM spindle has a non-serviceable drawbar.

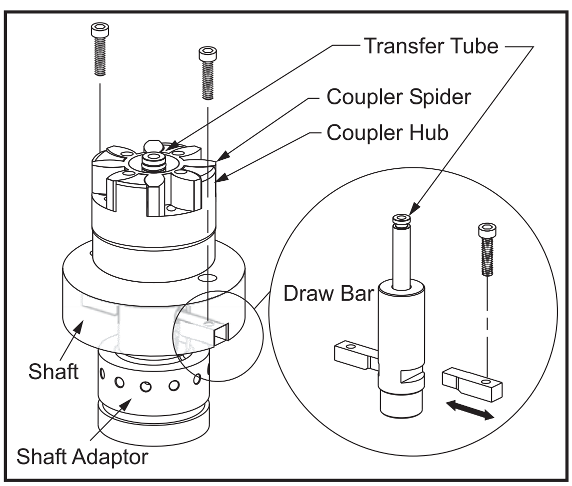
Note: **12000 spindles only**: Should a spindle fail, both the spindle and drawbar are to be replaced as a unit.

Removal

Remove the spindle as described in the Spindle Removal section.. Remove the keys from the drawbar, and remove the drawbar from the spindle.

Installation

Clean and grease the shaft and shaft adaptor. Install the drawbar unit. Install the two keys, flat side up. Use a "C" clamp to press the keys together to seat them against the drawbar. Torque the 5/16-18 retaining bolts to 30 ft-lb.



Verify the operation of the spindle by running it. If there is excessive vibration, loosen the bolts to the spindle cartridge and spindle head. Run the spindle at 1000 rpm and snug the bolts. Stop the spindle and tighten the bolts.

Drawbar Replacement - 50 Taper

1. Remove the head covers. Refer to the "Head Covers Removal / Installation" section.

2. Remove the tool release piston. Refer to the "50 Taper Spindle TRP Removal" section.

3. Remove the TSC extension tube if the machine is equipped with Through the Spindle Coolant option. Refer to the TSC section.

4. Remove the six bolts holding the spindle cap to the machine.

5. Remove the drawbar.

6. Thoroughly coat the replacement drawbar with grease, including the end of the shaft where the four holding balls are located.

CAUTION! Excess grease may cause the drawbar to hydraulic lock preventing the full stroke of the drawbar.

7. If machine is equipped with Through the Spindle Coolant option, grease the O-rings.

8. Insert six new balls in the replacement drawbar and insert into the spindle shaft. Be sure that as the shaft is installed, the balls do not fall out of the bores in the drawbar.

CAUTION! Insert the drawbar gently so the O-rings are not damaged. DO NOT use a hammer to force it.

NOTE: Carefully inspect the spindle shaft for galling or burrs inside the spindle shaft where the end of the drawbar rides. If it is damaged, the spindle must be replaced.

9. Install the drawbar.

10. Reinstall the tool release piston.

3.5 Tool Clamp/Unclamp Switch Adjustment

TOOLS REQUIRED

- **Right angle plate**
- **Machined aluminum block (2"x4"x4")**

Tool Clamp/Unclamp Switch Adjustment - Initial Preparation

1. Remove the rear enclosure panel.

2. Secure the right angle plate in place on the table.

3. Place the machined block of aluminum against the right angle plate.

4. POWER ON the machine.

5. Insert an empty tool holder into the spindle taper.

6. Go to HANDLE JOG mode. Choose Z-axis and set the jog increments to .01.

7. Jog the Z-axis in the negative (-) direction until the tool holder is approximately .03" from the block. At this point, stop jogging and press the TOOL RELEASE button (top left). The tool holder will come out of the taper.

NOTE: Do not jog too far in the negative (-) direction! This will cause overcurrent in the Z-axis.

Setting TRP Height

1. Press the MDI key and turn the jog handle to zero (0).
2. Press HANDLE JOG and set the increments to .01. Jog the Z-axis in the positive (+) direction .100".
3. Press and hold the TOOL RELEASE button, and try to move the block by hand. The block should be tight at .100" and loose at .110". If it 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 the block is tight.

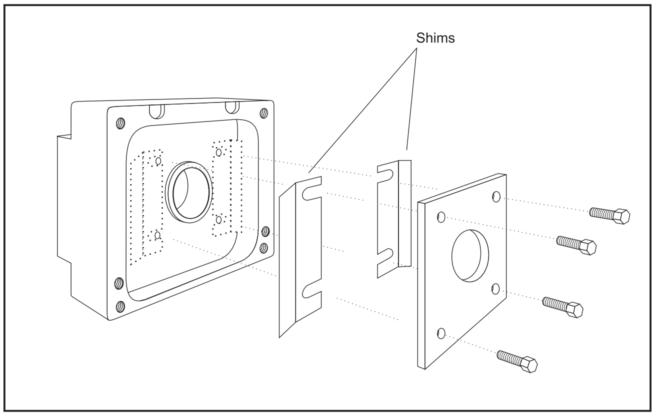
NOTE: The increments jogged in the Z negative (-) direction are the amount of shim that must be added to the tool release piston. Refer to the "TRP Shims" section.

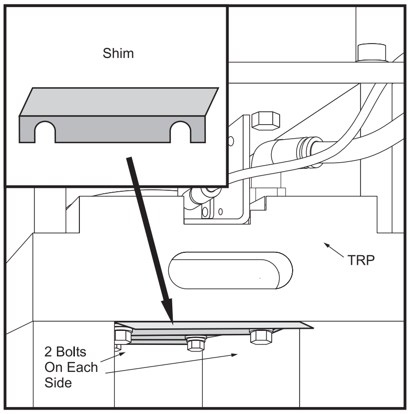
If the block is tight at .110", move the Z-axis in the positive (+) direction one increment at a time. Press the TOOL RELEASE button and check movement between increments until the block is loose.

NOTE: The increments jogged in the Z positive (+) direction is the amount of shim that must be removed from the tool release piston. Refer to the "TRP Shims" section.

TRP Shims

The drawbar uses a 1-piece shim which can be added or removed without having to remove the TRP assembly. Once the shims have been adjusted the TRP is reinstalled and the final torque on the bolts is 35 ft-lb.





Tool release piston assembly

> **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.

1. Check the condition of the tool release bolt and the draw bar. Repair or replace these items before setting the drawbar height.

2. To add or subtract shims, loosen the bolts that secure the retaining plate.

3. Add or subtract required shim washers (See previous section for correct amount to add or remove).

4. Tighten the retaining plate screws.

Adjustment of Switches

Unclamp Switch

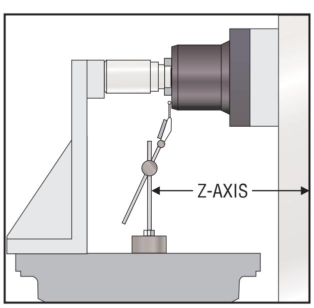
1. Drawbar height must be set properly before adjusting switches. Add or subtract shim washers to the tool release piston until proper height is achieved. In-line drive machines must have the precharge pressure verified. See the previous, "Setting Pre-Charge" section.

2. Push the PARAM/DGNOS twice to enter the diagnostic mode and confirm that DB OPN =0 and DB CLS =1.

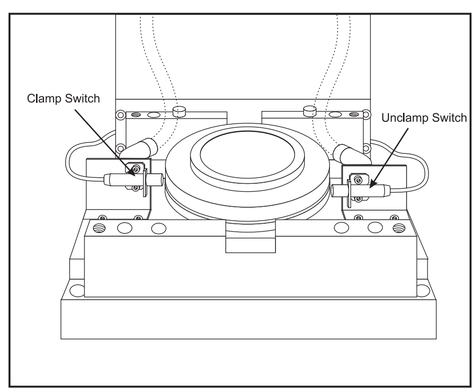
3. Using the same set-up for setting the drawbar height, jog the Z-axis to 0.06" above from where the tool holder was resting on the aluminum block.

4. Change Parameter 76 "Low air Delay" to 45000 to eliminate a low air pressure alarm.

5. In order to limit the spindle head deflection during this next part of the procedure the air pressure will need to be reduced to lower the output force of the TRP. Reduce the air regulator to about 60 psi. Place a 0.0005" test indicator between the table and front face of spindle head to measure axial deflection when the tool release piston is energized. Press and hold the tool release button and check that the block is tight and the head deflection is between 0.002 and 0.004". If the head deflection is too high, reduce the air pressure. If the head deflection is too low, or no deflection, increase the air pressure. Once the head deflection is between .002" and 0.004" proceed to the next step.



Indicator on Table



In-Line Drive Tool Release Piston Assembly

6. Press the tool release button and hold it in. Adjust the switch in or out until the switch just trips (DB OPN =1). Cycle the tool release several times and confirm the switch is tripping.

7. Check the adjustment. Jog the Z-axis down until the tool is .050 above the block and confirm that DB OPN=0 when the tool release button is pressed. The switch must trip (DB OPN =1) at 0.06" above the block and not trip (DB OPN =0) at 0.05" above the block.

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

9. Set the pressure regulator back to 85PSI.

10. Set parameter 76 back to the original setting.

Clamp Switch

1. If the machine is equipped with TSC, remove the seal housing before continuing. This step does not apply to In-line drives with TSC.

2. Remove the tool holder from the spindle.

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

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

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

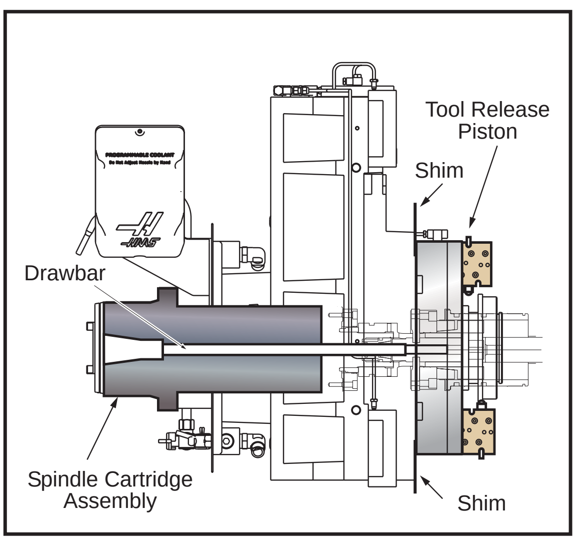
6. Press CYCLE START.

7. If DB CLS=0 (tool Unclamp) you are done (do not check with 0.04” shim).
   If not, adjust the upper switch out until the switch is just un-tripped (DB CLS=0).

8. Press RESET. Replace the 0.02” shim with a 0.04” shim. Press CYCLE START. See that DB CLS=1. Readjust and repeat steps 2-8 if necessary. This step is not necessary for In-Line Drive machines

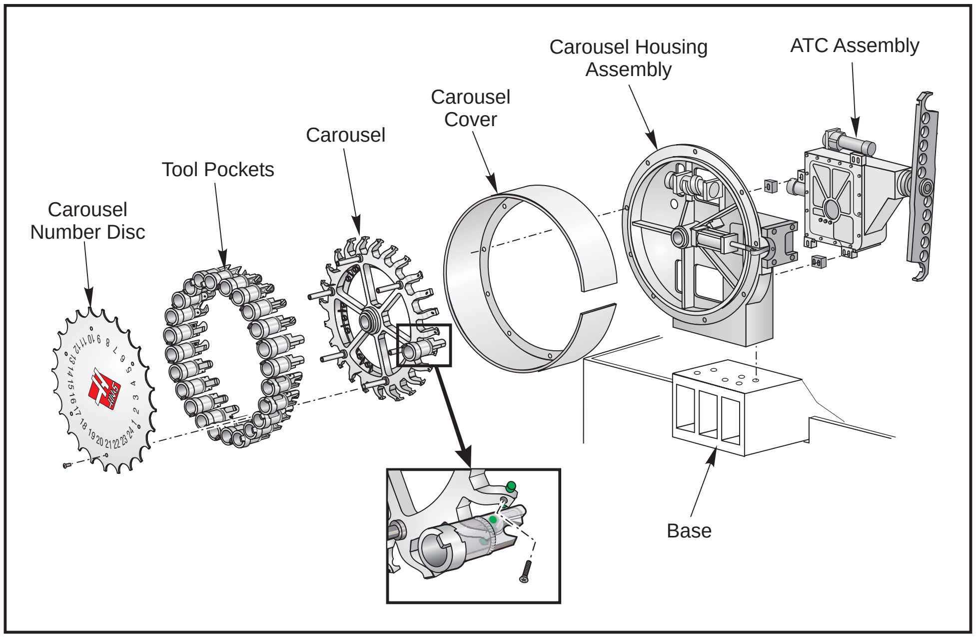
Checking with the 0.04” shim assures that the switch is not backed off too far. If switch is all the way in, this check is not needed.

CAUTION! Remove the tool holder from the spindle before performing the CLAMP switch adjustment. Failure to remove it could result in damage to the tool holder, the mill table, or cause severe personal injury.

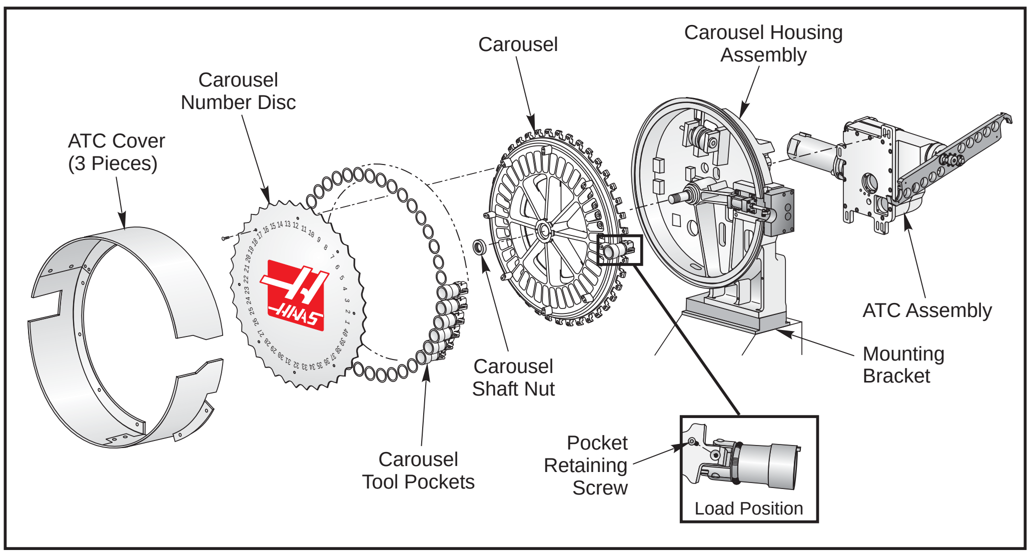


3.6 40 Taper Carousel Side Mount Tool Changer

40 Taper Carousel Removal and Installation



EC-300 Side Mount Tool Changer Assembly



EC-400 Side Mount Tool Changer Assembly

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

Removal:

1. Power Off machine.

2. Unscrew the BHCS from the carousel number disc and remove.

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.

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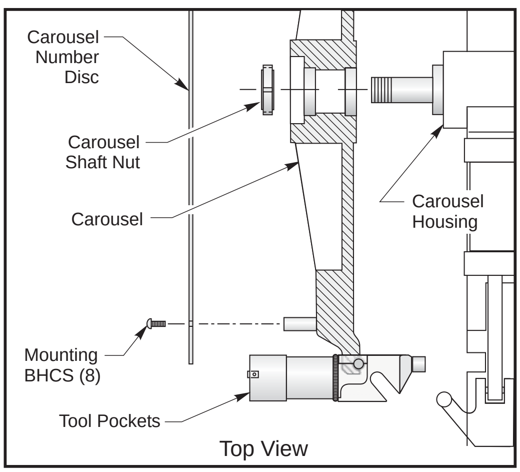
5. Unscrew the FHCS for each tool pocket. Remove the tool pocket holders from carousel.

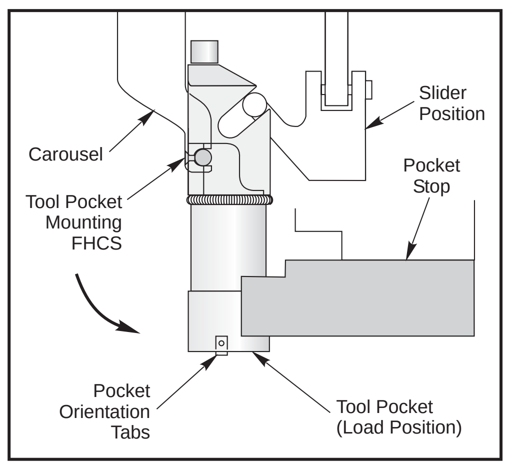
Installation:

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.

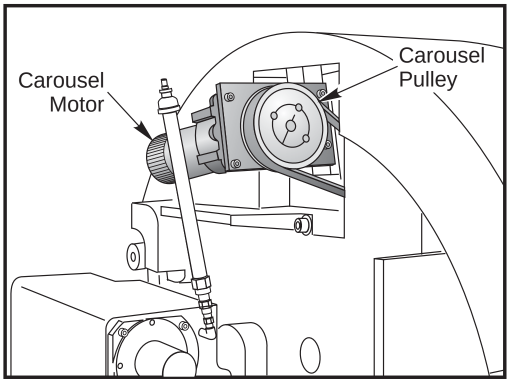


Carousel Assembly



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. The carousel can be rotated by manually rotating the carousel pulley by hand.



Pulley locations and ATC movement

4. Re-attach the carousel number disc with the BHCS. Apply blue loctite to the BHCS and tighten.

50 Taper Carousel Removal and Installation

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.

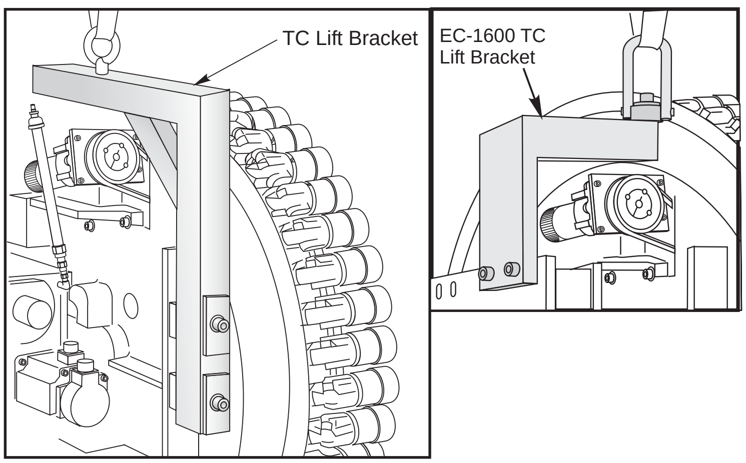
3. Install pockets into the carousel following the **50 Taper SMTC Pocket Removal and Installation** section.

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.

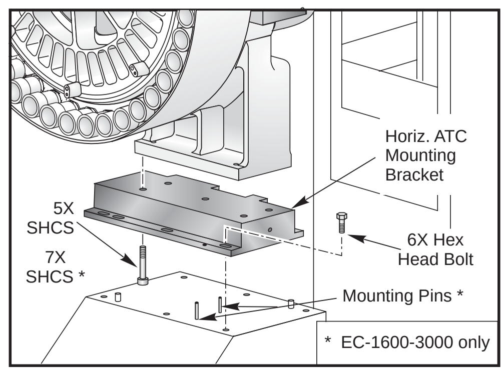
Removal:

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 eyebolt into the threaded 1/2-13 hole at the top of the carousel housing. Attach the lifting device to the eyebolt and support the ATC assembly. Remove the five carousel mounting SHCS from the ATC mounting bracket and move ATC assembly away from the column.
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.



Tool Changer Assembly Lifting Position



Tool Changer 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 reattach 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.

Automatic Tool Changer Alignment

Use Split Tool P/N	T-2086 for 40 taper, CT type	T-2088 for 50 taper, BT type
	T-2087 for 40 taper, BT type	T-2089 for 50 taper, CT type

This procedure is for a newly mounted ATC assembly without the double-arm installed. Perform the grid offsets and change parameter 64 to 0 according to the instructions in this manual before proceeding.

1. Power Up machine, then zero return the Z-axis.
2. Go to the Debug mode and push the tool changer restore button. Follow the instructions given.
3. Install the appropriate split tool (CT or BT).
4. Move the ATC forward until it stops.
5. In handle jog mode, align the split tool by jogging the X and Y axes until the alignment pin goes through the split tool with as little resistance as possible.
6. Go to the POS-RAW data page and record the actual encoder steps for the X and Y axes. Put the X-axis encoder steps reading into parameter 210 and Y-axis encoder steps into parameter 211.
7. Measure the distance between the spit tool and multiply it by the Z-axis ratio (par 33 = 83231 steps/unit).

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. Move the Z-axis all the way toward the spindle. 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).
4. POWER OFF the machine. Disconnect the air supply line at the rear of the machine. The tool pocket will swing out once the air is disconnected.
5. At the back of the ATC assembly, reverse the two air lines going from the solenoid valve to the air cylinder. Reconnect the air supply line at the rear of the machine. (The tool pocket holder in the tool change position should retract.)
6. At the back of the ATC assembly, manually rotate the cam box pulley clockwise until the output shaft is extended and just before it begins to rotate 180^0.
7. Align the double-arm to the tool pocket and the spindle with the unlocking finger buttons facing in. Place the double-arm on to the shaft and snug the lock ring on the bottom of the double-arm with the SHCS.
8. Place the split tool into the double arm end in front of the tool pocket. The split tool P/Ns for 40T are T-2084 for CT type and T-2087 for BT type; P/Ns for 50T are T-2089 for CT type or T-2088 for BT type. Depress the tool release button on the keypad and insert the split tool. Slightly push the double-arm in the clockwise direction to remove backlash in the drive assembly.

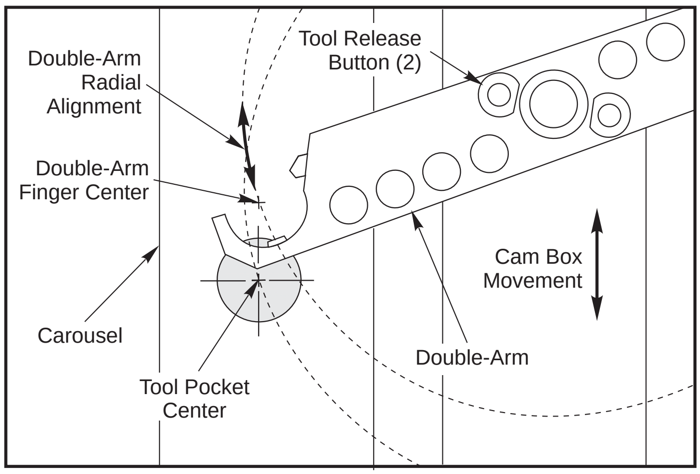
Radial Alignment of Double Arm to Carousel:

1. Rotate the cam box pulley counter-clockwise to raise the double-arm into the split tool. Visually check the centerline alignment of the split tool to the centerline of the tool pocket.

2. In order to adjust the radial alignment of the split tool to the double arm, loosen the lock ring SHCS and adjust the double-arm.

3. If the double arm is not aligned in the Y-axis with the centerline of the split tool, loosen the four cam box SHCS and insert a pry-bar between the slots. Adjust the cam box until the centerline of the split tool is aligned with the centerline of the tool pocket.

4. Torque the cam box SHCS to 80 ft-lbs.



Cam Box / Double Arm Alignment, front view.

Checking Parallelism of Double-arm to Table:

13. Rotate the cam box pulley clockwise to lower the double arm. Remove the split tool from the double arm.

14. Rotate the cam box pulley counter-clockwise to retract 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 back of the ATC assembly.** Reattach 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 extends and is parallel to the x-axis. Insert a split tool into the double arm by pressing the tool release button located near the shaft.

Place a magnetic base and indicator on to the machine table. Measure the end of the split tool to the nearest .001."

18. Move the split tool and indicator setup to the other end of the double-arm. Measure the end of the split tool to the nearest .001." The maximum allowable height tolerance between the two ends is .030." Adjust the alignment as necessary. Repeat this test with the arm rotated 180^0.

19. Remove the split tool from the double-arm. Return the double-arm to the home position.

Setting the Double-arm Extension:

20. Press the DOWN ARROW to command the tool pocket out. Place the split tool <u>with</u> the pull stud into the tool pocket. In TCR mode, rotate the double arm near the tool pocket.

21. Visually check the alignment of the double arm to the V-groove on the split tool. If necessary loosen the lock ring SHCS and adjust the extension of the double arm. Torque the lock ring SHCS to 15-17 ft-lbs.

22. Repeat steps 9 & 10 to re-check radial alignment.

23. Return the double-arm to the home position.

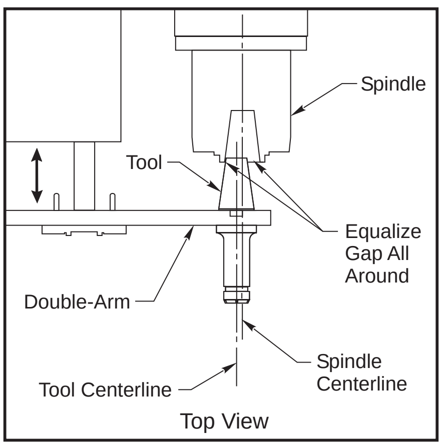
Double-Arm to Spindle Alignment:

1. ZERO RETURN the Z-axis.

2. In TCR mode, extend the double arm and re-insert the split tool into the double arm. Orient the spindle dogs for a tool change. (If the orientation has changed reset Parameter 257. Refer to section on setting spindle orientation). If spindle dogs are not aligned with the tool holder slot, manually rotate the spindle dogs.

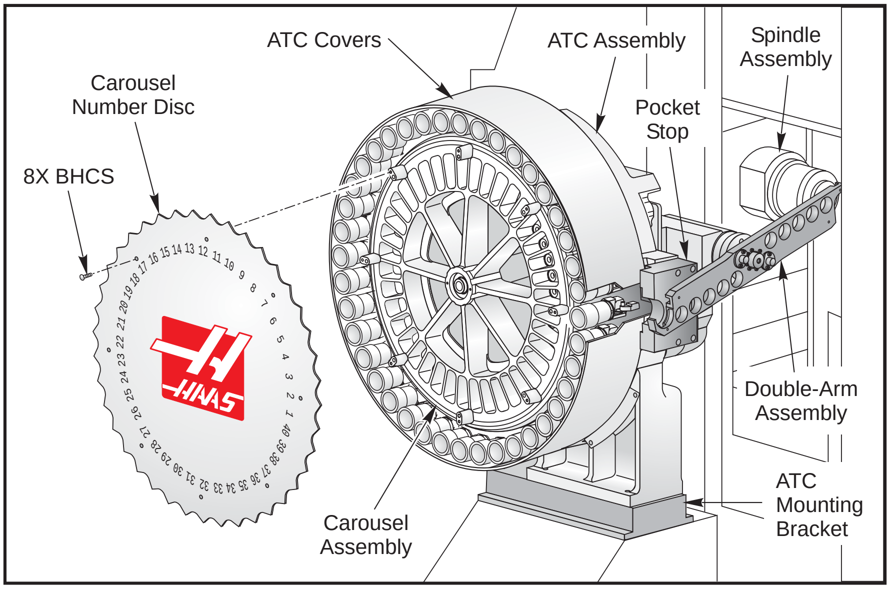
3. Retract and extend the double-arm to move the tool in and out of the spindle. Check for alignment.

4. Check the X-axis alignment of the split tool to the spindle center.



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

5. If necessary, loosen the five ATC mounting SHCS.



ATC Assembly Alignment.

6. Use a mallet to align the ATC mounting bracket. Adjust the bracket to align the split tool in the double arm to the center of the spindle in the X-axis.

7. Torque the SHCS to 80 ft-lbs.

8. Check the Y-axis alignment of the split tool to the spindle.

9. If necessary, loosen the five ATC SHCS and use a mallet to align the mounting bracket. Adjust the ATC along the mounting slots and align the tool and spindle's center.

10. Check the spindle tool change position. If the spindle tool change position has changed, reset Parameter 64 per the instructions in this chapter.

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 80 ft-lbs. Replace all cam box sheet metal covers and fasteners. Apply blue loctite to the fasteners and tighten.

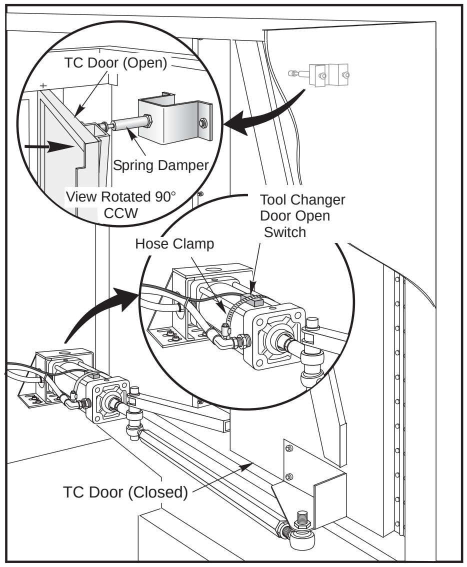
EC-300 Tool Changer Door Open Switch Adjustment

The tool changer door must be completely open before the sensor switch on the air cylinder changes its state.

1. With the machine on E-stop, disconnect the main air supply.

2. Clamped to the air cylinder with a hose clamp, is the tool changer door open switch. Move the sensor switch toward the rod end of the air cylinder until it reaches the end cap of the air cylinder.

3. Open the tool changer door all the way. Watch the diagnostic screen. Slowly slide the sensor switch back along the air cylinder until the tool changer door bit changes from 0 to 1.



4. Mark the spot where the bit changes to 1 and secure the switch with a hose clamp.
5. Reconnect the main air supply, and take the machine off of E-stop.
6. Run the tool changer door and check for speed.
7. Adjust the speed at the solenoid valve on the lube panel.
8. Check the action of the spring damper that stops the tool changer door when it opens. The tension can be adjusted by turning the adjustment screw on the back of the spring.

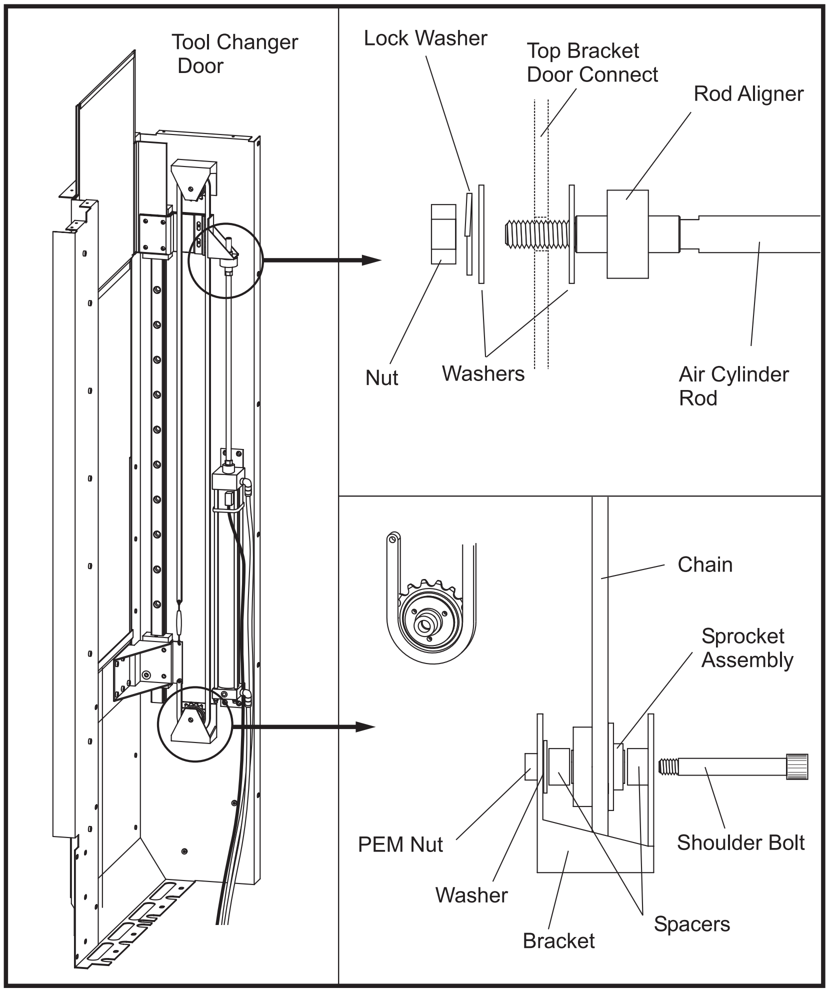
EC-400 Tool Changer Door Replacement

This procedure describes the installation of the complete door assembly. It may not be necessary to start the procedure from the beginning. Remove the damaged or inoperative parts and then rebuild the toolchanger door assembly.

Installation and Alignment

Linear Guides and Air Cylinder

1. Push the top of the linear guide towards main panel wall and tighten top bolt. Push the bottom of the linear guide towards panel wall and lightly tighten bottom bolt. Securely tighten the remaining bolts, and then tighten the top and bottom bolts. Install linear guide trucks and grease using fittings.
2. Grease shoulder bolt and slide through panel bracket, spacer, idler assembly, second spacer, and washer. Thread the bolt into the pemnut and tighten.



3. Push air cylinder towards linear guide rail while tightening bolts.
4. Thread & tighten onto cylinder rod end.

Tool Changer Doors

5. Grease main panel face where the door guide will be mounted. Mount door guide to main panel, with the guide spacer between them using 10-32 flat-head screws.
6. Grease the edges of the door that will be sliding against main panel & door guide. Slide top door into door guide and place flange onto linear guide pad (top/right). Put the top door bracket over the door flange and position the door between the bracket and the upper linear guide truck. Push door flush against main panel and tighten the four bolts that hold the bracket to the linear guide. Check sliding motion of top door, bracket and truck, this should be smooth and uniform.

7. Retract air cylinder rod. Place a 7/16 washer over rod aligner thread. Move top door bracket down to air cylinder rod aligner. The hole in bracket should line up with rod aligner without forcing it over rod end. If not loosen air cylinder mounting bolts, reposition and then retighten the bolts. Place flat washer and split washer over rod end and tighten with a 7/16-20 nut. By hand, move the cylinder rod, door bracket and door, in and out, looking for any binding. If there is any misalignment, loosen the air cylinder mounting bolts and let it self align, then retighten the bolts.

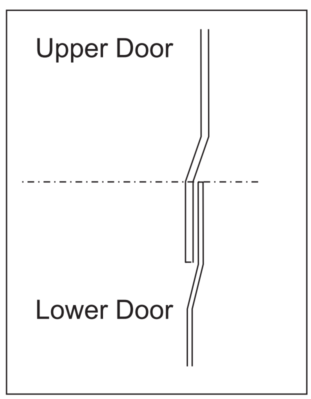
8. Grease main panel faces where door guides will be mounted. Mount door guides to main panel, with guide spacers sandwiched between them, via 10-32, zinc, flat head screws.

9. Attach the lower door bracket to bottom/left linear guide pad and leave bolts loose. Grease the edges of the door that will be sliding against main panel & door guide. Slide door into door guides and attach to the lower door bracket. Align door so it is square to panel prior to tightening the door bracket screws. Loosen 4 linear guide pad bolts and push door flush against main panel face and re-tighten.

Drive Chain

10. Place chain around idler assemblies and attach one end to bottom door bracket at the hole closest to the lower idler assembly using a master link. Install jam nut onto threaded, right-handed side of the turnbuckle. Attach the opposite end of the turnbuckle to the other hole in the bottom door bracket using a second master link. Make sure chain is properly located on both idler assemblies. Tighten the chain using the turnbuckle and lock with jam nut.

11. Retract air cylinder and top door to the closed position. Move the bottom door so the top edge is even with the first bend line in the top door. Attach chain retainer to top connect bracket and lock it into the chain.



12. Verify the operation of both doors. Move the top connect bracket back and forth with the cylinder stroke. The rod aligner should prevent any binding.

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).

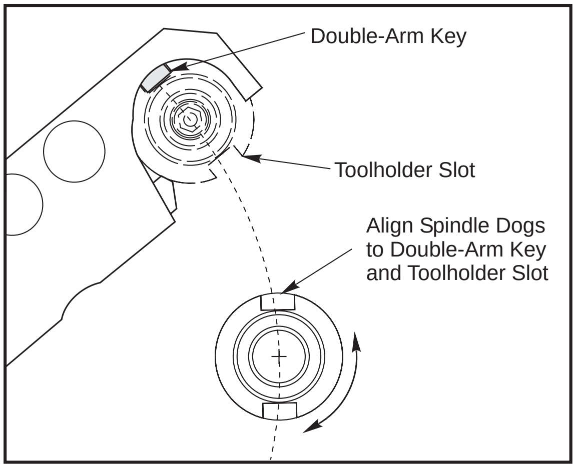
3. Enter DEBUG mode. Record the encoder value under “spindle orientation position”. Refer to Figure 3.12-13.

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.



Spindle Orientation Setting

DOUBLE ARM REMOVAL AND INSTALLATION

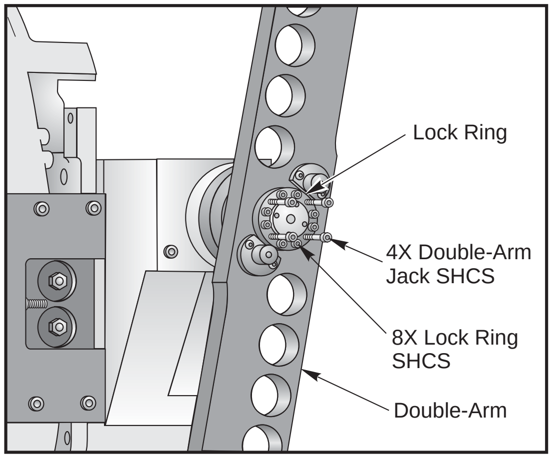
Removal

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.



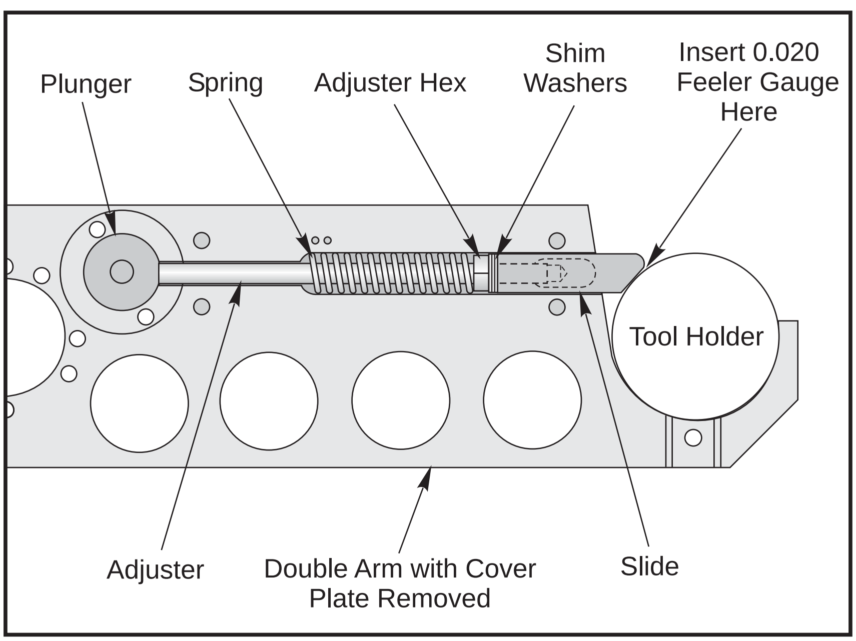
Removal of the Double Arm

Installation

1. Place the double-arm onto output shaft. Align the double-arm to the home position, then slide the lock ring onto the shaft.

2. Reattach the lock ring to the double-arm with eight (8) SHCS. Tighten in a star pattern to 15 ft-lbs, repeat this sequence 3 times to seat the arm lock bushing. Verify the slides are correctly adjusted on the double arm with the following procedure:

   With the double arm lowered, and the split tool inserted into the double arm, a 0.020 feeler gauge should fit between the slide and the tool flange O.D. The plunger should be able to rise fully to the locked position with the gauge between the split tool and the plunger.



The plunger will not return reliably to the fully raised locked position when the tool is inserted, if there is insufficient clearance. The split tool will be excessively loose in the doublearm if there is too much clearance.

To adjust the clearance, remove the slide and the cover by removing the cover plate and lifting the slide out at an angle. Be careful not to lose the spring. Loosen the adjuster and correct the clearance by adding or removing shims. 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 double arm alignment instructions in the previous “ATC alignment” section.

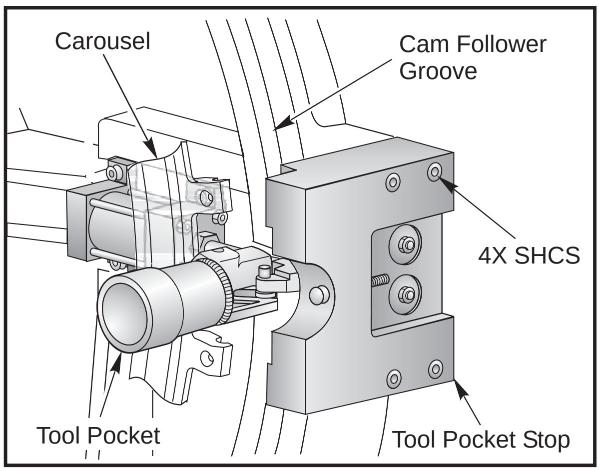
40 Taper SMTC Pocket Removal and Installation

Removal

1. Turn the machine on and rotate the carousel to the pocket you want to change. Remove the sheetmetal in order to gain access to pocket limit switches. Remove the sheetmetal disc covering the carousel.

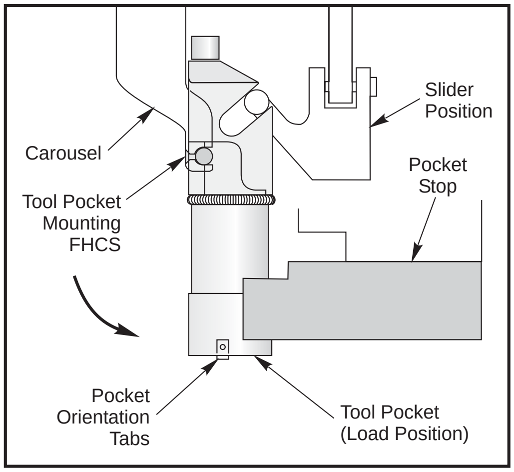
2. Press <**Tool Changer Restore**>. Press <**Y**> three times.

3. Remove the four SHCS that hold the pocket stop. 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.

4. Press <**v**> to retract the air cylinder shaft. Manually lower the pocket and remove the pocket retaining screw. See the following figure:



5. 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

1. 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.

2. 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.

3. 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.

Tool Pocket Slider Adjustment

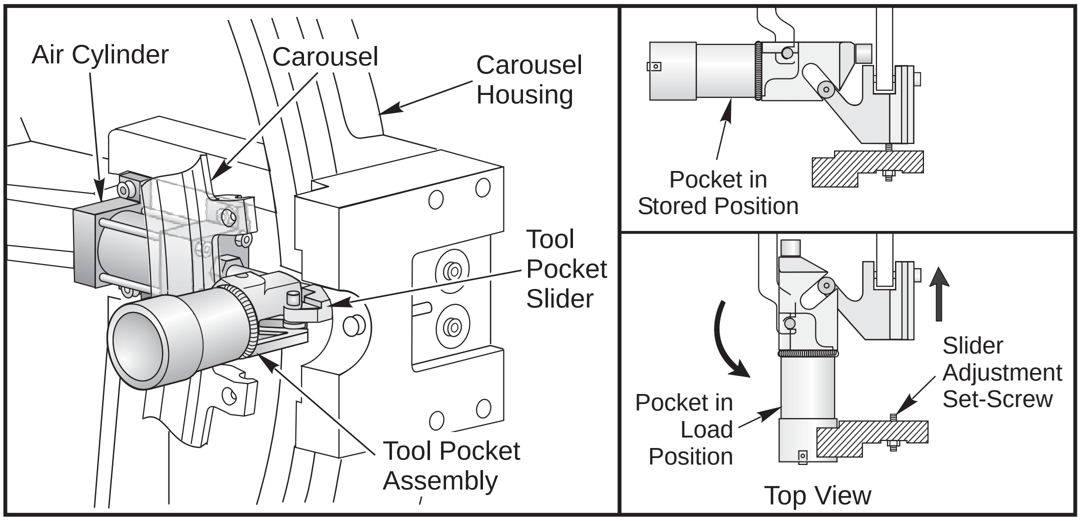
The slider set-screw is used to adjust the tool pockets' end-of-stroke with the circular path on the carousel housing.

1. Rotate carousel by turning the carousel cam pulley by hand.

2. Visually check for misalignment (tool pockets should move smoothly).

3. If necessary, loosen the setscrew nut. Adjust the setscrew 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 setscrew lock nut.



Tool Pocket Orientation / Set-Screw Adjustment

Proximity Switch Removal / Installation

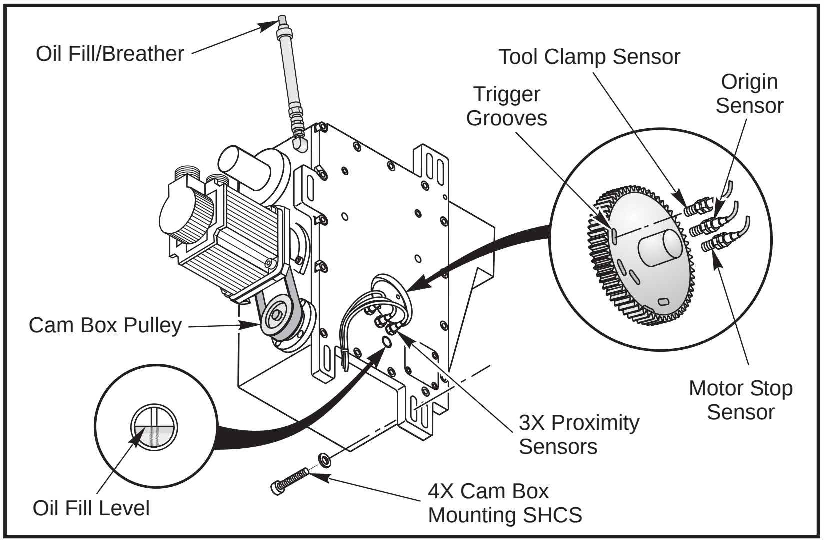
Removal

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 following figure.



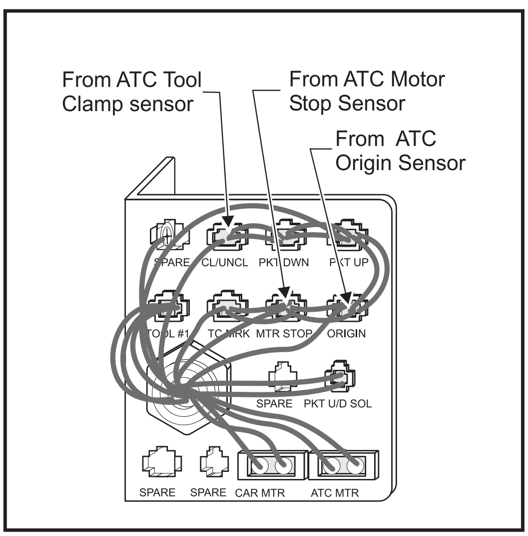
Proximity Sensor Switch Location

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.



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.

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

Caution: The EC-400 Z-axis can crash into the pallet changer actuator if Parameter 64 is not set correctly.

For Z-axis, this is the displacement from home switch to tool change position and machine zero.

(Distance from Home in Inches) X (Line Encoder Constant) = Z-axis tool change position setting

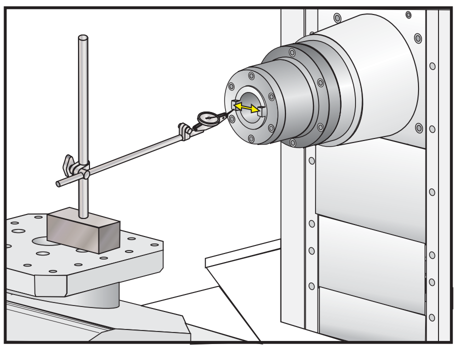
Example:
.625 x 138718 = 861699

To reset Parameter 64 (Z-axis tool change position) if an ATC assembly has been replaced or realigned.

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 position. Enter DEBUG and record Z-axis spindle position value.

3. Enter TCR mode. Press the DOWN ARROW, command a tool pocket down. Manually insert a tool into the tool pocket.



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.

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:

(Difference in Z-axis encoder counts) + (Old Z-axis Tool Change Setting) = New Z-axis Tool Setting
20681 + 861699 = 882380

8. Enter PARAMETERS page. UNLOCK settings and write new setting value for Parameter 64. LOCK parameter settings.

9. Perform a tool change and observe for misalignment. Adjust the PARAMETER 64 setting if necessary.

Servo Tool Changer Offsets

Invisible Axis Explanation

The SMTC uses an invisible axis to control the double arm. If the axis is made visible to service or adjust it, the safety interlocks are disabled, and the automatic operation of the tool changer is prohibited. Be sure the spindle head is out of the way before rotating the double arm.

Offsets

Both the Tool Change Offset and the Grid Offset must be set before using the tool changer. The Grid Offset must be set first.

Setting the Grid Offset

The control can calculate grid offset parameters with a ‘GRID’ command. A grid offset is an offset that is applied to the home position of an axis so that the zero location for that axis is re-defined to be half an encoder revolution away from the home switch. It is recommended that the GRID command be used on each axis separately.

1. Zero Return all the axis

2. Turn the machine off and back on. This will un-zero all the axes.

3. Select the ALARMS screen and enter DEBUG mode.

4. Perform a ZERO SINGLE AXIS on the Tt axis. Ignore the ZERO RET MARGIN TOO SMALL alarm if it occurs. The tool arm is out of position and must be repositioned using tool change recovery, if a tool arm fault is generated.

5. Select the Positions screen, enter “GRID TT” and press ENTER. The message GRID OFSET DONE should appear and the GRID OFFSET parameters for the homed axes will have been updated. If the message “NO ZERO” appears, this indicates that none of the axes had been zeroed.

Setting the Tool Change Offset

1. Set the Tool changer axis to “Visible”. This is done by setting bit 18 of Parameter 462 to zero.

2. Make sure the spindle head is up out of the way

3. Go to the Discrete Inputs page and look at the cambox origin display.

4. Handle jog (rate .01) the TT (B) axis until “Origin” and Motor Stop” are “1”.

5. Handle jog in the positive direction, until both the “Motor Stop” and “Origin” are “0”. Switch displays to the Position page and continue jogging the axis 3-5 degrees, in the same direction, past this position.

6. Handle jog the axis in the negative direction (.01 degrees per pulse) until both “Motor Stop” and “Origin” are ”1”. Note that you cannot back up if the mark is missed. If the mark has been missed go back to step 5.

7. Go to the Pos Raw Data page. Under the “Command” header the display shows the “B” axis encoder counts. Write down the current number.

8. Go back to the Discrete Inputs page. Watch “Motor Stop” and “Origin”. Handle jog in negative direction, until one of them changes to “0” (the first one to change).

9. Go back to the Position page and write down the current number from the same column as step 7. Add both numbers and divide by 2, this is the amount of tool change offset, but with the wrong sign.

10. Return to the Discrete Inputs page and handle jog the axis back until the “Motor Stop” and “Origin” are “1”.

11. Enter the calculated number, as a negative number in the TT axis, Parameter 487 (not the B-axis).

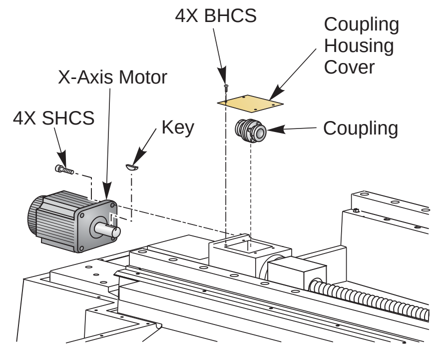
12. Return the axis to “Invisible”, set parameter 462 to 1, and cycle power.

13. Zero return the TT axis. The double arm should be in the middle of the home position.

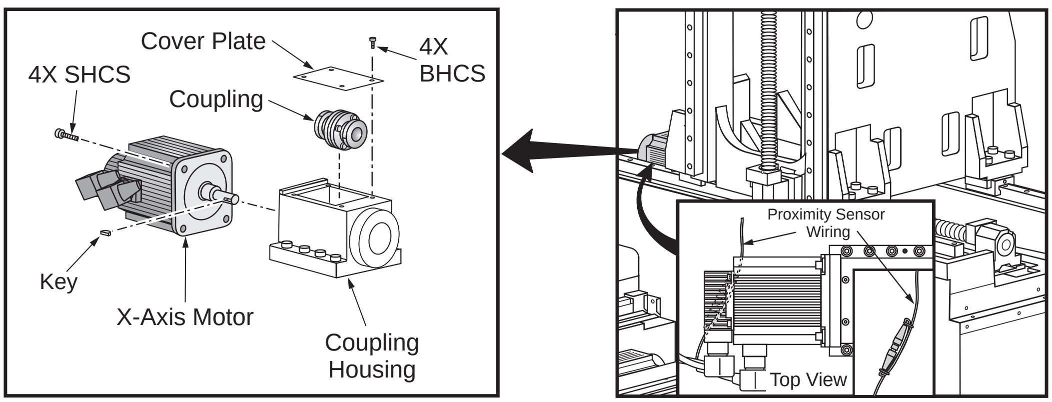
3.7 Axis Motors

Please read this section in its entirety before attempting to remove or replace the axis motors.

X-Axis Motor



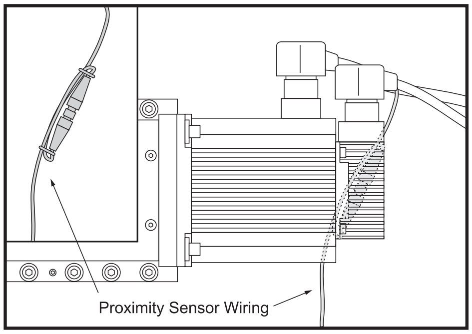
X-Axis Motor and Ball Screw Assembly EC-300



X-Axis Motor and Ball Screw Assembly EC-400

Removal

1. Power ON the machine. Zero return all axes and put machine in HANDLE JOG mode.
2. Jog the Y-axis to the bottom of its travel. Jog the X-axis away from the motor.
3. Remove the rear enclosure panel.
4. POWER OFF the machine.
5. On the top of the motor housing, remove the four BHCS and remove the coupling housing cover.
6. Loosen the SHCS on the motor coupling.
7. Disconnect all wiring from the motor and remove. Be careful of the proximity sensor wires when lifting out the motor.



8. Remove the SHCS motor mounting bolts and remove the motor from the coupling housing.

Installation

1. Inspect the motor coupling and replace it if required. Visually inspect the flex plates to ensure they are parallel to the coupling halves. Slide the new coupling onto the motor shaft until the coupling half is flush to the end of the shaft.

NOTE: The slot in the locking collar must be positioned 45 degrees between the bolt hole pattern of the coupler. If improperly aligned, the coupler will not have enough clamping force on the ball screw or motor shaft. **Refer to the diagram in coupling replacement section**.

2. Reconnect all wiring to the motor.

3. Align the key on the motor shaft. Slide the motor into the coupling housing, inserting the end of the ball screw into the motor coupling.

4. Reinstall and tighten down the four SHCS that hold the motor to the coupling housing.

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

6. Replace the housing cover and fasten the BHCS.

7. Replace the rear enclosure panel.

8. Check for backlash in the X-axis ball screw ("Troubleshooting" section) or noisy operation.

9. Set grid offset.

Caution: Work offsets will change.

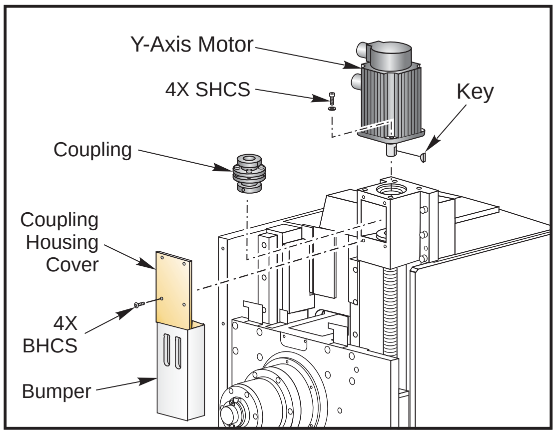
Y-Axis Motor

Removal

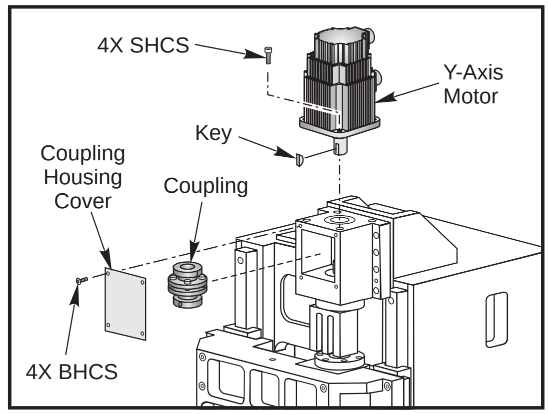
1. Power ON the machine. Zero return all axes and put machine in HANDLE JOG mode.

2. Remove the rear enclosure panel.

3. Jog the X-axis until the Y-axis motor can be easily accessed from the rear.
4. Install the column shipping bolts if available, or place a block of wood on the column casting beneath the spindle head casting. Lower the spindle head (Y-axis) until it rests on the wood.
5. POWER OFF the machine.
6. **EC-300** – Remove the right spindle head cover (looking at the spindle) from the inside of the machine.
7. Remove the motor coupling cover and loosen the SHCS on the motor coupling at the ball screw.



Y-axis motor and coupling EC-300



Y-axis motor and coupling EC-400

8. Remove the SHCS and remove the motor from the coupling housing.
9. Disconnect all wiring from the motor.
10. Remove the motor.

Installation

1. Inspect the motor coupling and replace it if required. Visually inspect the flex plates to ensure they are parallel to the coupling halves. Slide the new coupling onto the motor shaft until the coupling half is flush to the end of the shaft.

NOTE: The slot in the locking collar must be positioned 45 degrees between the bolt hole pattern of the coupler. If improperly aligned, the coupler will not have enough clamping force on the ball screw or motor shaft. **Refer to diagram in Coupling Replacement section**.

2. Reconnect all wiring to the motor.

3. Align the key on the motor shaft. Slide the motor into the motor housing, inserting the end of the ball screw into the motor coupling.

4. Reinstall and tighten down the SHCS that hold the motor to the coupling housing.

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

6. Remove the shipping bolts from the column, or raise the Y-axis and remove the wood blocks from the column casting.

7. Replace the rear enclosure panel.

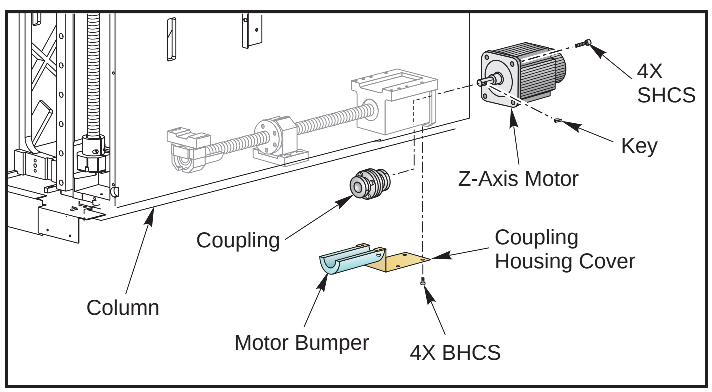
8. **EC-300** – Replace the right spindle head cover

9. Check for backlash in the Y-axis ball screw (Troubleshooting section) or noisy operation.

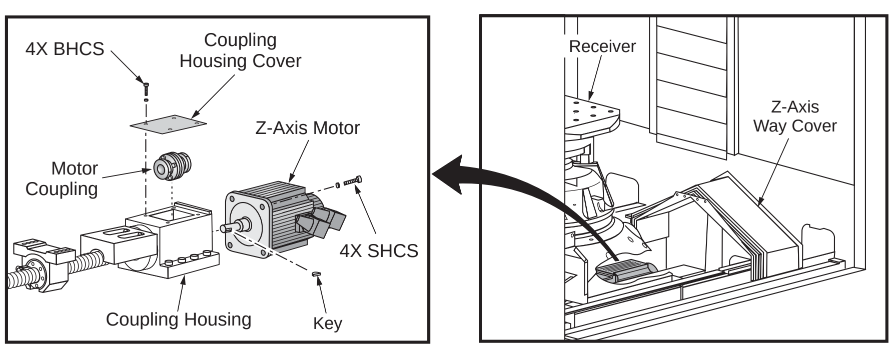
10. Check that Parameter 211, "Y-Axis Tool Change Offset", is set correctly, and adjust if necessary.

11. Set the grid offset after the new motor has been installed.

Z-Axis Motor



EC-300 Z-axis motor and ball screw assembly



EC-400 Z-axis motor and ball screw assembly

REMOVAL-

1. Power ON the machine. Zero return all axes and put machine in HANDLE JOG mode.

2. **EC-300** – Jog the Y-axis to the bottom of its travel. Jog the Z-axis to the back of the machine. **EC-400** – Jog the Z-axis away from the spindle.

3. POWER OFF the machine.

4. **EC-400** – Unbolt the Z-axis way cover from the receiver and pull it away from the receiver.

5. Remove the BHCS and the coupling housing cover plate from the coupling housing.

6. Loosen the SHCS on the motor coupling at the ball screw.

7. Disconnect all wiring from the motor.

8. Remove the SHCS and remove the motor from the coupling housing.

INSTALLATION-

1. Inspect the motor coupling and replace it if required. Visually inspect the flex plates to ensure they are parallel to the coupling halves. Slide the new coupling onto the motor shaft until the coupling half is flush to the end of the shaft.

NOTE: The slot in the locking collar must be positioned 45 degrees between the bolt hole pattern of the coupler. If improperly aligned, the coupler will not have enough clamping force on the ball screw or motor shaft. **Refer to diagram in Coupling Replacement section**.

2. Reconnect all wiring to the motor.

3. Align the key on the motor shaft. Slide the motor into the coupling housing, inserting the end of the ball screw into the motor coupling.

4. Reinstall and tighten down the SHCS that hold the motor to the housing.

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

6. Replace the cover plate.

7. **EC-400** – Replace the Z-axis way cover.

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

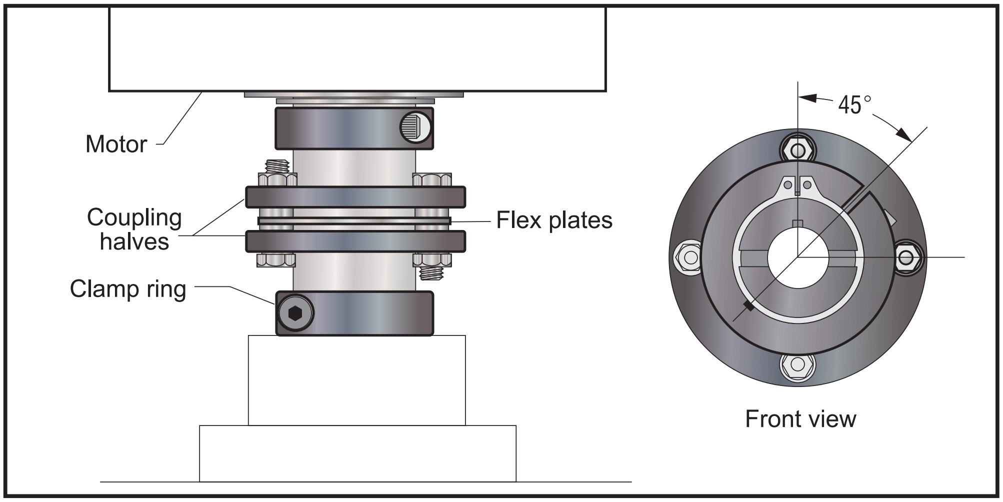
9. Set the grid offset after the new motor has been changed.

Coupling Replacement

REMOVAL-

1. Remove the axis motor in accordance with "Axis Motor Removal/Installation" section.

2. Completely loosen the two SHCS on the two coupling clamp rings and remove the coupling.



Motor Ccoupling Ccomponents.

INSTALLATION-

1. Slide the new coupling onto the motor shaft until the coupling half is flush to the end of the shaft.

NOTE: The slot in the locking collar must be positioned 45 degrees between the bolt hole pattern of the coupler. If improperly aligned, the coupler will not have enough clamping force on the ball screw or motor shaft.

2. Tighten the two SHCS on the coupling's clamp ring. Before tightening, add one drop of blue Loctite to each screw.

3. Reinstall the axis motor.

3.8 Bearing Sleeve

Please read this section in its entirety before attempting to remove or replace the bearing sleeve.

Removal

1. POWER ON the machine. Zero return all axes and put the machine in HANDLE JOG mode.

2. Remove the rear enclosure panel.

3. Jog the axis away from the bearing support.
Y-Axis Bearing Support – Install the shipping bolts in the column to secure the Jog the Y-axis to the bottom of its travel.

4. POWER OFF the machine.

5. Remove the hardstop bracket from bearing support end.

6. Remove the locknut.

7. Manually screw the column over in order to access the motor. This is not possible when repairing the Y-Axis.

CAUTION! Do not screw the column too far over since the hardstops are removed!

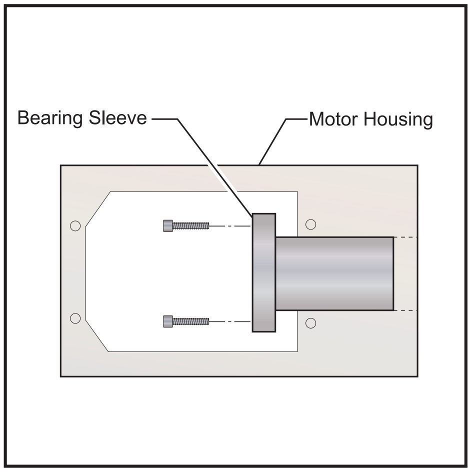
8. Remove the axis motor in accordance with the specific motor removal section.

9. Remove the coupling.

10. Loosen the SHCS on the locknut at the motor end of the ball screw, and remove the locknut.

11. Loosen the SHCS and remove the bearing sleeve from the coupling housing. Push on the opposite end of the ball screw to loosen.

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



Bearing Sleeve Mounting Location.

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. Place the bearing sleeve in the motor mount. It may be necessary to align the bearings in the sleeve to facilitate mounting on the ball screw.

3. Install the SHCS on the bearing sleeve, and torque to 15 ft-lb. (Place a drop of blue Loctite on each of the SHCS before inserting.)

4. Manually screw the column over in order to access the bearing support. This is not possible when repairing the Y-Axis.

CAUTION! Do not screw the column too far over since the hardstops are removed!

5. Screw the clamp nut on the motor end of the ball screw two or three turns, but do not tighten.

6. Loosen all of the SHCS on the bearing sleeve approximately 1/4 turn, then torque to 15 ft-lb. This ensures the ball screw is installed and runs parallel and flat to the linear guides and the saddle.

7. Tighten the ball screw against the clamp nuts as follows:
   • Tighten the clamp nut on the motor housing end of the ball screw to 15 ft-lb.
   • Tighten the SHCS on the clamp nut.
   • Place a spanner nut over the clamp nut on the support bearing end of the ball screw and slowly tighten to 4 inch-lb. Remove the spanner nut.
   •Tighten the SHCS on the clamp nut with Loctite, and mark it with yellow marking paint.

8. Reinstall and tighten the hard stop on the bearing support.

9. Reinstall the axis motor as described in the specific axis motor installation section.

10. Check for backlash in the ball screw (see the "Troubleshooting" section), or noisy operation.

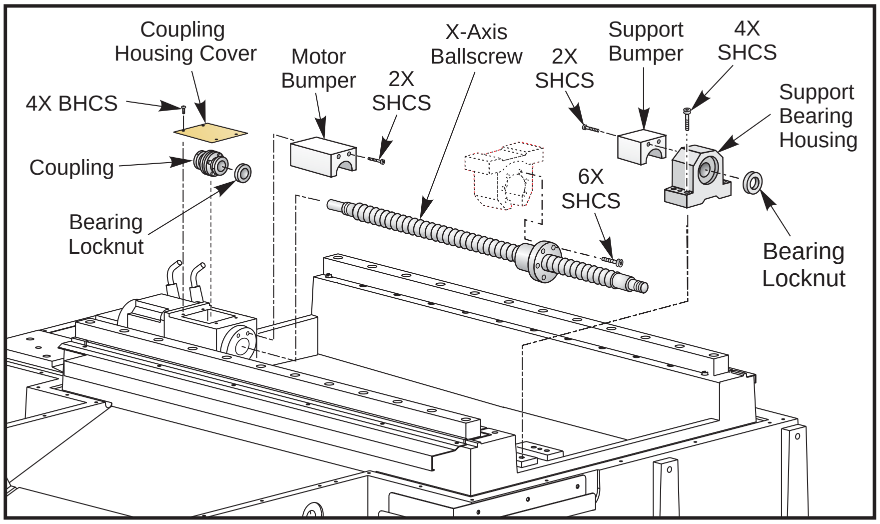
11. Set the grid offset.

3.9 Ball Screw

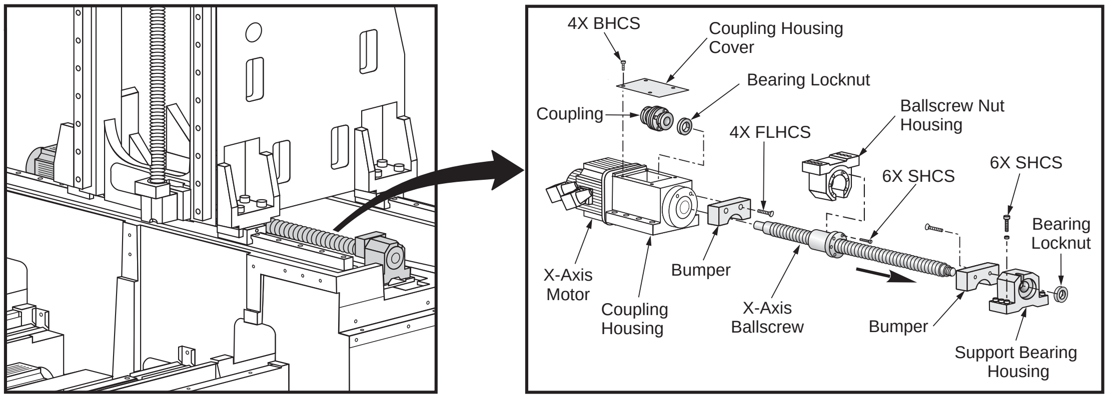
Please read this section in its entirety before attempting to remove or replace the ball screws.

TOOLS REQUIRED:
- Torque wrench
- Spanner nut

X-Axis Ball Screw



EC-300



EC-400

Removal

1. Turn the machine ON. Zero return all axes and put the machine in HANDLE JOG mode.
2. Remove the rear enclosure panel.
3. Jog the Y-axis to the bottom of its travel. Jog the X-axis towards the tool changer.
4. POWER OFF the machine.

5. Remove the hardstop and locknut from the bearing support.
6. Remove the SHCS that secure the nut housing to the ball screw nut.
7. Remove the oil line from the ball screw nut.
8. Rotate the nut on the ball screw, in order to move the nut near the bearing support end of the ballscrew.

CAUTION! Do not move the column too far over since the hardstops are removed!

9. Remove the X-axis motor and bearing sleeve in accordance with appropriate sections.
10. Pull the ball screw towards the control box side and out of the bearing in the bearing support.
11. Lift the ball screw up, forward, and to the side of the machine until the motor end of the ball screw is free. Carefully remove the ball screw.

Installation

1. Ensure all mating on the bearing sleeve, coupling 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. Hold the ball screw vertically with the motor end down and the nut near the support end (top).
3. Hold the ball screw at the front left side of the machine and lower into place, rotating the ballscrew into position.

CAUTION! Be careful not to bump or scratch ball screw.

4. Gently push the bearing support end of the ball screw into the bearing in the bearing support housing.
5. Replace the bearing pack.
6. Rotate the ballscrew nut so it goes into the nut housing and start the SHCS that secure the ballscrew nut to the nut housing. Do not tighten.
7. Reattach the oil line to the ball screw nut.
8. Replace the X-axis motor in accordance with the appropriate section.
9. Torque the SHCS from the nut to the nut housing to 15 ft-lb **(30 ft-lbs. for EC-1600)**.

10. The following sequence is important to ensure proper installation of the ball screw:
    • Tighten the locknut, hand tight, on the motor end.
    • Install and tighten locknut on bearing support. Ensure the nut **does not** touch the bearing support.
    • Install the shaft lock onto the bearing support end of the ballscrew. This will keep the ball screw from turning while torquing the lock.
    • Place a spanner wrench on the locknut at the motor end of the assembly.
    • **EC-300** Torque the clamp nut against the bearing sleeve to 15 ft-lbs.
    • **EC-1600** Torque the clamp nut against the bearing sleeve at the motor end to **50 ft-lbs.**
    • **EC-400** The ball screw lock nut on the bearing pack end should be torqued to 50 ft-lb, 10 ft-lb for the bearing support end.
    • With a T-handle wrench hand tighten the clamp nut screw and mark with yellow paint.
    • Remove the shaft lock.
    • **EC-300** Loosen the clamp screw and bearing lock nut and tighten to 4 IN-lbs. against the bearing. Retighten the clamp screw.
    • **EC-400 / EC-1600** Loosen the clamp screw and the bearing lock nut and tighten to 10 ft-lbs. against the bearing. Retighten the clamp screw.

11. Replace the bearing support end hard stop.

12. POWER ON the machine.

13. Rotate the ballscrew by hand to assure free movement.

14. Jog the X-axis to the left end of travel and check for free movement.

15. Replace the rear enclosure panel.

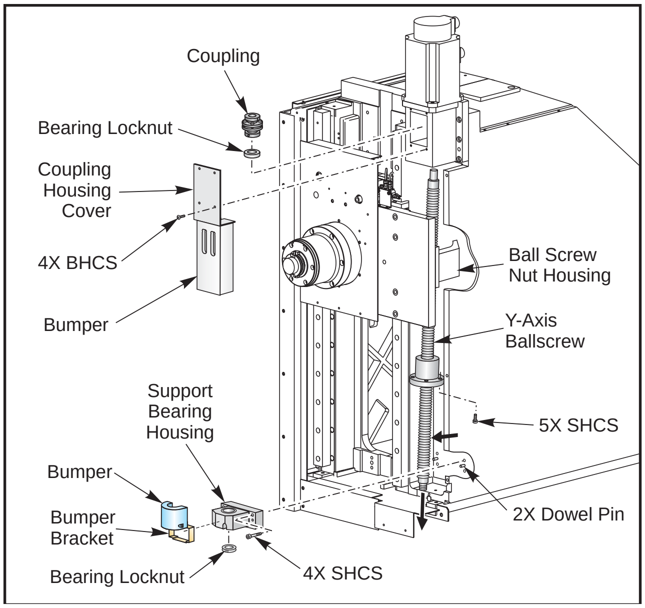
Y-Axis Ball Screw

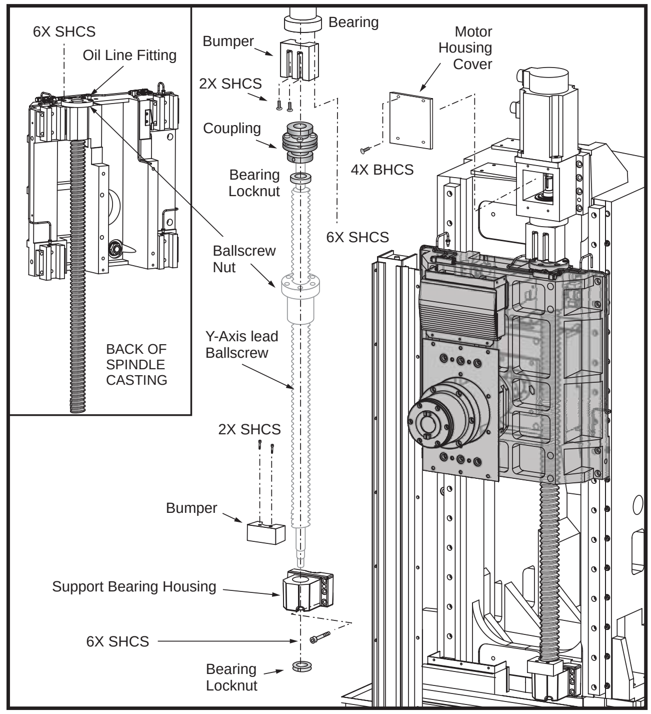
Removal

1. Power ON the machine, “zero return” all axes, and select “handle jog” mode.

2. Rest the Spindle on a sufficient block, Power OFF the machine, and remove the axis motor in accordance with "Y-Axis Motor Removal".

3. **EC-300:** Remove the right side spindle head cover.



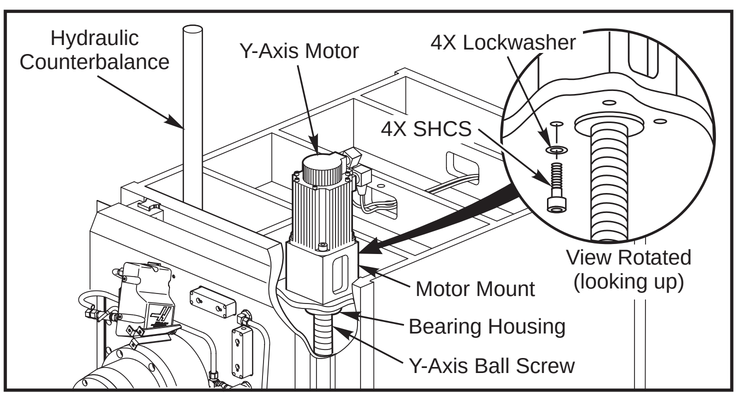


EC-300 Y-axis Ball Screw Assembly *EC-400 Y-axis Ball Screw Assembly*

4. **EC-300:** Remove the column hood from the machine.

5. **EC-300:** Remove the right side spindle head cover from the inside of the machine.

6. Remove or collapse the the Y-axis way covers, loosen the SHCS, and remove the clamp nut on the ball screw bearing plate end.



EC-1600

7. Loosen the SHCS and remove the clamp nut on the motor end of the ball screw.

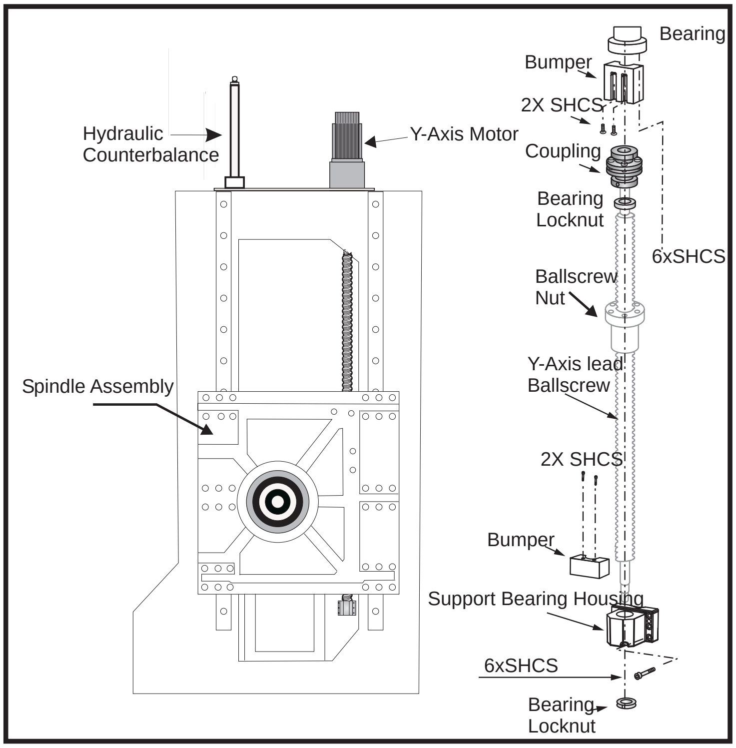
8. Disconnect the oil line from the ball nut.

9. Remove the bearing sleeve SHCS and remove it from the bottom of the column.

10. Remove the SHCS on the ball nut flange. Remove the ball nut from the ball nut housing by manually screwing the nut up the ball screw.

11. Remove the upper bearing pack.

12. Remove the ball screw out the top



EC-1600 Ballscrew and motor components

Installation

1. Place the hard stop on the new ball screw, so the hard stop is at the top of the column and the flange of the ball screw is mounted on the upper side of the nut housing and manually turn the ball nut up the ball screw (about halfway).

2. Insert the motor end of the ball screw through the upper bearing pack hole, then lower the ball screw, guiding the bearing support end of the screw into the bearing.

NOTE: Correct alignment is critical to sliding the ball screw into the bearing. Binding will not occur if it is guided carefully and correctly into the bearing.

3. Place the bearing sleeve onto the ball screw and attach it to the top of the column with the SHCS. Torque the SHCS to 30 ft-lb.

4. Loosely screw the locknut on the bearing plate end of the ball screw.

5. Orient the ball nut so the oil line can be connected, then turn the ball screw by hand to pull the ball nut flange down until it contacts the nut housing.

6. Insert the SHCS that hold the ball nut to the ball nut housing, but do not tighten completely.

7. Loosely install the locknut on the motor end of the ball screw.

8. Hand-turn the ball screw to move the spindle motor up and down, to assure free movement of the ball screw.

9. Torque the SHCS that hold the ball nut to the nut housing to 30 ft-lb.

10 The following sequence is important to ensure proper installation of the ball screw:
• Tighten the locknut and washer hand tight on the motor end.
• Install and tighten the locknut on the bearing support. Ensure that the nut **does not** touch the support bearing.
• Install the shaft lock onto the bearing support end of the ball screw. This will keep the ball screw from turning while torquing the bearing pack locknut.
• Place a spanner wrench on the locknut at the motor end of the assembly.
• **EC-300** Torque the locknut against the bearing sleeve to 30 ft-lb.
• **EC-400 / EC-1600** Torque the locknut against the bearing sleeve to 50 ft-lb.
• With a T-handle wrench hand tighten the lock nut screw and mark it with yellow paint.
• Remove the shaft lock.
• **EC-300** Loosen the clamp screw and bearing lock nut and tighten to 4 IN-lbs. against the bearing. Retighten the lock nut screw.
• **EC-400 / EC-1600** Loosen the clamp screw and bearing lock nut and tighten to 10 ft-lbs. against the bearing. Retighten the lock nut.

11. Reinstall the axis motor in accordance with "Y-Axis Motor - Installation".

12. Reconnect the banjo oil fitting to the ball nut and use Vectra oil to lubricate the ball screw.

13. To check for backlash or noisy operation in the ball screw see the "Troubleshooting" section.

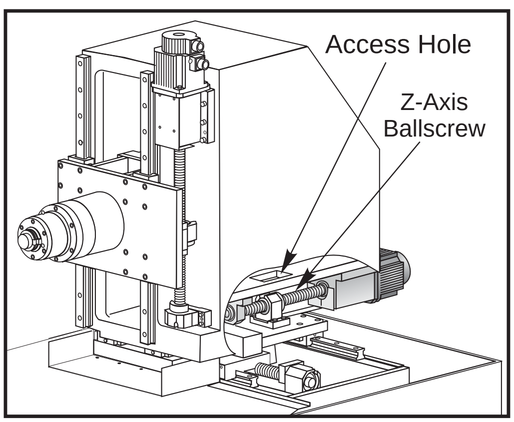
14. Reset the grid offset and tool changer height (See Grid Offset and Setting Parameter 64) sections.

15. **EC-300:** Replace the spindle head cover and the column hood.

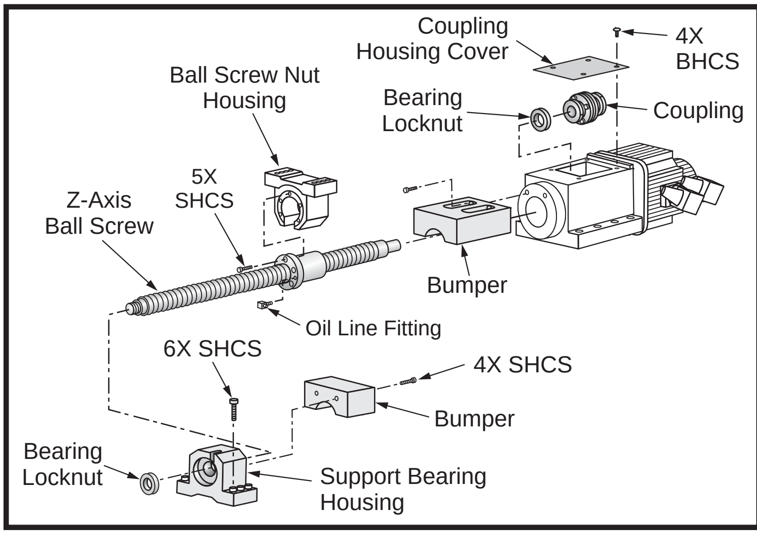
16. Replace the rear enclosure panel.

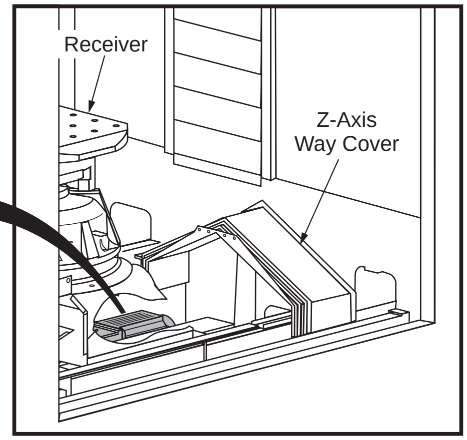
Z-Axis Ball Screw

Removal



EC-300 Z-axis Ball Screw Removal





EC-400 Z-Axis Ball Screw removal

1. Turn the machine ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.
2. Jog the Y-axis to the bottom of its travel.
3. **EC-300:** Remove the right front spindle head cover from the inside of the machine.
4. Remove the rear enclosure panel.
5. Remove the axis motor in accordance with "Z-Axis Motor - Removal".
6. **EC-400 / EC-1600:** Remove the left and right Z-axis way covers in accordance with “Z-axis Way cover removal.
7. Remove the support bearing housing and hard stop bracket from the ball screw support bearing end of the ball screw, at the front of the machine (for **EC-1600**, components are found at the rear of the machine).
8. Loosen the SHCS on the locknut at the bearing support end, and remove the locknut. For safety, replace the hardstop.
9. Loosen the SHCS on the locknut at the motor end, and remove the clampnut.
10. Disconnect the oil line at the ball nut.
11. Loosen the SHCS and remove the bearing sleeve from the motor mount. Push on the column or the opposite end of the ball screw to loosen.

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

---

12. Loosen and remove the five SHCS attaching the ball nut to the nut housing.
13. Hand-turn the ball screw toward the rear (towards the front for **EC-400 / EC-1600**) of the machine until the ball screw clears the bearing by aproximately 6”.

14. **EC-300:** Carefully push the ball screw towards the front of the machine and above the support bearing.
    EC-400: Carefully push the ballscrew to the side of the bearing support and then remove by pulling the ballscrew towards the spindle.
    EC-1600: Carefully push the ball screw back and under the column until the front of the ball screw clears the nut housing and remove.

Installation

1. Ensure all mating 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. **EC-300:** Slide the motor end of the ball screw from the front of the machine over the bearing housing, taking care not to damage the screw threads.
   EC-400: Slide the bearing support end of the ball screw past the rotary table towards the front of the machine.
   EC-1600: Slide the bearing support end of the ball screw under the column, taking care not to damage the screw threads. Position the ball screw to the right side of the nut housing and slide toward the front of the machine.

3. Place the motor end of the ball screw through the nut housing, and pull it toward the rear of the machine until the ball nut is seated in the nut housing.

4. Place the bearing sleeve in the motor mount. It may be necessary to align the bearings in the sleeve to facilitate mounting on the ball screw.

5. Screw the clamp nut on the bearing support end of the ball screw two or three turns, but do not tighten.

6. Pull the ball screw through the motor mount and loosely install the clamp nut on the opposite end.

7. Install and tighten the SHCS on the bearing sleeve and torque to 15 ft-lb. **EC-1600:** Place a drop of blue Loctite on each of the SHCS before inserting and torque to 30 ft-lb.

8. Install the two outer SHCS of the five SHCS that secure the ball nut to the nut housing. Torque to 15 in-lb.

9. Loosen the SHCS on the bearing sleeve approximately 1/4 turn; do not remove.

10. Hand-turn the ball screw until the ball nut is at the motor end of travel. Retighten the SHCS on the bearing sleeve, torquing them to 15 ft-lb (**EC-1600:** torque to 30 ft-lbs).

11. Torque the remaining SHCS that secure the ball nut to the nut housing. (Place a drop of blue Loctite on each of the SHCS before inserting). Torque to 15 ft-lb.

12. Reinstall and tighten the hard stop on the ball screw support bearing.

13. Reconnect the oil line to the ball nut.

14. Tighten the ball screw against the locknut as follows. The sequence is important to ensure proper installation of the ball screw:
    •Tighten the locknut, hand tight, on the motor end.
    • Install and tighten locknut on bearing support. Ensure the nut **does not** touch the support bearing.
    • Install the shaft lock onto the bearing support end of the ballscrew. This will keep the ball screw from turning while torquing the locknut.
    • Place a spanner wrench on the locknut at the motor end of the assembly.
    • Torque the locknut against the bearing sleeve to 10 ft-lb (**EC-1600:** torque to 50 ft-lbs.)
    • With a T-handle wrench hand tighten the locknut screw and mark with yellow paint.
    • Remove the shaft lock.
    • **EC-300** Loosen the locknut screw and locknut at the bearing support end and tighten to 4 in-lb. against the bearing. Retighten the clamp screw.
    • **EC-400 / EC-1600** Loosen the locknut screw and locknut at the bearing support end and tighten to 10 ft-lbs. against the bearing. Retighten the clamp screw.

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

16. Check for backlash in the Z-axis ball screw (Troubleshooting section), or noisy operation, and the grid offset.

17. **EC-400:** Clean and seal (Permatex) surfaces, then reattach the Z-axis way cover to the saddle cover.

18. Replace the rear enclosure panel.

3.10 EC-300 Pallet Changer

Pallet Changer Disassembly

Pallet Changer Disassembly can be done from the "Load Station" of the EC 300 without removing any enclosure parts.

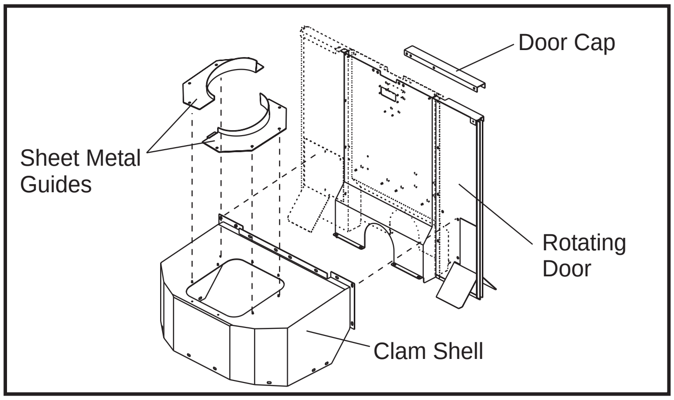
1. Enter "M-17" in MDI mode and press "Cycle Start" to un-clamp the pallet (recommend 25% rapid). Wait until the assembly has fully risen to its highest point and begins to rotate and press "Emergency Stop." Rotate the pallet as required to remove the components.

2. Remove the sheet metal guards on top of the "clam shell" cover.

3. Remove the clam shell by unbolting the twenty (20) screws in the rotating door and along the bottom of the clam shell.

Caution!! The clam shell can be removed by simply lifting up and over the rotary table once the sheet metal guards have been removed. **DO NOT** remove or adjust the pallet on the rotary table.

4. Remove the two door caps on top of the door panel (rotate the door 90°).



5. Remove rotating doors and the white plastic cable fairlead. (The doors come off in 2 halves). Keep cables out of the way. The Harmonic Drive Assembly can be removed at this point by removing the (6) six 3/8-24 socket head cap screws holding the Flange Plate and Servo Motor to the frame support and lifting the entire assembly straight out. **Mark the orientation of the plate first as it must be reassembled exactly as it was.**

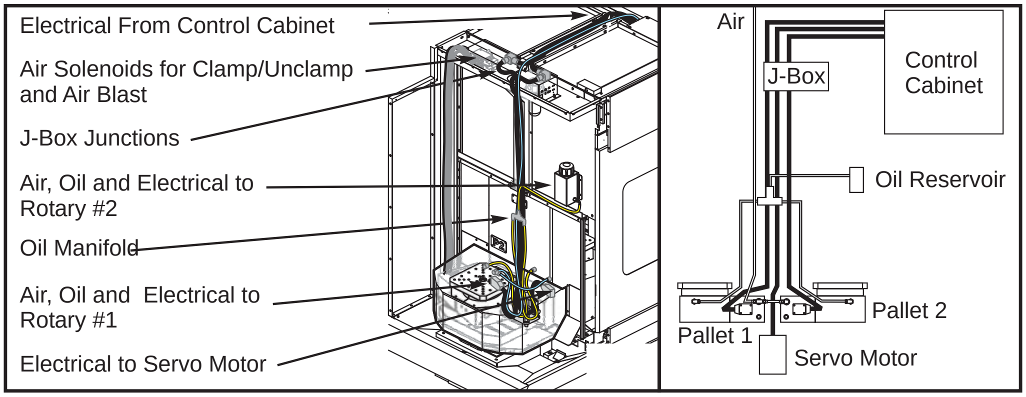
NOTE: If the Servo Motor has been removed, the "Grid Offset" has to be re-calculated in order to assure that there is no mis-allignment after re-assembling the motor. Refer to the "Pallet Changer Grid Offset" section of this manual.

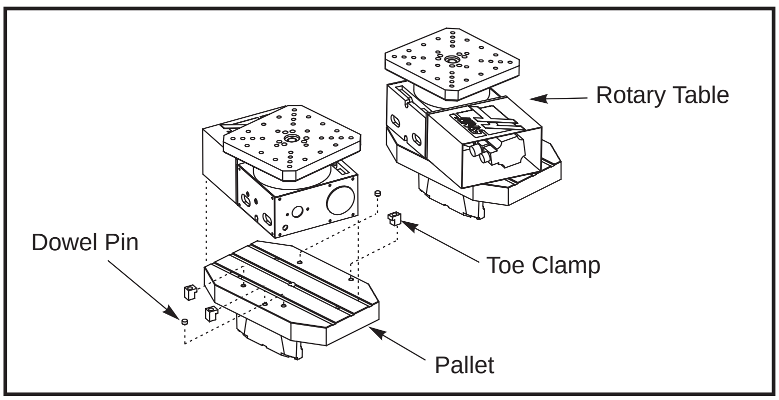
NOTE: Power off before disconnecting anything and unscrew the power cables for the Rotary Tables from J-box.

6. The power wires are located on top of the machine for the two rotary tables and are routed through the table to the top of the machine via the center compartment within the rotating doors.

NOTE: There are 2 power lines and 2 air lines: one pair connected to each table. There is also an oil line that splits to each table.

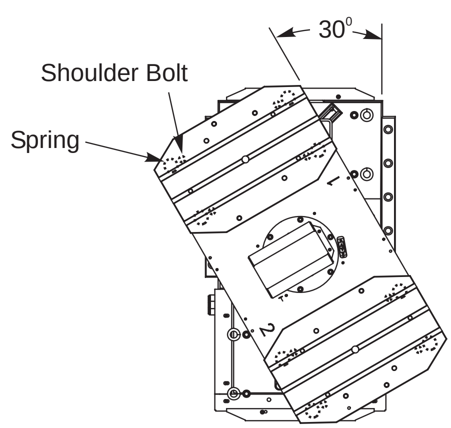
Remove the cable cover on the rotating door and pull the cables through. Disconnect the power cables from the J-box, remove the lubrication line and disconnect and crimp air lines leading to the rotary tables with a zip tie. There is a silk screen on the outside of the “J-box” that illustrates wire routing.



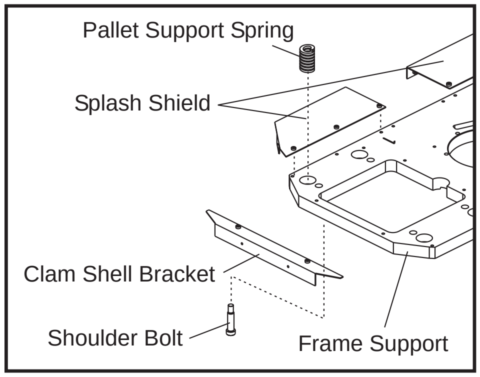


7. Remove the 3 “toe clamps” from the sides of the HRT-210 rotary tables and remove rotary tables with a lift.

8. Remove (2) two ½”dowel pins (2 per pallet) that are seated in non-threaded holes in the pallet for proper orientation of the rotary tables. **Do not lose these pins.** The Pallet Table assembly must be rotated approximately 30° away from the home position to access the 5/8" shoulder bolts underneath.



9. Remove the pallet changer tables by unbolting the (4) 5/8" shoulder bolts between the pallet changer and the frame support. After removing the shoulder bolts, the pallet is loose on the pallet support springs and can be lifted off using 2 “eye” bolts. (The table weighs aprox. 160 lbs. each).



10. Remove the 2 Splash Shields along with the Bracket Clam Shell located under and around the table area.

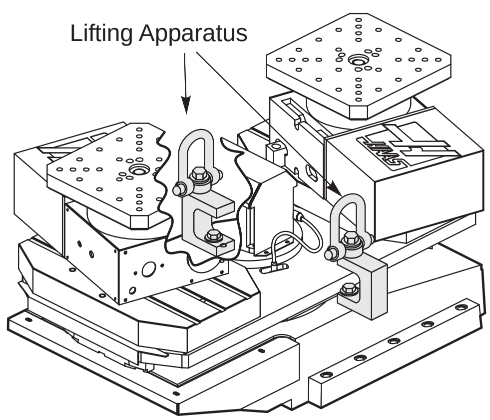
NOTE: Air pressure must stay connected throughout this process. **Do not** initiate a pallet change under any circumstance and only rotate assembly by hand.

Frame Support Removal: Remove the Splash Shields, the Bracket Shell, and disconnect the Home Switch. The frame support can be removed with the “Servo Motor” and “Flange Plate” still connected. The frame supports weigh approximately 195 lbs. and should be lifted out carefully.

To service the Pallet Clamp Piston assembly the entire pallet changer assembly must be removed.

1. Remove all front interior sheet metal pieces attached to the Pallet Changer in addition to steps 6-9.

NOTE: If enough lift capacity is available- 2,000 lbs. on an extended arm- the rotary tables, pallets, and frame support may stay in place, otherwise they must be removed (described in steps 6-10 and "Frame Support Removal").



2. Disconnect the Rotary Table power cables, remove the air lines located on the lower left of the Pallet Changer base and remove the 7 bolts that attach the piston to the shaft.

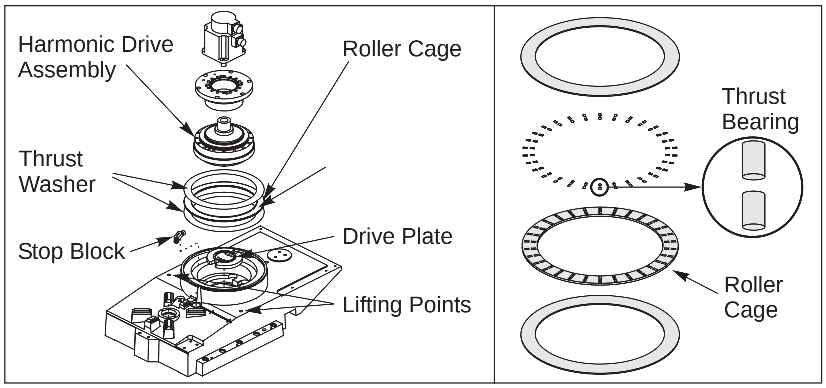
NOTE: Mark the air lines for proper re-assembly.

3. Disconnect the pallet clamp switch and remove the (10) 5/8 –16 socket head bolts holding the Pallet Changer base to the main base casting.

4. Bolt-in lifting tools and lift out. Disconnect the “un-clamp” air fitting on the bottom side of the Piston Cover Plate. Remove the Piston Cover, the Pallet Clamp Piston and P.C.Shaft to service the assembly.

To service the “Thrust Bearing” assembly, see "Frame Support Removal" and steps 1-10 in the Pallet Changer Disassembly section and remove the support frame which will expose the thrust bearings and thrust washers.

Note: The weight of the table rests on the thrust bearing.



If the thrust bearing and washers *have to* be removed, remove the unit as a whole so as not to loose the bearings. Inevitably, some bearings will fall out therefore it is advisable to have spare bearings for replacement.

To service the “Air Blast” assembly, the pallets must be rotated perpendicular to the home position and at least 1 Pallet table must be removed. After removing the pallet rotate the frame assembly with the empty pallet space back over clamp plate and remove the clamp plate followed by the air blast ring.

To service the Pallet Clamp Switch, follow steps above for servicing the "Air Blast" then unbolt the four socket screws and pull the assembly out.

To service the air tubing, remove the motor, motor flange plate and the harmonic drive assembly.

Re-assembly

APC Spring Seating Procedure (Pallet 1)

1. In MDI mode write a simple program (M17; M18;M99) to clamp and unclamp pallet.

2. While P1 is clamped, loosen but do not remove shoulder bolts retaining springs

3. In single block mode, cycle program to observe the direction of table movement.

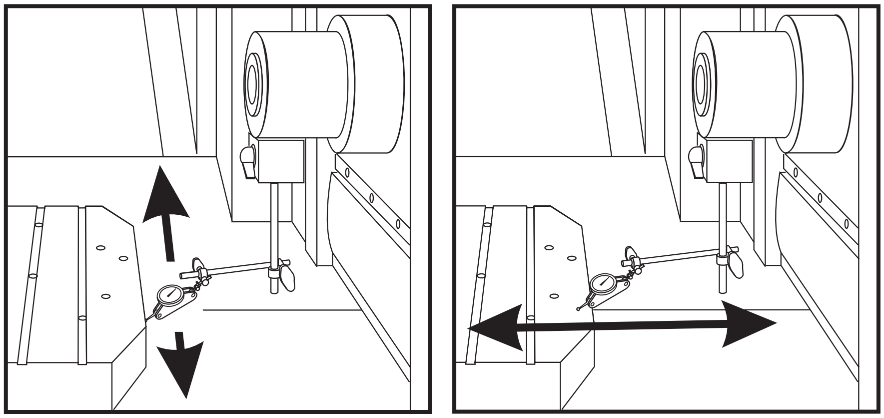
4. Adjust spring location by gently tapping springs in the opposite direction of the table movement. Run the program to verify adjustment.

5. Repeat previous step until all pallet movement is gone, then torque shoulder bolts to 75 ft/lbs. Run the program again to verify the adjustment was not affected.

6. Repeat this procedure for the other pallet.

NOTE: For more information on the indexer see the "Trouble Shooting" chapter of this manual.

Squaring The Pallet



1. Loosen all bolts from Pallet Changer to the base and align front-machined surface of pallet parallel to X-axis (NTE 0.002" overall). Perform a pallet change and verify other side.

2. Level the pallet along the X-axis by indicating across the pallet in the X-axis direction. Both pallets should be parallel to within 0.002"/10" of each other.

3. If the pallets are not level, shim between the pallet changer and base as required and tighten the pallet changer base bolts.

4. Rotate Pallet Changer and verify the other pallet.

5. Level the pallet along the Z-axis by indicating across the pallet in the Z-axis direction.

6. If necessary, adjust the shims between the pallet changer and base as required ensure all of the bolts are tight before continuing.

7. Rotate the Pallet Changer and verify the other pallet.

Align Rotary Tables

1. Clean and stone Pallet Changer surfaces before installing rotary tables.

2. Install the 2 dowel pins into the pallets and place the rotary tables accordingly.

NOTE: Make sure the dowel pins are seated in non-threaded holes in the pallet.

3. Connect the cables, lubrication lines, and air lines to the rotary table and ensure that the oil reservoir is full.

4. Install table clamps (3 per table) and fasteners and torque to 80 ft./lbs.

5. Indicate the top of the rotary table and take readings at 0,90,180 and 270 degrees. If necessary, adjust shims under rotary table to align the rotary axis perpendicular to XZ plane not to exceed 0.0003".

6. Indicate across rotary table surfaces along the X and the Z axes. The indications should be parallel to within 0.0005"/10".

7. Rotate the pallet changer, and indicate the other rotary table as described in step 5 above.

Pallet Changer Grid Offset

1. Make sure that Bit #28 in Parameter 209 has a value of 1. The pallet will stay up.

2. Verify that the Pallet Changer Type in Parameter 605 is 3.

NOTE: The APC is on the B-axis on machines with single Mocon PC board or the W-axis on machines with two Mocon PC boards.

3. The Grid offsets in parameter 445 should be the W -axis, and the offsets in parameter 170 should be the B-axis. Respectively, tool Changer offsets in parameter 451 should be the W-axis, and the offsets in parameter 213 should be the B-axis.

4. "Zero return" the appropriate axis, and set the "Grid Offset" for the (individual axis only) on "Zero return" again.

5. Press the "E-stop" and manually rotate the APC so that the locators on "Pallet 1" are aligned with the locators on the APC.

6. Lower the pallet onto the locators by lowering the air pressure at the main regulator. **Be careful** not to damage either the locators or the pallet.

7. Enter "Debug Mode," go to the "POS RAW DATA" page and take the **actual** value from the appropriate axis. Enter this value into the "Tool Change" offset parameter.

8. Restore the air pressure and "zero return" the axis.

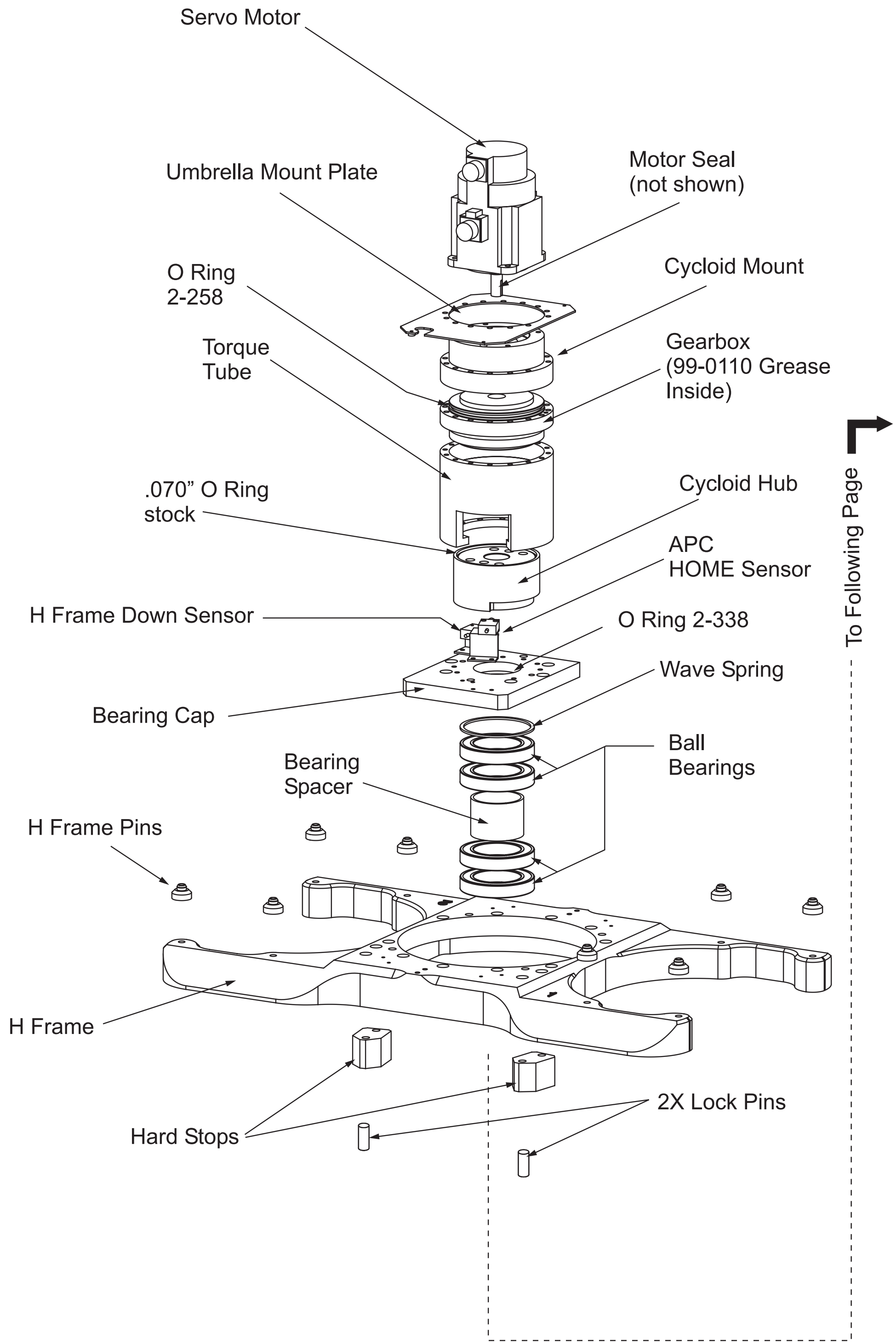
9. Verify that the pallet is aligned over the locators.

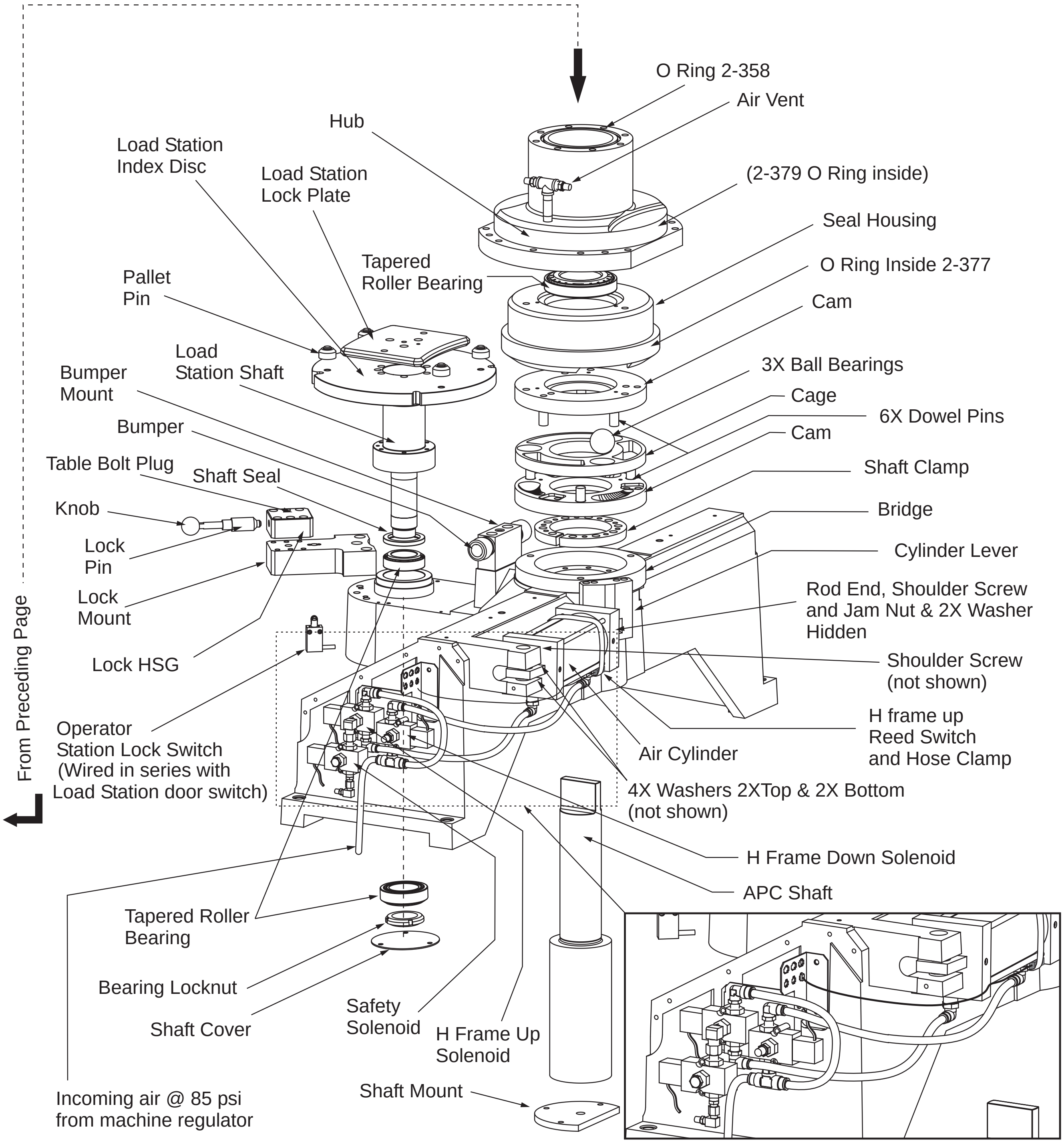
10. Change the Parameter 209 value to 0.

3.11 EC-400 Pallet Changer

Make sure the machine is turned off and the air pressure is discharged before attempting to work on this machine. Refer to the assembly drawing of the APC in the back of this manual.

The drive mechanism for the APC is located inside the rotating door. It can be accessed for troubleshooting by removing either half of the door. APC disassembly requires removing the door. Disassembly is a top down process.




O Ring 2-358
Air Vent
Hub
Load Station
Index Disc
Load Station
Lock Plate
(2-379 O Ring inside)
Seal Housing
Tapered
Roller Bearing
O Ring Inside 2-377
Pallet
Pin
Cam
Load
Station Shaft
Bumper
Mount
3X Ball Bearings
Cage
6X Dowel Pins
Bumper
Cam
Table Bolt Plug
Shaft Seal
Shaft Clamp
Knob
Bridge
Lock
Pin
Cylinder Lever
Lock
Mount
Rod End, Shoulder Screw
and Jam Nut & 2X Washer
Hidden
From Preceding Page
Lock HSG
Shoulder Screw
(not shown)
H frame up
Reed Switch
and Hose Clamp
Operator
Station Lock Switch
(Wired in series with
Load Station door switch)
Air Cylinder
4X Washers 2XTop & 2X Bottom
(not shown)
H Frame Down Solenoid
APC Shaft
Tapered Roller
Bearing
Bearing Locknut
Shaft Cover
Safety
Solenoid
H Frame Up
Solenoid
Shaft Mount
Incoming air @ 85 psi
from machine regulator

Pallet Changer Disassembly and Replacement

Disassembly

1. Remove the rotating door and the servo motor sheet metal cover.

2. Unplug the electrical wires to the servo motor. Dismount the servo motor held to the umbrella mount plate with four (4) SHCS.

3. Remove the SHCS that hold the gearbox and the cycloid tube to the torque tube. Remove the gearbox with the cycloid tube.

4. If the cycloid hub must be removed from the gear box, cover the gear box hole to prevent contamination.

5. Unbolt the torque tube from the bearing cap and lift it off of the dowel pins.

6. Unbolt the bearing cap and lift it off of the dowel pins, exposing the wave spring, four bearings, and bearing spacer.

7. Remove the two (2) hardstops from the H-frame.

9. Remove the eight (8) SHCS that hold the H-frame to the hub. Carefully lift off the H-frame from the dowel pins.

10. Lift the hub off of the APC shaft.

11. If the bearings need to be replaced, remove them from below the hub using a punch. If the bearings are removed, replace them. Pack the new bearings with Moly grease.

12. Remove the air cylinder per the instructions in the air cylinder removal section.

13. Lift the seal housing off of the bridge. The cam assembly is heavily greased and may be stuck inside the seal housing.

14. Remove the cam assembly which consists of the cage and three (3) balls.

15. Unbolt and remove the lower cam.

16. Remove the SHCS from the shaft clamp.

17. Loosen the tapered shaft clamp by loosening the mounting screws. Remove the shaft clamp.

18. Remove the 5/8" SHCS from the shaft mount located on the bottom of the shaft. Remove the shaft by lifting it straight up.

Reassembly

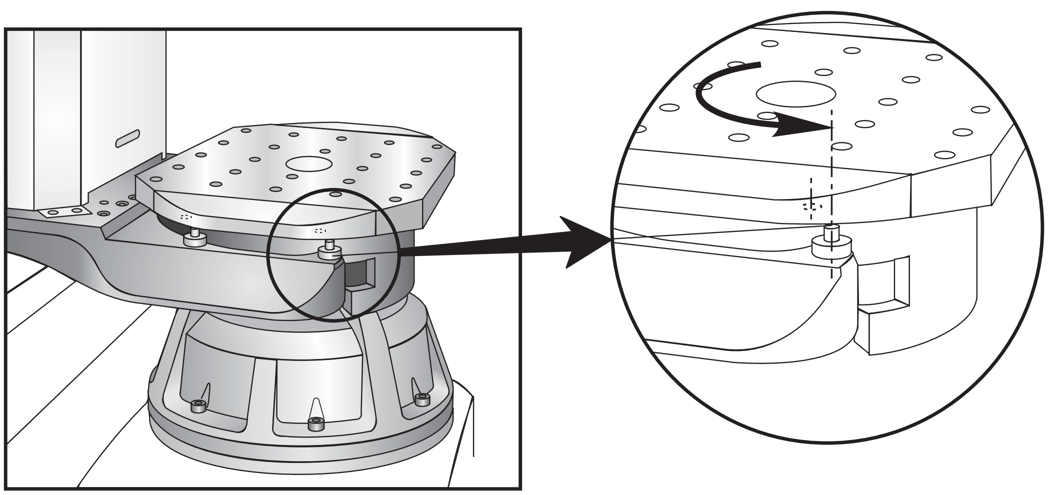
Reassemble the pallet changer in the order by which it was removed. Align the H-frame to the receiver pallet per the instructions in the Pallet Changer H-frame to Pallet Alignment section.

H-Frame Replacement

1. Remove the rotating door.
2. Remove the two (2) hardstops from the H-frame.
3. Remove the SHCS that fasten the H-frame to the hub.
4. Raise the H-frame with an appropriate lifting device until the H-frame is above the dowel pins.
5. Carefully guide the opening of the H-frame around the servo motor, connectors, and umbrella mount plate, and remove the H-frame from the machine.
6. Replace the H-frame in the reverse order from which it was removed. Be sure that the servo motor electrical connections are on the same side as the hard stops on the H-frame.
7. Align the H-frame per the Pallet Changer H-frame to Pallet alignment procedure.

Pallet Changer H-frame to Pallet Alignment

There are two stages to properly aligning the pallet changer H-frame and the pallets. The first is to align the pallets to the H-frame. The second is to align the pallet load station to the H-frame.



Stage 1

1. Go to the parameter page and scroll to find parameter 76. Write down the current value. Adjust parameter 76 to a large number (e.g. 99999999999), this will delay the low air alarm.
2. Enter Debug mode (Go to the Alarms page, key in "DEBUG" and press Enter) and scroll to the Pos Raw Data page.
3. Jog the Z-axis until the pins on the H-frame are aligned with the holes in the pallet. Enter the value of Z-axis Actual into parameter 64.
4. Enter the Pallet Changer Restore page (press Tool Changer Restore and select the pallet changer restore option).
5. Home the Z-axis and verify the pallet to H-frame alignment.
6. Unclamp the pallet and then turn down the main air pressure regulator to approximately 10 psi.

7. Press the key to raise the pallet. Turn up the air pressure (at the air regulator) slowly and verify that the H-frame and pallet are aligned. To lower the H-frame and pallet raise the air pressure and press the button for pallet down.

8. If the alignment is incorrect repeat the steps to set parameter 64.

9. Once the alignment is complete, restore the main air pressure regulator to the correct pressure (85psi) and finish the pallet changer restore sequence.

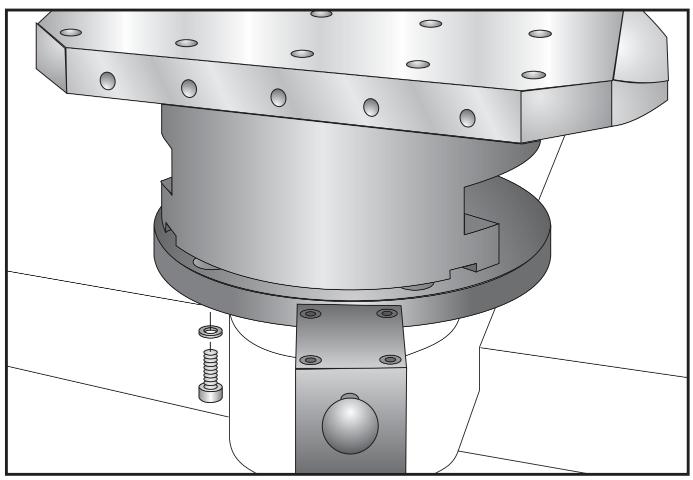
10. Exit Debug (type "DEBUG" and press Enter form the alarms page.

This completes the first stage of the alignment procedure.

Stage 2

Alignment of the pallet load station pins to the H-Frame. At this stage the H-frame has been aligned to the rotary axis (Stage 1 has been completed).

1. Loosen the four alignment pin bolts on the load station. Rotate the pallet at the load station to access all the bolts.



2. Rotate the pallet load station to home. Enter pallet changer recovery

3. Unclamp the pallet and raise the H-frame.

4. Reduce the main air pressure regulator to approximately 10 psi.

5. Enter pallet changer restore and Command the H-frame down.

6. Increase the air pressure at the main pressure regulator until the H-frame starts to lower. Verify the pallet is engaging the alignment pins.

7. Once the pallet is seated on the alignment pins tighten them.

8. Increase the main air pressure regulator to 85 psi and finish the pallet changer restore sequence.

9. Close doors and command several pallet changes to verify smooth operation.

10. Set parameter 76 to the original number.

Note pallet changer recovery reduces rapids to 25%. The pallet at the load station must always be returned to home before automatic pallet changes can occur.

H-Frame Switch Adjustment

H-frame up sensor

1. Remove the APC cylinder shield to access the up switch.
2. Loosen the switch clamp.
3. Find the correct position for the switch: Go to the APC diagnostics page. The status of "H-Frame Up" should be "0" for most of the air cylinder's travel, but will change to "1" when the cylinder is within 1/16" of being fully extended. It will remain "1" for the last 1/16" of travel.
4. Slide the switch lengthwise on the air cylinder to its correct position then tighten the clamp. Replace the APC cylinder shield.

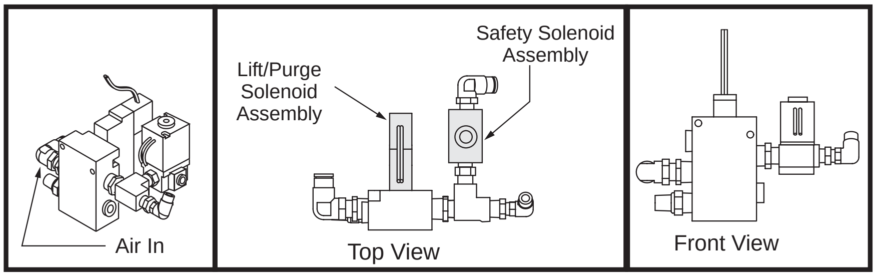
H-frame down sensor

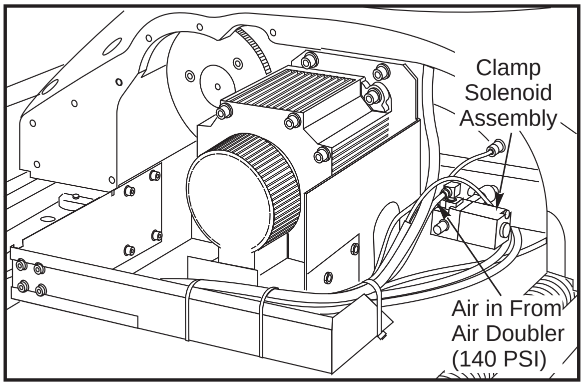
There is no adjustment for the H-frame down sensor.

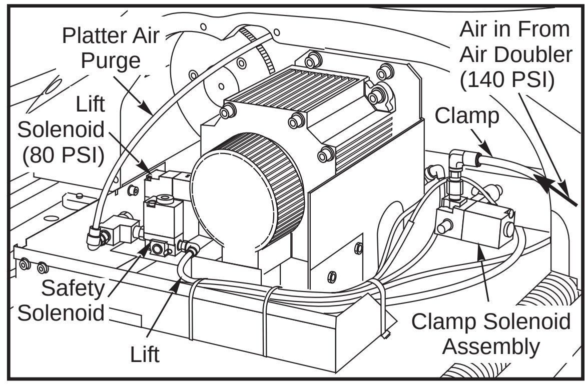
Air Cylinder

1. At the APC recovery page, confirm that the H-frame is commanded down.
2. Disconnect the machine's air.
3. Remove the APC cylinder cover.
4. Remove the H-frame up reed switch. Disconnecting it is not necessary.
5. Disconnect the two (2) air hoses.
6. Remove the shoulder bolts and washers that retain the air cylinder and remove the air cylinder..
7. Remove the air fittings, rod end and jam nut and assemble them on to the new air filter. Leave the rod end loose.
8. Wrap the air fittings with teflon tape.
9. Mount the fixed end of the air cylinder to the bridge using a shoulder bolt and two washers on either side of the spherical bearing.
10. Rotate the APC cam lever, cams and seal housing clockwise as viewed from the top until it stops.
11. Adjust the rod end as required to easily insert the shoulder bolt with the cylinder fully retracted.
12. Unscrew the rod one full turn and tighten the jam nut. The air cylinder should reach the end of its travel before the cams do.
13. Attach the rod end to the cylinder lever using the shoulder screw with one washer on each side of the rod end.
14. Torque both of the shoulder screws to 100 ft-lbs.
15. Reinstall and adjust the H-frame up switch.
16. Reinstall the airlines and the cylinder shield.
17. After completion, run a sample program to test for proper operation.

EC-400 Rotary Indexer Air Diagram







Receiver Replacement

The following instructions detail the procedure for leveling and verification of the receiver geometry. Machine level must be verified before replacing the receiver and check the receiver geometry for reference before it is removed.

Receiver/Pallet Verification

Leveling:

The machine must be level with absolutely no twist in the Z-axis.

Clean the pallet and precision level of all debris (The level can also be placed on top of the pallet clamp plate, with the pallet off of the machine) Center the X and Z axes.

Position the precision level on the center of the pallet parallel to X-Axis and note level.

Then position the level in line with the Z-axis and note level. If necessary, loosen the center leveling screws and adjust rough level before proceeding.

Roll
Position the precision level on center of the table parallel to X-Axis. Jog the Z-axis, full travel in each direction, and note any deviation in the level.

Pitch
Position the precision level on center of the table parallel to Z-Axis. Jog the Z-axis, full travel in each direction, and note any deviation in the level.

Adjust for any deviation of pitch or roll as necessary.

Receiver Geometry Verification:

Note: The receiver is never adjusted to correct pallet flatness. It is adjusted for runout and concentricity. Both need to be confirmed before the pallet is installed.

Indicate the receiver concentricity by first rotating the A-axis 45deg. Then indicate the outside vertical edge, or outermost edge of the locating key that is facing the spindle. Set the Z-axis position to zero and move the indicator off in Z-axis to allow for A-axis rotation. Then rotate at 90deg intervals until all 4 locating pads have been indicated. The specification is .0003"/.00762mm or less.

Indicate the receiver runout by indicating the top of the locating pads on the receiver. On machines with 1 or 45 degree indexers, move off the pad in Z-axis, rotate A-axis 90 deg to next pad and come back in to the same Z-axis axis position and note the indicator reading. For a full 4th rotary it is not necessary to move off the pad because pop up on the rotary will only be .0003". Rotate until all 4 locating pads have been indicated. The specification is .0003"/.00762mm or less.

Receiver Removal / Installation:

Removal

Home the A-axis before starting the removal procedure.

1. Remove the pallet from the receiver.

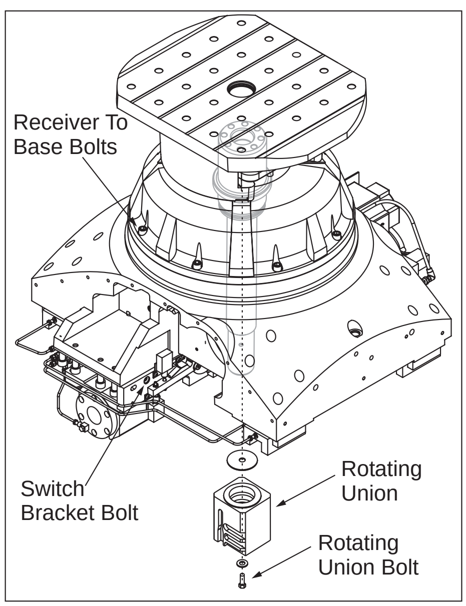
2. Remove the screws from the front and rear Z-axis waycovers and slide them away from the rotary base.

3. Disconnect the air supply from the machine and bump up parameter 76 to 999999.

4. Remove the single bolt securing the switch plate assembly and the switch plate assembly. Set safely aside.

5. For reference, label the 3 rotating union hoses. This will help when replacing them.

6. Remove the one bolt at the bottom of the rotating union. The rotary union is now loose and is pulled straight down to remove. Note that there are shim washers between the large fender washer and the bottom of the receiver shaft.



7. Remove the 8 bolts securing the receiver to the rotary platter.

The receiver is now ready to be removed from the machine.

8. Working through the operator door, use lifting equipment to remove the receiver. The receiver clamp plate has 1/2-13 tapped holes in it so that lifting eyes can be installed, or use straps to grip the top of the receiver. Remove the receiver assembly through the operator door.

9. Remove any shims that may be present on the rotary platter and put them aside for use later, if necessary.

Installation

1. Lift the receiver assembly into the machine.

2. Position the assembly, orienting the clamp plate, over the base and lower into place.

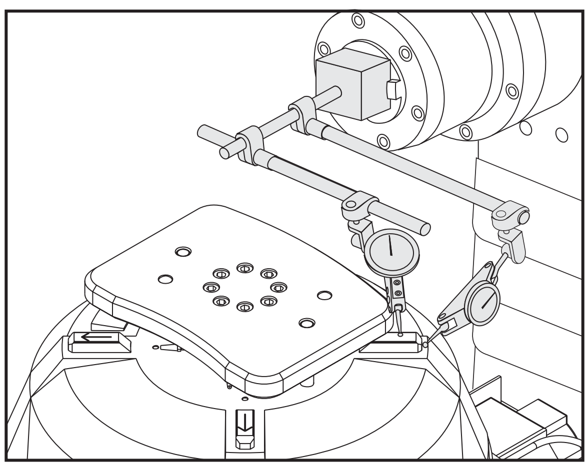
3. Loosely install the 8 bolts in the receiver.

4. Install the rotary union at the bottom of the receiver shaft.

5. Reconnect the 3 hoses to the rotary union.

6. Install and align the switch plate assembly. Slide the assembly toward the rotating union center of the rotary as far as possible and tighten the mounting screw. Make sure that the prox switches do not contact the union but are close enough to produce a sufficient reading.

7. Connect the air supply to the machine and reset parameter 76 to 1500.



8. Indicate the receiver using the verification procedure utilized before removing the receiver. Adjust the receiver concentricity with the 8 bolts that attach the receiver to the rotary platter just snug. If the concentricity changes the receiver runout will also change. Because of this the concentricity should be correct before indicating or adjusting the receiver runout.

9. If the receiver runout is not correct but the concentricity is, it will be necessary to shim under the receiver. It will only be necessary to lift the receiver just enough to install the shims. It is only necessary to remove the 8 bolts on the receiver, there is at least 2" of travel for lifting the receiver before the union contacts the bottom of the rotary. Shims are replaced at a 2:1 ratio for the error indicated on the locating keys. Example, indicated error of .001" would require a .002"shim. Install the shims as necessary and repeat the receiver verification procedure until the geometry is correct.

Indicating the pallet

1. Install the new pallet on the receiver and indicate across the 45 degree angles on the receiver locating keys until they are parallel with the X-axis. The keys must be parallel to the x-axis within .0005," if the keys are not parallel, proceed to step 9.

2. To indicate the flatness of the pallet, attach a magentic base to the spindle nose and using a .0001" or .0005" indicator. Indicate down the center of the pallet and note the reading at the front and back edge, about 1" from the edge of the pallet in Z-axis. Repeat this in the X-axis and note the reading.

NOTE: Check both pallets before making any adjustments. The pallets should be within .0005" of each other.

3. With magnetic base still on the spindle nose place the indicator on the face of the pallet at the center and 1" from the front edge, toward the spindle. Zero the indicator dial and set the Z-axis position to zero.

4. Jog Z-axis off of the pallet far enough to allow rotation of the A-axis.

5. Jog A-axis 90deg and return Z-axis to zero position.

6. Repeat step 5 until you have indicated and noted the pallet runout at 0-90-180-270 degrees.

7. If the flatness is correct skip to step 9.

8. Pallet flatness is adjusted by shimming under the rotary, between the rotary casting and on top of the Z-axis linear guide pads. Note: Any time adjustments are made in this area the ballnut and ballnut housing need to be realigned, which is also true for the next step.

9. The pallet square in relation to X-axis is adjusted on the full 4th axis by indicating the front edge of the pallet until parallel and adjusting par 212 (see the following section). On the 1 and 45 degree indexers, the entire rotary casting will need to be rotated until the pallet is parallel. To do this it will be necessary to loosen the Z-axis ballnut housing, then the 16 bolts on the Z-axis linear guide pads and physically shift the position of the casting. The specification when indicating the front of the pallet is .0005"/.0127mm or less. Once this is achieved it will be necessary to torque the 16 linear guide bolts, realign the ballnut housing and ballnut and verify alignment.

3.12 EC-400 Rotary Replacement

Warning

The indexer will crash if the following procedures are not followed. Read all material before proceeding.

When the Indexer is replaced in the EC-400, it must have the lift switch adjusted and parameter 212 set to zero before any other machine movement is attempted! Misalignment of the facegear at the home position, will cause malfunction. Make sure that software 12.08 or later is loaded and the table is initialized on the settings page. (This assures that all parameters are set for this option.)

To perform all of the procedures in this section, the Z-axis waycovers must be removed. See the Z-axis way-cover removal section of this chapter.

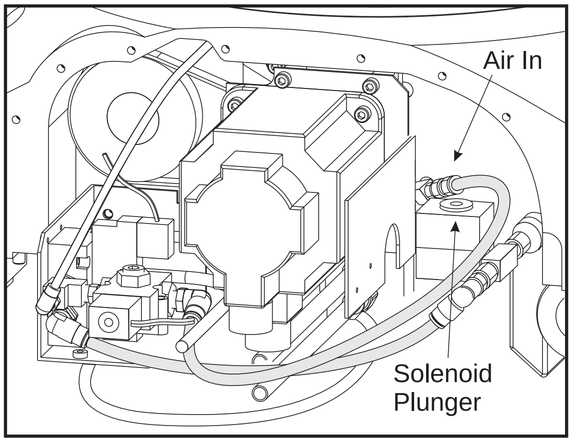
A-axis Indexer Lift Switch Setup

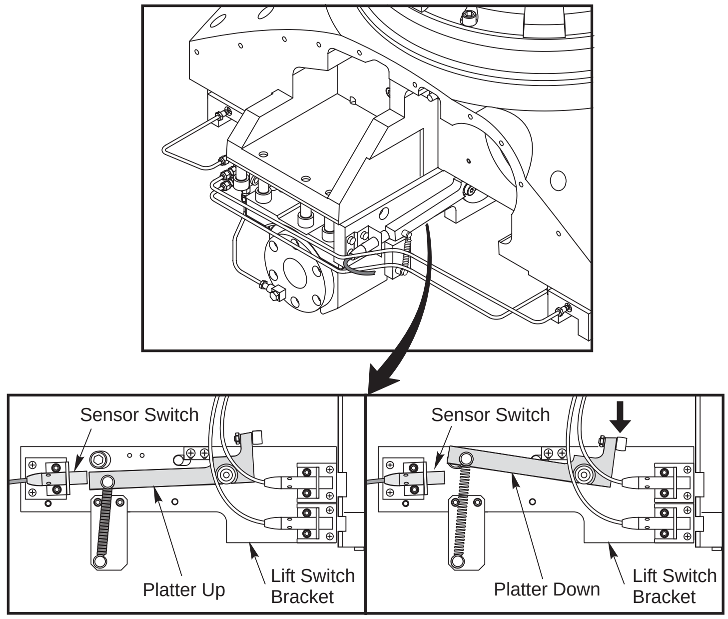
Lift Switch Setup

1. Disconnect the main air supply then plug the air line to the brake solenoid.

2. Release the air pressure at the table by activating the clamp release solenoid plunger.

3. Connect the test air regulator Haas P/N T-2150 to the shop air supply. Connect the outlet to the rotary table at the platter lift, air in connection (Air In). (Be sure that the regulator adjustment knob is fully open.)





4. Turn the regulator adjustment knob to 20-40 PSI and toggle the air pressure to the clamp fittings.

5. Set an indicator on the machine with the stylus on the platter or pallet.

6. Go to the diagnostics page (DGNOS).

7. Slightly loosen the two mounting screws on the lift switch mounted on the lift switch bracket.

8. Raise and lower the pallet with the regulator adjustment knob. Note that the platter up state is at 0 when up and 1 when down. Adjust the position of the switch so that the platter lift state becomes 0 at .052 above the down position.

9. Tighten the switch mounting screws when this height is achieved.

Bleeding the EC-1600 Brake

It will take about 1 hour to properly bleed the EC-1600 brake assembly.

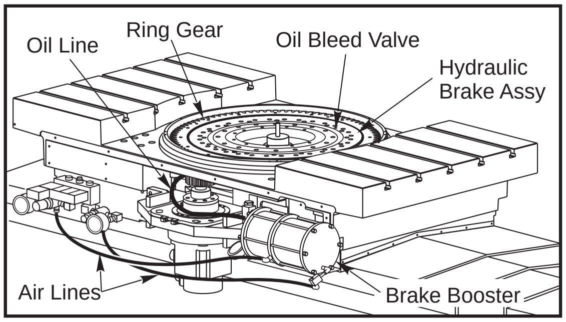
1. Power off the machine and remove the indexing platter from the table using a proper lift and eye bolts. The brake assembly and fly-wheel will be exposed underneath.

2. Disconnect all oil/air lines and remove the fly-wheel and clamp ring from the table. Set the clamp ring on a firm work surface and reconnect the air/oil lines.

4. Slightly loosen the bleed valve on the clamp ring and slightly elevate the brake assembly so that air bubbles can escape more efficiently.

5. Set air pressure to 1000 PSI. OR LESS. If air pressure is set to more than 1000 psi., the clamp will become permanently damaged.

6. Pressurize the clamp ring forcing air and air bubbles out of the oil through the bleed valve. Re-pressurize every five minuets for about 10 –12 cycles or until the oil is **completely clear** of any air bubbles. Re-tighten the bleed valve.



Setting Parameters 212 and 128 (Indexer A Axis Offset)

1. In Debug mode, go to parameter 212 and enter “0” then press the “Write” key. Repeat for parameter 128.
2. Toggle air pressure to the lift piston using Haas tool P/N T-2150 so that the platter is at the top of its travel.
3. Zero the A-axis only by pressing the ZERO RET key, then the A key, then the ZERO SINGL AXIS key.
4. Go to parameter 128 and record the value.
5. Jog the A-axis to line up the front edge of the pallet with the X-axis as close as the coupling position will allow. E-stop the machine.
6. Slowly discharge the air pressure to the A-axis and lower the platter into position.
7. Rotate the worm shaft pulley to the extents of its travel and record the value. The value at the middle of this range is the value for parameter 212. Enter that value.
8. Remove tool T-2150 and replace the hoses.
9. To fine adjust the front edge of the pallet, it may be necessary to loosen the sixteen (16) SHCS that fasten the rotary body to the trucks and the ten (10) SHCS for the Z-axis ball screw mount.
10. Tap the rotary body into position within .0005/10.00”.
11. Tighten then torque the sixteen (16) SHCS that fasten the receiver body to the trucks. Tighten the 5 Ballnut bolts allowing the housing to re-align, then torque the 10 housing bolts. After the housing bolts have been torqued, loosen the 5 Ballnut bolts and run the Ballnut away from and back to the motor. If not binding occurs, re-tighten the Ballnut bolts.

Setting Parameters 212 and 128 (Full 4th A Axis Offset)

Note: 1 and 45 degree indexer - Remove the Z-axis way cover from the 4th axis.

1. In debug mode, go to parameter 212 and enter “0” then press the “Write” key. Repeat for parameter 128.
2. Zero the A-axis only by pressing the ZERO RET key, then the A key, then the ZERO SINGL AXIS key.
3. Go to debug mode and type “GRID” followed by a space “A.”
4. Go to parameter 128 and verify that the value has been entered.
5. Jog the A-axis to line up the front edge of the pallet with the X-axis to a value of .0005/10.00”.
6. If removed, replace the Z-axis waycover.

3.13 Through the Spindle Coolant System - Adjustments

TOOLS REQUIRED

Tool holder with small through coolant drill or small orifice tool (#T-1461).
TSCHP Gauge Kit (P/N 93-9011), includes:
Ball valve
0-600 PSI coolant gauge

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.

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. Run TSC system for at least one minute.
4. Press the AUX CLNT button again to turn off TSC.

NOTE: If the "Low Tool Coolant" alarm is received, press RESET and turn TSC on again. If the "Low Tool Coolant" alarm still does not clear, check the pump pressure and coolant pressure switch settings as described below. If the pump pressure is less than 60 psi with no tool in the spindle, replace the pump head.

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).

1. Insert the 0-600 psi coolant pressure gauge into the coolant line between the machine enclosure 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 previously described.
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 tampering.

TESTING THE COOLANT PRESSURE SWITCH

1. Insert the ball valve and pressure gauge into the coolant line between the machine enclosure and the TSC pump hose. The ball valve must be *between* the pump and pressure gauge. Tighten the fittings snugly with wrenches. DO NOT OVERTIGHTEN !!

2. Run TSC system for one minute to purge air.

3. Insert a TSC type tool holder (with a TSC drill or restrictor) in the spindle.

CAUTION! Changing tools after running TSC can cause coolant to spray out. Wear safety glasses.

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 ± 10 psi). If the switch is outside this range, replace the switch.

NOTE: Test the electrical continuity of the switch cable and the control function by monitoring the "LO CLNT" bit on the Diagnostics page. Shorting the leads should cause the bit to switch from 1 to 0. Check this before replacing the pressure switch.

6. Reset Parameter 236 to the default value (1000).

3.14 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.

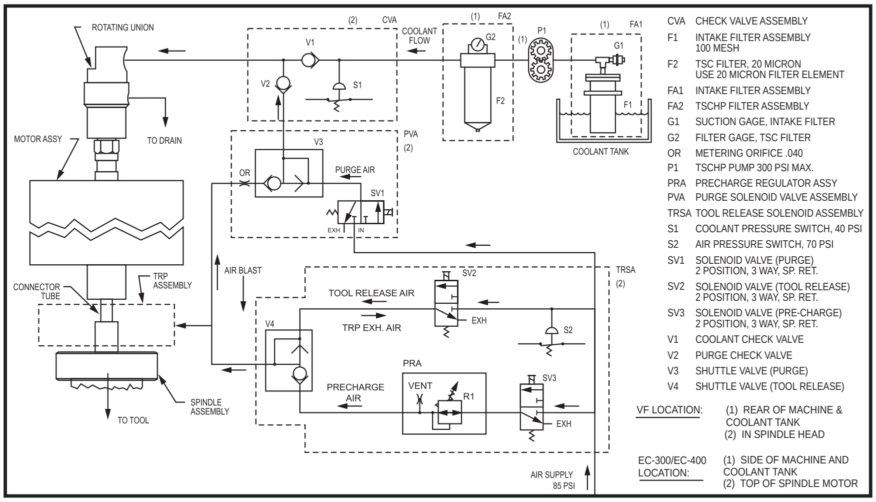
2) Select the ALARMS screen and enter DEBUG mode.

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.)

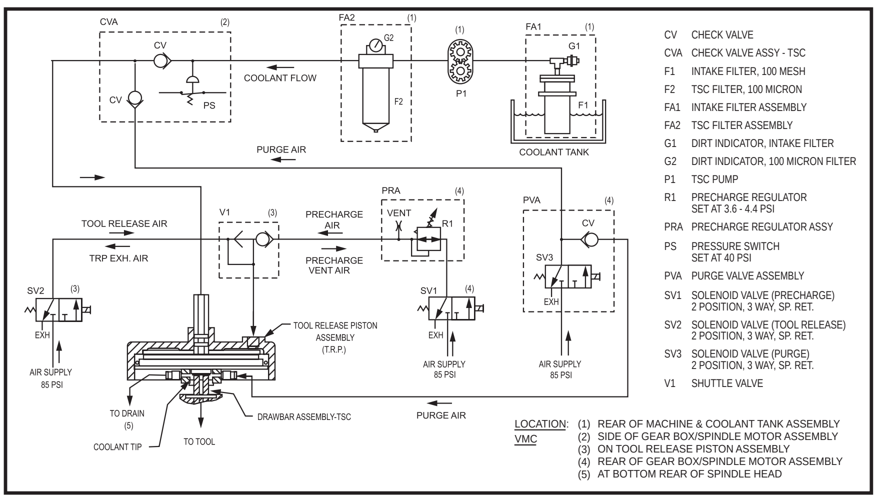
4) Select the Positions screen, enter GRID and press ENTER. The message GRID OFFSET DONE should appear and the GRID OFFSET parameters for the homed axes will have been updated. If the message "NO ZERO" appears, this indicates that none of the axes had been zeroed.

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".

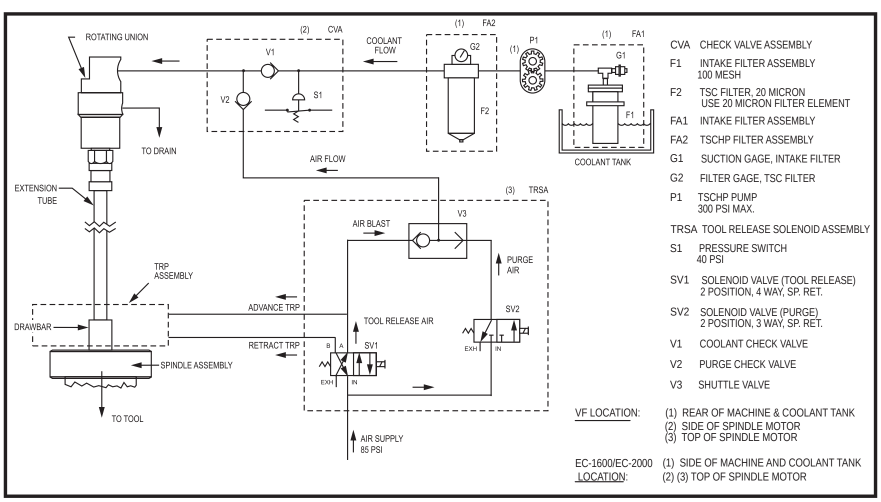
In-Line Drive



40 Taper



50 Taper



3.16 HS3-7R Air Valve Assembly (S/N 51003 And Before)

The Air Valve Assembly has three main components:

3-Way Air Valve
High-Pressure Regulator
Low-Pressure Regulator

Theory of Operation

The Air Valve Assembly actuates the Rotary Table brake. Supplied air flows though the high-pressure regulator (70 PSI) to supply the high-side of the Brake Valve Pressure Booster. This supplies 12:1 hydraulic pressure boost to pull down on the Brake Assembly. When the Brake Ring is released, a valve switches the supplied air into the low-side of the Pressure Booster. This action returns the Pressure Booster piston to its original position and refills the hydraulic cylinder from the reservoir.
This is a closed hydraulic system. A 70/20 PSI pressure differential is used to prevent air leaking into the Pressure Booster.

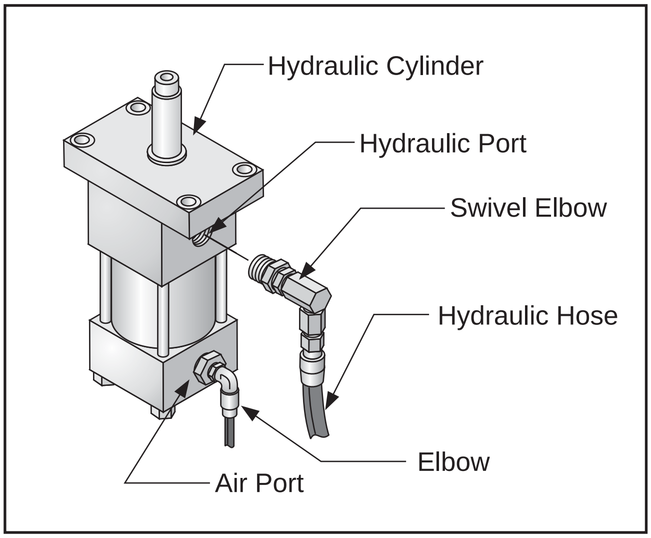
Assembly - Hydraulic Cylinder

1. Turn the hydraulic cylinder so that the two ports are facing up. Remove the two caps. The hydraulic cylinder is shipped with oil; take caution to avoid spillage.

CAUTION! Do not press the hydraulic cylinder piston in. Hydraulic oil will escape from the open port.

2. Using the correct hydraulic oil, fill the hydraulic port to remove any remaining air.

3. Install a reducer into the hydraulic port and then install a swivel elbow into the reducer. Thread the hydraulic hose, from the pressure booster, into the swivel elbow. Orient the swivel elbow as shown and tighten. Install an elbow into the air port and orient the elbow as shown.



Hydraulic Cylinder

4. Cut the tubing to fit once installed in the table. Insert one end of one piece of tubing into the elbow on the air side of the hydraulic cylinder.

5. Thread one of the two remaining elbows into the low-pressure port of the pressure booster, located in the middle of the pressure booster. Insert one end of one piece of tubing into the low-pressure elbow. Coil the tubing and mark with masking tape. See figure.

6. Place the pressure booster flat on the work surface. Route the braided hose upward; use caution to avoid fluid spillage.

7. Thread the remaining elbow into the high-pressure port, located on the rear of the pressure booster cylinder. Insert one end of one piece of tubing into the high-pressure elbow. Coil the tubing and mark with masking tape. See figure.

8. Use cable ties to secure the tubing lines to follow the hydraulic hose out.

Pressure Booster Assembly Bench Test

Prior to installation of the pressure booster assembly, a test of the entire system should be performed. This will identify leaks and allow for the system to be bled while it is still easily accessible. Set the air valve assembly and the hydraulic cylinder on top of the table or other high work surface. Set the pressure booster assembly onto the floor.

1. Identify the low-pressure tubing line coming from the low-pressure side of the pressure booster. Connect this tubing line to the low-pressure regulator of the air valve assembly.

2. Identify the high-pressure tubing line coming from the high-pressure side of the pressure booster. Connect this tubing line to the high-pressure regulator of the air valve assembly.

3. Connect the tubing line from the air port of the hydraulic cylinder to the unregulated source on the air valve assembly.

4. Attach a supplied air line to the air valve assembly. Supplied air should be set to 85 psi. Using the appropriate regulator adjuster on the air valve assembly, set the low-pressure regulator to 20 psi. Make sure that the swivel elbow connected to the hydraulic cylinder is at the highest point of the entire assembly.

Caution! During the following steps, spillage of hydraulic oil may occur. Wear eye protection and have sufficient rags on hand to clean up any purged oil.

5. Set the high-pressure regulator to approximately 5-10 psi. Remember that the pressure booster will still provide 12:1 pressure boost.

6. Loosen the connection between the hydraulic hose and the swivel elbow. Loosen this joint only enough to let air escape.

7. Apply air pressure to the pressure booster by pressing the yellow pin-button on the air valve assembly. Do not activate the pressure booster for more than a second at a time.

8. When all air has escaped the hydraulic system, tighten the hydraulic hose. Readjust the high-pressure regulator to 70 psi.

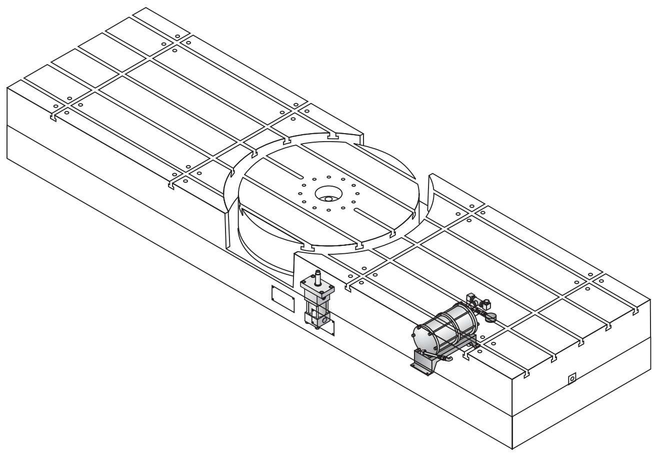
9. If any air leaks have been noticed during this operation, take appropriate measures to fix them before installing the assembly.

Installation - Hydraulic Cylinder

1. Lift the hydraulic cylinder into its area beneath the table. See the following figure for the approximate location. The hose connections should face the left of the table (away from the pressure booster) to prevent kinks in the lines when routed.

2. Thread (4) 1-1/4" shcs through the mounting tabs of the hydraulic cylinder into the table. Leave these loose for final alignment of the hydraulic cylinder (see **final alignment - hydraulic cylinder**).

3. Route the hydraulic hose and air port tubing beneath the hydraulic cylinder and through the holes machined to the right. Install cable plates using BHCS to retain the lines. Fit the plastic tabs over the cable plates to prevent damage to cables during operatio**n.**



Locations of Brake Cylinder Pressure Booster Components (installed from beneath)

Final Alignment - Hydraulic Cylinder

The following steps are performed from above the Table.

1. Apply air pressure to the hydraulic cylinder. This will cause the piston in the hydraulic cylinder to extend. When the piston has extended, thread an shcs into the pilot hole in the piston shaft and tighten. This will properly align the hydraulic cylinder to the brake assembly.

2. Tighten the four shcs that mount the hydraulic cylinder to the table. Relieve the hydraulic pressure.

3.17 HS-3/4/6/7 Motor and Transmission

Removal

Note: The motor and transmission are removed as a unit.

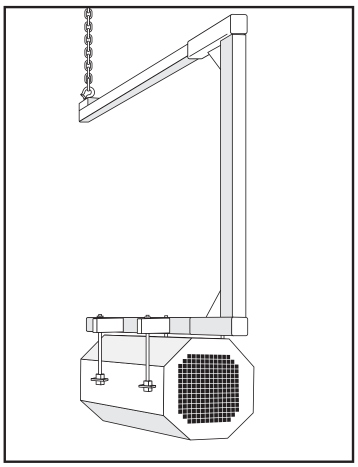
Caution: The motor/transmission assembly is very heavy; lifting equipment will be needed to safely remove and instal this assembly.

1. Remove the wire cover on the bottom of the motor and transmission. Mark and disconnect wires.

2. Remove the Tool Release Piston and Spindle Encoder as described in their specific sections.

3. From the back of the machine position a lifting device and fixture to support transmission. Loosen the transmission mounting bolts. The transmission can be lowered to remove the spindle belt from the back of the spindle (The encoder belt should be loose as the encoder was previously removed).

The transmission can also be removed by lowering it onto blocks of wood (4”x4”) inside the column casting. From this point the transmission is pulled toward the rear of the machine to separate from the spindle head.



Haas Factory lifting tool shown. Contact the factory for availability

4. Completely remove the transmission mounting bolts and pull the transmission towards the rear of the machine until it is clear of the column casting.

Installation

1. Put drive and encoder belts on transmission pulleys. This must be done before installing the transmission assembly.

2. Secure the lifting device to the transmission assembly. Lift and position the transmission on the back of the spindle head.

3. Install bolts and belts. Adjust the belt tension by lifting or lowering the transmission. Once proper belt tension is attained, tighten all the bolts.

4. Remove the lifting equipment.

5. Install Encoder and TRP as described in their specific sections.

6. Connect the cables to the motor and transmission, and then replace the cover.

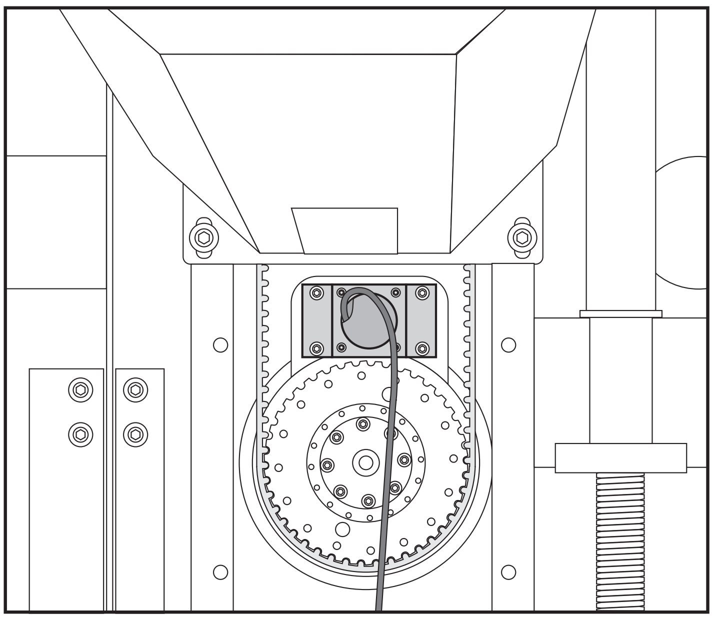
Belts Replacement

The motor and transmission assembly must be removed to replace the spindle drive and spindle encoder belt. See the motor and transmission section for instructions.

Spindle Encoder Replacement

Removal

1. Remove the tool release piston to access the encoder (See TRP Service section)



2. Remove the four bolts that hold the encoder bracket to the spindle head. Disconnect the cable. Remove the four bolts that hold the encoder to the bracket.

Installation

1. Bolt the encoder to the bracket.

2. Install the belt on the encoder pulley and then install the bracket to the spindle head. Verify that the belt is on the transmission shaft properly.

3. Tension the encoder belt to 2-10 lb.

4. Install the TRP.

3.18 50 Taper Spindle TRP Removal

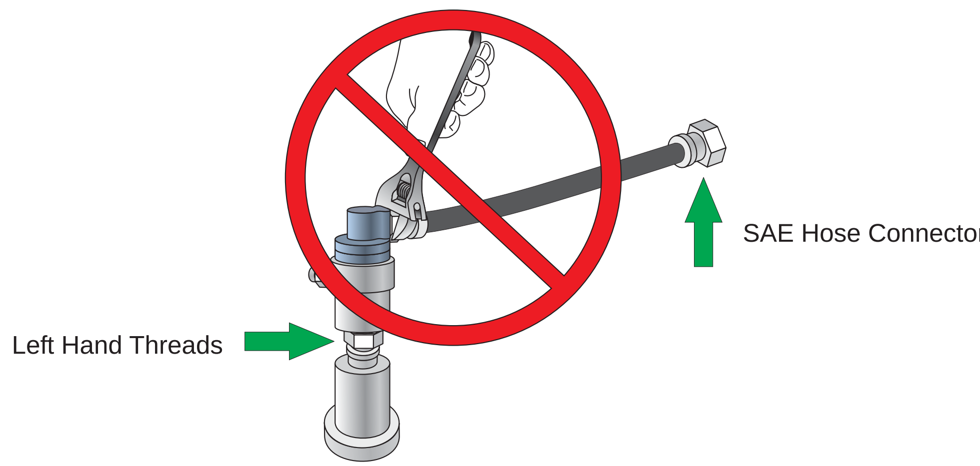
1. For TSC equipped machines, place a tool holder in the spindle.

2. Remove the screws that hold the lower Y-axis way cover from the head and lower the way cover.

3. For TSC equipped machines the coolant union and extension tube must be removed before proceeding. **They both have left handed threads.**

CAUTION: Do not remove pipe connectors from the coolant union!! Removing any pipe connector from the union will void your warranty on the union.

Use wrenches only on the SAE hose connector and the bottom nut of the Coolant Union. See arrows below:



a. Loosen the SAE hose connector at the Check Valve Assembly with a wrench (right arrow in diagram). Do not use a wrench on the pipe connector attached to the Coolant Union; the Union will be damaged and the Warranty voided.

b. Carefully cut off the clear plastic Drain Hose at the side of the Coolant Union. It is safest to use scissors or snips. Cut it close to the connector, since the hose will be re-used on the replacement union. Do not cut the Black coolant hose. (Note: If you are not replacing the Union, leave the Drain Hose attached to the union.)

c. Remove the coolant union from the Extension Tube (bottom arrow in diagram) using two wrenches (7/8 and 15/16). THIS IS A LEFT HAND THREAD.

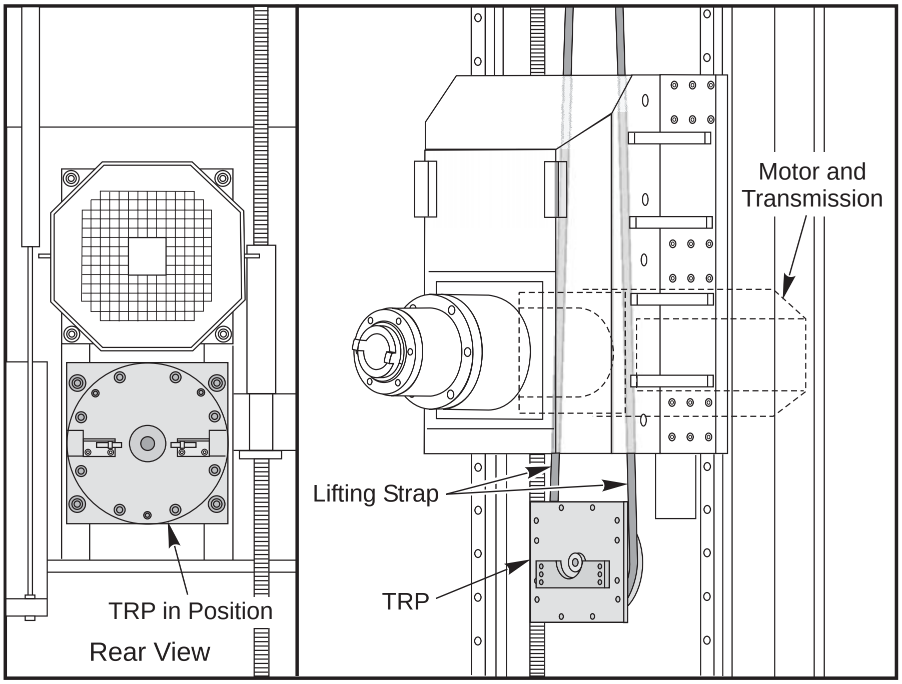
d. Return the Coolant Union with all pipe thread connectors and black coolant hose <u>intact</u> to Haas Automation for warranty. <u>Removal of any of the pipe connectors from the union will void any claims for warranty.</u>

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. Use a strap and overhead lifting device to hold the TRP in position. The TRP is heavy so secure properly with the strap.



TRP shown in position and as it is lowered

8. Remove the four shoulder screws holding the tool release piston assembly to the head casting.

9. Lower the TRP to remove it from the machine.

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. lb.
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)

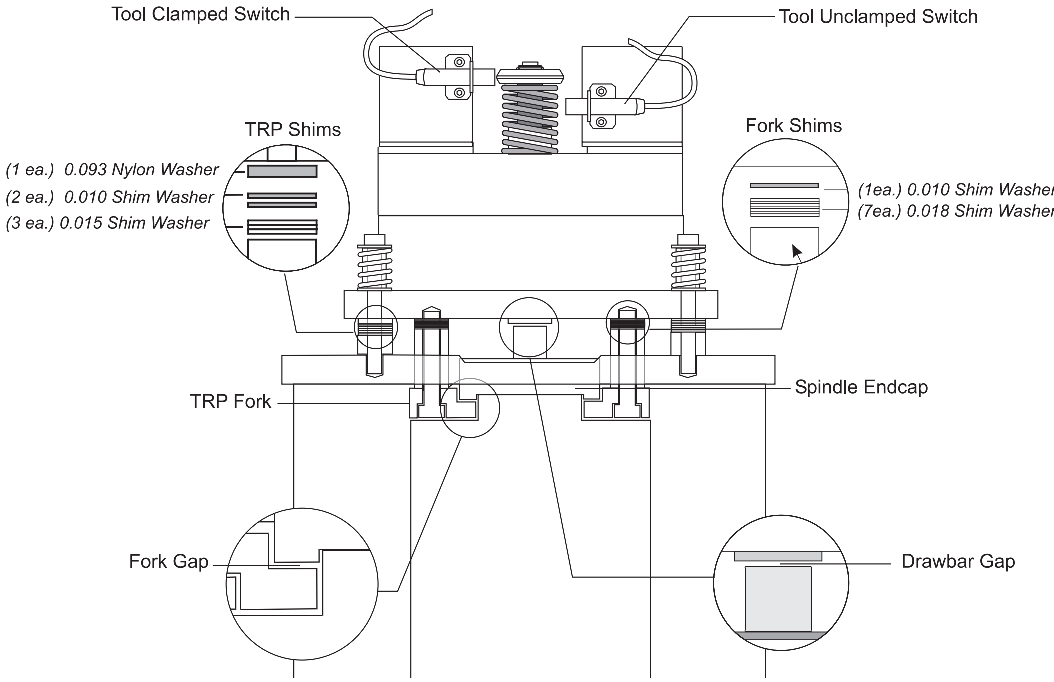


Figure 3-10. Shim and spacer location diagram.

1. Use the lifting straps to position the TRP. The TRP is heavy, use an overhead lifting device.
2. Install the 4 bolts, with the shim stock and spacers under the TRP.

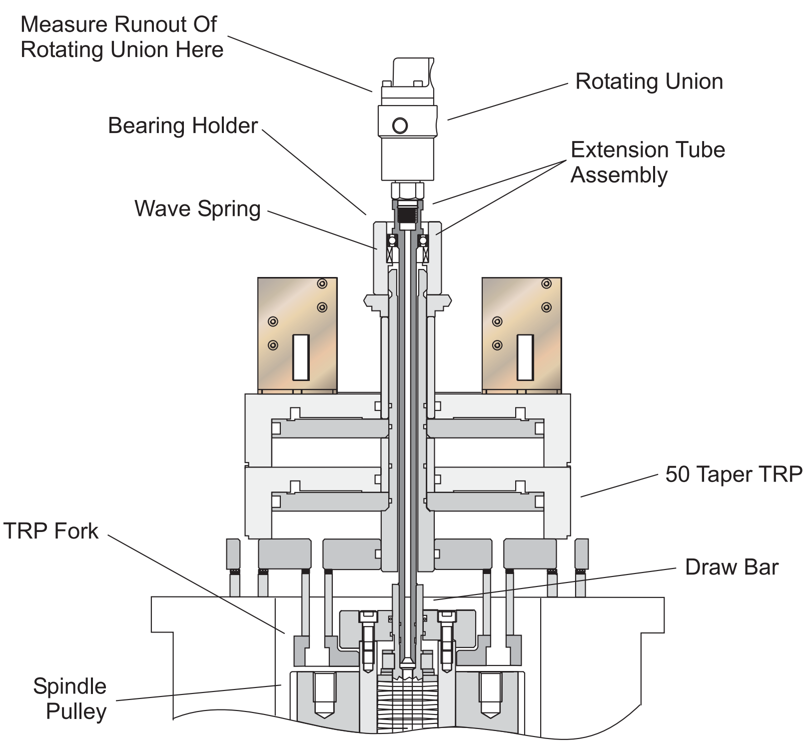
	Part No.	Description	30-0013A (NEW)	30-0013 (OLD STYLE)
Fork:	(45-0014)	0.010 Shim Washer	1 ea.	None
	(45-0015)	0.018 Shim Washer	7 ea.	5 ea.

TRP	(45-0019)	0.093 Nylon Washer	1 ea.	1 ea.
Spacers:	(45-0017)	0.010 Shim Washer	2 ea.	2 ea.
	(45-0018)	0.015 Shim Washer	3 ea.	2 ea.

(**NOTE:** TRP Spacers: the nylon washer goes on top of the shims.)

3. If the machine is equipped with TSC, re-install the Extension Tube and Rotating Union in the following manner. Otherwise, skip this step.

NOTE: If the Spindle, Drawbar or Extension Tube has been replaced the Extension Tube Runout must be adjusted.



a) Place a Tool Holder in the Spindle.

b) Insert a 5/8 Allen wrench into the lower end of the piston shaft. Loosen the 1/4-20 screw in the clamp collar on top of the piston shaft. Insert a large flat blade screwdriver into the slot in the clamp collar, and twist the collar off.

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

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

e) Replace the Tool Release Piston.

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

g) Lightly grease the O-Ring on the end of the Extension Tube Assy. (30-1242). Apply blue Loctite to the thread on the end. Insert the Extension Tube down into the Drawbar. Tighten by hand as far as possible **(It has left hand threads).**

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

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

j) Install the Rotating Union. Lightly grease the O-ring. DO NOT put Loctite on the threads.

i. Thread the Coolant Union onto the end of the Extension Tube (it has left hand threads). DO NOT USE LOCTITE. Tighten the threads snugly using two wrenches.

ii. Attach the clear plastic Drain Hose to the barb connector on the side of the union. Use a hose clamp if one is available. The hose must travel downward (below the union) to drain off collected coolant. The union will be damaged if coolant collects inside the union.

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

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

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

m) Test run the TSC system to check for leaks.

4. Plug the 3 air hoses in the TRP.
5. Plug in the clamp and unclamp switches.
6. Set the main air regulator to 85 psi.

NOTE: Tool Push Out Adjustment and Setting TRP Switches **must be** completed.

Tool Push Out Adjustment

1. Put tool holder in spindle.
2. Plug the spindle taper air blast.
3. Place an angle plate on the machine table. Place a clean aluminum block between the angle plate and the tool holder.
4. Jog the Z-axis towards the plate until the tool holder is about .030” from the aluminum block. Switch the jog increments to .001” and jog the Z-axis towards the plate, one increment at a time, until the tool holder just presses the block firmly against the angle plate. This is the zero point.
5. Plug the spindle taper air blast.

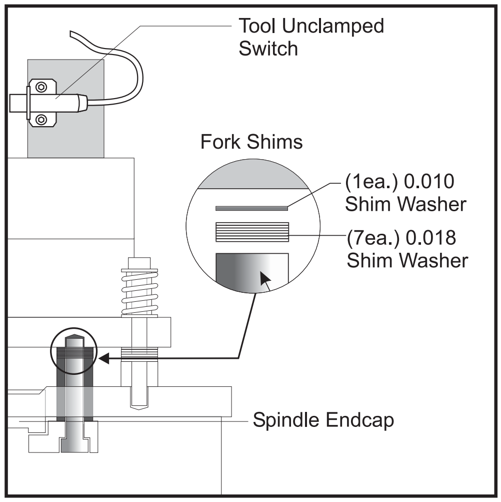


Figure 3.2-10 Fork shim location.

6. The Tool Push-out adjustment is 0.060” +/-0.010. Add or remove shims from the tool release fork to make adjustments. The shims come in 0.010” and 0.018” thicknesses.
   Jog away from the plate 0.060”. Press and hold the tool release button, and feel for movement in the aluminum block.
   - If the block is tight when the button is pressed, shims may have to be ADDED to the tool release fork.
   - If the block is loose when the button is pressed, shims may have to be REMOVED from the tool release fork.
   (This is the opposite of 40 taper adjustment.)
   - If the aluminum block is tight at 0.060”, release the button and jog the Z-Axis up 0.001” and press the tool release button again. Feel for movement in the aluminum block. Repeat this until movement is felt. Note the last position where the block was tight. If the position is 0.070” or more, add shims to the tool release fork.
   - If the aluminum block is loose at 0.060”, jog the Z-Axis downward 0.001” at a time and check for movement in the aluminum block. If the position where the block becomes tight is 0.050” or less, remove shims from the tool release fork.

7. If shims were added to the TRP fork, add half that amount to the TRP spacers supporting the TRP. This will keep the two clearance gaps between the TRP and the rotating Spindle equal (approximately 0.095” each). If shims were removed from the TRP fork, remove half that number of shims from the TRP spacers.

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

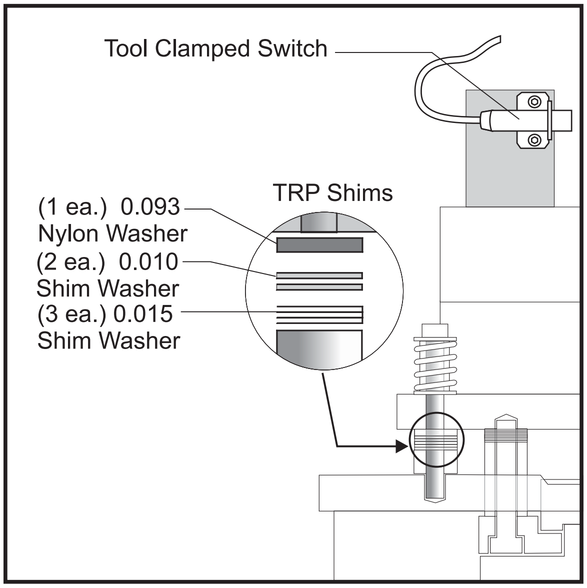


Figure 3.2-11 TRP shim location

50 Taper Switch Adjustment

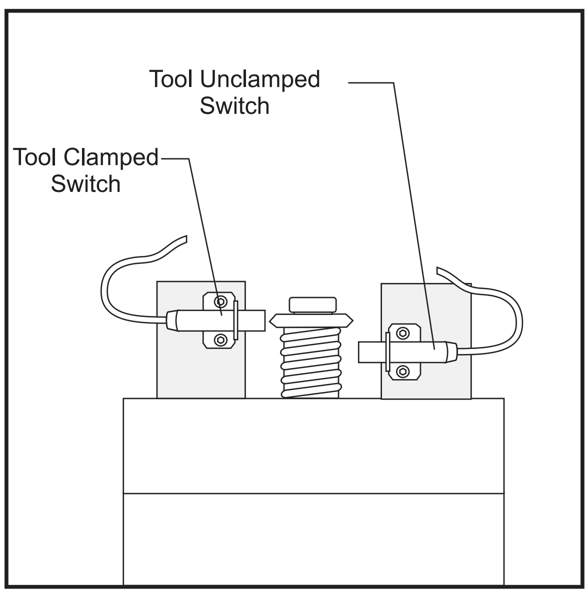


Figure 3.2-12 Tool Clamp / Unclamp Switches.

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) Go to Parameter 76 write down the value and then change it to 99999999, 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 reset parameter 76 to its original value.

3.19 Harmonic Drive Components

The Harmonic Drive unit is used to drive the rotary table on machines such as the HS 3,4,6,7 adn the EC-1600.

The Harmonic Drive Assembly is made up of the following components:

- Housed Harmonic Drive
  - O-Ring Pack (included in package)
  - Wave Generator (included in package)
- Yaskawa Sigma Motor
- Gearbox Adapter
- Pinion Gear, 22 Tooth
- Cam Backlash Adjuster

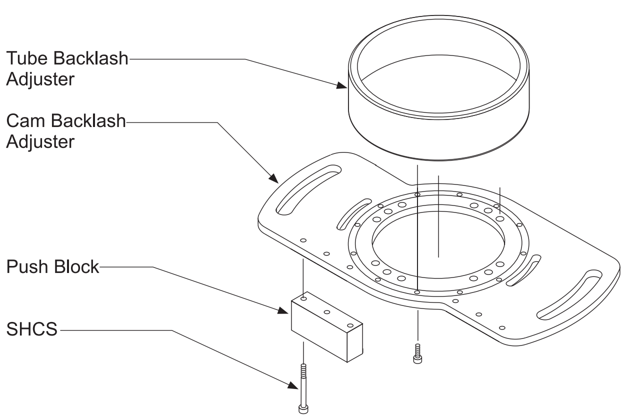
The Housed Harmonic Drive is prepacked with appropriate grease. It is a self-greasing unit, requiring no maintenance.

Assembly - Backlash Tube and Plate

1. Place the Tube Backlash Adjuster onto the Cam Backlash Adjuster plate. Turn the Tube so that the holes line up with the holes in the Plate. This is an interference-fit item. Insert the 12 SCHS into the Tube and thread into the Plate. Tighten the SCHS in a star-pattern to ensure proper positioning of the Tube.

2. Attach one Push Block to each side of the Plate, using existing drilled holes and 6 supplied SCHS.

NOTE: The Backlash Plate assembly is not attached to the Motor at this point to ease assembly into the table during installation.



Assembly - Motor / Wave Generator

1. Sweat the Pinion Gear (positioned so the groove is away from the flange) over the shaft of the Sigma Adapter and set aside.

2. Examine the spindle of your Yaskawa Sigma Motor. If your Motor has the Motor Shaft Spacer already sweated onto the shaft, skip to Step 4.

3. Sweat the Motor Shaft Spacer over the shaft of the Motor. Ensure the chamfer on the inner diameter spacer faces the motor.

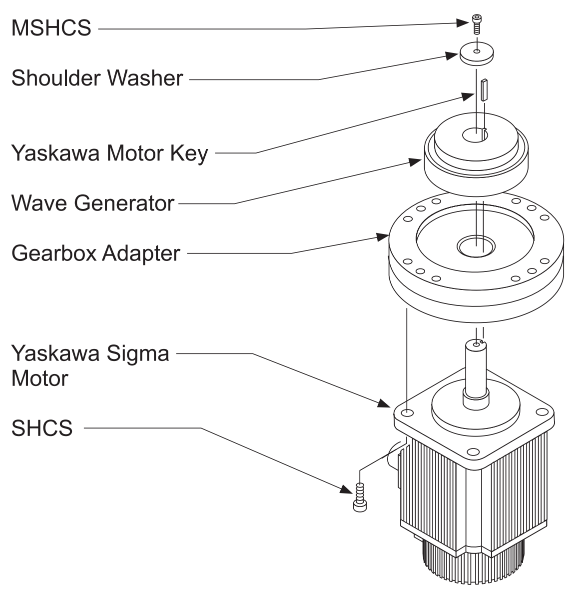
4. Turn the Motor so that the shaft faces upward. Place the Gearbox Adapter over the Motor shaft. Insert the four SHCS through the tabs of the Motor case into the Gearbox Adapter and tighten.

5. Place the Wave Generator over the Motor shaft. Align the keyway in the Wave Generator with the keyway in the Motor's shaft.

6. Insert the Yaskawa Motor Key into the combined keyway. Use a press to fit the key into the keyway. Do not use the HAAS Motor Key.

CAUTION!	Do not use a hammer or other forceful method of inserting the key. You will damage the fragile bearings and components of the Wave Generator.

7. Place the Shoulder Washer over the Motor shaft. Apply Loctite, insert the MSHCS and tighten.



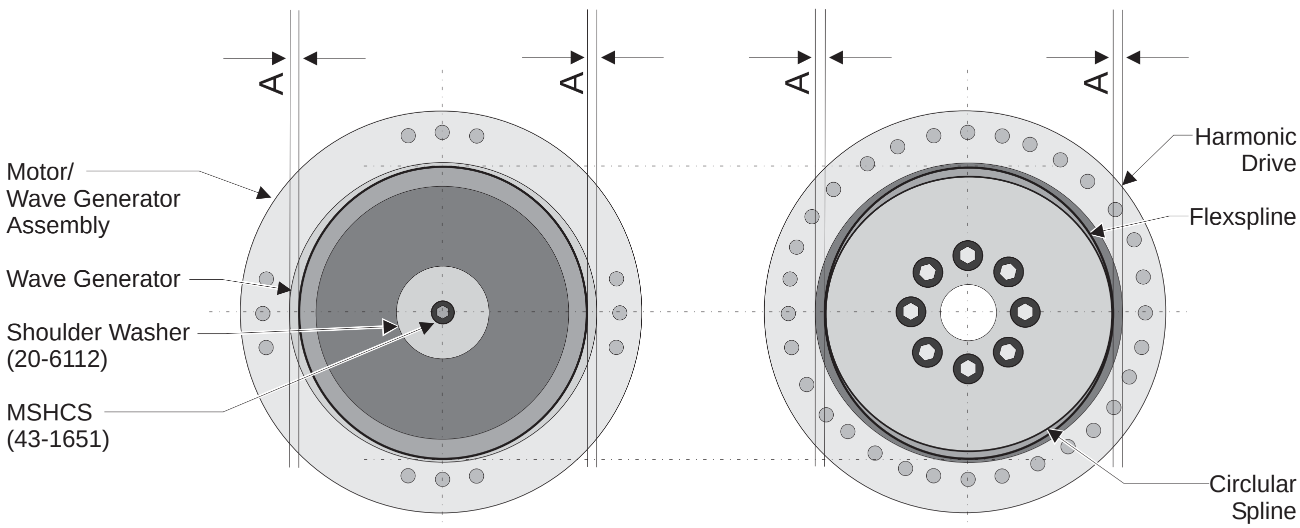
Assembly - Harmonic Drive

1. Cover your work area with a clean shop rag and place the Harmonic Drive with the smaller-diameter end down on the work surface. You should see the grease cavity of the Harmonic Drive.

2. Remove the large O-Ring from the included package and lightly grease. Place in the groove in the face of the Harmonic Drive.

NOTE: For proper operation of an HDC Gear Set, it is essential that the ring of the Wave Generator be concentric with the ring of the Harmonic Drive. The rings of the Wave Generator and Harmonic Drive are ellipses; they are not circular. Incorrect assembly will result in an off-center or "dedoidal" condition, resulting in **poor performance** and **reduced service life**.

3. Place the Motor/Wave Generator assembly next to the Harmonic Drive. Turn the Harmonic Drive elliptical ring until the ring is closest to the front of the Harmonic Drive. Orient the Wave Generator elliptical ring until it matches the positioning of the Harmonic Drive exactly.



Phasing the Wave Generator to the Harmonic Drive (view from above)

4. Turn the Motor/Wave Generator assembly over and set lightly on the Harmonic Drive. If the two elliptical rings are in phase, they will mesh. If they do not mesh easily, remove the Motor/Wave Generator assembly and verify correct alignment of the elliptical rings and repeat this Step.

5. Bolt the Gearbox Adapter to the Harmonic Drive by inserting four SHCS into the countersunk holes in the Gearbox Adapter.

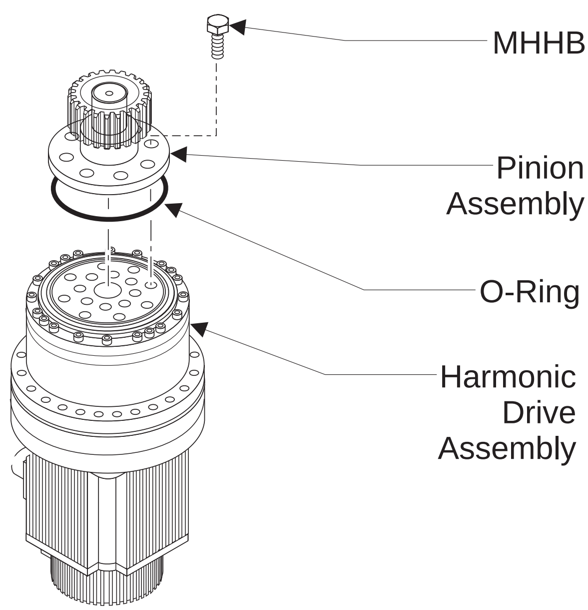
NOTE: To test for a dedoidal (out of phase) condition, perform the following operation:

Turn the Harmonic Drive/Motor assembly over and set it on the Motor casing, Harmonic Drive up. Insert a 5mm hex wrench through the center hole in the Harmonic Drive into the MSCHS installed in **Assembly - Motor / Wave Generator Step 7**. Turn the hex wrench with a drill. For one complete revolution of the input there should be two equal deflections, or pulses, felt through the drill.

6. Turn the complete assembly over to expose the Harmonic Drive. Keep this free of contaminents. Lightly grease and install the remaining O-Ring into the groove. This O-Ring seals the Harmonic Drive from coolant during machine operation.

7. Install the Pinion Assembly (from **Assembly - Motor / Wave Generator Step 1**) onto the Harmonic Drive. Be sure to orient the Pinion Assembly so that the bolt holes line up with the holes in the Harmonic Drive. This is an interference-fit item.

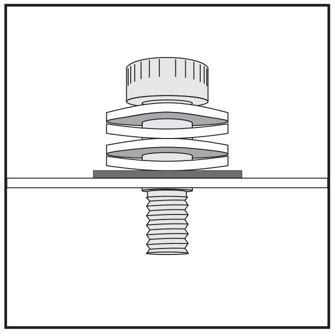
8. Place sealer on the 8 MHHB and thread into the holes of the Pinion Assembly. Tighten in a star pattern.



Installation - Backlash Tube and Plate

1. Apply grease to the outer side of the Tube and top side (as installed) of the Plate. Also apply grease to the counterbore for the Tube and the machined surface underneath the Table the Plate will move against.

2. Assemble four Spring Washers in series and one 3/8" Hard Washer onto each Shoulder Screw. They should be assembled so that a small space appears between the top and bottom pairs of washers.



3. Orient the Backlash Plate so that the Push Blocks face the access holes of the Table. Insert the Backlash Tube/Plate assembly into the counterbore from beneath the Table. Use caution to avoid marring the surface of the Tube.

4. Insert the Shoulder Screws through the slots in the Plate closest to the Tube (place the Hard Washer against this Plate) and thread into the Table. Tighten with a hex wrench to standard torque.

5. Place a Flat Washer (45-1725) and a Lock Washer (45-1720) onto each HHB. Thread the HHB up into the Table through the outer slots of the Plate. Leave loose until final adjustment.

Installation - Harmonic Drive

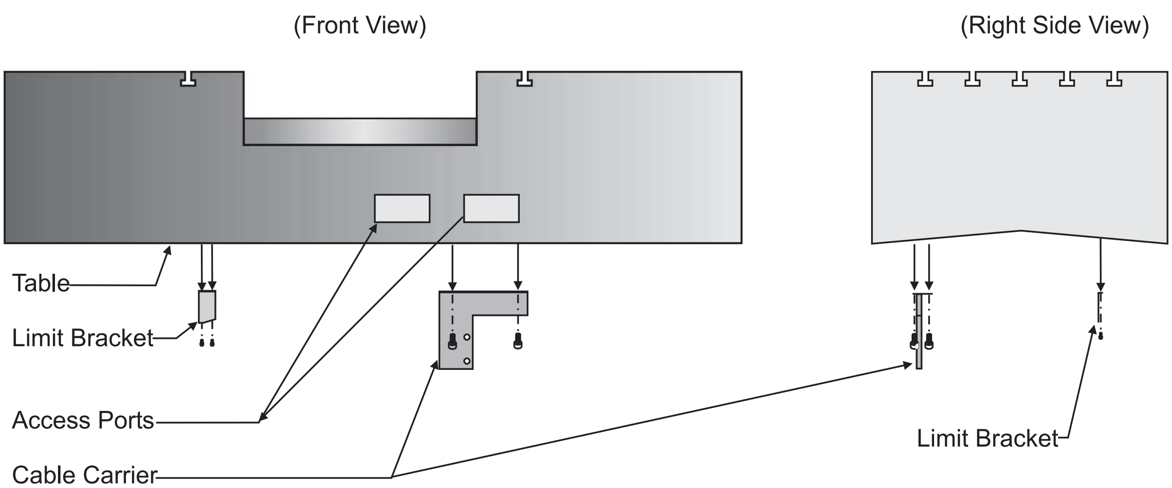
1. Thread an eyebolt into the pilot hole in the shaft of the Harmonic Drive assembly.

2. Connect a rope or hoist line to the eyebolt. Have an assistant lift the rope up through the counterbore and raise the Harmonic Drive.

3. Orient the Harmonic Drive so that the motor connectors can be accessed from the right of the Table. Insert (8) 70mm SHCS through the Gearbox Adapter into the Table. Torque to 35 ft/lbs.

Installation - Carrier Mount Bracket

1. Orient the Carrier Mount bracket so the edge side faces forward and the flush side is toward the center of the Table. Turn the Carrier bracket so that the mounting holes face the bottom surface of the Table. See the Figure below:



Cable Carrier and Bracket Installation

2. Place the Carrier bracket against the bottom side of the Table where indicated and insert the (4) SHCS through the bracket and thread into the Table. Tighten.

3. Orient the limit bracket so that the angled bottom edge faces to the right and the mounting tab faces toward the rear of the Table as shown in the Figure above. Mount using two SHCS.

Installation - Cable Box Encoder

1. Place the Cable Box Encoder into the left rear corner of the accessory box of the Table. Orient the Cable Box with the open sides against the casting of the Table for the Encoder cable.

2. Install the three SHCS and insert through the Cable Box into the Table. Tighten.

3. Apply Sikaflex around any gaps to prevent the Encoder cable from popping out when it is pushed down into the box after installation.

3.20 4TH AXIS BRAKE ASSEMBLY

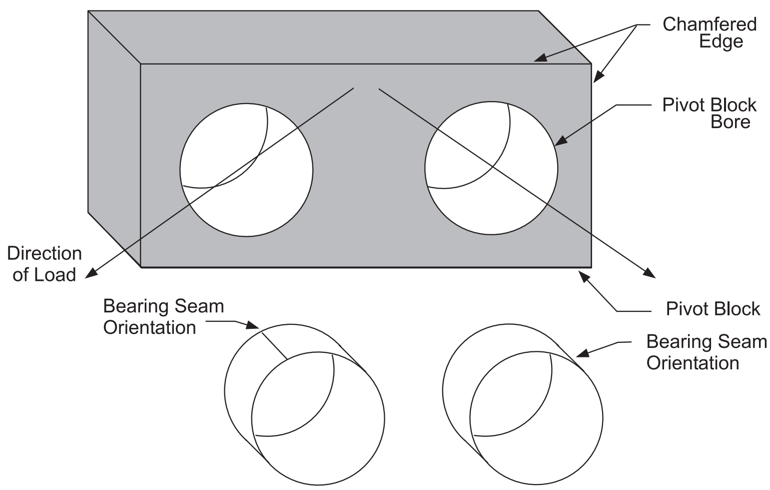
The Brake Assembly has five main components:

Brake Ring	Brake Arm	
Pivot Block	Pivot Pin	Bearing

ASSEMBLY

1. Orient the Pivot Block so that you will be inserting the Bearings (Step 2) from the 20-degree chamfered side.

2. Insert one Bearing into each bore of the Pivot Block. When installing the Bearings, orient the seam in the bearing out of phase of the direction of load.



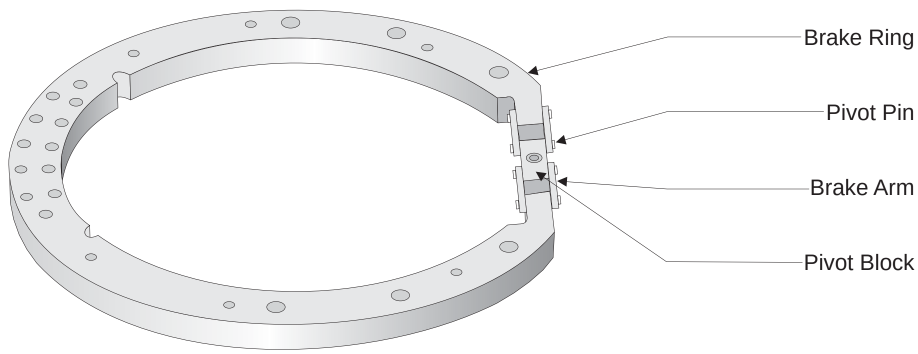
Proper Bearing Orientation

3. Clean the Pivot Pin with alcohol and a lint-free rag. Insert one Pivot Pin through each Bearing.

4. Place one Brake Arm over each end of the Pivot Pins. Secure each Pivot Pin with supplied E-Clips.

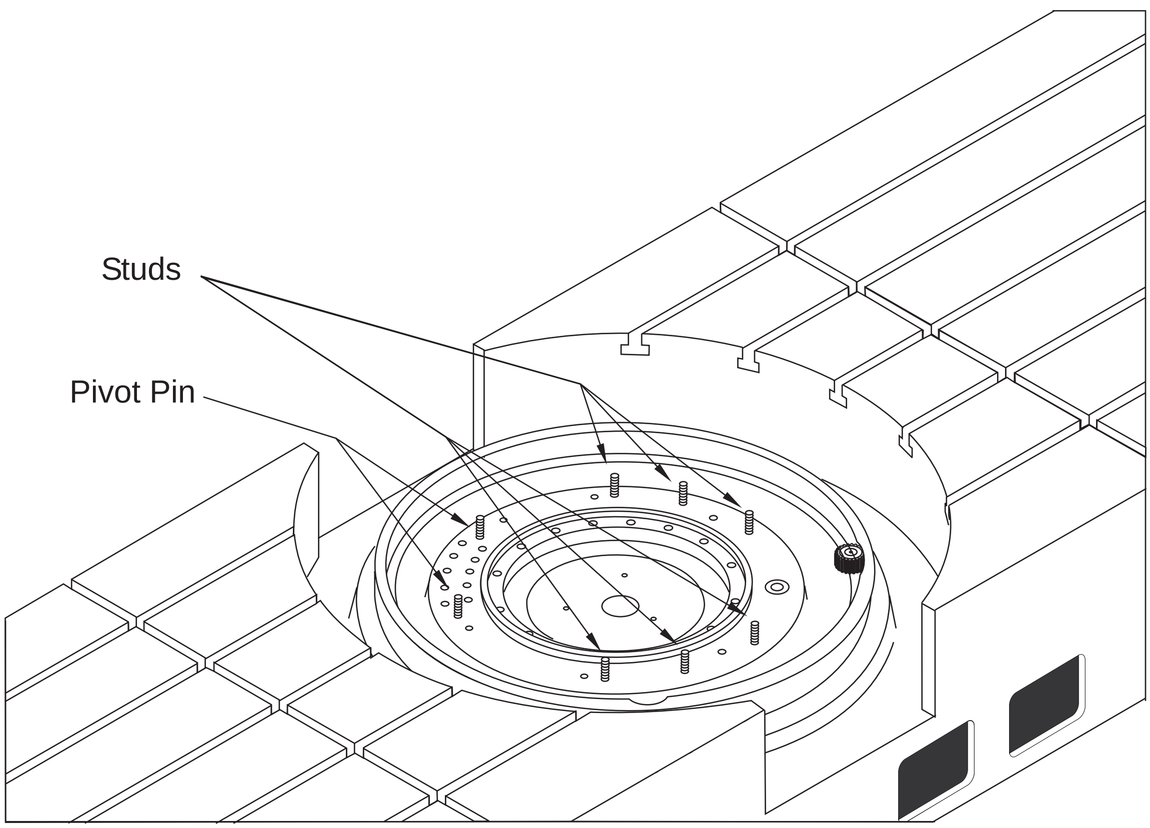
5. Insert the remaining two Bearings into the legs of the Brake Ring. Clean the remaining two Pivot Pins.

6. Place the Pivot Block assembly between the legs of the Brake Ring. Insert the Pivot Pins through the Brake Arms of the Pivot Block assembly. Secure each Pivot Pin with supplied E-Clips. See the following figure:



Installation - Brake Assembly

1. Clean the threaded holes in the table to remove all oil. Apply Red Loctite onto the (6) Studs (49-0024) and thread into the Stud holes indicated below. Install to a height of 2.175".



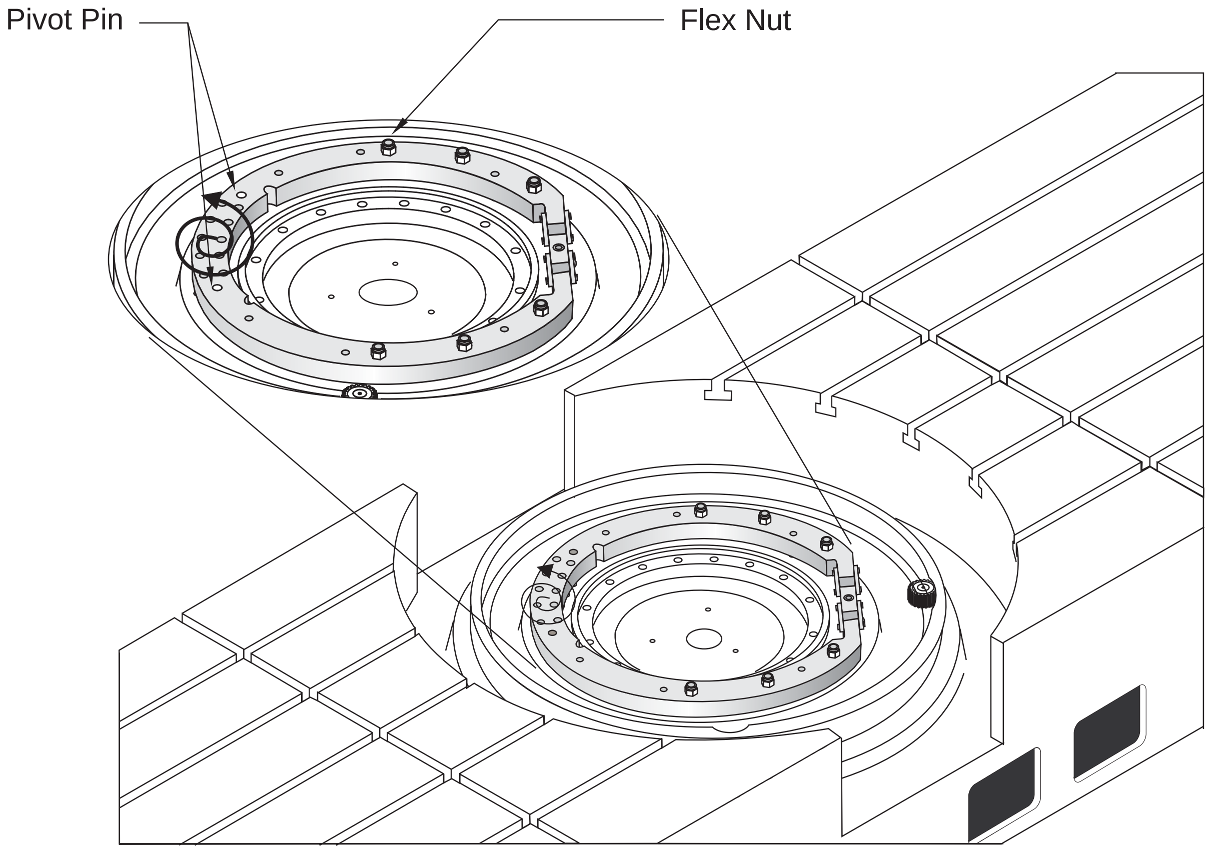
2. Use a brass hammer or punch to insert the (2) Pivot Pins into the table as shown in the figure on the previous page.

3. Clean the Brake Ring mounting surface with alcohol and a lint-free rag. Apply a coating of grease to the cleaned surface. Do not grease the area immediately surrounding the hole for the Hydraulic Cylinder shaft.

4. Place the Stop Block into the hole for the Hydraulic Cylinder shaft. Insert the two SHCS and tighten.

5. With an assistant, lift and lower the Brake Ring Assembly onto the Table. Fit the Brake Ring over the Pivot Pins and Studs. The Brake Ring should rest against the Table. If there is interference, make sure the Pivot Block is in the fully retracted position.

6. Place a drop of Loctite onto each of the (10) SHCS and insert into the machined holes in the area between the Pivot Pins. Tighten the SHCS in a circular pattern from the center outward as shown. The torque value is 80 ft./lbs.



Torque Sequence, Brake Ring SHCS

7. Grease the counterbores machined into the Stud holes along the legs of the Brake Ring. Place a Thrust Washer and a Flex Nut onto each Stud and tighten completely. Back off each Flex Nut slightly (approximately 1-3°). Check the actuation of the brake after completion of Hydraulic Cylinder installation procedure. The Flex Nuts should be as tight as possible while still allowing the brake to actuate smoothly.

Installation - Ring Gear

1. Lubricate and stone the mating surfaces of the Platter and Ring Gear. Wipe clean to remove grease and contaminents.

2. Clean the mating surfaces of the Platter and Ring Gear with alcohol.

CAUTION! The Ring Gear is a precision-machined piece. Take care in handling the Ring Gear. Do not drop the Ring Gear or set it heavily on the teeth.

3. Install eyebolts into the top of the Ring Gear. With an assistant, lift the Ring Gear by the eyebolts and place over the Platter.

4. The Ring Gear is an interference-fit item and will need to be clocked properly prior to the next Step. If necessary, adjust the position of the Ring Gear so that all the bolt holes line up exactly.

5. Apply a drop of Loctite to each of the (16) SHCS and insert into the holes in the Ring Gear. Start each SHCS by hand to ensure proper alignment of the Ring Gear and to prevent crossthreading the tapped holes.

6. Tighten the SHCS incrementally in a star pattern to slowly pull the gear down onto the platter. Do not tighten each SHCS completely in one attempt. This will foul the location of the Ring Gear.

7. When the Ring Gear is fully seated on the Platter, tighten the SHCS to full torque value.

3.21 4th Axis Air Valve Assembly

This section applies to machines with serial number 51004 and later. See the end of this section for information specific to machines built before 51004.

The Air Valve Assembly has three main components:
- 3-Way Air Valve
- High-Pressure Fixed Regulator
- Low-Pressure Regulator

Theory of Operation

The Air Valve Assembly actuates the Rotary Table brake. Supplied air flows though the high-pressure regulator (45 PSI) to supply the high-side of the Brake Valve Pressure Booster. This supplies 40:1 hydraulic pressure boost to expand the hydraulic pump. When the clamp is released, a valve switches the supplied air into the low-side of the Pressure Booster. This action returns the Pressure Booster piston to its original position and refills the hydraulic cylinder from the reservoir.
This is a closed hydraulic system. A 45/20 PSI pressure differential is used to prevent air leaking into the Pressure Booster.

Assembly

Individual assembly of the 3-Way Air Valve, the High-Pressure Regulator, and the Low-Pressure Regulator component parts is necessary and is not detailed in this Service Manual.

1. Apply a small amount of thread sealant to the threads of the High-Pressure Regulator Assembly and attach to the 3-Way Air Valve. Orient the Regulator to match the position of the part removed.
2. Apply a small amount of thread sealant to the threads of the Low-Pressure Regulator Assembly and attach to the 3-Way Air Valve. Orient the Regulator to match the position of the part removed.
3. Attach this assembly to the Mounting Plate using Loctite and supplied SHCS.

Installation

1. Position the Air Valve Assembly near its mounting location at the Air Lube Panel. Route all air tubing to the Air Valve.
2. Cut each air tubing line to fit and insert into the appropriate regulator/outlet on the Air Valve Assembly.
3. Position the Air Valve Assembly properly, then thread (4) SHCS into the mounting holes and tighten.

3.22 4th Axis Brake Cylinder Pressure Booster

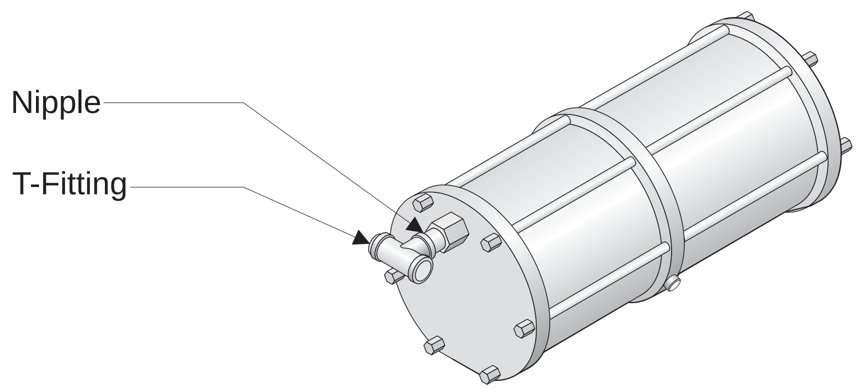
Theory of Operation

The Pressure Booster gives the ability to develop and use high hydraulic pressure without incurring the cost of an on-board HPU. The Pressure Booster has a high-pressure side, a low-pressure side, and a fluid fill-port on the front of the unit. The Pressure Booster Assembly is located in the bottom of the Rotary Table. There is a cutout underneath the Rotary Table to provide access for service and replacement of the Pressure Booster and component parts.

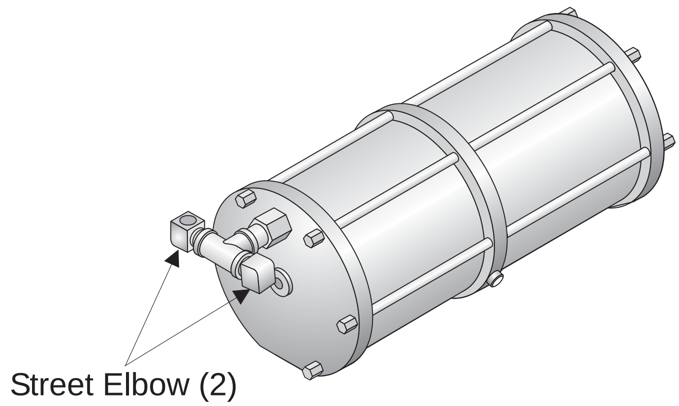
Assembly - Pressure Booster

The Pressure Booster comes packaged with extra components not needed for its proper operation in this application. Where applicable in the following steps, use a small amount of thread sealer on all pipe threads.

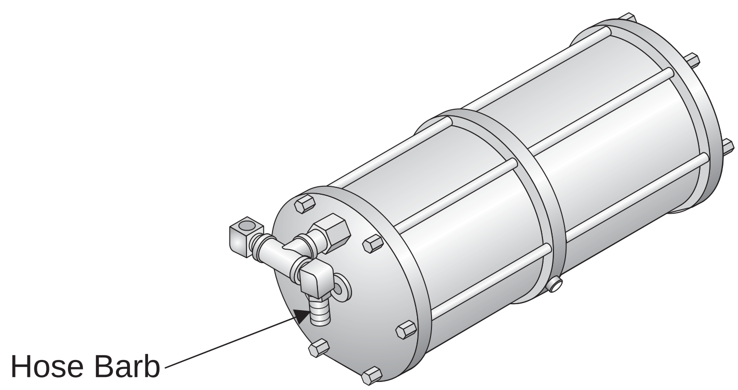
1. The Pressure Booster is shipped full of hydraulic oil. Tilt the Pressure Booster on end before removing the plug from the container.
2. Thread Adapter into the Pressure Booster and tighten.
3. Thread the Nipple (new part) into the Adapter.
4. Thread the T-Fitting onto the Nipple and tighten so that it is oriented as shown in the following figure:



5. Thread the Nipple into the right side of the T-Fitting. Thread the Street Elbow into the left side of the T-Fitting as shown below. Tighten all parts.
6. Thread 90-Degree Elbow onto the Nipple. Thread Nipple into the Elbow. Tighten to orient as shown in the following figure:



7. Thread the Hose Barb into the remaining 90-Degree Elbow and attach to the Pressure Booster assembly. Orient as shown in the following figure:

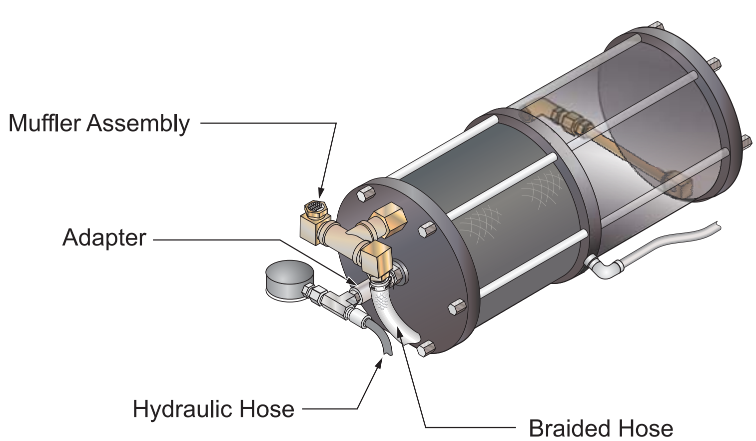


8. Attach the Braided Hose to the Hose Barb using the supplied hose clamp. Use caution when moving the Pressure Booster Assembly as the internal hydraulic fluid can spill from the Braided Hose.

9. Remove the plug in the center hole of the Pressure Booster. Thread a #4 SAE to NPT-female Adapter (new part) into the center hole.

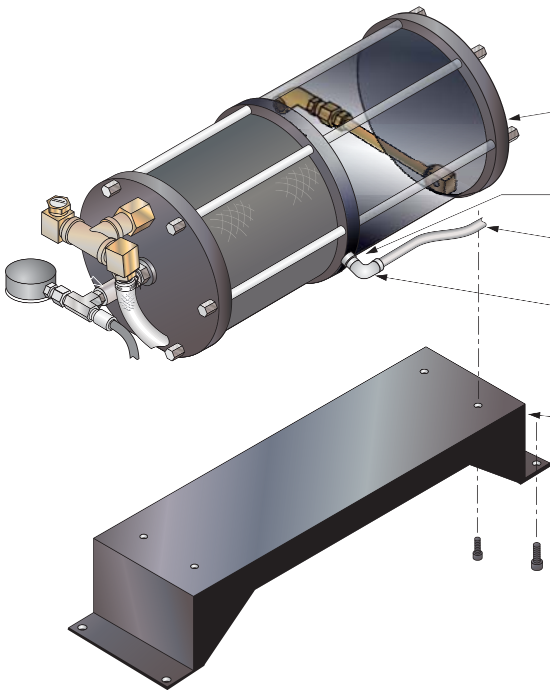
10. Thread the Hydraulic Hose into the Adapter.

11. Thread the Reducer into the Street Elbow. Thread the Muffler and Reducer together, then attach to the Street Elbow. Tighten all parts. This will act as a snorkel for the system.



Final Assembly

Orient the Plate as shown and attach to the bottom of the Pressure Booster.



Pressure Booster Final Assembly (bottom view)

Pressure Booster Assembly

Prior to installation of the Pressure Booster Assembly, a test of this system should be performed. This will identify leaks and allow for the system to be bled while it is still easily accessible. Set the Air Valve Assembly on top of the Table or other high work surface. Set the Pressure Booster Assembly onto the floor.

Bleed the Pressure Booster:

- The booster should be filled to the top fill line before starting.
- Use a manual vacuum pump to draw the air bubble out of the hose, stopping before the pump fluid reservoir is full.
- Release the pressure valve on the pump (depress small needle like feature on the bottom), empty the reservoir and repeat procedure.

It can take 5 to 8 vacuum cycles to remove all the air from the hose. Take caution to refill the booster before the fluid level falls below the lower fill line, or air will be introduced into the system. It is critical to remove all air from booster hose, failure to do so will introduce air into clamp ring.

1. Identify the low-pressure Tubing line coming from the low-pressure side of the Pressure Booster. Connect this Tubing line to the Low-Pressure Regulator of the Air Valve Assembly.

2. Identify the high-pressure Tubing line coming from the high-pressure side of the Pressure Booster. Connect this Tubing line to the High-Pressure Regulator of the Air Valve Assembly.

3. Attach a supplied air line to the Air Valve Assembly. Supplied air is preset to 45 PSI.

4. Using the appropriate regulator adjuster on the Air Valve Assembly, set the Low-Pressure regulator to 20 PSI.

CAUTION! During the following Steps, spillage of hydraulic oil may occur. Wear eye protection and have sufficient rags on hand to clean up any leaked oil.

5. Set the High-Pressure regulator to approximately 5-10 PSI. Remember that the Pressure Booster will still provide 40:1 pressure boost.

6. Apply air pressure to the Pressure Booster by pressing the yellow pin-button on the Air Valve Assembly. Do not activate the Pressure Booster for more than five seconds at a time.

7. If any air leaks have been noticed during this operation, take appropriate measures to fix them before installing the assembly.

Installation - Pressure Booster

Position the Pressure Booster, and Air Valve assemblies near the working areas.

1. Thread the 3/4 NPT Elbow (new part) into the Fill Port machined into the right side of the Table. The Elbow must be installed from the inside. Orient the Elbow so that it points down.

2. Thread a Hose Barb into the Elbow. Tighten with a 1-1/16" socket.

3. Lift the Pressure Booster Assembly into the cavity machined underneath the right front of the Table. See the Figure on the following page for the approximate location. Route the Hydraulic Hose and High- and Low-Pressure Tubing through the mouse hole. Secure to the Table with (4) 1/2" SHCS using the outermost holes in the Plate.

4. Cut the Braided Hose to length and attach to the Hose Barb with a clamp.

Installation - Bearing

1. Place the Bearing Retainer Ring onto the rotary table, flat side down. Orient the holes in the Ring so that they line up with the threaded holes in the rotary table.

2. Stone the Table mating surface. Clean with a lint-free rag.

3. With an assistant, lift and place the Bearing onto the Table, on top of the Spacer.

4. Align the bolt holes in the Table with the countersunk holes in the outer Bearing race. Make sure the Spacer will pull up into the inner Bearing diameter. There should be no interference-fit problems.

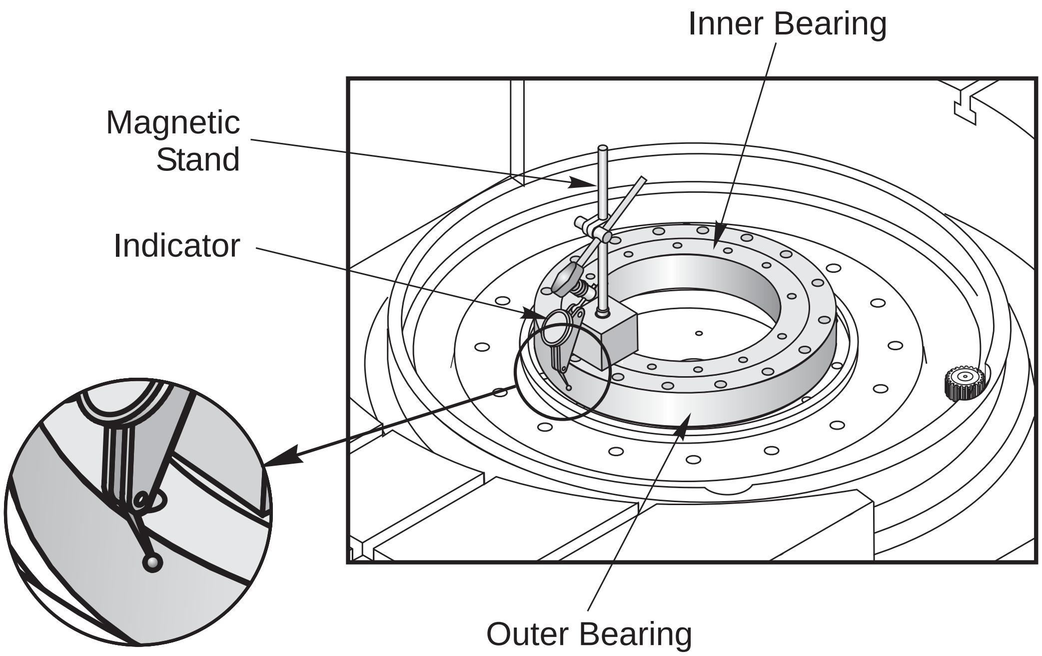
5. Insert the SHCS by hand through the Bearing and into the Table.

6. Tighten the SHCS in a star pattern until the screws are snug. Evenly tighten the screws to seat the Bearing, then back off each SHCS 1/16 turn.

NOTE: If you are installing the Bearing by yourself, it will be useful to have a mirror positioned to see the indicator when it is on the far side of you.

7. Remove four of the SHCS that lie along the X- and Y-axis.

8. Attach a Magnetic Indicator Stand (MIS) to the inner Bearing race. Adjust the indicator to point to the side of the outer Bearing surface as shown in the following figure.



9. Turn the inner race to find high and low spots. To ease this procedure, place a long bolt into one of the holes in the inner race. Do not use the MIS to rotate the Bearing.

NOTE: The acceptable tolerance for the Bearing is .0002”. This is due to the 3:1 distance differential between the Platter diameter and the Bearing diameter.

NOTE: During the following adjustment procedure, keep these guidelines in mind:
1. Adjust the Bearing runout only from the high spots.
2. Adjust out only 1/2 of needed measurement. The high side will shrink by half, the low side will grow by half.
3. Periodically rotate the Bearing completely to realign the bearing rollers after adjustment.

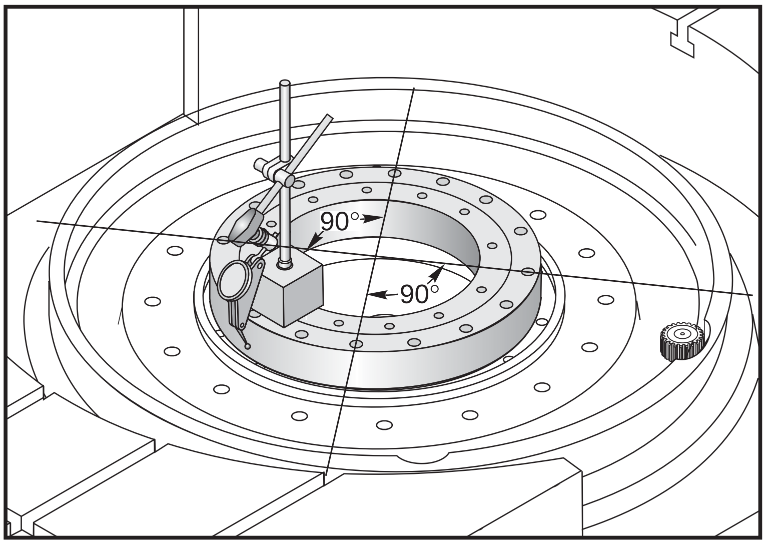
10. Turn the Bearing until the lowest spot is encountered. Zero the Indicator. Turn the Bearing until the high spot is encountered (this should be 180 degrees opposite the low spot).

11. Insert a long T-Handle hex wrench into the bolt hole in the outer Bearing nearest the high spot. Place pressure on the hex wrench towards the low side to adjust the Bearing.

NOTE: Adjusting the Bearing in this manner will move the top part of the outer bearing in the direction pressed, placing leverage against the bottom part of the outer bearing.

NOTE: During this procedure, it will be necessary to tighten selected bolts in the outer race to keep your adjustments. This is not exactly defined, depending upon adjustments necessary during this process.

12. Perform Steps 9 through 11 until the Bearing reads within .0002" of true. Torque the SHCS to 20 ft./lbs. in a star pattern (there should be very little effort needed to reach this value if you have tightened bolts during the previous Steps). Torque the SHCS in sets of four, rotating the Bearing between each screw. Each SHCS of the set should be 90 degrees from each other.



13. Recheck Bearing runout. Ensure the Bearing remains within at least .0002" of true. If the Bearing has slipped out of true, repeat Steps 9 through 11.
14. Torque the SHCS in 5 ft/lbs. increments. Recheck Bearing runout after each torque sequence. The final torque value is 45 ft/lbs.
15. Recheck Bearing runout. Make sure the Bearing has not shifted after the final torque sequence.

Rotary Table Platter Removal and Installation

Removal

1. Remove the Encoder cover plate
2. Remove the encoder shaft plate. Important: There are two set screw in the encoder shaft plate.
3. Remove the plastic bolt cover plugs and the bolts that secure the table to the bearing.
4. Fasten lifting plates to the platter. Do not use T-nuts and eyebolt; slippage can occur and the platter could fall. Use chains to lift the rotary table. **Do not** use synthetic lifting straps as these have a tendency to stretch which will cause the platter to be lifted off unevenly. An unevenly lifted platter may cause damage to the components beneath it.

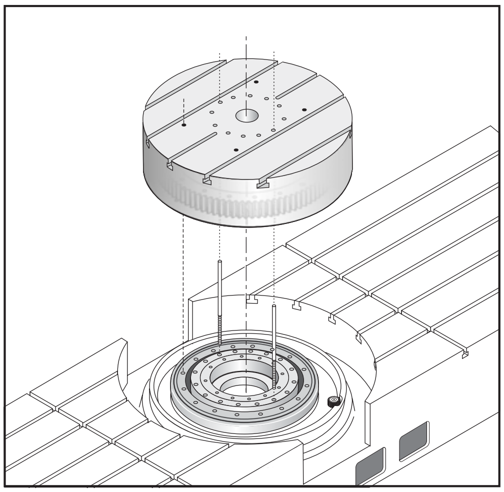
Installation

1. Generously apply red grease to the outer ring of the Brake, completely filling the two grooves. Apply Moly grease around the Stud Flex Nuts filling the counterbores on the Brake Ring, **horse shoe brake only**. Apply moly grease to the Pinion Gear and Ring Gear.

2. Stone and clean the Platter where it will mate with the Bearing. Rotate the inner Bearing holes so they line up on the X- and Y-axis.

3. Use the Backlash Adjusting screws to fully retract the Pinion Gear/Harmonic Drive Assembly.

4. Cut the heads off of two 3/8-16 x 7” threaded rods (40-0021). Insert each through a bearing mounting hole in the Platter so that they are 180° apart. Use these to rotate the Platter to align it with the holes in the inner Bearing. Install the threaded rods into the bearing, use them as a guide when lowering the platter.



5. Hoist the Platter over the Table using a chain fall. Do not use synthetic lifting straps to move or position the Platter.

6. Carefully lower the Platter over the pilot rods and onto the bearing. Thread the rods (from Step 4) into the Bearing Retaining Ring. Ensure the bolt holes in the Platter line up with the bolt holes in the Bearing.

7. When the Ring Gear attached to the Platter contacts the Pinion Gear, manually jog the A-axis so that the teeth mesh and the Pinion Gear does not force the Platter into position.

8. Slowly guide the Platter down the remaining distance.

CAUTION! Do not crash the Platter against the Table. These components are machined to very close tolerances and can be easily damaged by hard metal-to-metal contact.

9. Remove the threaded rods from Step 4.

10. Install the 12 3/8-16x4” (40-16430) SHCS to fasten the platter to the bearing.

NOTE: You will need a T-Handle wrench or a 6” long hex socket to tighten the SHCS in the Platter. Socket extensions will not fit.

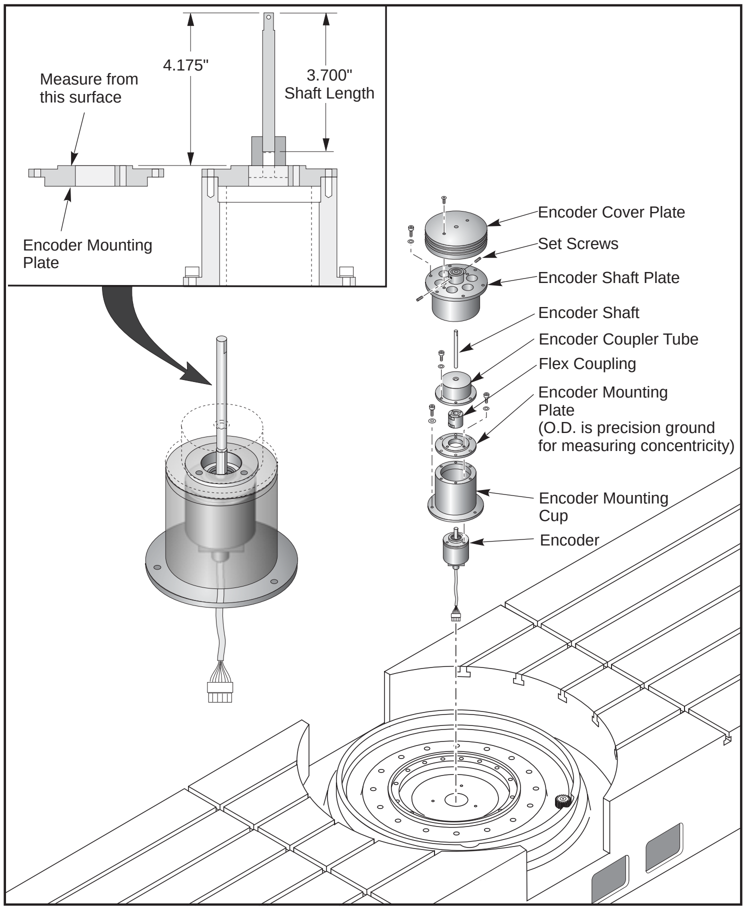
11. Tighten the SHCS incrementally in a star pattern to avoid misaligning the Bearing. Torque the SHCS in stages up to a final torque of 45 ft./lbs.
12. Before replacing the encoder shaft plate, make sure the set screws are backed off.
13. Tighten the screws securing the encoder shaft plate to the platter.
14. Tighten the set screws to clamp the shaft plate to the encoder shaft
15. Replace the encoder cover plate.

Installation - Encoder

Pre-assembly Verification

Before assembling the encoder mounting parts, perform the following checks:

1. Verify that the encoder mounting plate can be inserted into the encoder mounting cup without binding. The contacting surfaces must be burr-free.
2. Verify that the encoder shaft has no detectable side-to-side play. Perform this test by hand.
3. Verify that the encoder boss can be inserted into the encoder mounting plate without binding. The contacting mating surfaces must be flat and free of burrs.
4. Verify that the encoder shaft can be inserted into the encoder shaft plate to the full depth of the bore in the encoder shaft plate without binding.
5. Verify that the encoder shaft plate can be inserted into the platter bore without binding. The contacting surfaces must be flat and burr-free.



Assembly

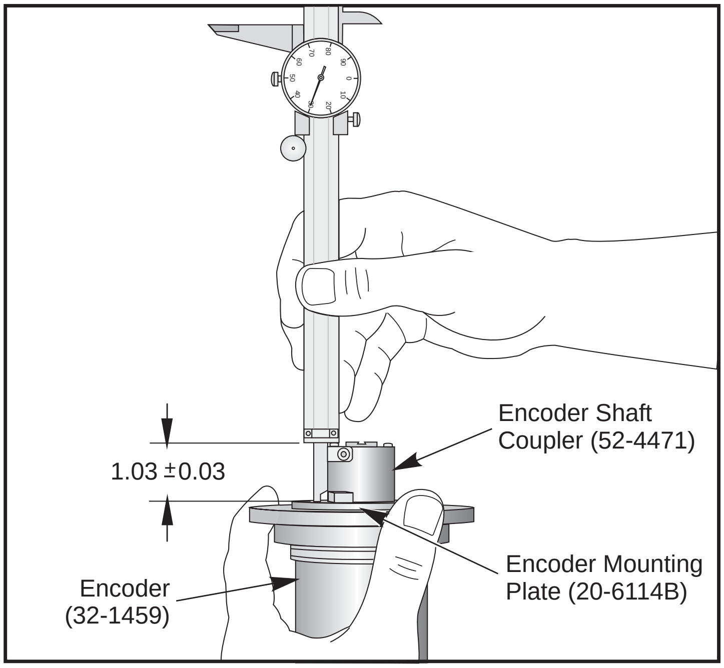
1. Install the encoder mounting cup with one 0.005, (Haas p/n 45-0057), shim washers under each screw location.

2. Install the encoder onto the bottom of the encoder mounting plate. Install the encoder mounting plate assembly onto the top of the encoder mounting cup. Use three screws at 120° spacing to mount plate. The remaining three threaded holes are for the encoder coupling tube.

3. Attach a magnetic base and indicator to the inner race of the cross-roller bearing and indicate off the top face of the encoder mounting plate. Add or subtract shims to adjust the face run-out of the top face of the encoder mounting plate, flatness NTE 0.0005”. Shims are available in the following thickness’: 0.001 (45-0054), 0.002 (45-0055), 0.003 (45-0056), and 0.005 (45-0057).

4. Adjust the indicator to indicate off the outer diameter of the encoder mounting plate. Sweep the outer diameter of the encoder mounting plate concentric to the cross-roller bearing, concentricity NTE 0.0005”.

5. Before proceeding, test fit the encoder shaft into the encoder shaft plate to ensure that it fits in completely without binding, and that the set screws have been completely backed out or removed. Install flex coupling. Install encoder shaft to the dimension shown in the assembly*. Install encoder coupling tube.
   ***Failure to install encoder shaft to correct height will result in damage to flex coupling.**



6. Install the rotary table platter and indicate its bore concentric with the cross-roller bearing, concentricity NTE 0.0005”.
   NOTE: Be careful not to deflect the encoder shaft - damage to the flex coupling may result.

7. When installing the encoder shaft plate, ensure that the flats on the encoder shaft are lined up with the set screw holes in the shaft plate. Set screws <u>must</u> be removed before performing this operation.

8. After seating the encoder shaft plate, tighten the screws securing the encoder shaft plate to the platter. Then install and tighten the set screws. Install o-ring onto the top of the encoder shaft plate.

9. Install the encoder shaft plate: Grease o-rings. Install o-rings onto the encoder cover plate. Install the encoder cover plate into the platter bore.

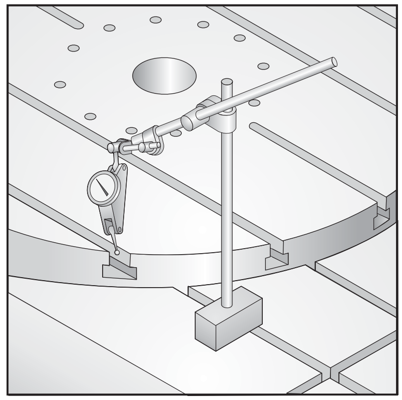
Checking A-axis Backlash

1. Command the A-axis brake to disengage. To do this enter MDI and command an M11. Do not disconnect the air to the machine.

2. Disable the A-axis encoder by setting the parameter 43 bit 3 to 1. Note: This will disable the rotary table position encoder and enable the drive motor encoder. The drive motor gear will now hold position allowing backlash to be measured between the ring and pinion gear.

3. Verify the brake is disengaged, by ensuring the platter can be rotated a slight amount.

4. Set up an indicator on the non-rotary part of the table and set the indicator needle against a T-slot. See figure.



5. Manually rotate the platter back and forth. At times additional force is required to overcome the friction. Use platter lifting plates or a fixture on the platter with a cheater bar between them, if necessary, to move the platter.

6. Take readings from the indicator every 10° for 360°. Note: the indicator must be repositioned each time. Backlash should be between .0005” and .0007”. If it is not within this range perform the following adjustment procedure.

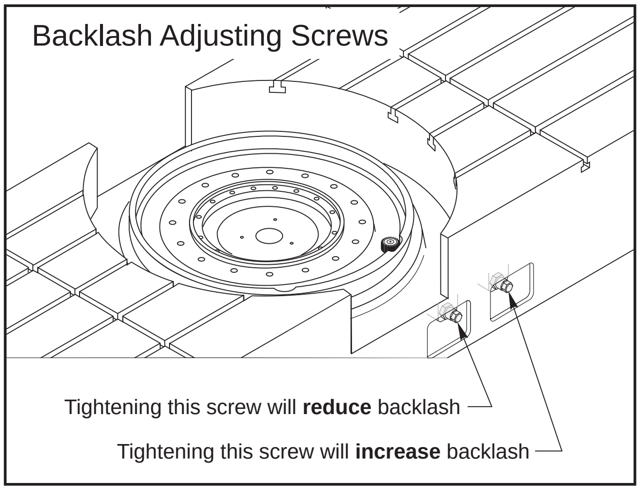
A-axis Backlash adjustment

1. Command the A-axis brake to disengage. To do this enter MDI and command an M11. Do not disconnect the air to the machine.

2. Disable the A-axis encoder by setting the parameter 43 bit 3 to 1. Note: This will disable the rotary table position encoder and enable the drive motor encoder. The drive motor gear will now hold position allowing backlash to be measured between the ring and pinion gear.

3. Loosen the 3/4-11 hex head bolts that secure the cam backlash adjuster (motor plate) to the underside of the table. It is not required to remove these bolts completely, only loosen them. The 2 SHCS that bolt through the plate are shoulder bolts and do not need to be loosened.

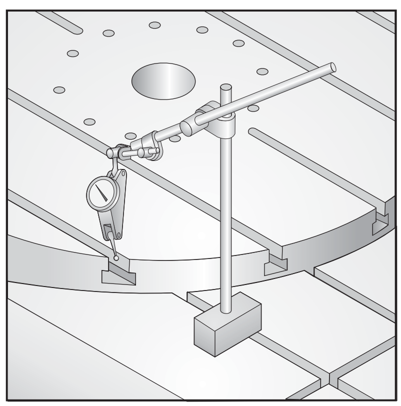
4. Loosen the backlash adjusting screw lock nuts on both of the adjusting screws. See the following figure. Loosen the left adjusting bolt and thread it back away from the plate. Tighten the right bolt three turns. This will increase the backlash between the drive and ring gear. Note: As this bolt is driven in it may start to bind. If this happens back the bolt off slightly and then continue tightening.



5. Verify the brake is disengaged and that backlash exists by manually moving the platter back and forth. At times additional force is required to overcome friction. Use platter lifting plates or a fixture on the platter with a cheater bar between them, if necessary, to move the platter within the allowable backlash.

6. Back the right bolt all the way out.

7. Set up an indicator on the non-rotary part of the table and set the indicator needle against a T-slot. See figure.



8. Begin tightening the left adjusting bolt and check the backlash. Using the cheater bar between the lifting plates or fixtures, nudge the table CW and CCW. Take readings from the indicator. Once the readings come close to .003”, rotate the table and take readings every 10° for 360°. Find the tightest of these spots and set the indicator up as in the previous step.

9. Tighten the left adjusting bolt until the backlash is between .0005” and .0007”

10. Snug the right adjusting bolt against the bracket.

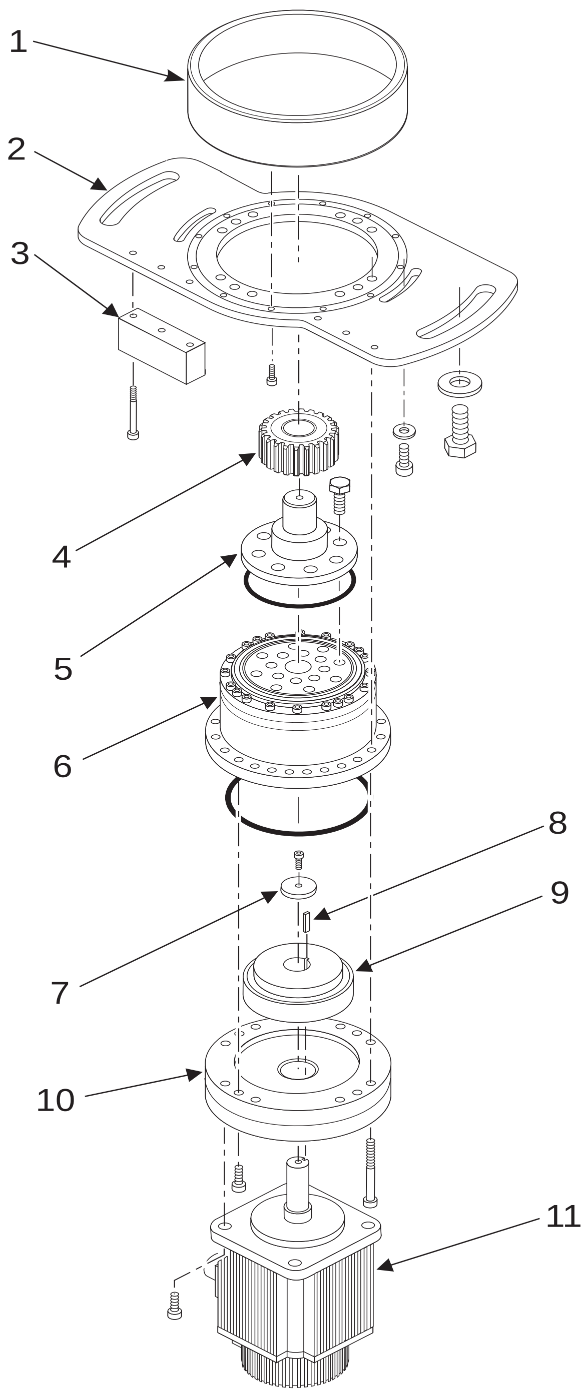
11. Tighten the 3/4-11 hex bolts that mount the cam backlash adjuster (motor plate).

12. Tighten the adjusting screw lock nuts.

13. Recheck the backlash. If adjustment is necessary, loosen the plate’s hex bolts and adjusting screw’s lock nuts before making adjustments.

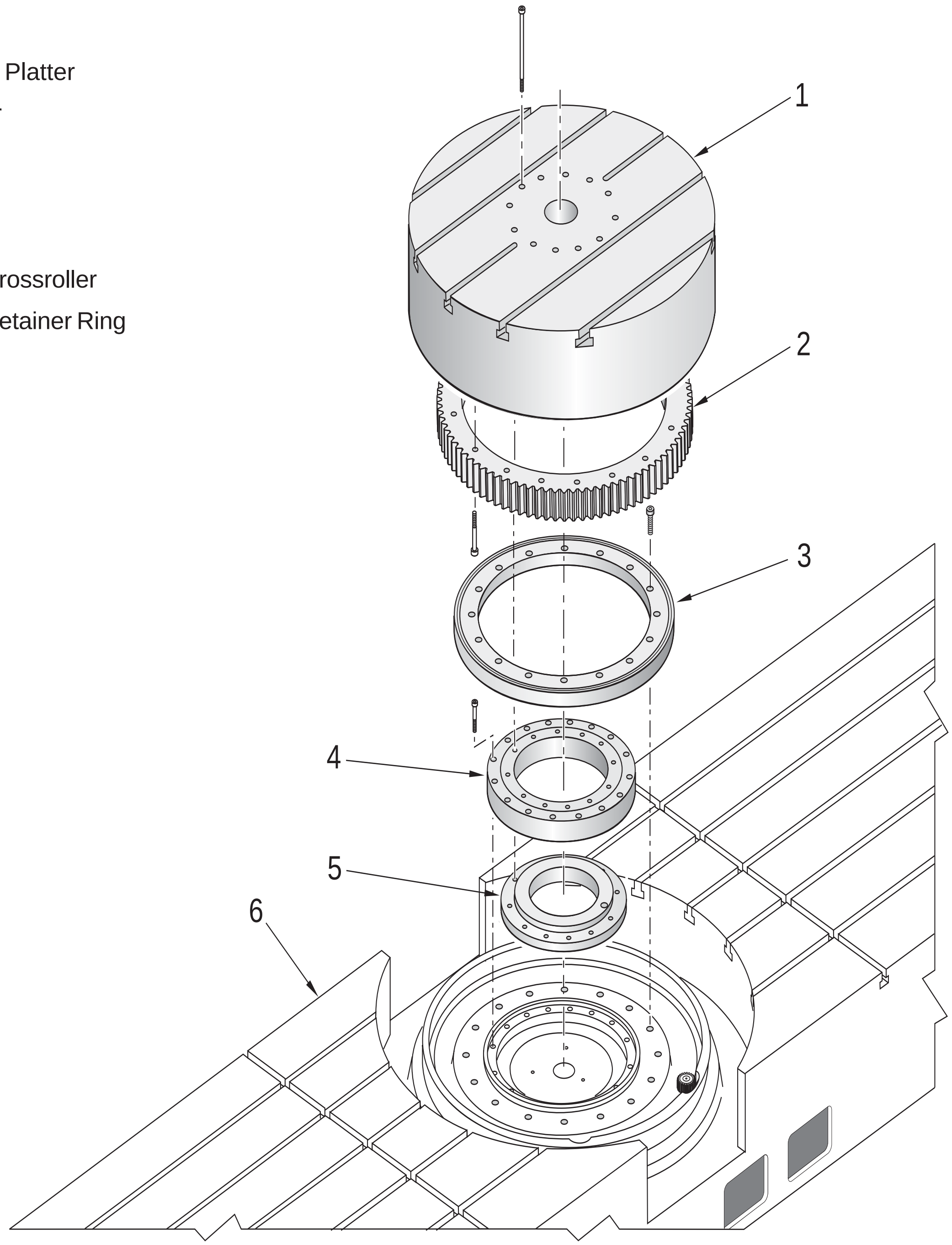
3.23 4th Axis Harmonic Drive Assembly - Exploded Parts List

1 Tube Backlash Adjuster
2 Cam Backlash Adjuster
3 Push Block
4 SCHS
5 SHCS
6 Pinion Gear
7 Sigma Adapter
8 Harmonic Drive
9 O-Ring
10 MSHCS
11 Shoulder Washer
12 Gearbox Adapter
13 SHCS
14 SHCS
15 Flat Washer
16 HHB
17 Spring Washer
18 Shoulder Screw
19 MHHB
20 O-Ring
21 Yaskawa Motor Key
22 Wave Generator
23 SHCS
24 Yaskawa Sigma Motor



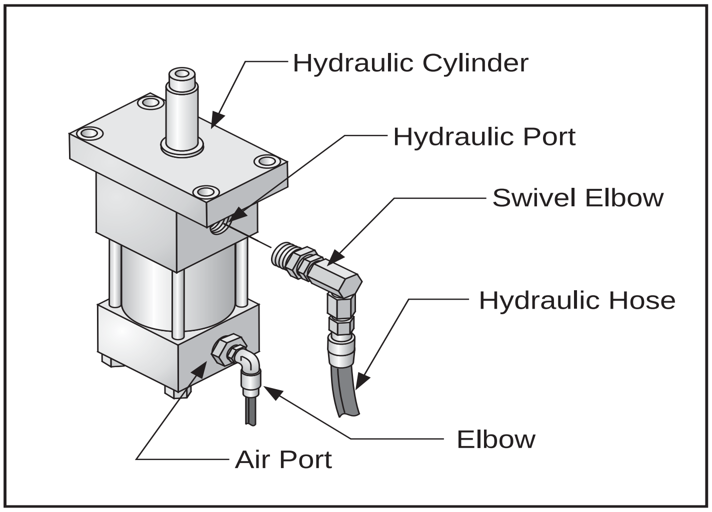
3.24 4th Axis Table Assembly - Exploded Parts List

1 SHCS
2 Machined Platter
3 Ring Gear
4 SHCS
5 Brake
6 SHCS
7 Bearing Crossroller
8 Bearing Retainer Ring



3. Thread a Reducer into the hydraulic port. Thread the Swivel Elbow into the Reducer. Thread the Hydraulic Hose from the Pressure Booster into the Swivel Elbow. Orient the Swivel Elbow as shown below and tighten.

4. Thread Elbow into the air port. Orient the Elbow as shown below:



Hydraulic Cylinder (side view)

5. Cut the Tubing to fit once installed in the Table. Insert one end of one piece of Tubing into the Elbow on the air side of the Hydraulic Cylinder.

6. Thread one of the two remaining Elbows into the low-pressure port of the Pressure Booster, located in the middle of the Pressure Booster. Insert one end of one piece of Tubing into the low-pressure Elbow. Coil the Tubing and mark with masking tape. See Figure.

7. Place the Pressure Booster flat on the work surface. Route the Braided Hose upward and use caution to avoid fluid spillage.

8. Thread the remaining Elbow into the high-pressure port, located on the rear of the Pressure Booster cylinder. Insert one end of one piece of Tubing into the high-pressure Elbow. Coil the Tubing and mark with masking tape. See Figure.

9. Use wire ties to secure the Tubing lines to follow the Hydraulic Hose out.

PRESSURE BOOSTER ASSEMBLY BENCH TEST

Prior to installation of the Pressure Booster Assembly, a test of the entire system should be performed. This will identify leaks and allow for the system to be bled while it is still easily accessible. Set the Air Valve Assembly and the Hydraulic Cylinder on top of the Table or other high work surface. Set the Pressure Booster Assembly onto the floor.

1. Identify the low-pressure Tubing line coming from the low-pressure side of the Pressure Booster. Connect this Tubing line to the Low-Pressure Regulator of the Air Valve Assembly.

2. Identify the high-pressure Tubing line coming from the high-pressure side of the Pressure Booster. Connect this Tubing line to the High-Pressure Regulator of the Air Valve Assembly.

3. Connect the Tubing line from the air port of the Hydraulic Cylinder to the unregulated source on the Air Valve Assembly.

4. Attach a supplied air line to the Air Valve Assembly. Supplied air should be set to 85 PSI.

5. Using the appropriate regulator adjuster on the Air Valve Assembly, set the Low-Pressure regulator to 20 PSI.

6. Make sure that the Swivel Elbow connected to the Hydraulic Cylinder is at the highest point of the entire assembly.

CAUTION! During the following Steps, spillage of hydraulic oil may occur. Wear eye protection and have sufficient rags on hand to clean up any purged oil.

7. Set the High-Pressure regulator to approximately 5-10 PSI. Remember that the Pressure Booster will still provide 12:1 pressure boost.

8. Break the mating of the Hydraulic Hose and the Swivel Elbow. Loosen this joint only enough to let air escape.

9. Apply air pressure to the Pressure Booster by pressing the yellow pin-button on the Air Valve Assembly. Do not activate the Pressure Booster for more than a second at a time.

10. When all air has escaped the hydraulic system, tighten the Hydraulic Hose. Readjust the High-Pressure regulator to 70 PSI.

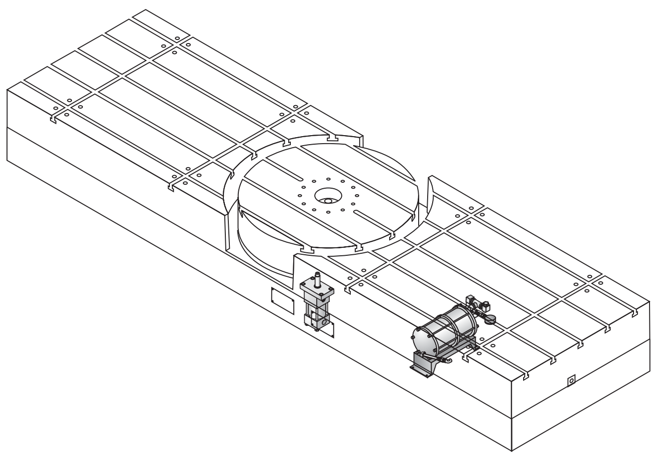
11. If any air leaks have been noticed during this operation, take appropriate measures to fix them before installing the assembly.

Installation - Hydraulic Cylinder

1. Lift the Hydraulic Cylinder into its area beneath the Table. See the Figure below for the approximate location. The hose connections should face the left of the table (away from the Pressure Booster) to prevent kinks in the lines when routed.

2. Thread (4) 1-1/4" SHCS through the mounting tabs of the Hydraulic Cylinder into the Table. Leave these loose for final alignment of the Hydraulic Cylinder (see **Final Alignment - Hydraulic Cylinder**).

3. Route the Hydraulic Hose and air port Tubing beneath the Hydraulic Cylinder and through the mouse holes machined to the right. Install Cable Plates using BHCS to retain the lines. Fit the plastic tabs over the Cable Plates to prevent damage to cables during operation.



Locations of Brake Cylinder Pressure Booster Components (installed from beneath)

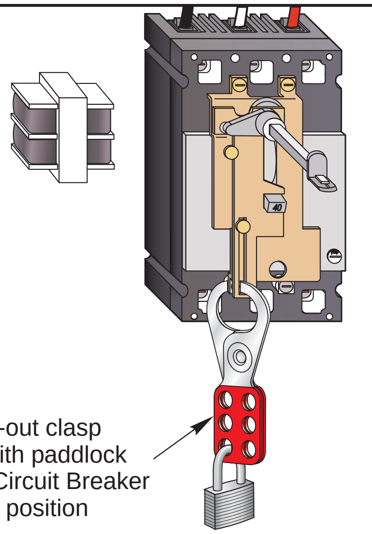
Final Alignment - Hydraulic Cylinder

The following Steps are performed from above the Table.

1. Apply air pressure to the Hydraulic Cylinder. This will cause the piston in the Hydraulic Cylinder to extend. When the piston has extended, thread an SHCS into the pilot hole in the piston shaft and tighten. This will properly align the Hydraulic Cylinder to the Brake Assembly.

2. Tighten the four SHCS that mount the Hydraulic Cylinder to the Table. Relieve the hydraulic pressure.

4. ELECTRICAL SERVICE



Install lock-out clasp and lock with paddlock to secure Circuit Breaker in the OFF position

Make sure the circuit breaker is locked in the off position before attempting any electrical work to avoid possible shock.

CAUTION! Working with the electrical services required for the Horizontal mill 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.

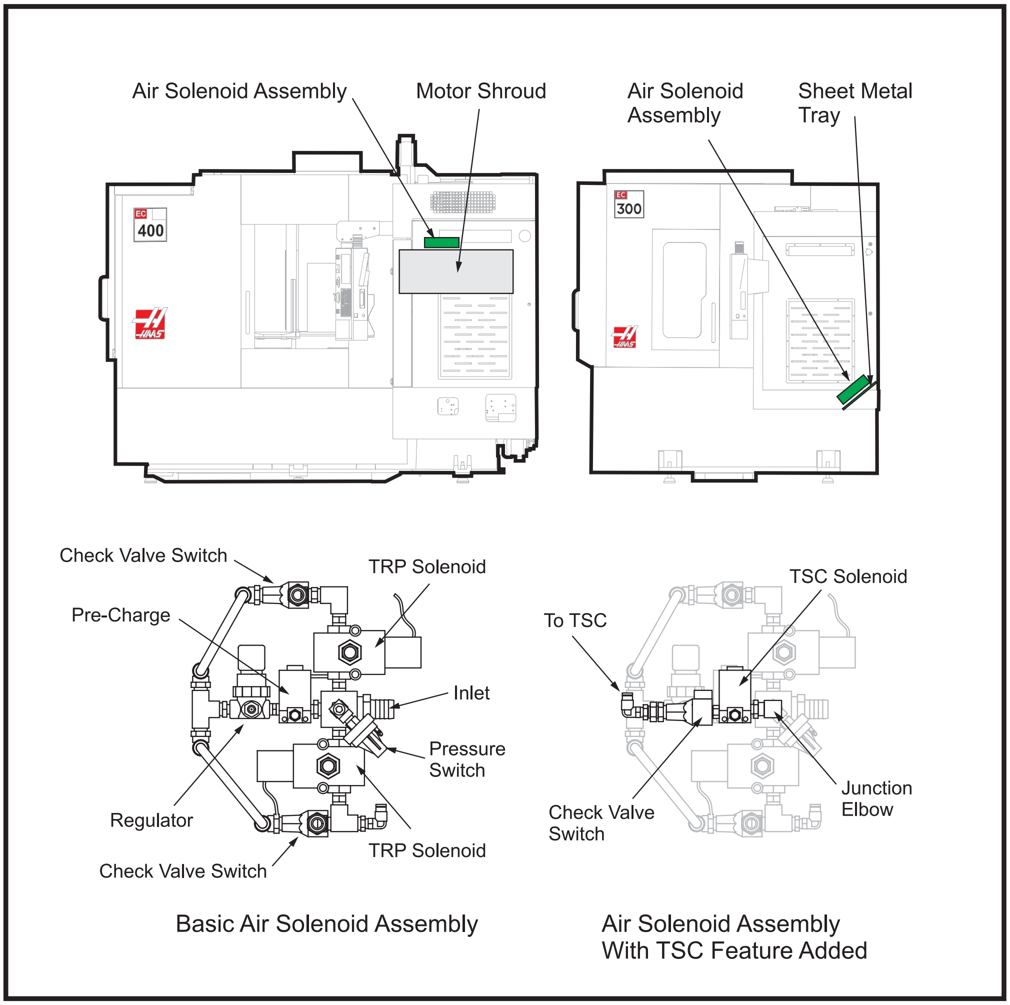
4.1 Solenoids

Please read this section in its entirety before attempting to replace any solenoid assemblies.

Tool Release Piston Air Solenoid Assembly

REMOVAL -

1. Turn machine power ON. EC-300 Raise the spindle head to its highest position (EC-400 lower the spindle head to the lowest position). Turn power OFF.
2. Remove the rear enclosure panel.
3. Remove air supply from machine.
4. Disconnect all air lines connected to the air solenoid assembly on the top front of the solenoid bracket.
5. Unplug the solenoid wiring.



Locations of EC-300 and EC-400 TRP Solenoids

6. Remove the screws holding the assembly to the bracket and remove the assembly.

INSTALLATION -

1. Replace the air solenoid assembly and attach to the bracket with the screws previously removed. Tighten securely.

2. Reconnect all air lines.

4. Reconnect the wiring to the plugs on the solenoid bracket.

5. Reconnect air supply to the machine, and check for leaks.

6. Replace the rear enclosure panel.

Spindle Lube Air Solenoid

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

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.

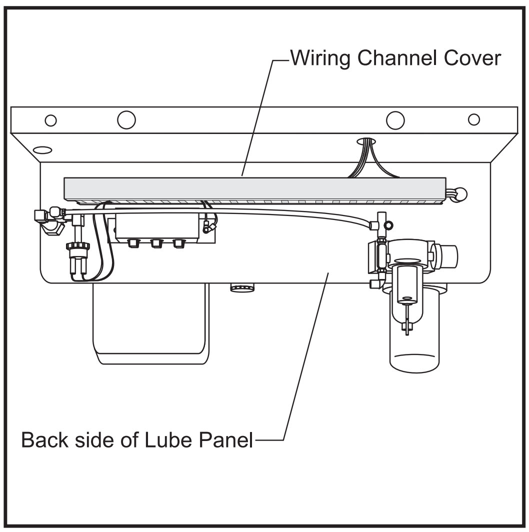


Figure 4.1-1. Top view of spindle lube/air solenoid assembly.

4. Unscrew the assembly from the T-fitting.

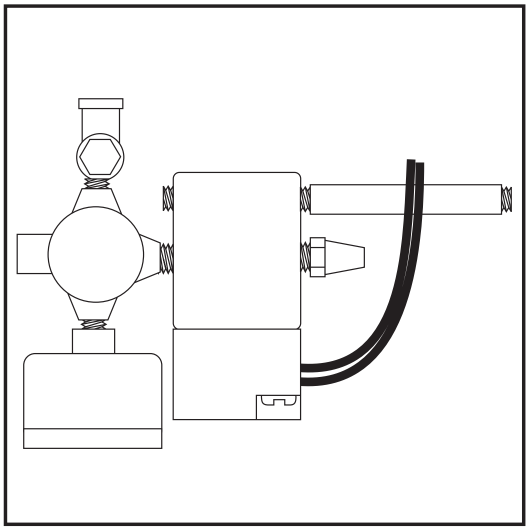


Figure 4.1-2. Top view of spindle lube/air solenoid assembly.

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.

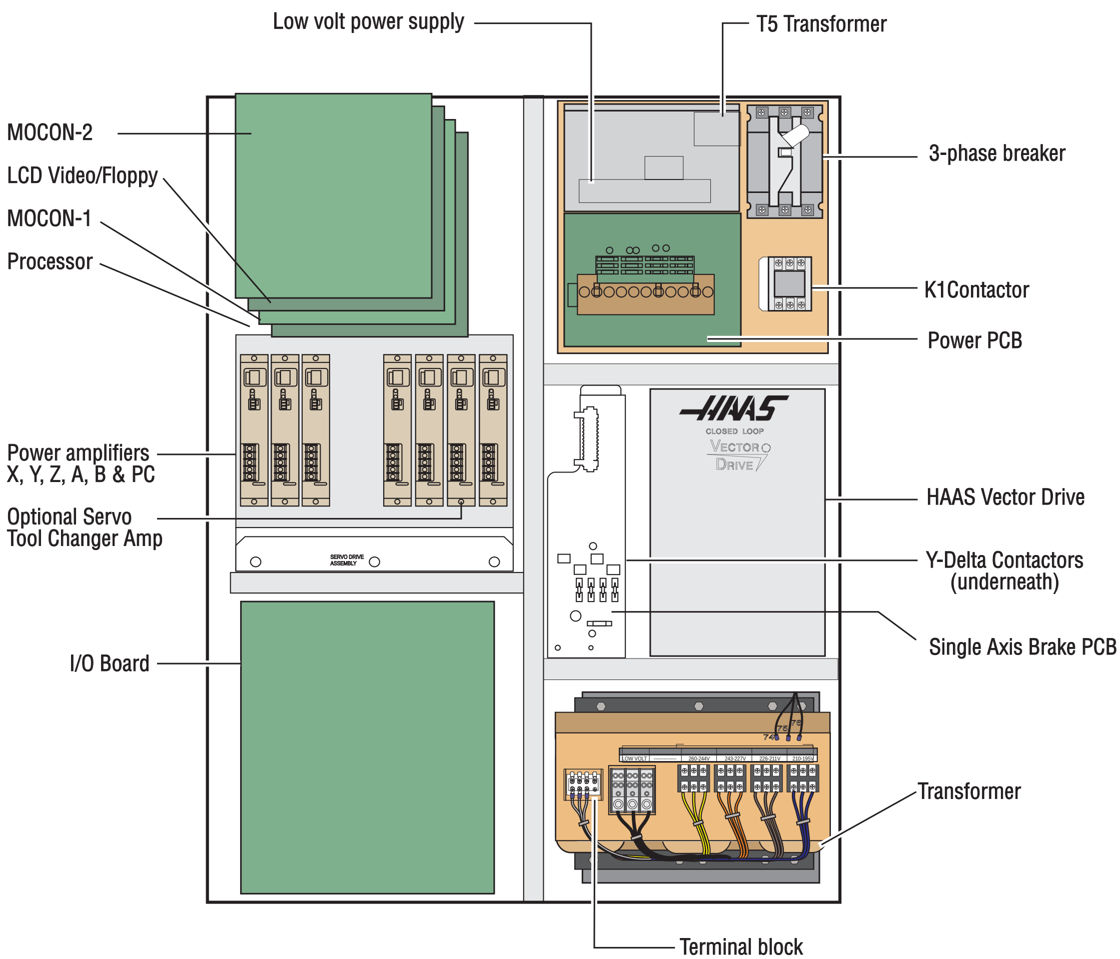
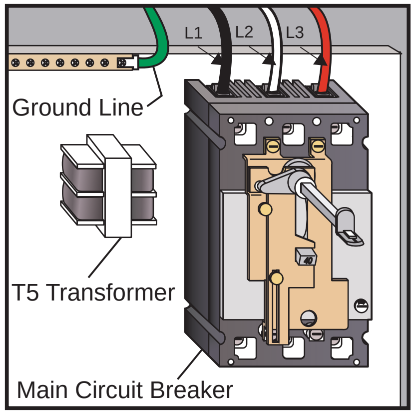


Figure 4.2-1. Control panel general overview (EC-300 Shown)

NOTE: The machine must have air pressure at the air gauge, or a "Low Air Pressure" alarm will be present on power up.



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.

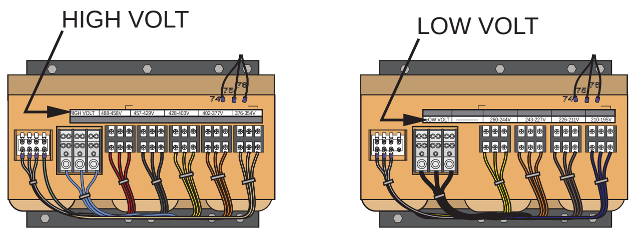
NOTE: Make sure that the service wires actually go into the terminal-block clamps. (It is easy to miss the clamp and tighten the screw. The connection looks fine but the machine runs intermittently or has other problems, such as servo overloads.) To check, simply pull on the wires after the screws are 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 (360 and 480 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.

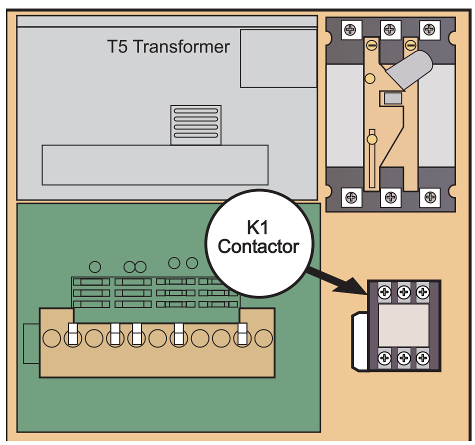
CAUTION! Make sure that the main breaker is set to OFF and the power is off at your supply panel BEFORE you change the transformer connections. Make sure that all three black wires are moved to the correct terminal block and that they are tight.

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 will 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.



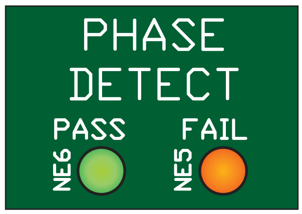
WARNING!

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 Fuses

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.

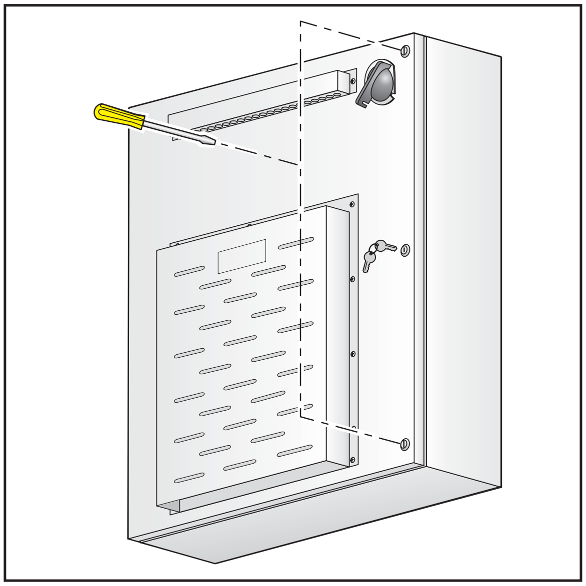


Figure 4.3-1

3. Open the cabinet door and wait until the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.

4. On the POWER SUPPLY board there are three fuses located in a row at the upper right of the board; these are the overvoltage fuses. An orange light will be on to indicate the blown fuse(s).

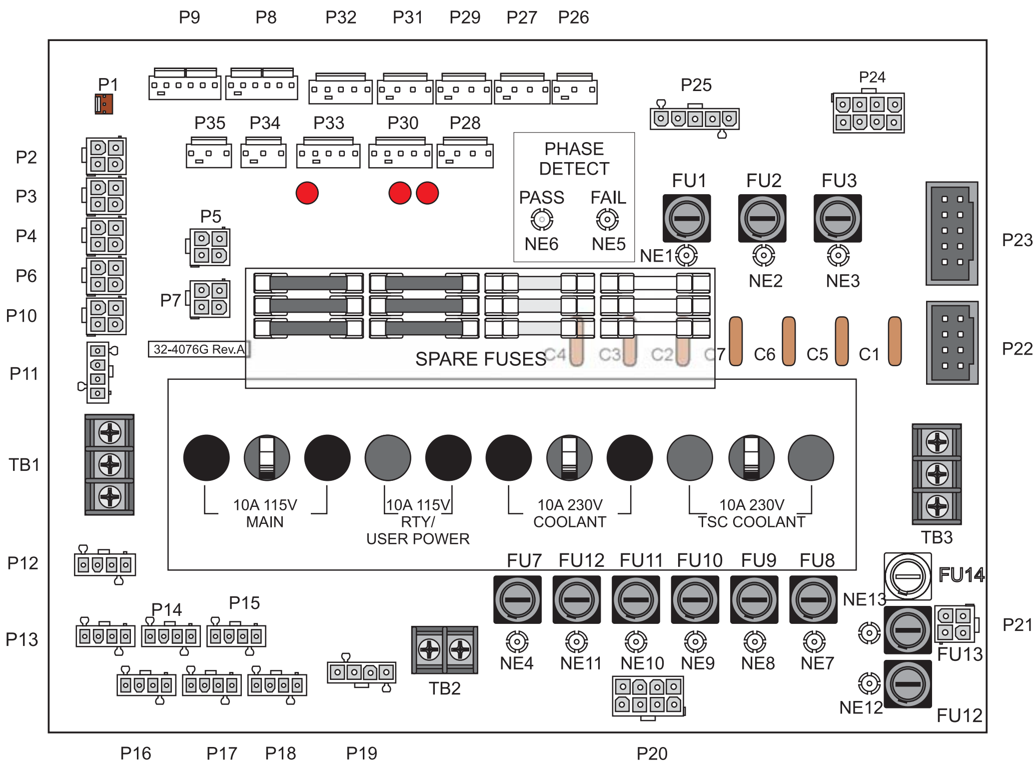


Figure 4.3-2 Power supply board; fuse locations.

5. Using a flat tip screwdriver, turn the fuse(s) counterclockwise to remove and replace the blown fuse(s) with ones having the same type and rating (½ amp, type AGC, 250V).

CAUTION! When the left fuse is blown, it is still possible to operate the machine, thereby making an overvoltage situation possible. VERIFY absolute voltage to the machine does not exceed 200 volts (Max 260 leg to leg or leg to ground, or 400 volts on high voltage machines-max 520 volts leg to leg of leg to ground).

4.4 PCB Replacement

Please read this section in its entirety before attempting to replace any PCBs.

Microprocessor, Mocon & Video / Keyboard

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 amplifiers go out. The servo amplifiers are 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.

GROUND STRAPS MUST BE USED WHEN HANDLING BOARDS

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.

MOCON 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. Open the cabinet door and wait until the red CHARGE light(s) on the servo amplifiers go out before beginning any work inside the electrical cabinet.
4. Disconnect all leads to the Motor Controller (MOCON) board. 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 board, attaching it to the VIDEO / KEYBOARD (beneath the MOCON 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 board as described in Steps 1-5.
9. Disconnect all leads to the Video / Keyboard. Ensure all cables are properly labeled for reconnecting later. The following illustration shows all cable numbers and the locations on the Video / Keyboard.

10. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.

NOTE: If the PROCESSOR board needs replacing, please skip the next step.

11. Replace the Video / Keyboard, attaching it to the PROCESSOR board (beneath the Video / Keyboard) with the standoffs.

12. Reconnect all leads (previously removed) to their proper connections.

PROCESSOR BOARD -

NOTE: Refer to "Cable Locations" for a diagram of this board.

13. Remove the MOCON board as described in Steps 1-7, and the Video / Keyboard as described in Steps 8-9.

14. Disconnect all leads to the Processor board. Ensure all cables are properly labeled for reconnecting later. The following illustration shows all cable numbers and the locations on the Processor 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 board, attaching it to the electrical cabinet (beneath the Processor board) with the standoffs.

17. Reconnect all leads (previously removed) to their proper 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 following illustration shows all cable numbers and the 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 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 Power Distribution 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. Do not 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 -

NOTE: Refer to "Cable Locations" for a diagram of this board.

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 following illustration shows all cable numbers and the 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.

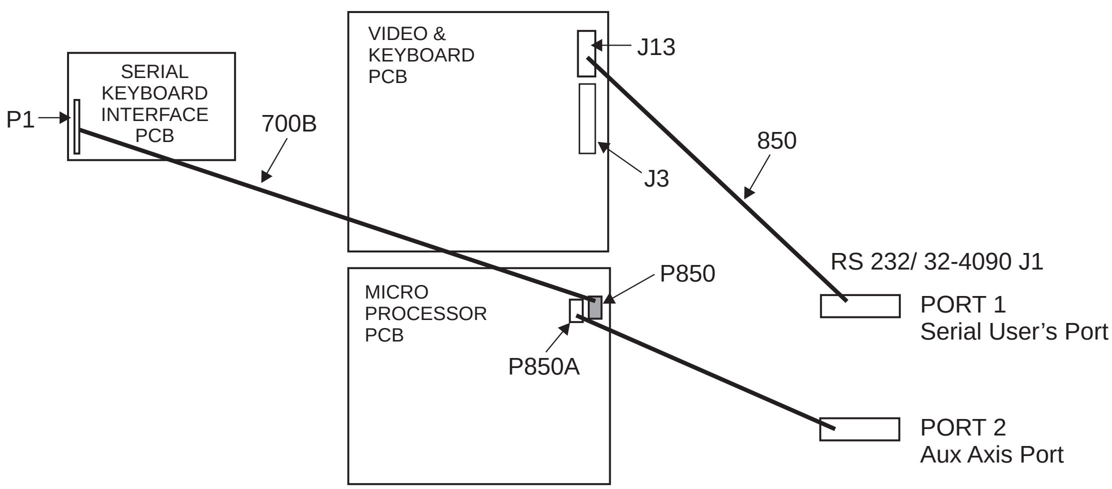
1. Follow all precautions noted previously before working in the electrical cabinet (See warning at beginning of "Servo Driver & SDIST" section).

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

NOTE: It is suggested to make use of a step ladder high enough to allow you to work from the top of the electrical cabinet. It will be necessary, when replacing the RS-232 board, to work from the inside and outside of the cabinet at the same time.

4. On the left side of the cabinet, at the top of the side panel are two serial port connections labeled "SERIAL PORT #1" and "SERIAL PORT #2", SERIAL PORT #1 being the upper connection.



* Serial interface replaces cable 700 with cable 700B.

Figure 4.4-1. RS-232 wiring pictorial (with serial keyboard).

5. To remove the RS-232 board, unscrew the two hex screws (on the exterior of the cabinet) holding the connector to the cabinet. From the inside of the cabinet, pull the connector through the panel, and disconnect the cable.

6. Replace the RS-232 board by first connecting the appropriate cable to the board (850 to SERIAL PORT #1, 850A to SERIAL PORT #2, then inserting the board (cable side up) through the left side panel. Attach with the two hex screws previously removed. Ensure the board for Serial Port #1 is the upper connector and the board for Serial Port #2 is the lower connector.

7. Replace the Serial Keyboard Interface (KBIF) board, using the four screws previously removed, starting at the top right. Attach the screw and standoff loosely, then all other screws and standoffs, until all are mounted. Tighten down completely.

8. Reconnect all cables to the Serial KBIF board at their proper locations.

RS-232 Serial Interface

There are two connectors used for the RS-232 interface. The RS-232 connector on the back of most PC's is a male DB-25, so only one type of cable is required for connection to the controller, or between controllers. This cable must be a DB-25 male on one end and a DB-25 female on the other. Pins 1, 2, 3, 4, 5, 6, 7, 8, and 20 must be wired one-to-one. It cannot be a Null Modem cable, which inverts pins 2 and 3. To check cable type, use a cable tester to check that communication lines are correct. The controller is DCE (Data Communication Equipment). This means that it transmits on the RXD line (pin 3) and receives on the TXD line (pin 2). The RS-232 connector on most PC's is wired for DTE (Data Terminal Equipment), so no special jumpers should be required.

The Down Line DB-25 connector is only used when more than one controller is to be used. The first controller's down line connector goes to the second controller's up line connector, etc.

The RS-232 interface sends and receives **seven data bits, even parity, and two stop bits**. The interface must be set correctly. The data rate can be between 110 and 19200 bits per second. When using RS-232, it is important to make sure that Parameters 26 (RS-232 Speed) and 33 (X-on/X-off Enable) are set to the same value in the controller and PC.

If Parameter 33 is set to **on**, the controller uses X-on and X-off codes to control reception, so be sure your computer is able to process these. It also drops CTS (pin 5) at the same time it sends X-off and restores CTS when is sends X-on. The RTS line (pin 4) can be used to start/stop transmission by the controller or the X-on/X-off codes can be used. The DSR line (pin 6) is activated at power-on of the controller and the DTR line (pin 20 from the PC) is not used. If Parameter 33 is 0, the CTS line can still be used to synchronize output.

When more than one HAAS controller is daisy-chained, data sent from the PC goes to all of the controllers at the same time. That is why an axis selection code (Parameter 21) is required. Data sent back to the PC from the controllers is OR'ed together so that, if more than one box is transmitting, the data will be garbled. Because of this, the axis selection code must be unique for each controller.

RS-232 Remote Command Mode

Parameter 21 must be non-zero for the remote command mode to operate as the controller looks for an axis select code defined by this parameter. The controller must also be in RUN mode to respond to the interface. Since the controller powers-on in RUN mode, remote unattended operation is thus possible.

RS-232 Line Noise

To minimize line noise on the serial port, reroute the cables; route them straight up the left-hand side of the control to the processor stack. Do not run them above the I/O PCB or up the center wire channel to the processor.

The best way to minimize transmission errors is to have a good common ground between the PC and CNC control

4.5 Front Panel

Please read this section in its entirety before attempting to replace any component of the control panel.

LCD Assembly Replacement

CAUTION! Use an electro-static discharge (ESD) strap on wrist when working inside the pendant.

1. Turn the power off and disconnect power to the machine.
2. Remove the screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.
3. Disconnect the data cable from the receiver board on the LCD assembly (J3).
4. Disconnect the power cable and ground wire from the power supply board on the LCD assembly (TB1).
5. Disconnect the cables to the keyboard from the receiver assembly (P1) and power supply (TB2) on the LCD assembly.
6. Remove the four (4) hex nuts and washers beginning with the bottom, then remove the LCD assembly and set aside in a safe place.

CAUTION! Take extreme care to not drop or damage the LCD assembly when removing from the control panel.

7. Use gloves to avoid getting fingerprints on the new LCD. Replace by sliding the new assembly onto the four bolts (two each on top and bottom). Place the washers and hex nuts on the bolts to hold in place. Refer to Fig. 4.5-1. Once all washers have been attached and nuts have been hand-tightened, tighten down completely.

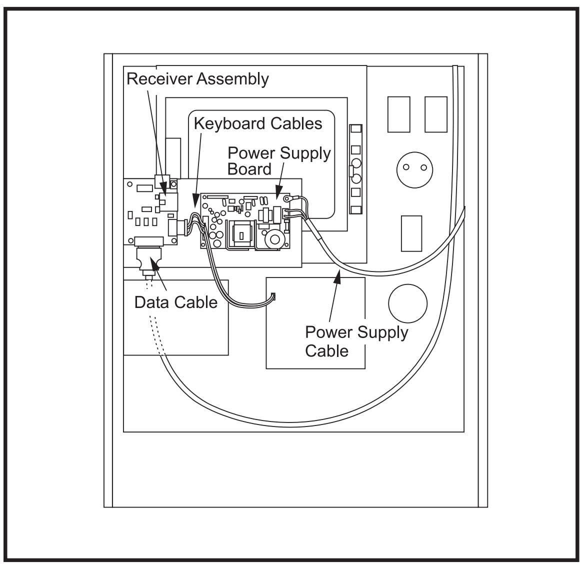


Figure 4.5-1 Interior of control panel (rear).

8. Plug the keyboard cables into the new receiver board (P1) and the power supply (TB2).
9. Plug the power cable into the power supply board (TB1) and attach the green wire to ground.
10. Plug the data cable into the receiver board (J3).
11. Replace the back cover panel and attach with the four screws previously removed.

Jog Handle Replacement

The JOG handle is actually a 100-line-per-revolution encoder. We use 100 steps per revolution to move one of the servo axes. If no axis is selected for jogging, turning of the crank has no effect. When the axis being moved reaches its travel limits, the handle inputs will be ignored in the direction that would exceed the travel limits.

NOTE: 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.

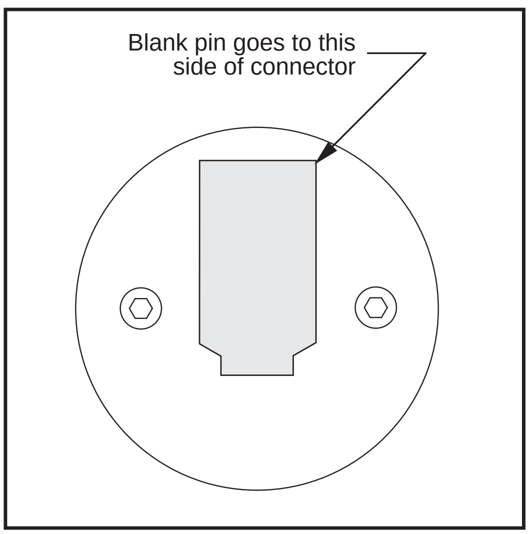
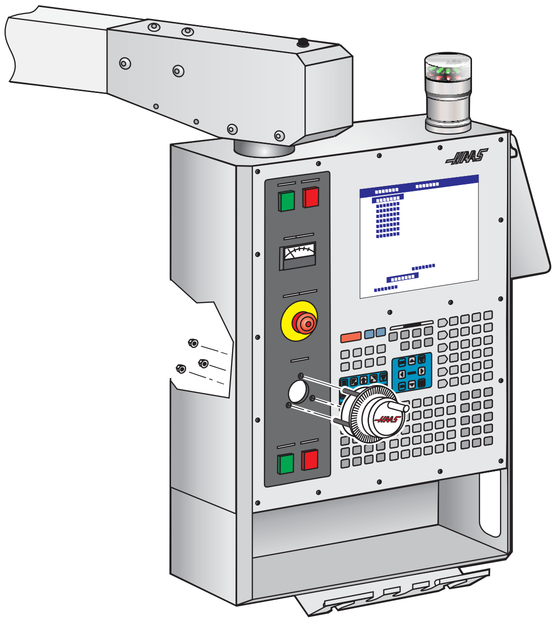


Figure 4.5-2. Jog handle encoder.

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



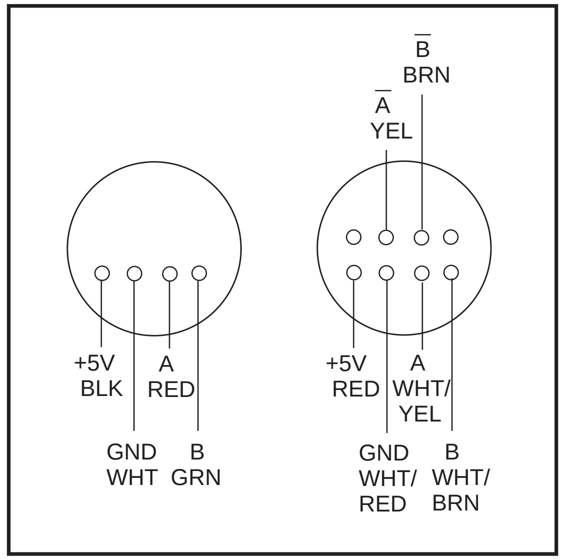


Figure 4.5-3. Jog Handle removal.

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 four 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 counter clockwise 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.

Spindle Load Meter Replacement

1. Turn the power off and disconnect power to the machine.
2. Remove the four 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.

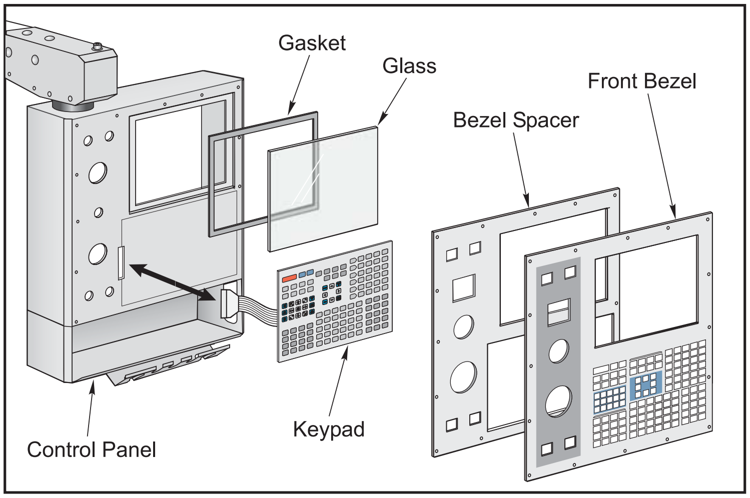


Figure 4.5-5. Keypad installation.

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

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 four 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

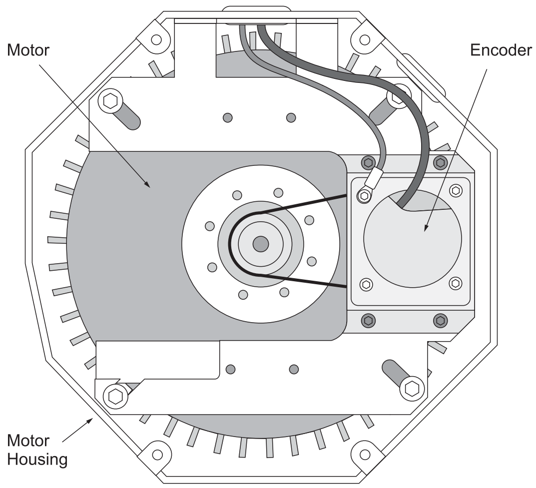
Please read this section in its entirety before attempting to remove or replace encoder.

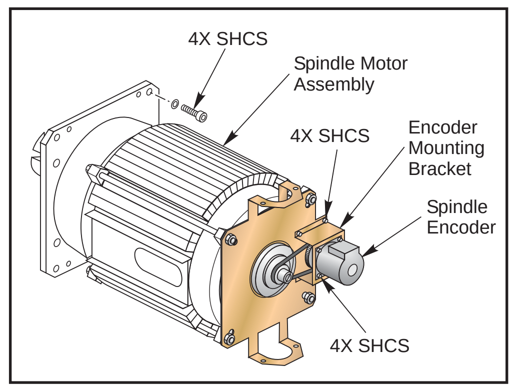
REMOVAL -

1. Turn machine power on. Lower the spindle head to a position that will allow you to easily work on the back of the spindle motor. Turn machine off.

2. Remove the fan and fan shroud (see Mechanical Service section).

3. Remove the four screws holding the encoder to the bracket. Remove the encoder belt to avoid misplacing it.





Spindle Encoder Installation (Fan and Fan Shroud Removed)

INSTALLATION -

1. Loosely bolt the encoder to the bracket.

2. Install the encoder belt to both the motor shaft pulley and encoder pulley.

3. Tension the belt by sliding the encoder in the bracket.

4. Tighten the encoder bolts.

5. TECHNICAL REFERENCE

5.1 Tool Changer

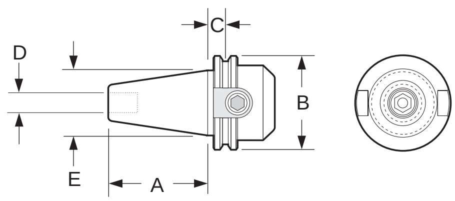
CAUTION!
- Extremely heavy tool weights should be distributed evenly
- Ensure there is adequate clearance between tools in the tool changer before running an automatic operation.

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. All wiring to the tool changer goes through connector P8 on the side of the control cabinet.

Pull Studs

The tool holders used are CT #40 taper, V flange, commonly called "CT 40". Use A 45 Degree, P40T Type 1, inch threads pull stud built to JMTBA standard MAS 403-1982. This pull stud is characterized by a long shaft and a 45° shoulder under the head. Do not use the short shaft or pull studs with a sharp right angle (90°) head as they will not work and will cause serious damage.

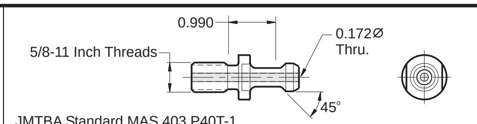
CT CAT V-Flange



	A	B	C	D	E
40T	2.69	2.50	.44	5/8"-11	1.75
50T	4.00	3.87	.44	1"-8	2.75

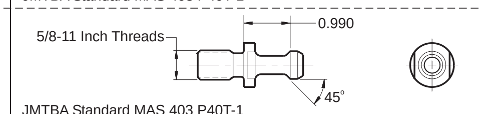
40T

20-7594 (TSC)



Kit # TPS24CT

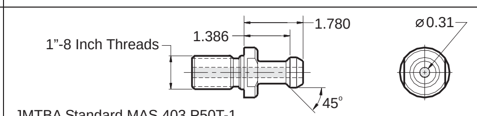
20-7164 (non-TSC)



Kit # PS24CT

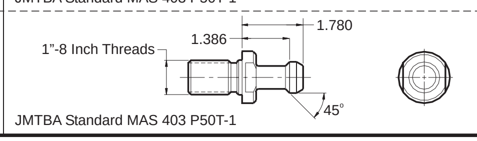
50T

22-0075 (TSC)



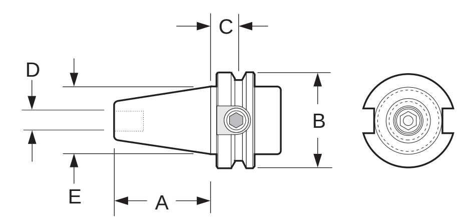
Kit # TPS24CT50

22-0039 (non-TSC)



Kit # PS24CT50

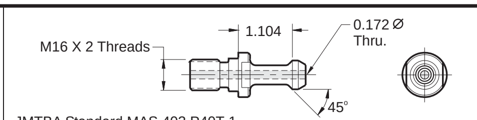
BT MAS 403



	A	B	C	D	E
40T	2.57	2.48	.65	M16X2	1.75
50T	4.00	3.94	.91	M24X3	2.75

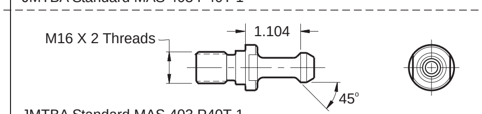
40T

20-7595 (TSC)



Kit # TPS24BT

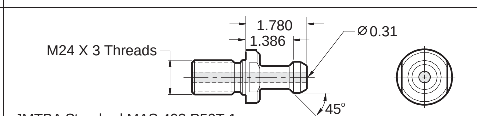
20-7165 (non-TSC)



Kit # PS24BT

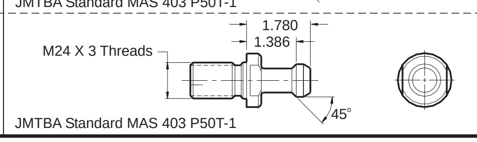
50T

22-7171 (TSC)



Kit # TPS24E50

22-7170 (non-TSC)



Kit # PS24E50

CT40T Pullstud - One Identification Groove
BT 40T - Two Identificaiton Grooves

Tool holders and pull studs must be in good condition and tightened together with wrenches or they may stick in the spindle taper. Clean the tool tapers with a lightly-oiled rag to leave a film to prevent rusting. Tools that make a loud bang when being released indicate a problem and should be checked before serious damage occurs. When the TOOL RELEASE button (on the keypad) is pressed, the tool should be pushed out of the spindle by a small amount (approximately .07"). This is an indication that the pull stud is correctly touching the release mechanism.

Air Pressure

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.

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 CB2.

An inadequate air supply will cause tool changer faults

Follow these guidelines:
Minimum air pressure to the machine is 100psi. Observe the air pressure gauge during a tool change; a 10psi drop is the maximum allowed. 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 10hp air compres-sor).

Use a minimum of 3/8” ID hose for the EC-300, or 1/2” ID for EC-400

Avoid quick disconnects in the air supply lines; they are restrictive.

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.

5.2 Tool Clamp/Unclamp

Air pressure is used to release the spring loaded 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 (not recommended), or from the keyboard. The manual button only operates in MDI or JOG modes.

Tool Clamp/Unclamp Air Solenoids

A single solenoid controls the air pressure to release the tool clamp. This corresponds to relay K15. When the relay is activated, 115V AC is applied to the solenoid. This applies air pressure to release the tool. Relay K15 is on the I/O PCB. Circuit breaker CB4 will interrupt power to this solenoid.

Tool Clamp/Unclamp Sense Switches

There are two switches located on the tool release piston assembly that are used to sense the position of the tool clamping mechanism. They are both normally closed, but one open once clamped and the other when unclamped. 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 tool is removed from the spindle. 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 TSC system applies low air pressure and releases the clamped switch.

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 10,000 RPM for all spindles.

The spindle is hardened and ground to the precise tool holder dimensions providing an excellent fit to the holder.

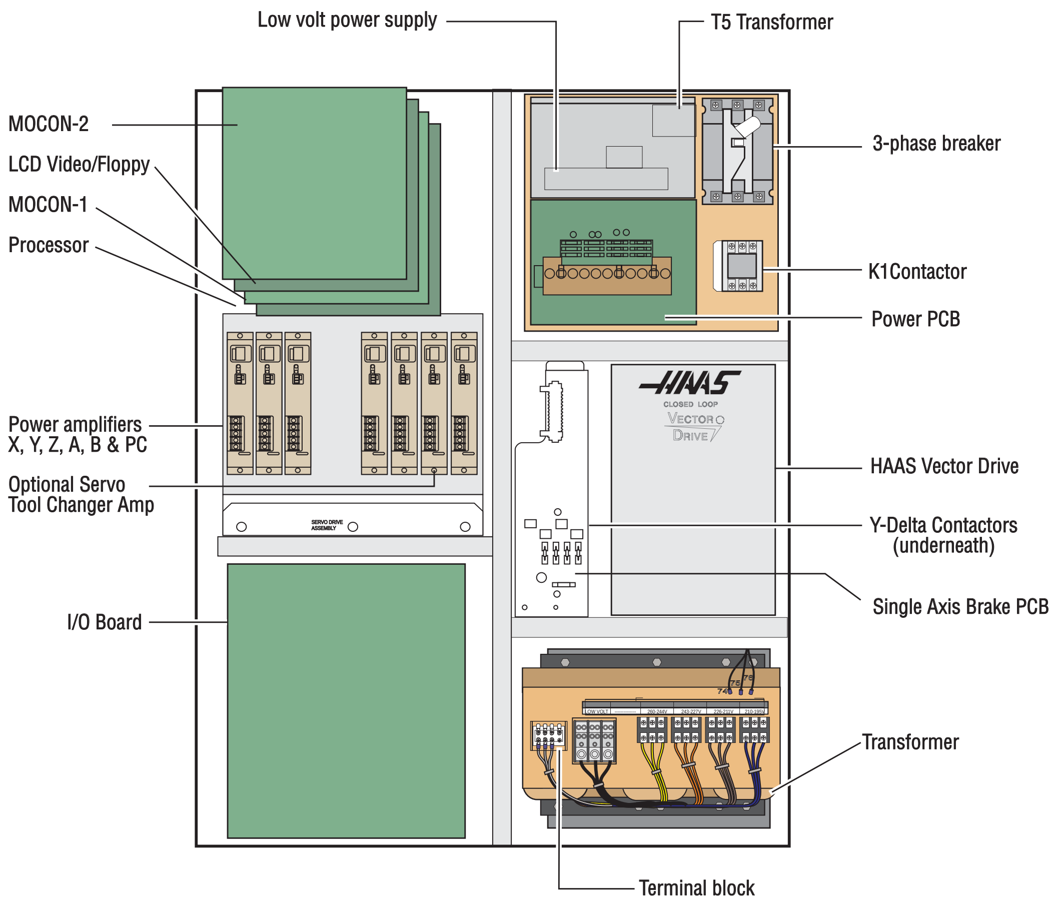
Spindle Warm-up

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).

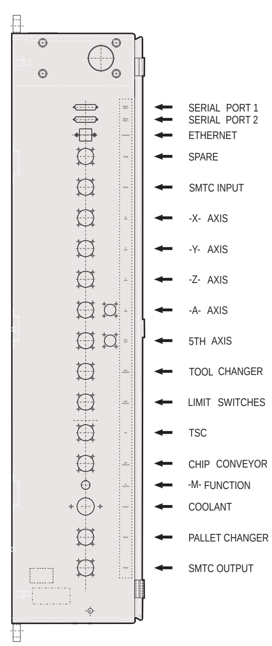
Spindle Orientation

Orientation is performed electrically. 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 in position. If the spindle is orientated, commanding spindle forward or reverse will release the spindle.

5.4 Control Cabinet



Control cabinet general overview.



Connectors on side of control cabinet.

5.5 Servos

Servo Encoders

Haas machines are equipped with brushless motors, which provide for better performance, and no maintenance. The brushless motors have built in 8192 line encoders built in, which result in differences a resolution of 32768 parts per revolution.

The motor controller board has a dedicated processor which does all the servo control algorithm.

Servo Amplifiers

NOTE: Refer to "Cable Locations" section in the Service manual for a diagram of the 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 10 amp (20A for a medium amplifier) supply fuse for failure protection. This fuse is relatively slow, therefore it can handle the 30 amp peak. Actual continues 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 in stalled 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 drawbar motors power on and off. This prevents any arcing of the drawbar motor relays and increases their life tremendously. This includes an adjustable current limit to the tool changer. Potentiometer R45 adjusts the current limit to the drawbar motors* motors. R45 should be set to limit current to between 9 and 11 amps.

The IOPCB also contains a circuit for sensing a ground fault condition of the servo power supply. If more than 1.75 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 drawbar motors*.

The Input/Output Assembly consists of a single printed circuit board called the IOPCB.

5.7 Two-Speed Gear Transmission (EC-1600 HS-3/4/6/7)

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

The transmission requires 5 quarts of Mobil DTE 25 oil. The level should be checked monthly with a dipstick (5 quarts = $4^{3}/_{4}$" deep).

The gear box uses an oil sump and is cooled by gear oil.

Gear Box Air Solenoids

There is a double solenoid valve controlling air to the gear box. 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 or low gear. Circuit breaker CB4 will interrupt power to these solenoids. Power is left on the solenoid which is commanded last.

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. 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.

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, used to move one axis at a time. 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%. Note that 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.

Note 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.

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.

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, 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:

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.

PGM Program signature found in memory.(Normally On)
If this light does not come on, it means that the main CNC program package was not found in memory or that the auto-start switch was not set. Check that switch S1-1 is on and the EPROM is plugged in.

CRT CRT/VIDEO initialization complete. (Normally On)
If this light does not come on, there is a problem communicating with the VIDEO PCB. Check the buss connectors and ensure the VIDEO PCB is getting power.

MSG Power-on serial I/O message output complete. (Normally On)
If this light does not come on, there is a problem with serial I/O or interrupts. Disconnect anything on the external RS-232 and test again.

SIO Serial I/O initialization complete. (Normally On)
If this light does not come on, there is a problem with the serial ports. Disconnect anything on the external RS-232 and test again.

POR Power-on-reset complete. (Normally On)
If this light does not come on, there is a serious problem with the processor PCB. Check that the EPROM is plugged in. Test the card with the buss connectors off.

HALT Processor halted in catastrophic fault. (Normally Off)
If this light comes on, there is a serious problem with the processor PCB. Check that the EPROM is plugged in. Test the card with the buss connectors off.

+5V **+5V logic power supply is present. (Normally On)**
If this light does not come on, check the low voltage power supply and check that all three phases of 230V input power are present.

There 1 two-position DIP switch on the processor PCB labled 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. The video PCB connectors are:

P1	Power connector
J3	Keyboard (700)
J4	Address bus
J5	Data
J10	Floppy V+
J11	SPARE
J12	Floppy
J13	Video (760)
J14	RS422 B
J15	RS422 A

Motor Controller (MOCON)

The mill is equipped with a microprocessor based motor controller board (MOCON). 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 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 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. A functional resistor will have a reading of 8 ohms.

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 is rated at 40 amps (20 for High Voltage option) and is 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 rating corresponds to as much as 15 horsepower.

Circuit breaker (CB-1) rating

HP Rating	195-260VAC	354-488 VAC
20-15	40Amp	20 Amp
40-30	80 Amp	40Amp

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 POWER PCB.

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.

Secondary Circuit Breakers

The following circuit breakers are located on the Power supply assembly:

CB2 Controls the 115 V power from the main transformer to the servo transformers and, if tripped, will turn off the servo motors and air solenoids. CB2 could be blown by a severe servo overload.

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.

Operator's Work Light

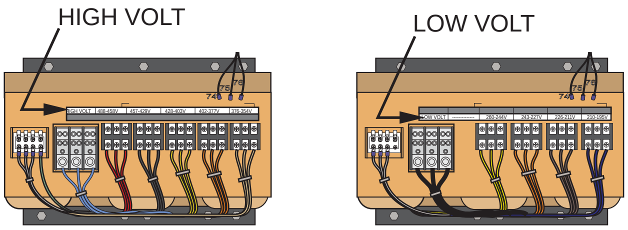
Main transformer (T1) outputs 115 VAC to the work light.

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.



Polyphase bank transformer.

Primary Connection To T1

Input power to T1 is supplied through CB1, the 40 amp three-phase main circuit breaker. Three-phase 230 to T1 is connected to the first three terminals of TB10.

Voltage Selection Taps

There are four labeled plastic terminal blocks. Each block has three connections for wires labeled 74, 75, and 76. Follow the instructions printed on the transformer.

Secondary Connection To T1

The secondary output from T1 is 115V AC three-phase CB2 protects the secondary of transformer T1 and is rated at 25 amps.

Optional 480V 60Hz Transformer

All machines will get the 45KVA transformer.

For domestic installations and all others using 60Hz power, the primary side should be wired as follows:

Input Voltage Range	Tap
493-510	1 (504)
481-492	2 (492)
469-480	3 (480)
457-468	4 (468)
445-456	5 (456)
433-444	6 (444)
420-432	7 (432)

Optional 480V 50Hz Transformer

Input Voltage Range	Tap
423-440	1 (504)
412-422	2 (492)
401-411	3 (480)
391-400	4 (468)
381-390	5 (456)
371-380	6 (444)
355-370	7 (432)

5.14 Fuses

The brushless amplifier has one fuse, F1 15 amps. This fuse protects the amplifier itself from drastic damage. If this fuse is ever blown, the associated motor will stop. A light on the amplifier will tell of a blown fuse. If necessary replace the fuse (Haas p/n 93-1089). If the fuse blows again the amplifier may be damaged, in which case the amplifier needs to be replaced.

The POWER PCB contains three ½-amp fuses located at the top right (FU1, FU2, FU3). If the machine is subject to a severe overvoltage or a lightning strike, these fuses will blow and turn off all of the power. Replace these fuses only with the same type and ratings. FU 4,5 and 5A protect the chip conveyor (FU6 is only used with 3 phase motors).

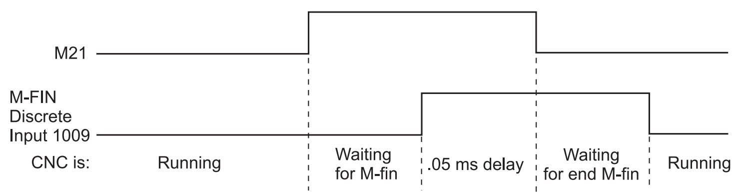
Size	Fuse Name	Type	Rating (amps)	Voltage	Location
5mm	FU1-FU3	Slo-Blo	½	250V	PSUP pcb, upper right
1/4	F1	Ultra fast	15	250V	Amplifier (X,Y,Z,A,B)
5mm	FU4,5	Fast blow	5A	250V	PSUP, bottom right corner

5.15 Spare User M code Interface

The M code interface uses outputs M21-25 and one discrete input circuit. M codes M21 through M25 will activate relays labeled M21-25. These relay contacts are isolated from all other circuits and may switch up to 120V AC at three amps. The relays are SPDT. **WARNING!** Power circuits and inductive loads must have snubber protection.

The M-FIN circuit is a normally open circuit that is made active by bringing it to ground. The one M-FIN applies to all of the user M codes.

The timing of a user M function must begin with all circuits inactive, that is, all circuits open. The timing is as follows:



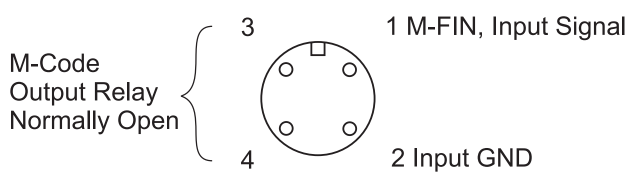
The Diagnostic Data display page may be used to observe the state of these signals.

NOTE: See the 8M option section for more details.

M Function Relays

The I/O PC board 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.

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.

5.16 Lubrication System

The lubrication system is a resistance type system which forces oil through metering units at each of the 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. The control monitors this system through an internal level switch in the reservoir and 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 108000. 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

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.

Each side door also has a limit switch. When open, these switches will also stop the machine with a "Door Hold" function.

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 with 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

X, Y, Z TRAVEL LIMIT SWITCHES

X - Left side of saddle by X-axis motor
Y - Top of column by Y-axis motor
Z - Base by Z-axis motor

The machine zero position is defined by a limit switch for each of the X, Y, and Z axes. After the search for machine zero has been completed, these switches are used to limit travel in the positive direction. In addition, travel in the negative direction is limited by stored stroke limits. It is not normally possible to command the servo axes past the machine zero as servo travel lookahead will decelerate and stop each motor prior to exceeding the stroke limits. All limit switches are wired through connector P5 on the side of the control cabinet. P5 also contains the wiring to the lubrication pump and an alternate connection to the DOOR OPEN switches.

Prior to performing 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.

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.

5.18 Y-Axis Brake Motor

The servo brake motor compensates for the weight of the spindle head. 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 parameters governs the ability of the brake motor, therefore, parameter 25, Y-Axis Torque Preload, set correctly. Check the parameters sections for the correct value.

5.19 Pallet Changer for the EC- Series

EC-300 Rotary Table (HRT210C3)

The rotary table is a HAAS 210 equipped with a special platter compatible with the pallet operation. The table is mounted on the pallet changer casting, and a drive shaft bearing assembly is inserted into its spindle (on the brake side). A nut housing is inserted into spindle of the table (on the platter side), and an air blast manifold is mounted onto the table platter.

Load Station

EC-300

The load station uses the 2 built-in rotary table to index the part while in the the load station. Hold the Pallet Index button and the pallet will rotate (The pallet rotates in one direction only)

EC-400

The load station is a 90 degree manual indexing station that holds a pallet securely into place while maintaining the ability to index freely. A manual indexing handle withdraws an indexing pin from the load station, which makes it possible to rotate the turntable (and the load) by hand. Four positions are available, at 90 degree increments, and at each increment the indexing pin will lock into position. Pallet must be in the home position before a pallet change can be commanded.

Power Supply Cables

The load station drawbar gearmotor and the main drawbar gearmotor each have a power supply cable. The load station motor is equipped with an extension cable to aid in motor replacement. The connector is about 12 inches from the gearmotor. Both power supplies are routed to their respective mounting locations from the central point of the solenoid mounting bracket (at the rear of the machine), where the disconnects are located.

Air Supply Lines

The lifting cylinder has one large air supply line for lifting the pallets and their loads. No return line is required because the cylinder is vented to the atmosphere and the weight of the assembly and load will cause the cylinder to lower.

The rotation cylinder is double-acting and has two smaller air supply lines for clockwise and counterclockwise rotation.

The air blast system has one large air supply line, which is connected to the lube tube adapter.

Each of the four air supply lines are routed to the solenoid mounting bracket (at the rear of the Horizontal), where the air solenoid assembly is located. Four solenoid valves are used to provide the responses required for the pallet change operation.

Lubrication Supply Lines

An oil supply line from the lube/air panel (on the right side of the machine) attaches to the lube tube adaptor. It provides lubrication to the rotary table drawbar, which carries oil mist from the air blast plug up the center of the main drawbar, to the drawbar and pallet nut.

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.

5.21 The Equations of Motion

An analysis of the physics of motion of a machine tool can give some important insights into the "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:

$$a = v*v/r \qquad (1)$$

and in motion:

$$v = b * l \qquad (2)$$

which gives:

$$b = v / l \qquad (3)$$

and

$$e = r - \mathrm{sqrt}(r*r-l*l/4) \qquad (4)$$

which gives:

$$r*r - 2*r*e + e*e = r*r - l*l/4 \qquad (5)$$

and:

$$l= \mathrm{sqrt}(8*r*e - 4*e*e) \qquad (6)$$

Since r>>e, e*e is small compare to r*e and we can assume:

$$l = \mathrm{sqrt}(8*r*e) \qquad (7)$$

And combining we get:

$$b = \mathrm{sqrt}(a*r) / \mathrm{sqrt}\ (8*r*e) \qquad (8)$$

Or

$$b = \mathrm{sqrt}(a / (8*e)\ ) \qquad (9)$$

Thus, block per second is dependent only on the machine acceleration and the maximum chordal error allowed. For a 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.

5.22 Formulas

TO FIND:

S.F.M

TO FIND THE SFM OF A CUTTER OR WORKPIECE

EXAMPLE: To find the SFM of a cutter rotating at 600 RPM with a diameter of 10 inches.

$$SFM = \frac{3.1416 \times d \times RPM}{12} = .262 \times d \times RPM$$

R.P.M.

TO FIND THE RPM OF A CUTTER OR WORKPIECE

EXAMPLE: To find the RPM of a cutter rotating at 150 SFM with a diameter of 8 inches.

$$SFM = \frac{12 \times SFM}{3.1416 \times d} = \frac{3.82 \times SFM}{d}$$

I.P.M.

TO FIND THE FEED (table travel in inches per minute)

EXAMPLE: To find the feed of a 10 tooth cutter rotating at 200 RPM with a feed per tooth of 0.012".

IPM = F.P.T. x T x RPM

TO FIND:

F.P.R.

TO FIND THE FEED PER REVOLUTION (in inches) OF A CUTTER.

EXAMPLE: To find the feed per revolution of a cutter rotating at 200 RPM with a table travel of 22 inches per minute.

$$F.P.R. = \frac{I.P.M.}{R.P.M.}$$

F.P.T.

TO FIND THE FEED PER TOOTH OF A CUTTER.

EXAMPLE: To find the feed per tooth of a cutter rotating at 200 RPM with a table travel of 22 inches per minute.

$$F.P.T. = \frac{I.P.M.}{T \times R.P.M.}$$

D = Depth of cut
d = diameter of cutter
I.P.M. = Feed (table travel in inches per minute)
K = Constant (cubic inches per minute per HPc). Power required to remove 1 cubic inch per minute.
HPc = Horsepower at the cutter
F.P.R. = Feed per revolution
R.P.M. = Revolutions per minute
T = Number of teeth in cutter
W = Width of cut (in inches)

6. PARAMETERS

Parameters are seldom-modified values that change the operation of the machine. These include servo motor types, gear ratios, speeds, stored stroke limits, ball screw compensations, motor control delays and macro call selections. These are all rarely changed by the user and should be protected from being changed by the parameter lock setting. If you need to change parameters, contact HAAS or your dealer. Parameters are protected from being changed by Setting 7.

The Settings page lists some parameters that the user may need to change during normal operation and these are simply called "Settings". Under normal conditions, the parameter displays should not be modified. A complete list of the parameters is provided here.

The PAGE UP, PAGE DOWN, up and down cursor keys , and the jog handle can be used to scroll through the parameter display screens in the control. The left and right cursor keys are used to scroll through the bits in a single parameter.

Parameter List

1 X SWITCHES Parameter 1 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 REV ENCODER Used to reverse the direction of encoder data.

1 REV POWER Used to reverse direction of power to motor.

2 REV PHASING Used to reverse motor phasing.

3 DISABLED Used to disable the X-axis.

4 Z CH ONLY With **A** only, indicates that no home switch.

5 AIR BRAKE With **A** only, indicates that air brake is used.

6 DISABLE Z T Disables encoder **Z** test (for testing only).

7 SERVO HIST Graph of servo error (for diagnostics only).

8 INV HOME SW Inverted home switch (N.C. switch).

9 INV Z CH Inverted **Z** channel (normally high).

10 CIRC. WRAP. With **A** only, causes 360 wrap to return to 0.

11 NO I IN BRAK With **A** only, removes **I** feedback when brake is active.

12 LOW PASS +1X Adds 1 term to low pass filter.

13 LOW PASS +2X Adds two terms to low pass filter.

14 OVER TEMP NC Selects a normally closed overheat sensor in motor.

15 CABLE TEST Enables test of encoder signals and cabling.

16 Z TEST HIST History plot of Z channel test data.

17 SCALE FACT/X If set to 1, the scale ratio is interpreted as divided by X; where X depends on bits SCALE/X LO and SCALE/XHI.

18 INVIS AXIS Used to create an invisible axis.

19 ALM ON LM SW Rotary alarms at the limit switch.

20 CK TRAVL LIM A Rotary travel limits are used. On mills with the Gimbaled Spindle (used on the VR series mills), A and B axes CK TRAVL LIM must be set to 1.

21 ROT TRVL LIM Rotary travel limits are used.

22 D FILTER X8 Enables the 8 tap FIR filter. Used to eliminate high frequency vibrations, depending on the axis motor.

23 D FILTER X4 Enables the 4 tap FIR filter. Used to eliminate high frequency vibrations, depending on the axis motor.

24 TORQUE ONLY For HAAS diagnostic use only.

25 3 EREV/MREV The 2 EREV/MREV and 3 EREV/MREV bits have two definitions depending on whether one or two encoders are present. For single encoder systems, the bits are used to define the ratio between the electrical rotation of the spindle motor and the mechanical rotation of the motor. For two encoder systems, the definition is the electrical rotation of the motor to the mechanical rotation of the spindle motor encoder, which includes any pulley ratio between the motor and the motor encoder.

26 2 EREV/MREV The 2 EREV/MREV and 3 EREV/MREV bits have two definitions depending on whether one or two encoders are present. For single encoder systems, the bits are used to define the ratio between the electrical rotation of the spindle motor and the mechanical rotation of the motor. For two encoder systems, the definition is the electrical rotation of the motor to the mechanical rotation of the spindle motor encoder, which includes any pulley ratio between the motor and the motor encoder.

27 NON MUX PHAS For HAAS diagnostic use only.

28 BRUSH MOTOR Enables the brushless motor option.

29 LINEAR DISPL This bit changes the display from degrees to inches (or millimeters) on the A and B axes.

30 SCALE/X LO With SCALE/X HI bit, determines the scale factor used in bit SCALE FACT/X,

31 SCALE/X HI With SCALE/X LO bit, determines the scale factor used in bit SCALE FACT/X. See below:

	HI	**LO**
0	0	3
0	1	5
1	0	7
1	1	9

2 X P GAIN Proportional gain in servo loop.

3 X D GAIN Derivative gain in servo loop.

4 X I GAIN Integral gain in servo loop.

5 X RATIO (STEPS/UNIT) The number of steps of the encoder per unit of travel. Encoder steps supply four (4) times their line count per revolution. Thus, an 8192 line encoder and a 6mm pitch screw give:

8192 x 4 x 25.4 / 6 = 138718
(5 steps per unit inch/mm ratio)

6 X MAX TRAVEL (STEPS) Max negative direction of travel from machine zero in encoder steps. Does not apply to A-axis. Thus a 20 inch travel, 8192 line encoder and 6 mm pitch screw give:

20.0 x 138718 = 2774360

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

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

9 X MAX ERROR Max error allowed in servo loop before alarm is generated. Units are encoder steps. This is the maximum allowable error in Hz between the commanded speed and the actual speed. The purpose of this parameter is to prevent "motor runaway" in case of phasing reversal, or bad parameters. If this parameter is set to 0, it defaults to 1/4 of parameter 183 Max Frequency.

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

11 X TORQUE PRELOAD TORQUE PRELOAD is a signed number that should be set to a value from 0 to 4095 where 4095 is the maximum motor torque. It is applied at all times to the servo in the same direction. It is used to compensate, in the vertical direction, for gravity on a machine with an axis brake instead of a counterbalance. Normally, the brake is released when the servo motors are activated. When the vertical axis is commanded to move, the brake is released and the servo motors are activated. This parameter specifies the bias torqu needed to compensate for gravity.

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

8192 x 4 = 32768

13 X BACKLASH Backlash correction in encoder steps.

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

15 Y SWITCHES See Parameter 1 for description.

16 Y P GAIN See Parameter 2 for description.

17 Y D GAIN See Parameter 3 for description.

18 Y I GAIN See Parameter 4 for description.

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

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

21 Y ACCELERATION See Parameter 7 for description.

22 Y MAX SPEED See Parameter 8 for description.

23 Y MAX ERROR See Parameter 9 for description.

24 Y FUSE LEVEL See Parameter 10 for description.

25 Y TORQUE PRELOAD See Parameter 11 for description.

26 Y STEPS/REVOLUTION See Parameter 12 for description.

27 Y BACKLASH See Parameter 13 for description.

28 Y DEAD ZONE See Parameter 14 for description.

29 Z SWITCHES See Parameter 1 for description.

30 Z P GAIN See Parameter 2 for description.

31 Z D GAIN See Parameter 3 for description.

32 Z I GAIN See Parameter 4 for description.

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

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

35 Z ACCELERATION See Parameter 7 for description.

36 Z MAX SPEED See Parameter 8 for description.

37 Z MAX ERROR See Parameter 9 for description.

38 Z FUSE LEVEL See Parameter 10 for description.

39 Z TORQUE PRELOAD See Parameter 11 for description.

40 Z STEPS/REVOLUTION See Parameter 12 for description.

41 Z BACKLASH See Parameter 13 for description.

42 Z DEAD ZONE See Parameter 14 for description.

43 A SWITCHES See Parameter 1 for description AND make sure that this parameter is set to enable the fourth axis before you try to enable the fourth axis from settings.

44 A P GAIN See Parameter 2 for description.

45 A D GAIN See Parameter 3 for description.

46 A I GAIN See Parameter 4 for description.

47 A RATIO (STEPS/UNIT) This parameter defines the number of encoder steps required to complete one full rotation of the platter. For example an HRT 210 with a 90:1 gear ratio, a final drive ratio of 2:1, and an encoder count of 2000 lines would be:

2000 x 4 x (90 x 2) / 360 = 4000 steps

for a brushless HRT 210 with a 90:1 gear ratio, a final drive ratio of 2:1 and an encoder count of 8192 the formula would be:

8192 x 4 x (90 x 2) / 360 = 16384 steps

If for example 16384 ended up being 13107.2 (non integer) the user must make sure the single bits SCALE FACT/X and the COMBINATION OF SCALE/X LO and SCALE/X HI are turned on in parameter 43. When the scale factor/x bit is 1 the scale ratio is interpreted as divide by X: where X depends on scale/ x lo and scale/ x hi (see parameter 1 for scale/ x lo and scale x hi values). For example:

8192 x 4 x (72 x 2) / 360 = 13107.2

You would then turn on the scale fact/x bit and the scale/ x lo bit which would give you a factor of 5 thus:

13107.2 x 5 = 65536 encoder steps

48 A MAX TRAVEL (STEPS) See Parameter 6 for description. Normally this parameter would not apply to the A axis, however this parameter is used on mills with a gimbaled spindle (5-axis mills). On a VR-series mill this parameter is used to limit the amount of angular movement of the spindle (A and B axes). The A and B axes are limited in movement to a distance between negative MAX TRAVEL, and positive TOOL CHANGE OFFSET. On 5-axes mills A and B axes ROT TRVL LIM must be set to 1, MAX TRAVEL and TOOL CHANGE OFFSET must be calibrated and set correctly.

49 A ACCELERATION See Parameter 7 for description.

50 A MAX SPEED See Parameter 8 for description.

51 A MAX ERROR See Parameter 9 for description.

52 A FUSE LEVEL See Parameter 10 for description.

53 A BACK EMF See Parameter 11 for description.

54 A STEPS/REVOLUTION See Parameter 12 for description

55 A BACKLASH See Parameter 13 for description.

56 A DEAD ZONE See Parameter 14 for description.

57 COMMON SWITCH 1 Parameter 57 is a collection of general purpose single bit flags used to turn some functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 REVERSE CRANK DIR Reverses direction of jog handle.

1 DISABLE TOOL CHANGER. Disables tool changer operations.

2 DISABLE GEAR BOX Disables gear box functions.

3 POWER OFF AT E-STOP Stops spindle then turns the power off at EMERGENCY STOP

4 RIGID TAPPING Indicates hardware option for rigid tap.

5 REV SPINDLE ENCODER Reverses sense direction of spindle encoder.

6 NETWORK/HD/USB Is used to activate the internal Zip/Enet PC104 board at power-on time. When it is set to 0, the CNC will not access the board. When it is set to 1, the CNC will access it at power-on time and display the message “LOADING” on the Zip/Enet settings page just below setting 139. After some time (2 minutes maximum,) the control will instead display the message “DISK DONE” indicating that communications have been established with the internal PC104 board and the user can now use the control.

7 EXACT STOP MODE CHG Selects exact stop in moves when mode changes.

8 SAFETY CIRCUIT This enables safety hardware, if machine is so equipped.

9 SPINDLE DRV LIN ACCEL Selects linear deceleration for rigid tapping. 0 is quadratic.

10 UNUSED

11 COOLANT SPIGOT Enables coolant spigot control and display.

12 OVER TEMP IS N/C Selects Regen over temp sensor as N.C.

13 SKIP OVERSHOOT Causes Skip (G31) to act like Fanuc and overshoot sense point.

14 NONINV SPINDLE STOP Non-inverted spindle stopped status.

15 SPIND. LOAD MONITOR Spindle load monitor option is enabled.

16 SPIND. TEMP MONITOR Spindle temperature monitor option is enabled.

17 ENABLE ROT & SCALNG Enables rotation and scaling.

18 ENABLE DNC Enables DNC selection from MDI.

19 ENABLE BKGRND EDIT Enables BACKGROUND EDIT mode.

20 ENABLE GROUND FAULT Enables ground fault detector.

21 M19 SPINDLE ORIET This bit makes the P and R codes a protected feature which can only be enabled with an unlock code. The unlock code will be printed on the parameter listing. If this bit is set to 0, an M19 will orient the spindle to 0 degrees regardless of the value of any P or R code in the same block. If this is set to 1, a P code in the block will cause the spindle to be oriented to the specified angle such as P180. Alternately, a decimal R code can be used, such as R180.53. Note that the P and R codes only work on a vector drive machine.

22 ENABLE MACRO Enables macro functions.

23 INVERT SKIP Invert sense of skip to active low=closed.

24 HANDLE CURSOR Enable use of jog handle to move cursor.

25 NEGATIVE WRK OFFSET Selects use of work offsets in negative direction.

26 TRANS OIL LOW PRESS Enables transmission low oil pressure detection.

27 QUICK CODE Enables conversational programming.

28 OILER ON/OFF Enables oiler power when servos or spindle is in motion.

29 OVERVOLT INPUT N/CInverts sense of over voltage signal.

30 SPINDLE ENCODER #2 This parameter bit enables a second encoder that is mounted on the spindle motor and wired into the “C” axis input of the Mocon. It is required to control the vector algorithm on a belted machine when the belts slip at high load.
When two encoders are present, the first is mounted on the spindle or output of the transmission, and is wired to the “spindle” input on the MOCON.
Most mills use a single encoder that is mounted on either the spindle (transmission output) or spindle motor but always connected to the spindle input on the Mocon.

31 DOOR STOP SPINDLE Enables functions to stop spindle and manual operations at door switch.

58 LEAD COMPENS SHIFT Shift factor when applying lead screw compensation. Lead screw compensation is based on a table of 256 offsets; each +\-127 encoder steps. A single entry in the table applies over a distance equal to two raised to this parameter power encoder steps.

59 MAXIMUM FEED Maximum feed rate in inches per minute.

60 TURRET START DELAY Maximum delay allowed in start of tool turret. Units are milliseconds. After this time, an alarm is generated.

On Horizontal mills with a side mount tool changer, this parameter is used to specify the time (in milliseconds) allowed for motor driven motions of the shuttle and arm. If the motion has not completed within the time allowed by this parameter, alarm 696 ATC MOTOR TIME OUT is generated. This parameter should be set to 2000.

61 TURRET STOP DELAY Maximum delay allowed in motion of tool turret. Units are milliseconds. After this time, an alarm is generated.

On Horizontal mills with a side mount tool changer, this parameter is used to specify the time (in milliseconds) allowed for air-pressure driven arm in/arm out moves. If the motion has not completed within the time allowed by this parameter, alarm 695 ATC AIR CYLINDER TIME OUT is generated. This parameter should be set to 10000.

62 SHUTTLE START DELAY This parameter is used to specify the time (in milliseconds) needed to allow the tool pocket to settle (stop bouncing) after being lowered in preparation for a tool change.

63 SHUTTLE STOP DELAY This parameter is also used for vertical mills with a Side Mount Tool Changer. It is used to specify the time allowed (in milliseconds) for the tool arm motor to stop. If the arm has not stopped after the allowed time alarm 627 ATC ARM POSITION TIMEOUT is generated.

64 Z TOOL CHANGE OFFSET
On Vertical mills: For Z-axis; displacement from home switch to tool change position and machine zero. About 4.6 inches, so for an 8192 line encoder this gives:
4.6 x 138718 = 638103
Alternate use for machines with a type 4 servo axis pallet changer. This parameter positions the pallet for a pallet change. For example, the Z-axis travel on the EC400 is done by moving the pallet, not the column, and therefore will not affect a tool change. Also, parameter 64 is generally used during zero return, and that usage is consistent in the EC400.

65 NUMBER OF TOOLS Number of tool positions in tool changer. This number must be set to the configuration machine. The maximum number of tool positions is 32, except Horizontal mills with a side mount tool changer. This parameter must be 60 for the HS 60 SMTC and 120 for the HS 120 SMTC.

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

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

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

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

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

71 DRAW BAR OFFSET Offset provided in motion of Z-axis to accommodate the tool pushing out of the spindle when unclamping tool. Units are encoder steps.

72 DRAW BAR Z VEL UNCL Speed of motion in Z-axis to accommodate tool pushing out of the spindle when unclamping tool. Units are encoder steps per second.

73 SP HIGH G/MIN SPEED Command speed used to rotate spindle motor when orienting spindle in high gear. Units are maximum spindle RPM divided by 4096. This parameter is not used in machines equipped with a Haas vector drive.

74 SP LOW G/MIN SPEED Command speed used to rotate spindle motor when orienting spindle in low gear. Units are maximum spindle RPM divided by 4096. This parameter is not used in machines equipped with a Haas vector drive.

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

76 LOW AIR DELAY Delay allowed after sensing low air pressure before alarm is generated. Alarm skipped if air pressure returns before delay. Units are 1/50 seconds.

77 SP LOCK SETTLE TIME Required time in milliseconds that the spindle lock must be in place and stable before spindle orientation is considered complete.

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

79 SPINDLE STEPS/REV Sets the number of spindle encoder steps per revolution of the spindle. This number takes into account the pulley ratio between transmission and spindle, plus transmission and encoder.

80 MAX SPIN DELAY TIME The maximum delay time control will wait for spindle to get to commanded speed or to get to zero speed. Units are milliseconds.

81 M MACRO CALL O9000 M code that will call O9000. This parameter can contain a value from 1 through 98, inclusive, zero causes no call. However it is best to use a value that is not already in use (see current M code list). Using M37 the value 37 would be entered in parameter 81 (for example). A program would be written to include the M37, such as:

```
G X0...
M37
.
.
M30
```

The control would run the program until it got to the M37, It would call program O9000, run that, and then return to the point that it left, and continue the main program.
Be aware that, if program O9000 contains another M37, it will call itself, and keep calling until it fills the stack (9 times) and then alarm out with 307 SUBROUTINE NESTING TOO DEEP.
Note that if M33 (for example) is used, it would override the normal M33 Conveyor Stop function.

82 M MACRO CALL O9001 See parameter 81 for description

83 M MACRO CALL O9002 See parameter 81 for description

84 M MACRO CALL O9003 See parameter 81 for description

85 M MACRO CALL O9004 See parameter 81 for description

86 M MACRO CALL O9005 See parameter 81 for description

87 M MACRO CALL O9006 See parameter 81 for description

88 M MACRO CALL O9007 See parameter 81 for description

89 M MACRO CALL O9008 See parameter 81 for description

90 M MACRO CALL O9009 See parameter 81 for description

91 G MACRO CALL O9010 G code that will call O9010. This parameter can contain a value from 1 through 98, inclusive, zero causes no call. However it is best to use a value that is not already in use (see current G code list). Using G45 the value 45 would be entered in parameter 91 (for example). A program would be written to include the G45, such as:

```
G X0...
G45
.
.
M30
```

The control would run the program until it got to the G45, It would call program O9010, run that, and then return to the point that it left, and continue the main program.
Be aware that, if program O9010 contains another G45, it will call itself, and keep calling until it fills the stack (4 times) and then alarm out with 531 MACRO NESTING TOO DEEP.
Note that if G84 (for example) is used, it would override the normal G84 Tapping Canned Cycle.

92 G MACRO CALL O9011 See parameter 91 for description

93 G MACRO CALL O9012 See parameter 91 for description

94 G MACRO CALL O9013 See parameter 91 for description

95 G MACRO CALL O9014 See parameter 91 for description

96 G MACRO CALL O9015 See parameter 91 for description

97 G MACRO CALL O9016 See parameter 91 for description

98 G MACRO CALL O9017 See parameter 91 for description

99 G MACRO CALL O9018 See parameter 91 for description

100 G MACRO CALL O9019 See parameter 91 for description

101 X AXIS IN POSITION LIMIT How close the motor must be to the endpoint before any move is considered complete when not in exact stop (G09 or G61). Units are encoder steps. As of mill version 9.06, this parameter does not apply to feeds. This parameter should be equivalent to .050 inches.

102 Y AXIS IN POSITION LIMIT See Parameter 101 for description

103 Z AXIS IN POSITION LIMIT See Parameter 101 for description

104 A AXIS IN POSITION LIMIT See Parameter 101 for description

105 X AXIS MAX CURRENT Corresponds to maximum peak current provided by the amplifier. 4095 = 30A (small amp) 45A (Medium amp) 60A (large amp).

106 Y AXIS MAX CURRENT See Parameter 105 for description

107 Z AXIS MAX CURRENT See Parameter 105 for description

108 A AXIS MAX CURRENT See Parameter 105 for description

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

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

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

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

113 X ACC/DEC T CONST Acceleration time constant. Units are 1/10000 seconds. This parameter provides for a constant ratio between profiling lag and servo velocity at the endpoint of a rapid motion.

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

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

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

117 LUB CYCLE TIME If this is set nonzero, it is the cycle time for the lube pump and the Lube pressure switch option is checked for cycling in this time. It is in units of 1/50 seconds.

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

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

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

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

122 Y PHASE OFFSET See Parameter 121 for description.

123 Z PHASE OFFSET See Parameter 121 for description.

124 A PHASE OFFSET See Parameter 121 for description.

125 X GRID OFFSET This parameter shifts the effective position of the encoder **Z** pulse. It can correct for a positioning error of the motor or home switch.

126 Y GRID OFFSET See Parameter 125 for description.

127 Z GRID OFFSET See Parameter 125 for description.

128 A GRID OFFSET See Parameter 125 for description.

129 GEAR CH SETTLE TIME Gear change settle time. This is the number of one millisecond samples that the gear status must be stable before considered in gear.

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

131 MAX SPINDLE RPM This is the maximum RPM available to the spindle. When this speed is programmed, the D-to-A output will be +10V and the spindle drive must be calibrated to provide this.

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

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

134 X EXACT STOP DIST.

135 Y EXACT STOP DIST.

136 Z EXACT STOP DIST.

137 A EXACT STOP DIST. These parameters control how close each axis must be to its end point when exact stop is programmed. They apply only in G09 and G64. They are in units of encoder steps. A value of 34 would give 34/ 138718 = 0.00025 inch.

NOTE: To change the values of parameters 134-137 permanently the machine must be rebooted.

138 X FRICTION COMPENSATION

139 Y FRICTION COMPENSATION

140 Z FRICTION COMPENSATION

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

142 HIGH/LOW GEAR CHANG This parameter sets the spindle speed at which an automatic gear change is performed. Below this parameter, low gear is the default; above this, high gear is the default.

143 DRAW BAR Z VEL CLMP This parameter sets the speed of the Z-axis motion that compensates for tool motion during tool clamping. Units are in encoder steps per second.

144 RIG TAP FINISH DIST This parameter sets the finish tolerance for determining the end point of a rigid tapping operation. Units are encoder counts.

145 X ACCEL FEED FORWARD

146 Y ACCEL FEED FORWARD

147 Z ACCEL FEED FORWARD

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

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

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

151 B SWITCHES See Parameter 1 for description.

152 B P GAIN See Parameter 2 for description.

153 B D GAIN See Parameter 3 for description.

154 B I GAIN See Parameter 4 for description.

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

156 B MAX TRAVEL (STEPS) See Parameter 6 for description. Normally this parameter would not apply to the A axis, however this parameter is used on mills with a gimbaled spindle (5-axes mills). On a VR-series mill this parameter is used to limit the amount of angular movement of the spindle (A and B axes). The A and B axes are limited in movement to a distance between negative MAX TRAVEL, and positive TOOL CHANGE OFFSET. On 5-axes mills A and B axes ROT TRVL LIM must be set to 1, MAX TRAVEL and TOOL CHANGE OFFSET must be calibrated and set correctly.

157 B ACCELERATION See Parameter 7 for description.

158 B MAX SPEED See Parameter 8 for description.

159 B MAX ERROR See Parameter 9 for description.

160 B FUSE LEVEL See Parameter 10 for description.

161 B BACK EMF See Parameter 11 for description.

162 B STEPS/REVOLUTION See Parameter 12 for description.

163 B BACKLASH See Parameter 13 for description.

164 B DEAD ZONE See Parameter 14 for description.

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

166 B AXIS MAX CURRENT Same definition as Parameter 105.

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

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

169 B PHASE OFFSET See Parameter 121 for description.

170 B GRID OFFSET See Parameter 125 for description.

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

172 B FRICTION COMPENSATION See Parameter 138 for description.

173 B ACCEL FEED FORWARD Same description as Parameter 145.

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

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

NOTE: The C-axis parameters (176-200) are used to control the Haas Vector Drive. Parameter 278 bit HAAS VECT DR must be set to 1 for these parameters to be available.

176 C SWITCHES See Parameter 1 for description.

177 C P GAIN See Parameter 2 for description.

178 C D GAIN See Parameter 3 for description.

179 C I GAIN See Parameter 4 for description.

180 C SLIP GAIN The slip rate calculated depends on two other variables: speed and current.

Slip rate = slip gain x (speed/max speed) x (current/max current)

The slip gain value is the value that slip rate would assume at maximum speed, and maximum current (16.384=1 Hz).

181 C MIN SLIP The minimum value allowed from the slip rate. From the equation:

Slip rate = slip gain x (speed/max speed) x (current/max current)

It can be seen that at a zero speed, the slip rate would become zero. Therefore a minimum value for slip rate is required. (16.384 =1Hz).

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

183 C MAX FREQ The frequency at which the motor will be run when maximum spindle RPM is commanded. Units: 0.01 Hz (two implied decimal places).

184 C MAX ERROR The maximum allowable error (in Hz) between commanded spindle speed and actual speed. If set to zero, it will default to 1/4 of Parameter 183.

185 C FUSE LEVEL See Parameter 10 for description.

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

187 C HIGH GEAR STEPS/REV This name is used when a Vector Drive is installed. This function takes on two meanings depending on how many spindle encoders are used on the machine. If only one encoder is present, it is the number of encoder steps per mechanical revolution of the spindle motor when the transmission is in high gear. (On direct drive machines, the encoder is mounted on the motor, while on others, it is on the spindle or transmission output.) N = (Encoder steps/enc rev)/(Enc pulley ratio X High Gear Ratio) For machines with a spindle and spindle motor encoder, it is the number of spindle motor encoder steps per mechanical revolution of the encoder. Its purpose is to specify the resolution of the spindle motor encoder. This parameter is used in conjunction with parameter 176 bits 25 and 26, which control the ratio between the electrical revolution of the motor to the mechanical revolution of the encoder.
If a vector drive is not installed, this parameter is called: STEPS/REVOLUTION and is not used.

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

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

190 C HI SP CURR LIM At speeds higher than the base frequency, the maximum current that is applied to the motor must be reduced. This is done linearly from base frequency to max frequency. This value is the max current at the max frequency.

191 C MAX CURRENT Sets maximum current allowed from the vector drive to the spindle motor: 4095 = max.

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

193 C SPIN ORIENT MARGIN When a spindle orientation is done, if the actual position of the spindle is within this value (plus or minus), the spindle will be considered locked. Otherwise, the spindle will not be locked.

194 SPINDLE STOP FREQ The spindle is considered to be stopped (discrete input SP ST*=0) when the speed drops below this value. Units are encoder steps/millisecond.

195 C START/STOP DELAY This delay is used at the start of motion to magnetize the rotor before acceleration starts. When the motor comes to a stop it remains energized for this amount of time. Units are in milliseconds.

196 C ACCEL LIMIT LOAD This parameter is used when a Vector Drive is installed. This is the % load limit during acceleration. If the load reaches this limit during acceleration the control slows down the acceleration. If a Vector Drive is not installed, this parameter is called C axis EXACT STOP DISTANCE, and is not used.

197 SWITCH FREQUENCY (Unit:Hz.) This is the frequency at which the spindle motor windings are switched. Note that there is a hysteresis band around this point, defined by parameter 198.

198 SWITCH HYSTERESIS (UNIT:Hz) This defines the $\pm$ hysteresis band around parameter 197. For example if parameter 197 is 85 Hz, and parameter 198 is 5Hz, the switching will take place at 90Hz when the spindle is speeding up, and at 80 Hz when the spindle is slowing down.

199 PRE-SWITCH DELAY (UNIT: ms) This is the amount of time allowed for the current in the motor to drop before the winding change contactors are switched.

200 POST- SWITCH DELAY (UNIT: ms) This is the amount of time allowed for the contactors to stabilize after a switch is commanded, before current is applied to the motor.

201 X SCREW COMP. COEF. This is the coefficient of heating of the ball screw and is used to shorten the screw length.

205 A SCREW COMP. COEF. This parameter should be set to 0.

206 SPIGOT POSITION Vertical mills only. Maximum number of spigot positions.

207 SPIGOT TIMEOUT (MS) Vertical mills only. Maximum timeout allowed for spigot to traverse one spigot location.

208 SPIN. FAN OFF DELAY Delay for turning the spindle fan off after the spindle has been turned off.

209 COMMON SWITCH 2 Parameter 209 is a collection of general purpose single bit flags used to turn some functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 HS SERIES CNCSet to one for HS series mills; set to zero for all other mills.

1 RESET STOPS TL CHGR Tool changer can be stopped with RESET button.

2 CHAIN TOOL CHANGER On all HS mills with the 60 or 120 pocket chain-style tool changer, it must be set to 1. On all other mills, it must be set to zero.

3 ENABLE CHIP CONVEYR Enables chip conveyor, if machine is so equipped.

4 50% RAPID KEYBOARD When (1) the control will support the 50% rapid traverse key. For controls without a 50% rapid keypad set this bit to (0).

5 FRONT DOOR When enabled the control will look for an additional door switch and will generate an operator message.

6 NO Z HOME IN TL CHG In Horizontal mills only. This bit prevents Z-axis motion to machine zero prior to a tool change.

7 M36 AUTO PAL ROTATE In Horizontal only. When set to (1), an M36 rotates the A-axis after the PART READY button is pressed.

8 AUX AXIS TL CHANGER In Horizontal mills only. When enabled, means the tool changer carousel is driven by an aux. axis.

9 APIGOT KEY INVERT This bit controls the direction the spigot moves when the Coolant Up and Coolant Down buttons are pressed. Changing this bit reverses the direction the spigot moves when the buttons are pressed. It has no effect on the direction the spigot moves when commanded by the M34 and M35 codes.

12 REVERSE CONVEYOR Reverses the direction of the chip conveyor.

13 PRE-ORIENT TAP When this parameter bit is set to 1, a spindle orient command is issued automatically prior to the repeat rigid tap function.

14 UNUSED

15 GREEN BEACON When (1) user relay M25 is used to flash a beacon. If the control is in a reset state, the beacon will be off. If the control is running normally, the beacon will be steadily on. If the control is in a M00, M01, M02, M30 feedhold, or single block state, then the beacon will flash.

16 RED BEACON When (1) user relay M26 is used to flash a beacon. The beacon flashes if the control is experiencing an alarm or emergency stop condition.

17 CNVR DOOR HOLD OVRD When (1) the conveyor will continue to run with the door open. When (0) the conveyor will stop when the door is open, but will resume when the door is closed. For safety it is recommended that the bit be set to (0).

18 DISABLE COOLANT IN If set to 1 low coolant input will not be used.

19 UNUSED

20 REMOTE TOOL RELEASE If set to 1, allows use of remote tool release button on spindle head.

21 FLOPPY ENABLE If set to 1, enables the optional disk drive.

22 TL CHG RECOV KEYPAD If set to 1, enables tool changer restore button on keypad.

23 MCODE RELAY BOARD If set to 1, allows for M-code addressing. This adds the availablility of additional outputs.

24 TSC ENABLE When set to 1, "DSBL CLNT IN" bit is ignored, M24, M54 and M64 are disabled, and TSC will operate. When set to zero, the control functions normally.

25 AUX JOG NACC If the jog handle is moved rapidly the auxiliary axis will not develope extremely large lags.

26 ALIAS M PROGR START Alias M codes during program restart.

27 DISABLE JOG TEST Disables the encoder test for the jog handle.

28 NO ZERO CLAMP During zero return of the pallet changer, the general sequence is 1) lift, 2) home, 3) lower. When this bit is set to 1, only the first two steps are executed. The pallet remains in the unclamp position. This bit was added to prevent damage to the pallet changer prior to Grid Offset and Tool Change Offset (zero return offset for the pallet changer axis) set up.

29 PAL READY BUTTON This parameter accommodates both the APC on the vertical mill the Rotary Pallet Changer on the Horizontal mill. This bit should be set to 1 on 2-pallet APC's to designate a single pallet button configuration. Four pallet APC's have a 2 schedule pallet button and should have this bit set to zero. Note that this bit should be zero on Horizontal Mills as it is intended for future pallet changer software that replaces the macro program.

30 UNUSED

31 SPINDLE NOWAIT When (1), the machine will not wait for the spindle to come up to speed immediately after an M03 or M04 command. Instead, it will check and/or wait for the spindle to come up to speed immediately before the next interpolated motion is initiated. This bit does not affect rigid tapping or the TSC option.

210 X AXIS TOOL CHANGE OFFSET Used on the HS-2RP mill for X axis displacement from the home position to tool change position.
If this parameter contains an incorrect value, a horizontal mill will crash when it does a tool change.

211 Y AXIS TOOL CHANGE OFFSET Used on the HS-2RP mill for Y axis displacement from the home position to tool change position.
If this parameter contains an incorrect value, a horizontal mill will crash when it does a tool change.

212 A TOOL CHANGE OFFSET This parameter sets the distance between the **A**-axis grid offset (Parameter 128) and the spindle home position. The **A**-axis will be limited in movement to the area between the positive value of this parameter and the negative MAX TRAVEL.

213 B TOOL CHANGE OFFSET This parameter sets the distance between the **B**-axis grid offset (Parameter 170) and the spindle home position. The **B**-axis will be limited in movement to the area between the positive value of this parameter and the negative MAX TRAVEL. This parameter must be used on all mills with the 60 or 120 pocket chain-style tool changer, as opposed to parameter 215, CAROUSEL OFFSET, which is used on other side mount tool changers. Note that on a machine with a single mocon board, the Tt axis parameters are automatically copied to the B axis parameters and only the Tt axis parameters can be altered.

214 D:Y CURRENT RATIO % (UNIT: %) This defines the ratio between the two winding configurations. This default winding is Y, and the parameters are set for the Y winding. This number is used to adjust the parameters for the delta winding when the windings are switched.

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

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

217 CNVYR IGNORE OC TIM Amount of time in 1/50 seconds before overcurrent is checked after conveyor motor is turned on. Default is 50.

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

219 CONVYR RETRY LIMIT Number of times that the conveyor will cycle through the reverse/forward sequencing when an overcurrent is sensed before the conveyor will shut down. An overcurrent is sensed when chips jam the conveyor. By reversing and then forwarding the conveyor, the chip jam may be broken. Default is 5.

220 CONVYR RETRY TIMEOUT Amount of time in 1/50 seconds between consecutive overcurrents in which the overcurrents is considered another retry. If this amount of time passes between overcurrents, then the retry count is set to (0). Default is 1500, 30 seconds.

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

222 ROTARY AXIS INCRMNT For Horizontal mills only. This parameter sets the degrees of rotation of the A-axis at an M36 or Pallet Rotate.

223 AIR TC DOOR DELAY For Horizontal mills only. This parameter sets the delay to open the tool changer door (in milliseconds). If the tool changer does not have a pneumatic door, this parameter is set to zero.

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

225 MAX ROT AXIS ALLOW For Horizontal mills with a wheel fixture only. This parameter sets the maximum rotation (in degrees) allowed before stopping at front door.

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

227 DISK DIR NAME When the disk drive is enabled and a directory is read the directory listing is placed into a program as comments. The program is then made the current program so the user can read the contents of the disk drive. This parameter designates where to write the directory listing. Program 08999 is the default value.

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

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

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

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

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

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

235 TSC PISTON SEAT With the 50 TSC option, the amount of time given for the piston to seat during system start-up. The default is 500 milliseconds. If machine has a **50 Taper spindle** and the TSC option, this parameter **must be set to 0.**

236 TSC LOW PR FLT After the TSC system has stabilized following start-up, Alarm 151 is generated if coolant pressure falls below 40 psi for the amount of time set in this parameter. The default is 1000 milliseconds.

237 TSC CLNT LINE PURGE The amount of time given for the coolant to purge when the TSC system is shut off. This parameter may be increased by the user to a higher value to help purge coolant from small orifice tooling. The minimum (default) value is 2500 milliseconds.

238 MAX TSC SPINDLE RPM When TSC is enabled and in use, this parameter limits the maximum spindle speed. Default value is 10000 RPM. On 50 taper machines, the maximum spindle speed is 5000 RPM

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

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

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

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

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

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

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

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

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

248 SMTC RLY ON / OFF DLY Vertical mills with sidemount tool changers only. It specifies the time needed (in milliseconds) between turning off one relay and turning on the other one, when reversing the carousel.

249 TOOL CLAMP DELAY This parameter provides a delay after the tool has been clamped and before retraction of the tool carousel at the end of a tool change. For most mills, this parameter should be set to zero. Units are milliseconds.

250 TOOL UNCLAMP DELAY This parameter provides a delay after the tool has been unclamped and before the spindle is backed away at the beginning of a tool change. For most mills, this parameter should be set to zero. Units are in milliseconds.

251 A DOOR OPEN ERRTIME This parameter supports the Auto-Door feature. It is used for several things:
1) It specifies the number of 50ths of a second for the motor to run to open the door.
2) The value of this parameter plus one second specifies the number of 50ths of a second for the motor to run to close the door.
3) If, at the end of the door-close time, the door has not yet reached the switch, alarm 238 DOOR FAULT is generated.
If an automatic door is installed, this parameter should be set to 5500 (5.5 seconds) nominally, otherwise it should be set to zero.

252 GEAR MOTOR TIMEOUT This parameter supports the Auto-Door feature. It specifies the length of time (in ms) that is allowed for the door to begin opening. If the door does not move off the door-closed switch within this amount of time, alarm 238 DOOR FAULT will be generated. This parameter should be set to 1000 (1.0 seconds) nominally.

253 SPIGOT FWD POS DLY This parameter is used to specify the length of a delay (units are ms) when moving the coolant spigot forward. This parameter should be set to zero on all machines.

254 TC AIR DOOR CLEARANCE This parameter incorporates the X-axis door clearance for the Mini-horizontal. The mill uses this position during a tool change to avoid hitting the tool changer door, as part of the tool changer door enters the machining area during a tool change.

This parameter also supports the VB-1 Bridge Mill tool carousel air door. The air door is a clamshell shaped door covering the tool carousel, which raises up at one side by air power to allow the spindle to access the tools. In order for it to open and close, there must be sufficient clearance between it and the spindle. This parameter must be set to the correct value (in encoder units), parameter 223 AIR TC DOOR DELAY must set to a non-zero value, parameter 267 ZERO AXIS TC must be set to 1 and parameter 278 TC DR SWITCH must be set to 1. When a tool change is commanded, the following steps are performed:

1) The Y axis is moved to the position specified by parameter 254.
2) The air door is commanded to open.
3) There is a delay specified by parameter 223 to allow the door to open fully.
4) The Y axis is moved to zero and the tool change is performed.
5) The Y axis is moved to the position specified by parameter 254.
6) The air door is commanded to close.
7) There is a delay specified by parameter 223 to allow the door to close fully.

255 CONVEYOR TIMEOUT The number of minutes the conveyor will operate without any motion or keyboard action. After this time, the conveyor will automatically shut off. Note that this parameter value will cause the conveyor to turn off even if the intermittent feature is functioning. Note also that if this parameter is set to zero, the chip conveyor will shut off immediately, i.e., pressing CHIP FWD or CHIP REV will not turn it on.

256 PALLET LOCK INPUT The setting for EC300 must be 26, the EC400 must be 32, and the MDC1 must be 27 or alarm 180 will occur when the spindle is turned on.

257 SPINDL ORIENT OFSET If the machine is equipped with a spindle vector drive (as set in bit 7 of Parameter 278), this bit sets the spindle orientation offset. The offset is the number of encoder steps between the Z pulse and the correct spindle orientation position. It is used to orient the spindle properly anytime it needs to be locked, such as prior to a tool change, or orient spindle command.

258 COLD SPINDLE TEMP The first time Cycle Start is pressed after the machine has been turned on, the control will compare the microprocessor temperature (in degrees Fahrenheit) against the value of this parameter. If the microprocessor is colder, the control will assume that the spindle is too cold or inadequately lubricated to be run safely at high speed and the following message will be displayed:

!!!WARNING!!!
YOUR MACHINE IS COLD, RUN A WARM-UP PROGRAM BEFORE
RUNNING THE SPINDLE AT HIGH SPEED OR DAMAGE MAY RESULT
PRESS 'CANCEL' TO CONTINUE

The user must press CANCEL before continuing. It is recommended that a spindle warm-up program be run immediately. This message will only appear once each time the machine has been turned on. The initial value for this parameter is 70 (degrees F). To disable this feature, change it to zero.

259 COLD SPINDLE DAYS The first time Cycle Start is pressed after the machine has been turned on, the control will compare the number of days that have passed since the machine was turned off against the value of this parameter. If the machine has been off longer, the control will assume that the spindle is too cold or inadequately lubricated to be run safely at high speed and the following message will be displayed:

!!!WARNING!!!
YOUR MACHINE IS COLD, RUN A WARM-UP PROGRAM BEFORE RUNNING
THE SPINDLE AT HIGH SPEED OR DAMAGE MAY RESULT
PRESS 'CANCEL' TO CONTINUE

The user must press CANCEL before continuing. It is recommended that a spindle warm-up program be run immediately. This message will only appear once each time the machine has been turned on. The initial value for this parameter is 3 (days). To disable this feature, change it to 999999.

266 X SWITCHES Parameter 266 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 X LIN SCALE EN Used to enable linear scales for the X axis.

1 X INVRT LN SCL Used to invert the X-axis linear scale.

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 X ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGE OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes.

4 X 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 X NEG COMP DIR Used to negate the direction of thermal compensation.

6 X DELAY AXIS 0 Used with an APL to ensure X axis is zeroed before A axis of APL

7 X MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 X TEMP SENSOR This performs Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. =-28000
351 TEMP PROBE OFFSET =450000

16 SCALE Z HIST For HAAS diagnostic use only.

267 Y SWITCHES Parameter 267 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 Y LIN SCALE EN Used to enable linear scales for the Y axis.

1 Y INVRT LN SCL Used to invert the Y-axis linear scale.

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 Y ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGER OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes.

4 Y 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 Y NEG COMP DIR Used to negate the direction of thermal compensation.

6 Y DELAY AXIS 0 Used with an APL to ensure Y axis is zeroed before A axis of APL.

7 Y MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 Y TEMP SENSOR This performs Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. =-28000
351 TEMP PROBE OFFSET =450000

16 SCALE Z HIST For HAAS diagnostic use only.

268 Z SWITCHES Parameter 268 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 Z LIN SCALE EN Used to enable linear scales for the Z axis.

1 Z INVRT LN SCL Used to invert the Z-axis linear scale

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 Z ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGER OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes.

4 Z 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 Z NEG COMP DIR Used to negate the direction of thermal compensation.

6 Z DELAY AXIS 0 Used with an APL to ensure Z axis is zeroed before A axis of APL

7 Z MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 Z TEMP SENSOR This performs Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. =-28000
351 TEMP PROBE OFFSET =450000

16 SCALE Z HIST For HAAS diagnostic use only.

269 A SWITCHES Parameter 269 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 A LIN SCALE EN Used to enable linear scales for the A axis.

1 A INVRT LN SCL Used to invert the A-axis linear scale.

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 A ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGER OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes.

4 A 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 A NEG COMP DIR Used to negate the direction of thermal compensation.

6 A DELAY AXIS 0 Used with an APL to ensure A axis is zeroed before B axis of APL.

7 A MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 A TEMP SENSOR This performs Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. =-28000
351 TEMP PROBE OFFSET =450000

16 SCALE Z HIST For HAAS diagnostic use only.

270 B SWITCHES Parameter 270 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 B LIN SCALE EN Used to enable linear scales for the B axis.

1 B INVRT LN SCL Used to invert the B-axis linear scale.

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 B ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGER OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes. On all mills with 60 or 120 pocket chain-style tool changer, this bit must be set to 1. It will cause to tool changer offset parameter to be used for tool changes.

4 B 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 B NEG COMP DIR Used to negate the direction of thermal compensation.

6 B DELAY AXIS 0 Used with an APL to ensure B axis is zeroed before A axis of APL.

7 B MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 B TEMP SENSOR This performs Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. =-28000
351 TEMP PROBE OFFSET =450000

16 SCALE Z HIST For HAAS diagnostic use only.

271 C SWITCHES Parameter 271 is a collection of single-bit flags used to turn servo related functions on and off. This parameter is not used when the machine is equipped with a Haas vector drive. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 C LIN SCALE EN Used to enable linear scales for the C axis.

1 C INVRT LN SCL Used to invert the C-axis linear scale.

2 DSBL SCALE Z Used to disable the linear scale Z test.

3 C ZERO AXIS TC Used to return axis to the position specified by the TOOL CHANGER OFFSET parameter prior to a tool change. On mills with a gimbaled spindle, this bit must be set to 1 on the A and B axes (parameter 269 and 270) and 0 on all other axes.

4 C 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.

5 C NEG COMP DIR Used to negate the direction of thermal compensation.

6 C DELAY AXIS 0 Used with an APL to ensure C axis is zeroed before A axis of APL.

16 SCALE Z HIST For HAAS diagnostic use only.

272 X SCREW COMP T. CONST. This parameter is the thermal compensation time constant, and is the time constant governing the rate of cool down of the screw.

273 Y SCREW COMP T. CONST. This parameter is the thermal compensation time constant, and is the time constant governing the rate of cool down of the screw.

274 Z SCREW COMP T. CONST. This parameter is the thermal compensation time constant, and is the time constant governing the rate of cool down of the screw.

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

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

278 COMMON SWITCH 3 Parameter 278 is a collection of general purpose single bit flags used to turn some functions on and off. This bit will cause the machine to use discrete outputs 21 and 26 to command the shuttle to move in and out. On mills with the Air Driven Shuttle it must be set to 1. On all other mills it must be set to 0. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 INVERT GEARBOX SIGS This bit allows an alternate gearbox configuration. It inverts the sense of the gearbox inputs. Used for 50 taper option.

1 DPR SERIAL Causes the main serial inputs/outputs to go through the disk video board.

2 CHECK PALLET INPUT If set to 1, the discrete input specified by parameter 256 PALLET LOCK INPUT is checked prior to the execution of a spindle command. If the input was high (i.e. an open circuit), alarm 180 would be generated. The input is also checked while the spindle is turning and will generate the same alarm if it goes high. Thus, the input can now be used to stop a program after the spindle has been commanded to turn (such as by a pressure switch from the user's clamp or fixture).

3 CHK HIDDN MACRO VAR This bit is used on horizontal mills only.

4 DISPLAY ACTUAL RPM When set to 1, displays the actual spindle speed on the Current Commands display page.

5 TSC PURGE ENABLE Enables purge output on TSC option.

6 SINGLE CLAMP SWITCH This parameter enables the control to rely up on a single switch to detect the clamp position of the Side Mount Tool Changer arm. When this bit is set to zero, both the upper and the lower switches are used to detect the arm position. When it is set to one, only the lower switch will be used. This means that the control will not wait until the upper switch is tripped to conclude that the tool is clamped, so subsequent operations can begin immediately. This increases tool change speed.

7 SPINDLE DRIVE LOCK This bit must be set to 1 if machine is equipped with a non-Haas vector spindle drive. This bit must be set to 1 if the machine has a 50 taper spindle or a non-Haas vector drive.

8 UNUSED

9 CONCURENT SPINDLE When set to 1, the spindle will be commanded to start concurrently with other commands in the same block. In the following example, with this bit set to 1, the spindle will start at the same time as the rapid move:

G0 X-1. S7500 M3;

10 HS3 HYDRAULIC TL CH This parameter bit is used with the 38 tool SMTC on the HS-3. When this is set to zero, the mill will behave normally. When it is set to 1, the control will recognize that the toolchanger is a 38-Tool SMTC.

11 HAAS VECTOR DRIVE This bit must be set to 1 if machine is equipped with a HAAS vector spindle drive. When set to 1, voltage to the Haas vector drive is displayed in the diagnostics display as DC BUSS.

12 uP ENCLOSURE TEMP (Microprocessor Enclosure Temperature) When set to 1, the enclosure temperature will be displayed on INPUTS2 screen of the diagnostics display.

13 HAAS REMOTE JOG HDL (Haas Remote Jog Handle) This bit must be set to 1 if the machine is equipped with a Haas 5-Axes Remote Jog Handle.

14 SPIN MOTOR OTEMP NC (Spindle Temperature Sensor Normally Closed) This bit specifies the type (normally open or normally closed) of the spindle temperature sensor. This bit should be set to 1.

15 AIR DRIVE SHUTTLE This bit will cause the machine to use discrete outputs 21 and 26 to command the shuttle to move in and out. On mills with the Air Driven Shuttle it must be set to 1. On all other mills it must be set to 0.

16 GIMBAL SPINDLE Used on 5-axes mills. This bit will cause the machine to check that the Z,A and B axes are at zero before a tool change is started. If one is not, alarm 150 will be generated. On mills with the gimbaled Spindle it must be set to 1. On all other mills it must be set to 0.

17 NO MFIN CHK ON P-UP When this bit is set, it will prevent checking of MFIN at power-up. It should be set for 1 for all machines that have the Haas Automatic Pallet Changer attached, and 0 for all other machines.

18 DEL:Y SWITCH ENABLE (Delta Wye switch enabled). This bit is used for the Vector Drive. The bit enables the switching of spindle motor windings, provided the hardware ENABLE is installed, and the proper parameters are set. If this switch is set, but bit 19 is not, then the winding switching will only be done when the spindle is at rest, depending on the target speed of the spindle.

19 DEL:Y SWITCH ON FLY This bit enables switching on the fly, as the spindle motor is accelerating or decelerating through the switch point. If bit 18 is not set, this switch will be ignored.

20 5 AX TOFS -X This bit is used with the G143 (modal 5 axes tool length compensation) on machines with a Gimbaled Spindle. If it is set to 1, this means that when the corresponding rotary axes is moved, the sign of the X Position must be inverted. Normally, this bit should be set to 0.

21 5 AX TOFS -Y This bit is used with the G143 (modal 5 axes tool length compensation) on machines with a Gimbaled Spindle. If it is set to 1, this means that when the corresponding rotary axes is moved, the sign of the Y Position must be inverted. Normally, this bit should be set to 0.

22 B+C 5 AXES This bit is used with the G142 (modal 5 axes tool length compensation) on machines with a Gimbaled Spindle. The B-axis normally moves the A-axis, but if this is not true, this bit can be set to change which is the inner axis. Normally, this bit should be set to 0.

23 TL CHGR DOOR SWITCH Horizontal tool carousel door configuration. This bit specifies the Horizontal Mill tool carousel door configuration. If it is set to 0, this indicates the configuration where the door is driven open by a timed operation. If it is set to 1, this indicates the configuration where the door is spring-loaded closed and is driven open by the timed operation against the door open switch. In open position, the door switch signal is 0 (low). The switch status is checked before and after commanding the door to open in order to be fail-safe.

For all horizontal mills that have the switch installed, this bit must be set to 1. For all other mills, this bit must be set to 0.

24 HS2 SMTC CAROUSEL

25 HS3 SMTC CAROUSEL

26 S MNT BIT 1 Bits 26, 27, and 28 work together to specify the type of sidemount tool changer that is installed on a vertical mill. The following table shows the bit combinations that must be used:
Bit 26 27 28

0 0 0 No side-mount tool changer installed
1 0 0 Serpentine 1
0 1 0 Serpentine 2
1 1 0 Serpentine 3
0 0 1 Disk 1
1 0 1 Disk 2
0 1 1 Disk 3
1 1 1 Disk 4

27 S MNT BIT 2 Bits 26, 27, and 28 work together to specify the type of sidemount tool changer that is installed on a vertical mill.

28 S MNT BIT 3 Bits 26, 27, and 28 work together to specify the type of sidemount tool changer that is installed on a vertical mill.

29 DOOR SAFETY SW INV This bit supports the CE door interlock that locks when power is turned off. For machines that have the regular door lock that locks when power is applied, this bit must be set to 0. For machines that have the inverted door lock, this bit must be set to 1.

30 SWAP A & C AXES This parameter causes the A and C axes to be swapped internally. This parameter bit should be set to 1 for the bridge mill. All other mills should set this bit to 0.

31 INV SPIND SPD DECEL Inverse Spindle Speed Deceleration. When this parameter is set to 1, the spindle decelerates faster at lower speeds, resulting in a shorter deceleration time.

279 X SCALE GAIN MULT This is used on machines with linear scales. Linear scales are used to continuously correct any errors in the encoder position. The parameter determines the gain of the correction factor, that is, how fast it corrects. This parameter should be set to 40.

280 Y SCALE GAIN MULT See parameter 279 for description

281 Z SCALE GAIN MULT See parameter 279 for description

282 A SCALE GAIN MULT See parameter 279 for description

283 B SCALE GAIN MULT See parameter 279 for description

284 RESERVED

285 X LINEAR SCREW OFFS This parameter is used on machines with linear scales. This parameter accounts for the unused portion of the ball screw between zero and the actual motor. This parameter should be a positive value (400000) unless the NEG COMP DIR bit for the axis is set, in which case this parameter should be a negative value (-400000.)

286 Y LINEAR SCREW OFFS See parameter 285 for description.

287 Z LINEAR SCREW OFFS See parameter 285 for description.

288 A LINEAR SCREW OFFS See parameter 285 for description.

289 B LINEAR SCREW OFFS See parameter 285 for description.

291 A AXIS BRAKE OIL TIME This parameter supports the EC1600 A-axis brake oil sensor. The units are seconds. When this parameter is set to a non-zero number and the sensor indicates a low oil condition for more than that amount of time, the control will cause the red beacon to flash and display the message LOW BK OIL on the screen. If the low oil condition continues alarm 643 LOW BRAKE OIL A-AXIS will be generated when the program ends.

292 AUTO DOOR PAUSE
This parameter supports the Auto-Door feature. It specifies the length of a pause (in 50ths of a second) that occurs during the door close sequence. As the door closes and the switch is activated, the motor is turned off for this amount of time and the door coasts. This allows the door to close smoothly. This parameter should be set to 1 (0.02 seconds) nominally. It works in conjunction with parameter 293.

293 AUTO DOOR BUMP This parameter supports the Auto-Door feature. It specifies the length of time (in 50ths of a second) that the motor should be reactivated after the pause specified by parameter 292. This causes the motor to close the door fully and smoothly. This parameter should be set to 2 (0.04 seconds) nominally.

294 MIN BUSS VOLTAGE This parameter specifies the minimum Haas Vector Drive buss voltage. It should be set to 200 (the units are volts). Alarm 160 will be generated if the voltage falls below this value.

295 SHTL SETTLE TIME Used on mills with an air driven shuttle. This parameter allows settling time for the shuttle after it has moved toward the spindle and before a tool change is performed. It should be set to approximately half a second (500) on all mills with the Air Driven Shuttle. This may very. All other mills can be set to 0 as they are unaffected by it.

296 MAX OVER VOLT TIME Specifies the amount of time (in 50ths of a second) that an overvoltage condition (alarm 119 OVER VOLTAGE) will be tolerated before the automatic shut down process is started.

297 MAX OVERHEAT TIME Specifies the amount of time (in 50ths of a second) that an overheat condition (alarm 122 REGEN OVERHEAT) will be tolerated before the automatic shut down process is started.

298 MAX FEED (DEG/MIN) Used on 5-axes mills. This parameter specifies the maximum rotary feed rate in degrees per minute. Any attempt at cutting faster than this will result in "LIM" being displayed next to the FEED message on the Program Command Check screen.

On mills with a Gimbaled Spindle, this parameter must be set to 300. For all other mills, this bit should be set to 99999.

299 AUTOFEED-STEP-UP This parameter works with the AUTOFEED feature. It specifies the feed rate step-up percentage per second and should initially be set to 10.

300 AUTOFEED STEP-DOWN This parameter works with the AUTOFEED feature. It specifies the feed rate step-down percentage per second and should initially be set to 20.

301 AUTOFEED-MIN-LIMIT This parameter works with the AUTOFEED feature. It specifies the minimum allowable feed rate override percentage that the AUTOFEED feature can use and should initially be set to 1.

302 FEED ACCELERATION This parameter supports the motion control feature. This is the acceleration that applies to feed motion in encoder steps per second squared. For vertical mills, 1/2 of the value of parameter 7 is a good starting point. For horizontal mills, 1000000 is a good value to start with. This parameter can be further updated as necessary.

303 FEED TIME CONSTANT This parameter supports the motion control feature. It is the base 2 exponent of the feed time constant in milliseconds. It should be set to 3.

304 SPIGOT REV POS DLY This parameter is used to specify the length of a delay (units are ms) when moving the coolant spigot in reverse. This parameter should be set to zero on all machines.

305 SERVO PO BRK DLY The SRV PO (Servo Power On) discrete output is used to engage and disengage an axis brake. This parameter is used to specify a time in milliseconds that the control should wait after activating the SRV PO output and turning off power to the servo motors via the MOCON. This parameter also specifies the time to wait after deactivating the SRV PO output and reactivating the servo motors via the MOCON.

306 POCKET UP / DN DELAY This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) for the tool pocket to be raised or lowered. If the pocket does not move to its commanded position within the time allowed by this parameter and by parameter 62, alarm 626 TOOL POCKET SLIDE ERROR is generated. For mills without a side mount tool changer, this parameter should be set to 0.

307 POCK UN / LOCK DELAY This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) to lock or unlock a tool pocket. For mills without a side mount tool changer, this parameter should be set to 0.

308 ARM ROTATE TIME This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) for the arm to rotate to the next position. The positions are, Clamp, Unclamp, and Origin. If the arm does not move to the commanded position within the allowed time, alarm 622 TOOL ARM FAULT is generated. For mills without a side mount tool changer, this parameter should be set to 0.

309 MOTOR COAST TIME This parameter supports the side mount tool changers. It specifies the time allowed for the tool changer to start only. If the arm has not moved after the allowed time, alarm 627 ATC ARM POSITION TIMEOUT is generated. Units are milliseconds.

310 CAM LOCK DELAY This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) to lock the cam by pushing the shot pin in, or to unlock the cam by pulling the shot pin out. If the shot pin has not moved to its commanded position within the allowed time, alarm 625 INVALID TC START CONDITION is generated.

311 ARM BUMP TIME/DEG This parameter supports the side mount tool changers. During tool change recovery, the arm may be moved a small amount by pressing the ATC FWD or ATC REV key. Each press of the key will cause the arm motors to run for the amount of time (in milliseconds) specified by this parameter. For mills without a side mount tool changer, this parameter should be set to 0.

For the high speed tool changer, this parameter specifies the number of thousandths of degrees to bump the arm (i.e., 1000=1 deg.)

On horizontal mills with a side mount tool chager, the arm may be rotated a small amount by pressing the END or PAGE DOWN keys. The shuttle may be moved by pressing the Left Arrow or Right Arrow keys. Each press of the key will cause the motor to run for the amount of time (in milliseconds) specified by this parameter. This parameter is most commonly set to 30.

312 CAROUSEL BUMP TIME This parameter supports the side mount tool changers. During tool change recovery, the carousel may be moved a small amount by pressing the Left Arrow or Right Arrow key. Each press of the key will cause the carousel motors to run for the amount of time (in milliseconds) specified by this parameter. For mills without a side mount tool changer, this parameter should be set to 0.

313 POCKET INCREMENT This is a parameter for the bridge mill. Under normal circumstances it should be set to 1. If it is set to 2, for example, the control will only recognize every other pocket. That is, it will treat the tools and pockets as follows:

Tool 1 is in pocket 1
Tool 2 is in pocket 3
Tool 3 is in pocket 5
Tool 4 is in pocket 7
etc...

If this parameter is set to 3 the control will only recognize every third pocket and so on. **It is the operator's responsibility to ensure that the total number of pockets in the tool changer is evenly divisible by this parameter value.** If not, the control will pick the wrong pocket after the carousel has exceeded a full revolution.

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

315 COMMON SWITCH 4

0 ALIS M GRPHC When this bit is set to 0, all user defined M codes (such as M50 normally used to do a pallet change on a horizontal mill) will be ignored when a program is run in graphics mode. If it is necessary to have graphics recognize such M codes, this bit should be set to 1.

1 GANTRY

2 NO X MOVE NEXT TOOL This parameter only affects horizontal mills, and is intended for use primarily on the HS-3. If this bit is set to zero, it will have no effect. If it is set to one, the X-axis will not move following a NEXT TOOL button press. The reason for this is because after pressing NEXT TOOL on an HS-1 or HS-2, the spindle, which is mounted on the X-axis, is moved closer to the operator so the next tool can be manually installed. On an HS-3, the X-axis is on the table and there is no advantage to moving it. Setting this bit to one will save time.

3 EXTRA-LARGE TOOLS This parameter enables the user to specify that large tools are considered to be extra large, and allow the Tool Pocket table to get set up as shown below. This parameter bit should be set to 1 on all mills with the 50 Taper Side Mount Tool Changer. It will enable the control to recognize tools that occupy three pockets.
An example of a tool pocket table with extra large tools:
1 –
2 L
3 –
4 –
5 L
6 –

Note that when this parameter bit is set to 1, the following tool pocket configuration is not allowed (see alarm 422).
–
L
–
L
–

4 HIGH SPD MACHINING This parameter bit enables the High Speed Machining feature. This parameter requires an unlock code in order to set the bit to 1. This option requires the Floating Point Co-Processor and Floating Point software. If this option is turned on when non-floating point software is installed the High Speed option will have no effect.

5 FAEMAT SPINDLE This bit controls the tool clamp and unclamp sequence for different spindles. This bit should be set to 1 when the mill has a Faemat spindle installed. Otherwise the bit should be set to 0. This improvement is intended primarily for the VB-1 bridge mill.

6 MANUAL TOOL CHANGER This parameter must be set to 1 when a TM-1 has no tool changer and zero when it has a tool changer. When it is set to 1, an M06 will stop the program and display a message requesting the operator to change tools manually.

7 RESET STOPS PAL CHG This parameter enables the RESET button to stop a pallet change. It is intended for use with the future hard-coded pallet changer macro program. It should be set to zero.

8 MINI POWER SUPPLY When parameter 315 bit 8 MINI MILL is set to 1, the Over Voltage discrete input will be displayed as P.S. Fault.
When it is set to 1:

(a) The DC BUSS voltage that is normally displayed on the diagnostics screen for a Vector Drive machine will not be displayed.

(b) The conditions that would normally generate alarm 119 OVER VOLTAGE and alarm 160 LOW VOLTAGE will instead generate alarm 292 320V POWER SUPPLY FAULT and this alarm will be added to the alarm history only after a 1 second delay to prevent false 292 alarms being added to the alarm history at the moment power is turned off. This parameter bit must be set to 1 on all Mini Mills.

9 DOOR OPEN SWITCH The bit allows the software to work with an optional door-open switch. This bit should be set to 1 on all machines fitted with the second door switch. If this bit is set to 1, the control will look for a second door switch when the door is opened automatically to the fully open position. If the switch is not found, alarm 238 DOOR FAULT will be generated. If this bit is set to zero, the control behaves as before.

10 PALLET HARDCODE This bit supports the hard-coded APC pallet changer function. It must be set to 1 when an APC is present that is wired for two APC door switches. On all other machines, it must be set to 0.

11 M50 CLOSES DOOR The MDC-1 pallet changer station auto door closes before an M50 pallet rotate and opens afterward provided that this parameter bit is set to 1. If the bit is set to zero, a flashing message directing the operator to close the pallet changer door (manually or by pushing the PART READY button) will be displayed and the pallet change will not occur until the door is closed. Note that the door will not close automatically if the Pallet Schedule Table is used to schedule a pallet.

12 MANUAL JOG TRM/TRL This parameter bit enables the manual jog feature for the Tool Room Mill's handwheels.

13 SAFTY SWITCH When set to zero, the control behaves as normal. When it is set to 1, the Toolroom Mill's safety switch must be pressed by the operator for controlled motion to start or continue.

14 FOURTH AXIS This parameter bit prevents unauthorized use of the 4th (A) axis. It can only be set to 1 with a magic code. When it is set to zero, it prevents the user from altering setting 30 and prevents the user from zeroing the parameter 43 DISABLED bit. When this parameter bit is changed to zero, setting 30 will be returned to OFF and the parameter 43 DISABLED bit will be set to 1.

15 FIFTH AXIS This parameter bit prevents unauthorized use of the 5th (B) axis. It can only be set to 1 with a magic code. When it is set to zero, it revents the user from altering setting 78 and prevents the user from zeroing the parameter 151 DISABLED bit. When this parameter bit is changed to zero, setting 78 will be returned to OFF and the parameter 151 DISABLED bit will be set to 1. Note that when parameter 209 HORIZONTAL is set to 1, setting 78 is unavailable and not displayed because the B axis is used for the tool changer.

16 TOOL CAGE DOOR Supports the machines fitted with the side-mount tool changer cage door. When a machine has a cage door, this parameter must be set to 1. On all other machines, it must be set to zero.

17 VIBRATION SENSOR This parameter enables the vibration sensor. When it is set to 1, the output from the sensor will be converted to Gs and displayed on the Current Commands Tool Load screen. When this parameter is set to zero, NO SENSOR will be displayed instead.

18 HIGH Z TOOL CHANGER Setting this parameter to 1 and commanding either a G28 move of all the axes, or a pressing Second Home will cause the Z axis to move to the maximum position prior to moving to machine zero. When this parameter is set to zero, the Z axis will move directly to machine zero. Previously, the Z axis would move directly to machine zero regardless of this parameter bit. This enhancement was made primarily for the Gantry Router mills.

19 PAL LOAD AUTODOOR This bit tells the control that the pallet changer has an automatic door, as opposed to the operator Auto Door feature. This is so that an MDC can have either an Auto Door or an automatic pallet changer door.

20 MAP 4TH AXIS This bit enables the Rotary Index button at the load station and prevents movement of the rotary outside of the work area (i.e., rotary mounted on the outside pallet position.)

21 INV PAL DOOR SWITCH This parameter bit must be set to 1 on the MDC1 and zero on all other machines. This bit indicates the polarity of the pallet changer door closed switch.

22 PAL RECIEVER SWITCH This parameter supports the APC pallet receiver position switch. When the switch is present, the bit must be set to 1, otherwise it must be set to zero.

23 RAPID -> HS FEED This bit enables straight line rapid moves. Normally, during a rapid move of two or more axes, the axis with the shorter distance will finish first. When this parameter is set to 1, the control will treat rapid moves as high-speed feeds, that is, all axes will complete their motion at the same time.

25 POWER DICONN RELAY When it is set to zero, the machine behaves as before. When it is set to 1, and parameter 57 SAFETY CIRC is set to 1, and the door is opened, I GAIN on all axes will be cleared. When the door is closed and power to the servos is restored, the I GAIN values will be restored. This is intended to be used in conjunction with special hardware by customers who require the servo power to be cut when the door is opened.

26 STATUS RELAYS This parameter bit supports the Machine Data Collection enhancement. The default value for all machines is zero.

27 UNUSED

28 ADVANCED TOOL MGMT. This feature allows the user to specify groups of tools. When the life of a tool (based on feed time, total time, usage, number of holes, tool load, or vibration) has expired, the control will automatically use another tool from the same group. When all the tools from a group are used up, the control will alarm.

29 RND5 TRM/TRL

30 RND5 HANDWHEEL

31 INTUITIVE PROG SYS When set to 1, the Intuitive Programming System is activated.

316 APC PAL. CLAMP TIME
This is the time required to clamp the APC pallet to the receiver. It should be set to 4000 on all pallet changing machines except the the EC-300 and MDC, which should be set to 1000. Units are milliseconds.

317 APC UNCLAMP TIME This is the time required to unclamp the APC pallet from the receiver. It should be set to 4000 on all pallet changing machines except the the EC-300 and MDC, which should be set to 1000. Units are milliseconds.

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

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

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

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

327 X SCALES PER INCH This parameter is used on machines equipped with linear scales. This parameter should be set to 25,400 on mills fitted with linear scales. On all other mills, they should be set to zero.

328 Y SCALES PER INCH This parameter is used on machines equipped with linear scales. This parameter should be set to 25,400 on mills fitted with linear scales. On all other mills, they should be set to zero.

329 Z SCALES PER INCH This parameter is used on machines equipped with linear scales. This parameter should be set to 25,400 on mills fitted with linear scales. On all other mills, they should be set to zero.

330 A SCALES PER INCH This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.

331 B SCALES PER INCH This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.

333 X SCALES PER REV This parameter is used on machines equipped with linear scales. This parameter should be set to 50,000 on mills fitted with linear scales. On all other mills, they should be set to zero.

334 Y SCALES PER REV This parameter is used on machines equipped with linear scales. This parameter should be set to 50,000 on mills fitted with linear scales. On all other mills, they should be set to zero.

335 Z SCALES PER REV This parameter is used on machines equipped with linear scales. This parameter should be set to 50,000 on mills fitted with linear scales. On all other mills, they should be set to zero.

336 A SCALES PER REV This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.

337 B SCALES PER REV This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.

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

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

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

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

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

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

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

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

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

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

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

352 RELAY BANK SELECT This parameter allows the user to change which bank of relays is to be used (Parameter 209 bit 23 MCD RLY BRD assumes that relay bank one is to be used). It may be set to a number from 0 to 3 (inclusive). M codes M21 through M28 will be switched to the selected bank. This parameter requires a revision “S” I/O board. If a previous board is installed (without the additional banks of relays), this parameter should be set to zero.

Bank #	Relay Location	Description
0	I/O PCB	Internal machine functions
1	I/O PCB	User relay outputs (some may be used for internal functions)
2	1st M-code PCB	8M option. 8 additional user outputs.
3	2nd M-code PCB	Typically used for built in options such as, side mount tool
	2nd M-code PCB	changer, etc.

430 W RATIO (STEPS/UNIT) For the EC300 and MDC1, this parameter is set to 57344. This parameter controls the rotation of the pallet. When a pallet change is performed, the pallet will rotate 180 degrees. It is essential that this parameter is checked after a software upgrade.

586 MAX DOOR OPN SP RPM This parameter specifies the maximum allowable spindle RPM after the door has been opened manually or commanded open by an M80.

588 X ENC. SCALE FACTOR This axis parameter work in place of the axis parameters called SCALE/X LO and SCALE/X HI. If SCALE FACT/X is set to 1, the scale ratio is determined by SCALE/X LO and SCALE/X HI as follows:

HI	LO	
0	0	3
0	1	5
1	0	7
1	1	9

If, however, SCALE FACT/X is set to zero, the value of ENC. SCALE FACTOR will be used for the scale ratio instead. Note that any value outside the range of 1 to 100 will be ignored and the scale ratio will remain unaffected. Note also that currently, these parameters are intended for use only on rotary axes (A and B).

589 Y ENC. SCALE FACTOR See parameter 588 for description

590 Z ENC. SCALE FACTOR See parameter 588 for description

591 A ENC. SCALE FACTOR See parameter 588 for description

592 B ENC. SCALE FACTOR See parameter 588 for description

593 Sp ENC. SCALE FACTOR See parameter 588 for description

594 U ENC. SCALE FACTOR See parameter 588 for description

595 V ENC. SCALE FACTOR See parameter 588 for description

596 W ENC. SCALE FACTOR See parameter 588 for description

600 PEAK SPIN. PWR (KW) This parameter supports the spindle kilowatt (KW) load display which appears on the current commands page, next to the spindle load percentage. This parameter should be set to the peak power output in KW for the spindle motor.

601 TOOL CHANGE DELAY On a mill where the operator needs to be warned that a running program is about to do a tool change (no enclosure) it will beep and delay for the duration specified by parameter 601.
If parameter 601 is set to zero, there will be no beep or delay. If the operator changes tools by pressing buttons on any kind of tool changer, there will be no beep or delay.
If the machine has a manual tool changer and an M06 is commanded from a running program, there will be no beep or delay because the control will stop and prompt the operator to manually insert the tool.

605 Pallet Changer Type This parameter defines the type of pallet changer on the machine. Also see Parameter 606

606 Number of Pallets This parameter specifies the number of pallets present in the installed pallet changer. Also see Parameter 605.

Pallet Changer	Parameter 605	Parameter 606
APC (Pallet Ready button)	0	2
APC (Schedule Pallet Buttons)	2	2
Rotary Pallet Changer (HS 1/2)	1	2
Quad APC	2	4
MDC-1 / EC300	3	2
EC400	4	2
2 Pallet APC	2	2

612 Spigot Type This parameter supports the programmable coolant spigot. Type 0 uses the peaks of the spigot fan for positioning. Type 1 uses the peaks and valleys of the spigot fan for positioning. All other values are treated the same as type 0. Note that if parameter 253 SPIGOT FWD POS DLY and parameter 304 SPIGOT REV POS DLY are non-zero, type 1 processing uses those values. Otherwise, the type 1 processing calculates the delay value for positioning from parameters 613 and 614.

613 Spigot FWD MTR DLY This parameter supports the programmable coolant spigot. It specifies the delay time in ms from the moment the spigot motor is turned off to the moment the spigot is stopped in the forward direction.

614 Spigot REV MTR DLY This parameter supports the programmable coolant spigot. It specifies the delay time in ms from the moment the spigot motor is turned off to the moment the spigot is stopped in the reverse direction.

619 Pre Gear Change Dly This parameter specifies the delay time (in milliseconds) after the spindle has been commanded to stop and before the solenoid for the gear change is commanded to start. It should be set to 100 on all machines.

620 X-Axis Plus Travel Limit Note that only parameters 623 and 624 for the A and B axes are intended to be used, and only on the Trunnion Mills (VF5TR and VF6TR) where it is necessary to place the home switch in the middle of the travel range (in order to keep the table flat when at the home position) and limit movement to +/-120 degrees. The PLUS TRAVEL LIMIT parameter is used to store the number of encoder steps that a rotary can take in the plus direction from its current home position. The control then takes into account these updated travel limits for jog and feed conditions. For example, if the steps/unit on the A axis is 4000 and the PLUS TRAVEL LIMIT is set to 20000 then the control will allow the A rotary to go up to +5 degrees before stopping. (This assumes that the encoder scale factor is set to zero). The same applies for the B axis. This feature will enable the home switch to be moved to any desired location so that a rotary can make the proper orientation during zero return. Note that parameter 591 and 592 AB ENC. SCALE FACTOR will be applicable in determining the limits. So if this parameter is set to 3, then in the above example the rotary will be allowed to go up to +15 degrees due to encoder scaling. Similar results will be achieved when the SCALE FACT/X bit is set to 1 (based on SCALE/X LO and SCALE/X HI bits =0). To deactivate this feature on any axis, the PLUS TRAVEL LIMIT should be set to zero.

621 Y-Axis Plus Travel Limit See Parameter 620

622 Z-Axis Plus Travel Limit See Parameter 620

623 A-Axis Plus Travel Limit See Parameter 620

624 B-Axis Plus Travel Limit See Parameter 620

629 Sp-Axis Plus Travel Limit See Parameter 620

626 U-Axis Plus Travel Limit See Parameter 620

627 V-Axis Plus Travel Limit See Parameter 620

628 W-Axis Plus Travel Limit See Parameter 620

630 Tt-Axis Plus Travel Limit See Parameter 620

644 X-Axis Indexer Increment Note that only parameters 647 and 648 for the A and B axes are intended to be used, and only on Horizontal Mills fitted with a Rotary Indexer. The Rotary Indexer is a device that holds a part to be machined and rotates in one-degree increments. It can rotate only in rapid motion (G00), it cannot rotate in a feed motion (G01). It can be jogged by pressing a jog button, or with a jog handle. Before it can be rotated, air is applied to lift the indexer from its clamped position. The message, A UNCLMP (for example) will appear at the bottom of the screen, and remain as long as the rotary indexer is in the up position. When the commanded position is reached, the indexer will automatically move forward or backward to the closest proper locking angle, then settle into its clamped position. The locking angle is computed from the INDEXER INCREMENT parameter which is in units of one-thousandth of a degree. For example, if the A axis INDEXER INCREMENT parameter is set to 1000 (1.0 degrees) and the A axis is jogged to 25.5 degrees, when the operator leaves jog mode, the indexer will automatically settle and clamp itself at 26.0 degrees. If the parameter contains a 1 (one-thousandth of a degree) or less, the rotary indexer feature is turned off and a regular rotary platform is assumed.

645 Y Axis Indexer Increment See Parameter 644

646 Z Axis Indexer Increment See Parameter 644

647 A Axis Indexer Increment See Parameter 644

648 B Axis Indexer Increment See Parameter 644

650 U Axis Indexer Increment See Parameter 644

651 V Axis Indexer Increment See Parameter 644

652 W Axis Indexer Increment See Parameter 644

653 Sp Axis Indexer Increment See Parameter 644

654 Tt Axis Indexer Increment See Parameter 644

659 Indexer Down Timeout Supports the indexer rotary table. It specifies the amount of time (in ms) allowed for seeking the indexer Down-switch. If the switch is not detected within the allowed time, alarm 960 INDEXER SWITCH NOT FOUND IN TIME is generated. When this parameter is set to zero, the feature is bypassed. Note that parameter 69 AIR BRAKE DELAY is used as the allowed time for seeking the Up-switch. If the switch is not detected within the allowed time, alarm 925 A INDEXER IS NOT FULLY IN THE UP POSITION is generated.

680 – 689 LEAD COMPENS SHIFT
These parameters specify the amount of shift needed for proper indexing into the Lead Screw Compensation table. Note that these parameters are very similar to Param 58. The difference is that these parameters hold a non-zero value, they take precedence over the general parameter 58. For example:

Param 58 [LEAD COMPENS SHIFT] = 14 (General Parameter)
Param 683 [A LEAD COMPENS SHIFT] = 12 (axis Parameter A)
Param 684 [B LEAD COMPENS SHIFT] = 0 (axis Parameter B)

In the above example, the A axis will take its lead screw shift value from Parameter 683 since it is a non-zero value, but the B axis will get its shift value from Parameter 58 (NOT from Parameter 684). Determining the appropriate value for lead screw compensation: Example: Assume Steps Per Unit on A is 2800 (Parameter 47)

a) Take steps per unit and multiply by 360 (unscaled).
2800 x 360 = 1008000
b) Apply Enc. scale factor (if present). For example with a scale factor set to 3, we have: (1008000/3) = 336000
c) Determine the smallest number ‘n’ that will hold the inequality:
336000/(2^n) < 256 => 336000/(2^11) < 256 ; so n = 11
d) Therefore, set Par 683 to 11

671 Indexer Down Settle Supports the indexer rotary table. It specifies the amount of time (in ms) the machine is allowed to settle after detecting the indexer Down-switch. If the parameter is zero, the feature is backward compatible.

704 SMTC2 UNCLAMP POS This parameter supports the high speed tool changer. It specifies the absolute position in degrees *1000 which the TT axis will stop at in order to unclamp the tool.

705 SMTC2 CLAMP POS This parameter supports the high speed tool changer. It specifies the absolute position in degrees *1000 which the TT axis will stop at in order to clamp the tool.

708 Pallet Changer Axis Specifies the mocon channel of the MDC-1 and EC-300 pallet changer. It enables both the servo axis pallet changer and the Super SMTC tool changer to operate on the same machine. On an MDC-1 with a single mocon board, this parameter must be set to 4. On an MDC-1 or EC-300 with two mocon boards, this parameter must be set to 8. On all other machines, this parameter must be set to 0. Note also that when this parameter is set to 4, the B axis parameters are used to control the pallet changer and the message “USE Tt PARAMS” will not be displayed. When this parameter is set to 8, the W axis parameters are used to control the pallet changer.

709 SMTC DR Output Rely Specifies the output relay that should be activated for the tool changer door. Set to 39 for the EC300. Set to 1 for the EC400. Set to 26 for the HS series mills. Set to zero for all other mills without a tool changer door.

710 Tool Changer Type Specifies which type of tool changer is installed on the machine. Note that if this parameter is set to zero, the control will automatically reset it based upon the parameters which previously specified the tool changer type. The following types are recognized:

1 Generic Geneva or umbrella type - This is the default.

2 Horizontal type using W axis

3 Horizontal type using B axis

4 Horizontal type using TT axis

5 Generic Vertical Side Mount Tool Changer (VSMTC)

6 Super2 VSMTC, using TT axis

7 Chain Type

8 Mori Side Mount Tool Changer

9 Manual Tool Changer

711 Pocket Up Settle This parameter supports the vertical mill side mount tool changer. It specifies the amount of time, in 50ths of a second, that the carousel is to wait after a tool change before it is allowed to move. It should be set to 20 on all mills.

715 Color Message Used to change the color of the text messages displayed at the bottom of an LCD monitor. Any value from 0 to 255 can be used. The following are some suggestions:

Black: 0	Brown: 3, 4, 11, 12, 19, 20
Red: 5, 6, 13, 143	Orange: 7, 15, 23
Yellow: 30, 31, 39, 55, 63	Pink: 95, 103, 111, 119, 159, 167, 175, 183
Purple: 67, 75, 77, 83, 140, 141, 198, 215	Blue: 64, 88, 210, 248
Green: 24, 40, 56, 104, 120	

716 Color CMD Position Used to change the color of the positions text displayed on the Current Commands page on an LCD monitor. See color values listed for parameter 715.

717 Color CMD G-Code Used to change the color of the active G and M code text displayed on the Current Commands page on an LCD monitor. See color values listed for parameter 715.

718 Color CMD Axes Load Used to change the color of the axis load text displayed on the Current Commands page on an LCD monitor. See color values listed for parameter 715.

719 Color CMD Bold Text Used to change the color of the large feed and speed text displayed on the Current Commands page on an LCD monitor. See color values listed for parameter 715.

720 Coor Override Used to change the color of the spindle and axis override text displayed on the Current Commands page on an LCD monitor. See color values listed for parameter 715.

721 'RUNNING' RELAY Supports the Machine Data Collection feature which specifies an output relay that will be turned on when the machine is in RUNNING mode. Note that this only works when it is set to 32 or larger and specifies an actual relay, and when parameter 315 bit 26 STATUS RELYS is set to zero. Note also that if SINGLE BLOCK is activated while the machine is running, the relay may not turn off at the end of the current block.

727 APC CHAIN MIN TIME Defines the time to wait BEFORE some switch fault checks are to begin. It should be set to 3000 on all APC mills and zero on all others. The units are milliseconds.

730 PWR FAULT THRESHOLD
731 PWR FAULT MAX TIME
Parameter 730 and 731 support the optional Power Failure Detect Module. Parameter 730 PWR FAULT THRESHOLD units are an analog to digital value. Parameter 731 PWR FAULT MAX TIME units are millisecond/20. If the Power Failure Detection Module is not installed, parameters 730 and 731 should both be set to zero.

733 APC AIR BLAST RELAY
Defines the output relay that turns on the air blast on the EC-300 and MDC-500. Set to 39 for the Mill Drill Center and EC-300, or zero for all other mills

734 INPUT MASK (Used for the Office Mills)

0 TOOL CHANGER IN	16 SPARE
1 TOOL CHANGER OUT	17 SPARE
2 TOOL #1 IN POSITION	18 SPARE
3 LOW TSC PRESSURE	19 SPARE
4 TOOL IN POSITION	20 LOW TRANS OIL PRESS
5 SPINDLE HIGH GEAR	21 APC DOOR
6 SPINDLE LOW GEAR	22 APC PIN CLEAR #1
7 EMERGENCY STOP	23 APC PIN CLEAR #2
8 DOOR/SAFETY SWITCH	24 TOOL UNCLAMP REMOTE
9 M-CODE FINISH	25 SPARE
10 OVERVOLTAGE	26 APC PALLET #2 HOME
11 LOW AIR PRESSURE	27 APC PALLET #1 HOME
12 LOW LUBE PRESSURE	28 GROUND FAULT
13 REGEN. OVERHEAT	29 G31 BLOCK SKIP
14 DRAWBAR OPEN	30 SPIGOT POSITION
15 DRAWBAR CLOSED	31 CONVEYR OVERCURRENT

Ball Screw Compensation

Separate ball screw compensation is provided for each of the **X**, **Y**, and **Z** axes. The operator-entered compensation values are spaced at 0.5 inch intervals within the machine coordinate system. The compensation values are entered in inches with a resolution of 0.0001 inch. The operator entered values are used to interpolate into a table of 256 entries. The spacing between two entries in the table of 256 is defined by Parameter 58. The entered values are limited to +/-127 encoder steps; so the limit in inches is dependent on Parameters 5, 19, and 33.

Note that the first entry corresponds to machine position zero and subsequent entries are for increasingly negative positions in the machine coordinate system. The user should not ever need to adjust the ball screw compensation tables.

Electronic Thermal Compensation

When ballscrews rotate they generate heat. Heat causes the ballscrews to expand. In constant duty cycles, the resultant ball screw growth can lead to cutting errors on the next morning start up. The Haas ETC algorithm can accurately model this heating and cooling effect and electronically expand and contract the screw to give near glass scale accuracy and consistency.

This compensation is based on a model of the lead screw which calculates heating based on the distance traveled and the torque applied to the motor. This compensation does not correct for thermal growth due to changes in ambient temperature or due to part expansion.

Electronic thermal compensation works by estimating the heating of the screw based on the total amount of travel over its length and including the amount of torque applied to the screw. This heat is then turned into a thermal coefficient of expansion and the position of the axis is multiplied by the coefficient to get a correction amount.

If the machine is turned off when there is some compensation applied (due to motion and heating of screw), when the machine is turned back on, the compensation will be adjusted by the clock indicated elapsed time.

Spindle Head Thermal Compensation

This feature integrates spindle speed over time and builds a model of thermal growth. As the model shows the spindle head warming up, the control adjusts the Z axes to compensate for thermal growth.

7. MAINTENANCE

General Requirements

Operating Temperature Range: 41°F to 104°F (5 to 40°C)
Storage Temperature Range: -4°F to 158°F (-20 to 70°C)
Ambient Humidity: 20% – 95% relative humidity, non-condensing
Altitude: 0-7000 ft.

Electricity Requirements

All Machines Require:

AC input power is three phase Delta or Wye power, except that the power source must be grounded (e.g. leg or center leg for delta, neutral for Wye)
Frequency range of 47-66 Hz
Line voltage that does not fluctuate more than ± 10%
Harmonic distortion not to exceed 10% of the total RMS voltage

20-15 HP System (Standard VF and 10K, EC300, EC400)

	195-260V Voltage Requirements	354-488V High-Voltage Requirements
Power Supply [1]	50 AMP	25 AMP
Haas Circuit Breaker	40 AMP	20 AMP
If service run from elec. panel is less than 100' use:	8 GA. WIRE	12 GA. WIRE
If service run from elec. panel is more than 100' use:	6 GA. WIRE	10 GA. WIRE

40-30 HP System (50 Taper, 40 Taper HT 10K, VF Super Speed, EC-300, EC-400 12K)

	195-260V Voltage Requirements	354-488V High-Voltage Requirements[2]
Power Supply[1]	100 AMP	50 AMP
Haas Circuit Breaker	80 AMP	40 AMP
If service run from elec.panel is less than 100' use:	4 GA. WIRE	8 GA. WIRE
If service run from elec. panel is more than 100' use:	2 GA. WIRE	6 GA. WIRE

40-30 HP System (VS 1/3, HS 3-7 incl R models)

	195-260V Voltage Requirements
Power Supply	125 AMP
Haas Circuit Breaker	100 AMP
If service run from ele.panel is less than 100' use:	2 GA. WIRE
If service run from ele. panel is more than 100' use:	0 GA. WIRE

WARNING!

A separate earth ground wire of the same conductor size as the input power is required to be connected to the chassis of the machine. This ground wire is required for operator safety and for proper operation. This ground must be supplied from the main plant ground at the service entrance, and should be routed in the same conduit as the input power to the machine. A local cold water pipe or ground rod adjacent to the machine cannot be used for this purpose.

Input power to the machine must be grounded. For wye power, the neutral must be grounded. For delta power, a central leg ground or one leg ground should be used. The machine will not function properly on ungrounded power. (This is not a factor with the External 480V Option.)

The rated horsepower of the machine may not be achieved if the imbalance of the incoming voltage is beyond an acceptable limit. The machine may function properly, yet may not deliver the advertised power. This is noticed more often when using phase converters. A phase converter should only be used if all other methods cannot be used.

The maximum leg-to-leg or leg-to-ground voltage should not exceed 260 volts, or 504 volts for high-voltage machines with the Internal High Voltage Option.

[1] The current requirements shown in the table reflect the circuit breaker size internal to the machine. This breaker has an extremely slow trip time. It may be necessary to size the external service breaker up by 20-25%, as indicated by "power supply", for proper operation.

[2] The high-voltage requirements shown reflect the Internal 400V configuration which is standard on European machines. Domestic and all other users must use the External 480V option.

Air Requirements

The mill requires a minimum of 100 psi at the input to the pressure regulator on the back of the machine. A volume of 4 scfm (9scfm for EC and HS mills) is also necessary. This should be supplied by at least a two-horsepower compressor, with a minimum 20-gallon tank, that turns on when the pressure drops to 100 psi.

NOTE: Add 2 scfm to the above minimum air requirements if the operator will be using the air nozzle during pneumatic operations.

Machine Type	Main Air Regulator	Input Airline Hose Size
EC-300	85 psi	1/2" I.D.
EC-400	85psi	1/2" I.D.
EC-1600	85psi	1/2" I.D.
HS 3/4/6/7 incl R models	85psi.	1/2" I.D.
VF-1 - VF-11 (40Taper)	85psi	3/8" I.D.
VF-5 - VF-11 (50 Taper)	85psi	1/2" I.D.
VR Series	85psi	1/2" I.D.
VS 1/3	85psi	1/2" I.D.

The recommended method of attaching the air hose is to the barb fitting at the back of the machine with a hose clamp. If a quick coupler is desired, use a 1/2" coupler.

NOTE: Excessive oil and water in the air supply will cause the machine to malfunction. The air filter/regulator has an automatic bowl dump that should be empty before starting the machine. This must be checked for proper operation monthly. Also, excessive contaminants in the air line may clog the dump valve and cause oil and/or water to pass into the machine.

NOTE: Auxiliary air connections should be made on the unregulated side of the air filter/regulator.

WARNING!

When the machine is operating and the pressure gauge (on the machine regulator) drops by more than 10 psi during tool changes or pallet changes, insufficient air is being supplied to the machine.

Maintenance Schedule

The following is a list of required regular maintenance for the machining center. Listed are the frequency of service, capacities, and type of fluids required. These required specifications must be followed in order to keep your machine in good working order and protect your warranty.

Interval	Maintenance Performed
Daily	• Check coolant level each eight-hour shift (especially during heavy TSC usage). • Check way lube lubrication tank level. • Clean chips from way covers and bottom pan. • Clean chips from tool changer. • Wipe spindle taper with a clean cloth rag and apply light oil.
Weekly	• Check Through the Spindle Coolant (TSC) filters. Clean or replace element if needed. • Check for proper operation of auto drain on filter regulator. • On machines with the TSC option, clean the chip basket on the coolant tank. Remove the tank cover and remove any sediment inside the tank. Disconnect the coolant pump from the cabinet and **power off** the machine before working on the coolant tank. **Do this MONTHLY for machines without the TSC option.** • Check air gauge/regulator for 85 psi. Check the spindle air pressure regulator for 17 psi. For 15K-spindle machines, check spindle air pressure regulator for 20 psi. • For machines with the TSC option, place a dab of grease on the V-flange of tools. **Do this MONTHLY for machines without the TSC option.** • Clean exterior surfaces with mild cleaner. **DO NOT** use solvents. • Check the hydraulic counterbalance pressure according to the machine's specifications.
Monthly	• Check oil level in gear box. **For 40 taper spindles:** Remove inspection cover beneath spindle head. Add oil slowly from top until oil begins dripping from overflow tube at bottom of sump tank. **For 50 taper spindles:** Check oil level in sight glass. Add from side of gearbox if necessary. • Inspect way covers for proper operation and lubricate with light oil, if necessary. • Place a dab of grease on the outside edge of the guide rails of the tool changer and run through all tools. • **EC-400** Clean the locating pads on the A-axis and the load station. This requires removing the pallet
Six Months	• Replace coolant and thoroughly clean the coolant tank. • Check all hoses and lubrication lines for cracking. • Check the rotary A-axis. If necessary add oil (Mobil SHC-630). The correct oil level is halfway on the sight glass.
Annually	• Replace the gearbox oil. Drain the oil from the bottom of the gearbox. Remove inspection cover beneath spindle head. Add oil slowly from top until oil begins dripping from overflow tube at bottom of sump tank. **For 50 taper spindles**, add oil from the side of the transmission. • Check oil filter and clean out residue at bottom of filter. • Check SMTC oil level in sight glass, (see Side Mount Tool Changer Oil Level in this section).
2 years	• Replace air filter on control box every 2 years. • **EC-400** Replace the Rotary A-axis oil

Periodic Maintenance

A periodic maintenance page is found on the Current Commands screens titled “Scheduled Maintenance” and accessed by pressing Page Up or Page Down to activate and deactivate a series of checks.

An item on the list can be selected by pressing the up and down arrow keys. The selected item is then activated or deactivated by pressing Origin. If an item is active, the remaining hours will be displayed, a deactivated item will display, “—” instead.

The maintenance item time is adjusted by using the left and right arrows. Pressing the Origin key will reinstate the default time.

Items are tracked either by the time accumulated while power is on (ON-TIME) or by cycle-start time (CS-TIME). When the time reaches zero the message “Maintenance Due” is displayed at the bottom of the screen (a negative number of hours indicates the hours past due).

This message is not an alarm and does not interfere with machine operation in any way. After the necessary maintenance has been performed, the operator can select that item on the “Scheduled Maintenance” screen, press the Origin button to deactivate it, then press Origin again to reactivate it with the default number of hours remaining.

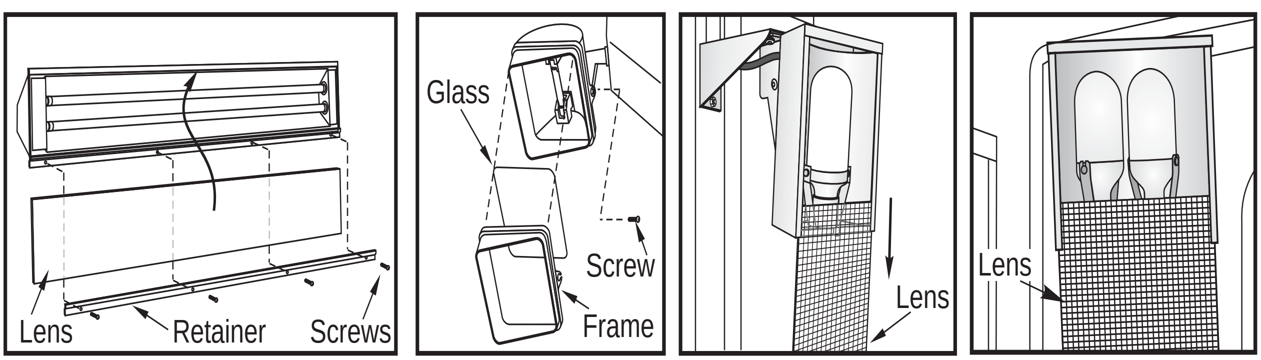
Windows / Guarding

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

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

Worklight

There are threetype of worklights for the Haas mills. Turn off power to the machine at the main breaker before doing any work on the mill.



Chip Auger

During normal operation, most chips are discharged from the machine at the discharge tube. However, very small chips may flow through the drain and collect in the coolant tank strainer. To prevent drain blockage, clean this strainer regularly. Should the drain become clogged and cause coolant to collect in the pan, stop the machine, loosen the chips blocking the drain, and allow the coolant to drain. Empty the coolant tank strainer, then resume operation.

Spindle Air Pressure

Verify Spindle air pressure using the gauge located behind the air regulator panel. VF, VR and VS mills should be set to 17 psi. EC-series and HS Series should be set to 25psi. Adjust if necessary.

15K Spindle

The air pressure for the 15K Spindle is 20 psi. The 15K Spindle requires higher pressure to slightly reduce the amount of oil and speed the delivery of the oil to the bearings.

TSC Maintenance

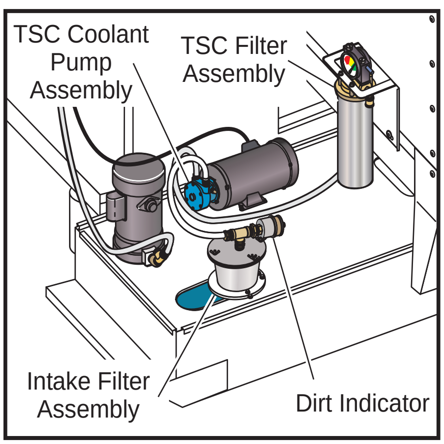
The TSC pump is a precision gear pump and will wear out faster and lose pressure if abrasive particles are present in the coolant.

• Check the dirt indicator on the 100-micron mesh filter with the TSC system running and no tool in the spindle. Change the element when the indicator reaches the zred zone.

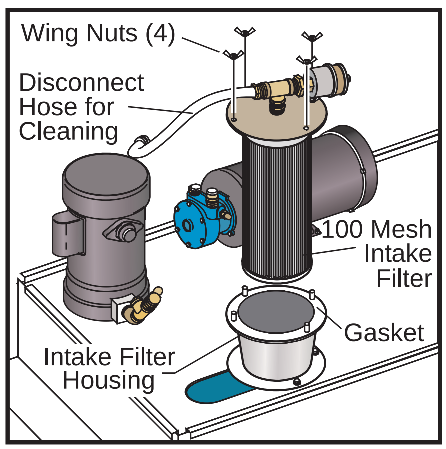
• Clean the pump intake filter when indicator is in the red zone. Reset indicator with button. All intake filters can be cleaned with a wire brush.

• After changing or cleaning filter elements, run TSC system with no tool in spindle for at least one minute to prime system.

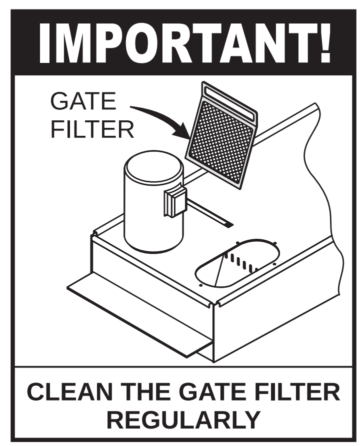
• Coolant will be used more quickly when the TSC system is in use. Make sure to keep the coolant level up and to check the level more frequently (check after every eight hour shift). **Premature wear of the pump can result from running with a low coolant level in the tank**.



TSC Coolant Pump Assembly



Cleaning the Intake Filter



Gate Filter

Warnings

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

Shortened pump life, reduction of pressure and increased maintenance are normal and to be expected in abrasive environments and are not covered by warranty. A special filter, in addition to the standard filter should be used; contact Haas for recommendations.

Machining of ceramics and the like voids all warranty claims for wear and is done entirely at customer's risk. Increased maintenance schedules are absolutely required with abrasive swarf. The coolant must be changed more often and the tank thoroughly cleaned of sediment on the bottom. An auxiliary coolant filter is recommended.

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

Lubrication Chart

System	Lubricant	Quantity
Vertical Mills		
Way lube and pneumatics	Mobile Vactra #2	2-2.5 qts
Transmission	Mobil DTE 25	40Taper 34 oz 50 Taper 51oz
A and B axis (VR-Series)	Mobile SHC 630	A-axis 5qts B-axis 4qts
EC-Series		
Way lube and pneumatics	Mobile Vactra #2	2-2.5 qts
Transmission	Mobil DTE 25	34oz
Rotary Table	Mobil SHC-630	Cover sight glass
HS 3/4/6/7 incl R		
Way lube and pneumatics	Mobile Vactra #2	2-2.5 qts
Transmission	Mobil DTE 25	34oz
Rotary Table	Mobil SHC-630	Cover sight glass

Coolant and Coolant Tank

Machine coolant must be water-soluble, synthetic oil based or synthetic based coolant/lubricant. **Using mineral cutting oils will damage rubber components throughout the machine**.

Do not use pure water as a coolant; machine components will rust. Do not use flammable liquids as coolant.

If the mill is equipped with Through-the-Spindle Coolant (TSC) do not use coolants with extremely low lubricity; these types of coolant can damage the TSC Coolant tip and pump.

The coolant tank must be thoroghly cleaned periodically, especially for mills equipped with TSC.

Coolant Overview

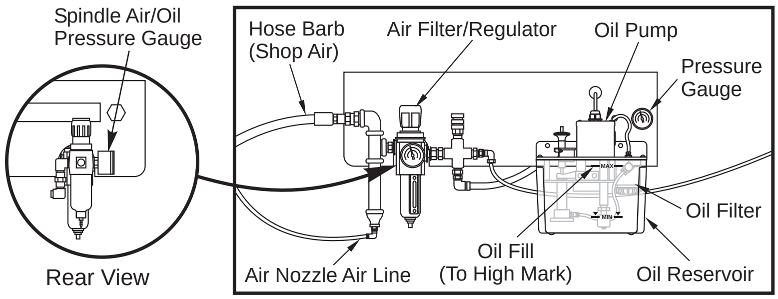
As the machine runs the water will evaporate which will change the concentration of the coolant. Coolant is also carried out with the parts.

A proper coolant mixture is between 6% and 7%. To top-off coolant only more coolant or deionized water should be used. Be sure that the concentration is still within the range. A refractometer can be used to check the concentration.

Coolant should be replaced at regular intervals. A schedule should be set and held to. This will avoid a build up of machine oil. It will also ensure that coolant with the proper concentration and lubricity will be replaced.

Lubrication System

All machine lubrication is supplied by the external lubrication system. Current lube level is visible in the reservoir; Add oil as necessary to maintain proper oil level. **Warning!** Do not add lube above the “high” line marked on the reservoir. Do not allow the lube level to go below the “low” line marked on the reservoir as machine damage could result.



External Lubrication System

Lube Oil Filter

The way lube oil filter element is a 25-micron porous metal filter (94-3059). It is recommended that the filter should be replaced annually or every 2000 hours of machine operation. The filter element is housed in the filter body, which is located **in** the oil pump reservoir (internal filters).

To change the filter element follow these steps:

1. Remove the screws that hold the oil reservoir to the pump body, carefully lower the reservoir and set aside.

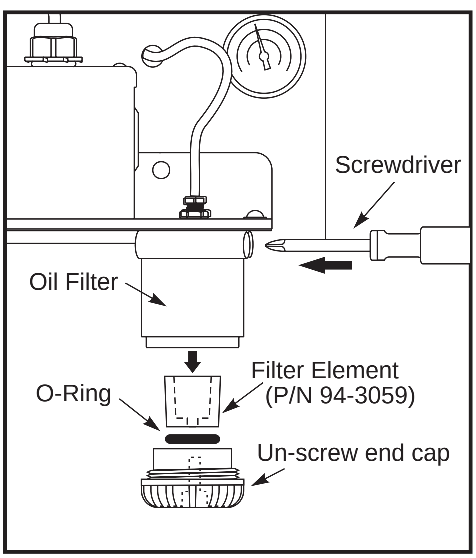
2. Use a strap wrench, pipe wrench or adjustable pliers to unscrew the end cap (see the figure). **Caution:** Use a screwdriver or similar tool to stop the filter from turning while the end cap is removed.

3. Remove the oil filter element from the filter body once the end cap is removed.

4. Clean the inside of the filter housing and the filter end cap as required.

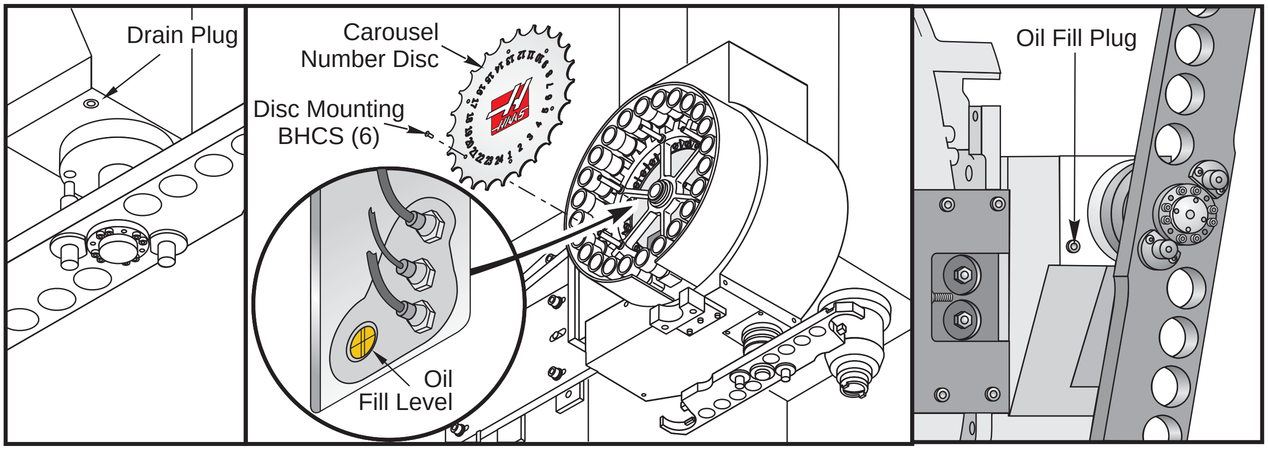
5. Install the new oil filter element (p/n 94-3059), O-ring and the end cap. Use the same tools that were used to remove the filter end cap, to tighten it - Do Not Over Tighten.

6. Replace the oil reservoir; ensure the gasket seats properly between the reservoir and the top flange.



Side Mount Tool Changer Gearbox Oil

Checking the oil level



Vertical Mills *EC-Series Mills*

Vertical Mills: View the Oil level sight glass in the location shown. The proper level is half way on the sight glass. If more oil is needed, fill the gear box to the proper level at the oil fill/breather where shown.

EC-Series: Remove the plug and feel for oil with your finger. If no oil is felt, add oil until the oil starts to come out of the oil. Replace plug.

SMTC Oil Types

Mobilgear 632 or equivalent, for standard tool changers
Mobil SHC 630 or equivalent, for high speed tool changers

HS 3/4/6/7 38-Tool Tool Changer Maintenance

Six Months •Lubricate the following parts using red grease:
Magazine Drive Gear,
Tool Pot,
Changer Slide Rack.

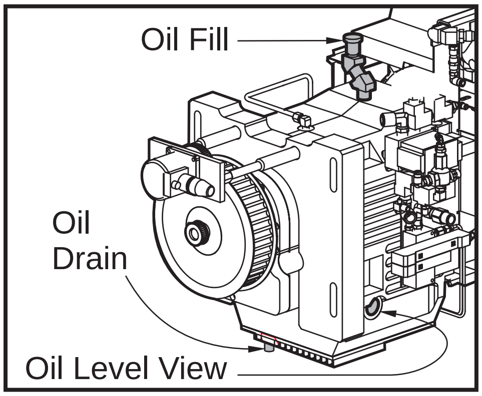
• Lubricate the Arm Shaft using Moly grease.

Annually • Lubricate the Changer Slide Linear Guide with red grease.

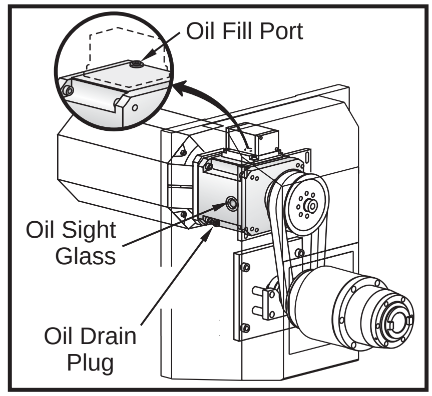
Tool Pot Chain Tension

The tool pot chain tension should be checked regulary as a preventative maintenance procedure. Chain tension adjustment is performed in the lower left area of the magazine. Loosen the four 12x50 SHCS from the front of the magazine. This will allow the plate to move. Loosen the hex lock nut on the shaft and tighten the shaft using the hex bolt. Lock in the adjustment with the hex lock nut, and retighten the four 12x50 SHCS. Tensioning will not change the indexed pot location, but check the alignment between the manual tool push cylinder and the tool pot.

EC-1600 and HS 3/4/6/7 Transmission Oil



EC-1600



HS-3/4/6/7

Oil Check

Remove the sheet metal necessary to gain access to the transmission. View the sight glass on the side of the transmission box as shown. The oil level should be half way on the sight glass. Fill as needed.

Oil Change

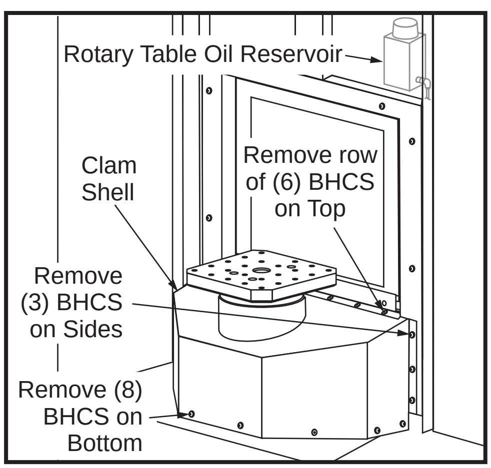
1. Remove the sheet metal from the spindle head.
2. Remove the drain plug as shown. Inspect the magnetic drainplug for signs of metal particles.
3. Blow downward with an air hose in the vicinity of the fill hole to prevent dirt and metal particles from entering the gear case. Remove the fill plug.
4. Add Mobil DTE-25 gear oil until the oil level is half way up the sightglass.
5. Run a spindle warm-up and check for leaks.

EC-Series Pallet Changer Rotary Table

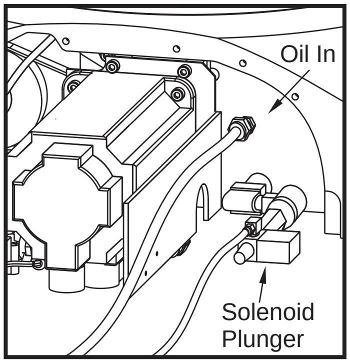
Oil Replacement

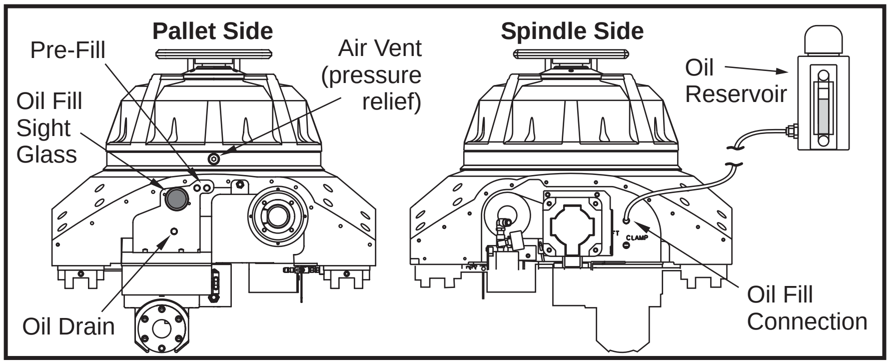
EC-300

Periodically check the oil level in the reservoir and keep it filled. It is not necessary to replace the oil.



EC-400 Full Fourth Axis Rotary Table (Perform Every 2 years)





1. Remove the fourteen (14) BHCS on the right Z-axis way cover at the receiver end and slide it toward the column.

2. Remove the left Z-axis way cover: Jog the Z-axis all the way toward the column and rotate the H-frame 45° counter clockwise. Remove the thirteen (13) BHCS that fasten the waycover to the receiver and remove it through the door at the control pendant.

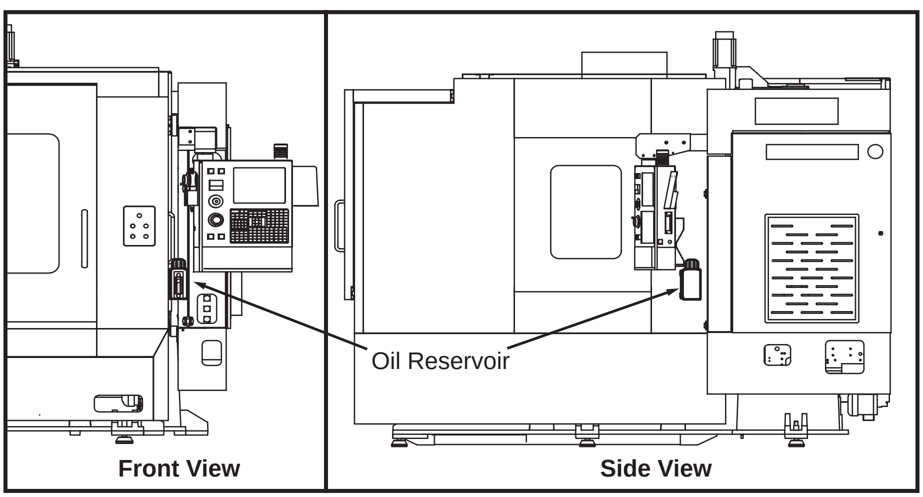
3. Disconnect the reservoir at the rotary indexer end and plug the end of the hose.

4. Remove the drain plug on the opposite side of the rotary indexer. Replug the hole when the oil has drained.

5. Remove the air escape hole plug on the side of the platter.

6. Fill the rotary table until oil begins to escape from the air escape hole and plug it.

7. Replace the reservoir hose and the way covers. Command the receiver 180° to 0° repeatedly for fifteen minutes. The reservoir will drop in level as it continues to replace the oil. Add oil as needed to the reservoir to just below the full line.



Rotary Indexer (1° or 45°)

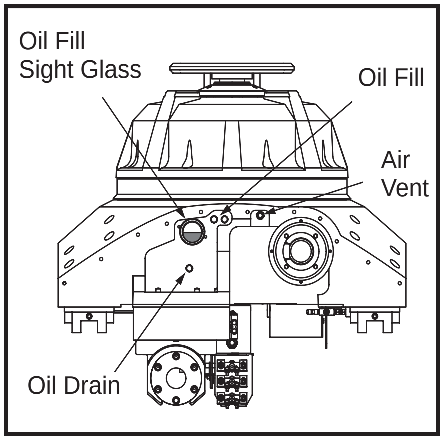
1. Remove the drain plug located on the left side of the rotary indexer. Replace the plug when the oil has drained.

2. Remove the air vent plug located to the upper right of the drain hole.

3. Fill the rotary indexer at the oil fill hole shown in the illustration. Replace the plug when oil begins to seep from the air vent.

4. Command a 180° to 0° rotation for fifteen minutes. This will remove air remaining in the system. The rotary indexer is full when the oil level is half way on the site glass. Fill as needed.

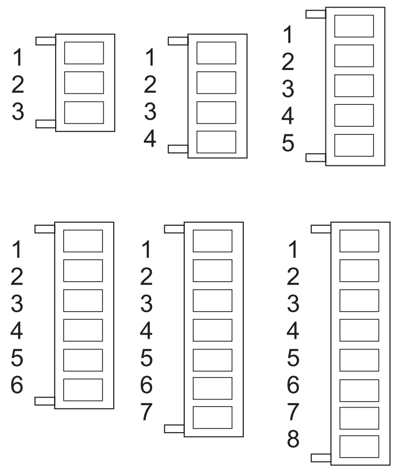
5. Replace the waycover.



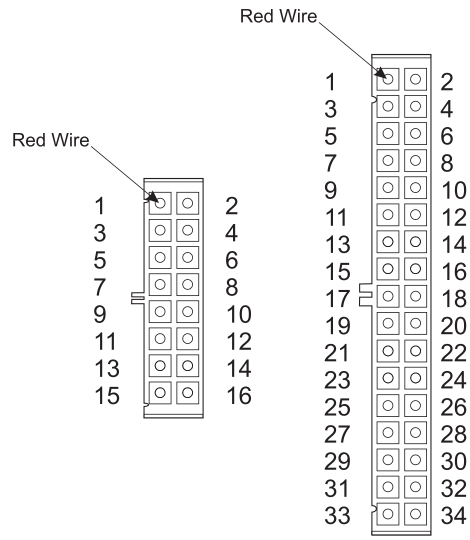
EC-400 Rotary Indexer

8. PCBs, CABLE LOCATIONS AND BOARD DIAGRAMS

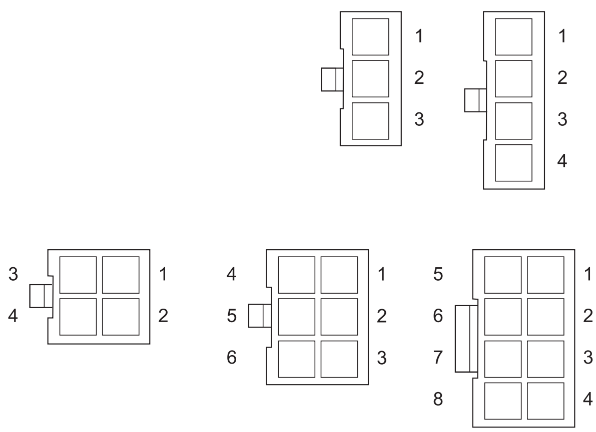
Shown below are three types of commonly used cable connectors. **They are shown as seen when plugged into the pc board.** These diagrams are to aid in locating the pins for trouble shooting.



Friction Lock



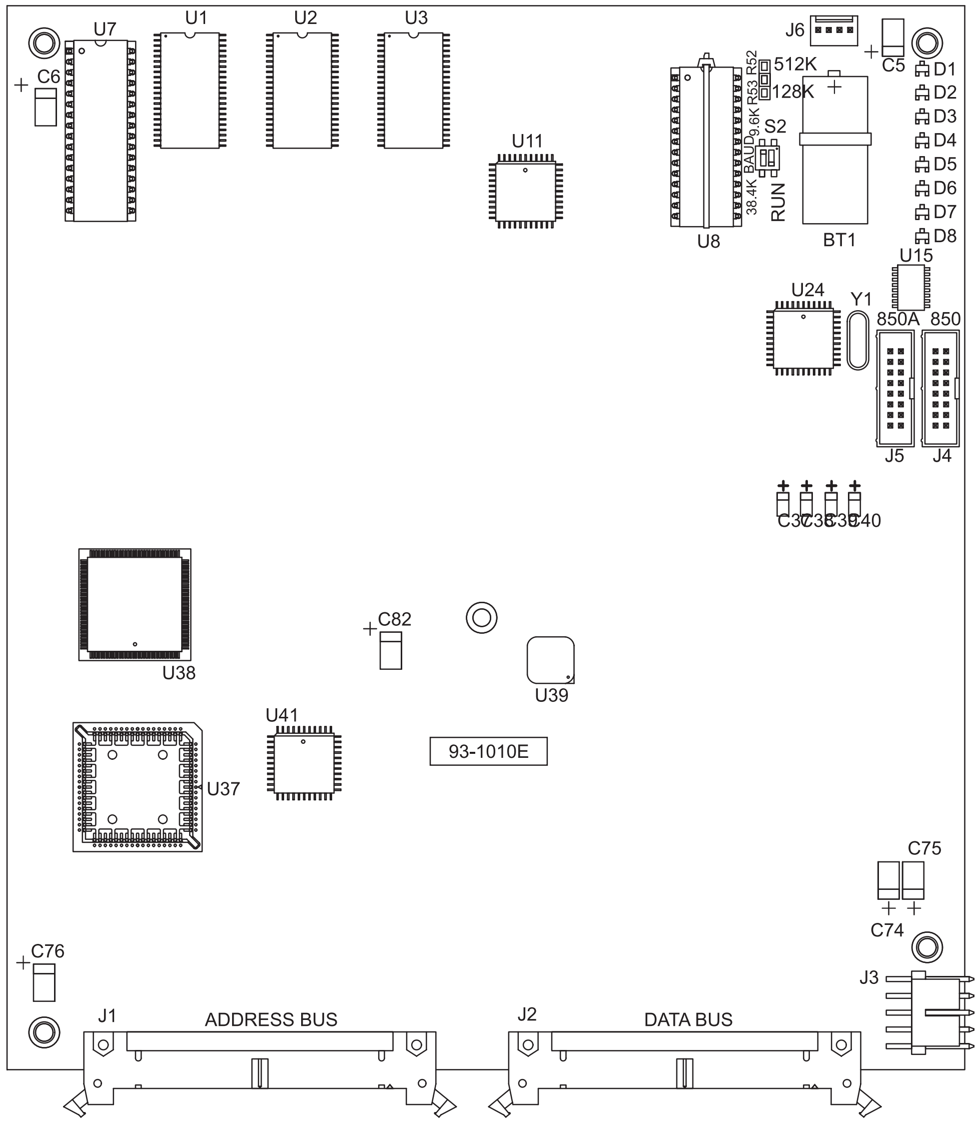
Ribbon Cables



Mini Fit

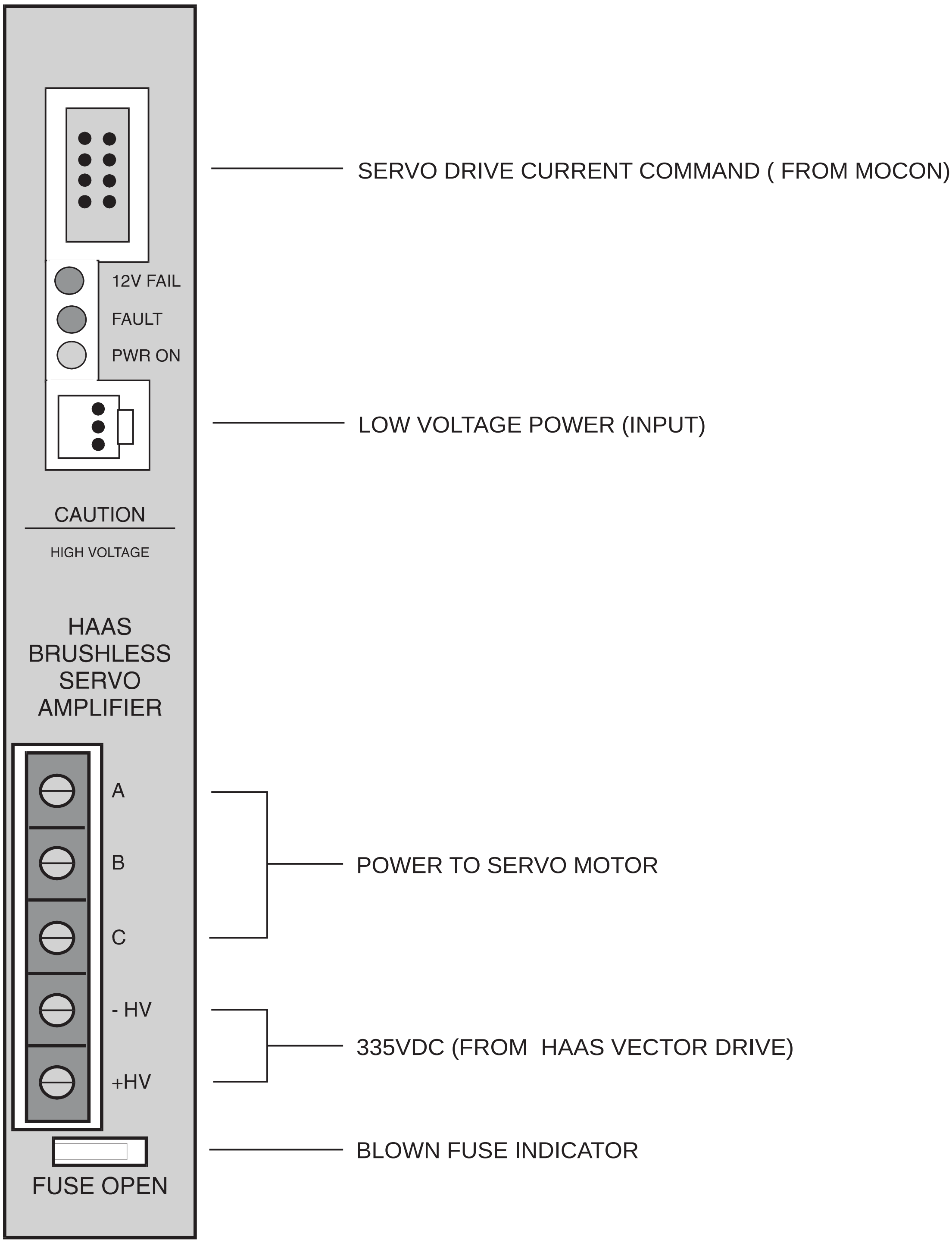
Note:The numbering sequence is the same regardless of the number of pins.

MICRO PROCESSOR PCB CABLE CONNECTIONS



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	——

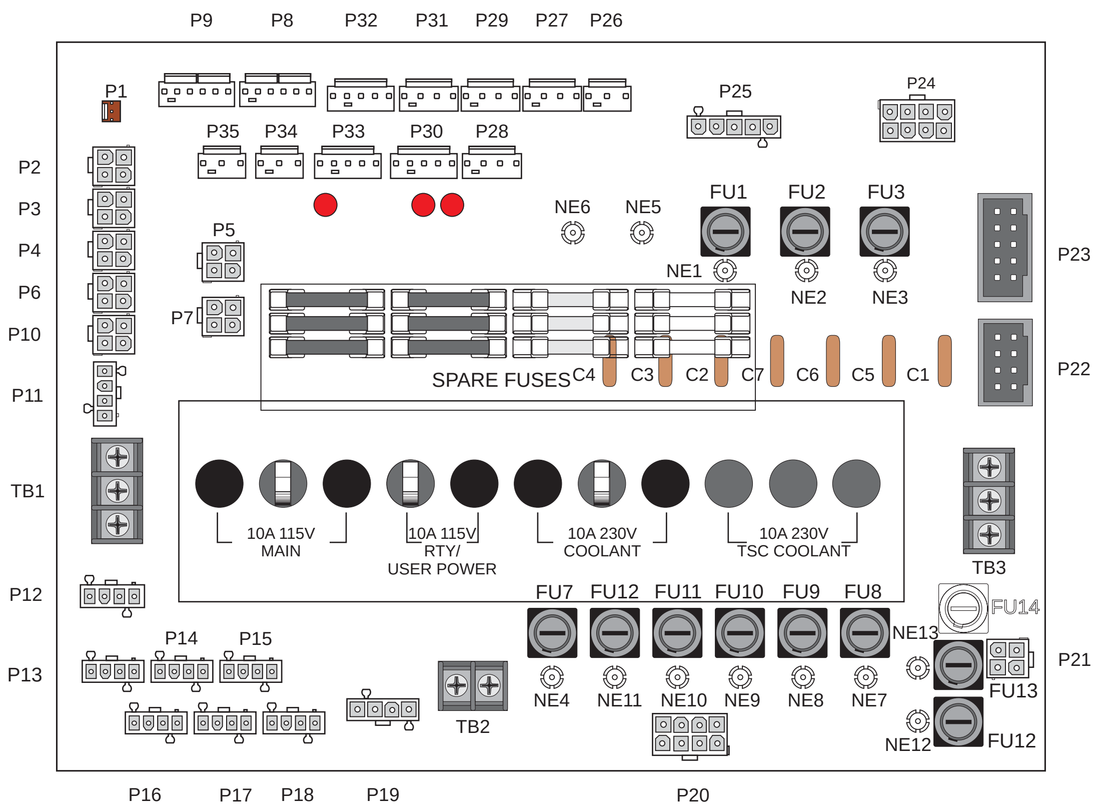
BRUSHLESS SERVO AMPLIFIER



BRUSHLESS SERVO AMPLIFIER CABLE CONNECTIONS

MOCON PLUG #	CABLE #	SIGNAL NAME ⇨ TO ⇨	LOCATION	PLUG #
X AXIS AMP				
P	570	LOW VOLTAGE	L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE	X SERVO MOTOR	——
P	610	X DRIVE SIGNAL	MOCON PCB	P2
TB -HV +HV	——	335VDC	SPINDLE DRIVE	——
Y AXIS AMP				
P	580	LOW VOLTAGE	L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE	Y SERVO MOTOR	——
P	620	Y DRIVE SIGNAL	MOCON PCB	P3
TB -HV +HV	——	335VDC	SPINDLE DRIVE	——
Z AXIS AMP				
P	590	LOW VOLTAGE	L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE	Z SERVO MOTOR	——
P	630	Z DRIVE SIGNAL	MOCON PCB	P4
TB -HV +HV	——	335VDC	SPINDLE DRIVE	——
A AXIS AMP				
P	600	LOW VOLTAGE	L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE	A SERVO MOTOR	——
P	640	A DRIVE SIGNAL	MOCON PCB	P5
TB -HV +HV	——	335VDC	SPINDLE DRIVE	——

POWER PCB

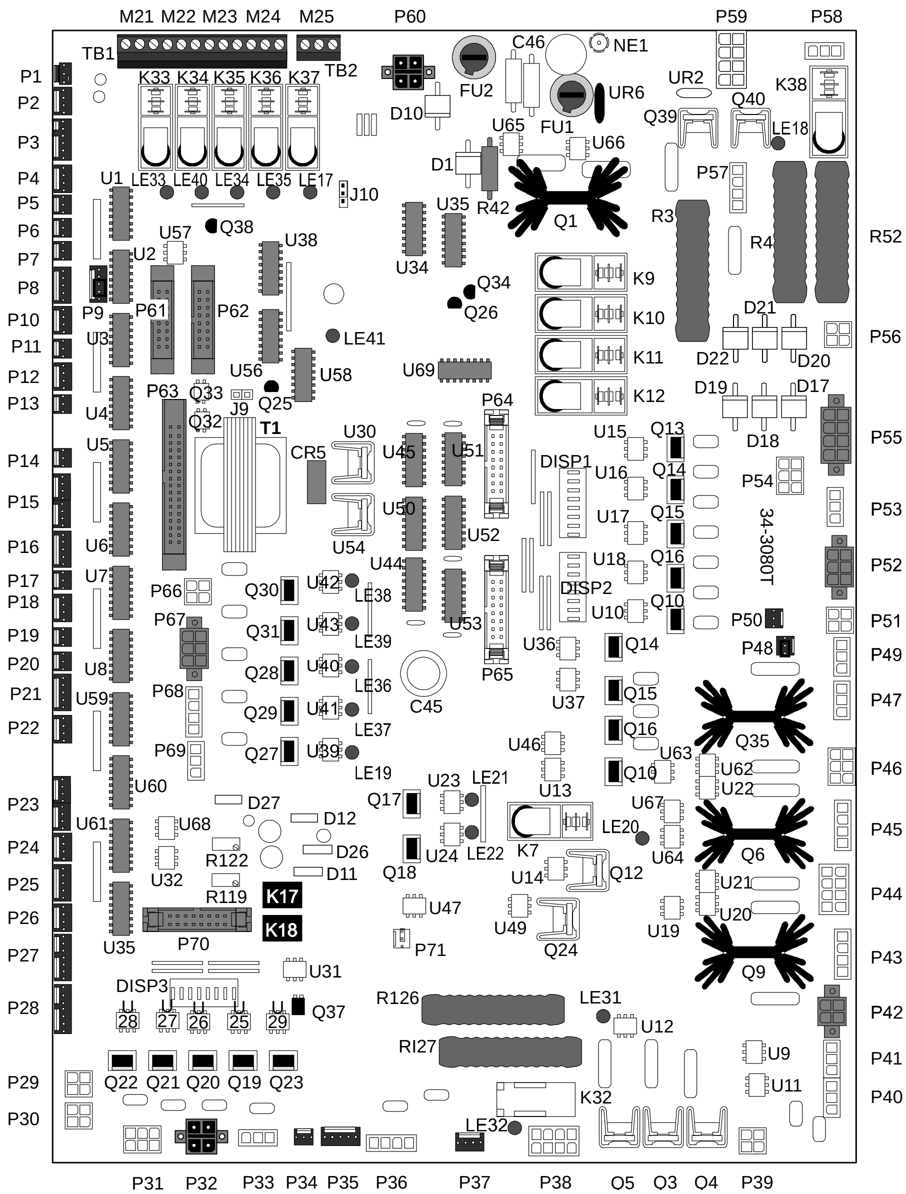


P9
P8
P32
P31
P29
P27
P26
P1
P35
P34
P33
P30
P28
P25
P24
P2
P3
P4
P6
P10
P11
P5
P7
NE6
NE5
FU1
FU2
FU3
NE1
NE2
NE3
P23
P22
SPARE FUSES
C4
C3
C2
C7
C6
C5
C1
TB1
10A 115V
MAIN
10A 115V
RTY/
USER POWER
10A 230V
COOLANT
10A 230V
TSC COOLANT
TB3
P12
FU7
FU12
FU11
FU10
FU9
FU8
FU14
NE13
P14
P15
P21
P13
FU13
NE4
NE11
NE10
NE9
NE8
NE7
TB2
NE12
FU12
P16
P17
P18
P19
P20

POWER PCB
CABLE CONNECTIONS

PLUG #	CABLE #	SIGNAL NAME ⇨ TO ⇨	LOCATION	PLUG#
P1		+12VDC	CNC Unit Fan	
P2	90B	115VAC	Low Voltage Power Supply	
P3	90B	115VAC	Probe PS	
P4	90B	115VAC	Work Light	
P5	90B	115VAC	Switch Door Fan	
P6	90B	115VAC	Servo Fan	
P7	90B	115VAC	Delta-Wye	
P8	860	+12/-12/+5 VDC In	From Low Voltage Power Supply	
P9	860	+12/-12/+5 VDC In	From Low Voltage Power Supply	
P10	90B	115VAC	Door Fan	
P11	90B	115VAC	Monitor	
P12	90C	115VAC	Regen Fan	
P13	90C	115VAC	SMTC PCB	P4
P14	90C	115VAC	spare	
P15	90C	115VAC	spare	
P16	90C	115VAC	spare	
P17	90C	115VAC	Trans PCB	P2
P18	90C	115VAC	spare	
P19	90	3PH 115VAC	IO PCB	P56
P20	930	230V CLNT/TSC	IO PCB	P44
P21	160	Chip Conv. 230V 3PH	IO PCB	P39
P23	170	Auto Off/Contactor	Contactor K1/IO PCB	P42
P22	740	On/Off	Front Panel	
P24		Prim/Sec	To T5	
P25	71, 72, 73	Overvolt Protection	From Contactor K1	
P26	860	+12VDC	SKBIF	
P27	860	+12/+5 VDC	IO PCB	P60
P28	860	+12/+5 VDC	Motif PCB	P15
P29	860	+12/+5 VDC	Processor PCB	J3
P30	860	+12/-12/+5 VDC	spare	
P31	860	+12/+5 VDC	Video PCB	P1
P32	860	+12/-12/+5 VDC	Mocon 1 PCB	P15
P33	860	+12/-12/+5 VDC	Mocon 2 PCB	P15
P34	860	+12 VDC	SMTC PCB	P2
P35	860	+12 VDC	MCD Relay PCB	P2
TB1	94, 95, 96	115VAC	From Transformer	
TB2	90A	115 VAC Out	Barfeeder / T/C PCBA	P8
TB3	77, 78, 79	3PH 230V In	From Transformer	

I/O PCB

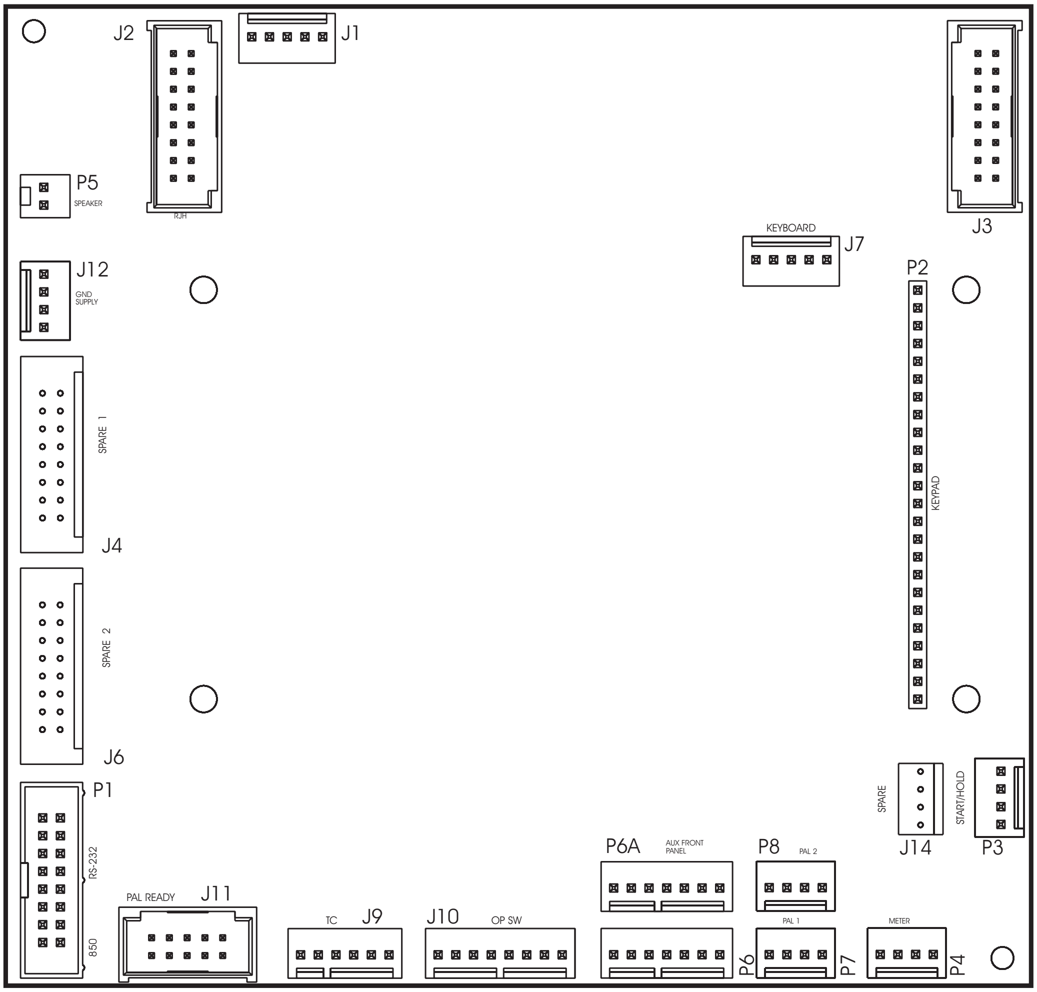


I/O PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1	140B		Chip Conveyor	
P2	820B		T/C In/smtc arm mark T	
P3	820		DB Up/Down / TC out SMTC / shuttle out	
P4	900		TSC Pump (Low TSC pressure)	
P5	770		E-Stop Switch A Front Panel	
P6	770A		E-Stop Switch B	
P7	770B		E-Stop Switch C	
P8	1050		Side Door Open	
P9	1050A		Side Door Open (spare)	
P10	100		(External) M-Fin	
P11	970		Vector Drive Over Volt	VD J1
P12	950		Low Air/Oil	
P13	960		Low Air/Lube	
P14	830		Regen Overheat	

I/O PCB CABLE CONNECTIONS

I/O PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P15	890		Spin Head Status / SP DB open	
P16	780		Spare/ 2nd VD OV/contactor on/ cntr balance	
P17	410		T/C Air Door SW	
P18	790		Pallet CW/CCW	
P19	190		Frnt Door sw / Lo phase	
P20	190A		Op Station Locked/Frnt Door sw.	
P21	240		Pallet Up/Down / BF load bar, Q / grnd fault	
P22	1070		Skip	
P23	420		Mori pin in / arm in	
P24	440		Mori arm in / cage door open / arm out	
P25	450		Mori arm CW/CCW	
P26	460		Mori slide 1/2 way / slide left	
P27	470		Mori swing spin / SMTC shuttle mark	
P28	480		Spare	
P29	1040A		Door Interlock	
P30	1040		Door Interlock	
P31	230		5th Axis Brake	
P32	250		HTC Shuttle / mori manual tool release	
P33	270		TSC Purge	
P34	260		Pal Ready	
P35	200		Spare	
P36	280		Beacons	
P37	140A		Side Chip Conv En/Rev	HOPT P5
P38	140		230V to Chip Conv Mtrs	
P39	160		230V to Chip Conv. Circuit	PSUP P21
P40	300		Panel Lube Oil Pump	
P41	300A		SP Fan/Oil Pump/Luber	
P42	170		Auto Off	PSUP P23
P43	940		Coolant Mtr	
P44	930		230V to TSC/Coolant Circuit	PSUP P20
P45	940A		TSC coolant	
P46	390		4th Axis Brake	
P47	350		Axis Brake	TRANS P6
P48	120		Coolant O/T Sensor	
P49	350A		Hyd En	TRANS P4
P50	130		TSC O/T Sensor	
P51	430		Pallet Up	
P52	710		BF Collet open / close	
P53	880C		Wye-Delta Switch	
P54	880A		High/Low Gear 50T	
P55	880B		Chuck unclamp	
P56	90		115V Power To IOPCB	PSUP P27
P57			Ext. Drawbar Mtr. Resitor	HOPT P3
P58	810A		PC main DB fwd/rev / BF load Q/bar	
P59	810		Main DB Up/Dwn / Shuttle In/Out Mtrs	
P60	860A		5V/12V Logic Pwr IOPCB	PSUP 27
P61	540		Outputs Cable 24-55	MOCON P14
P62	540A		Outputs Cable 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		Beeper	
P68	310		Pallet CW/CCW	
P69	220		TC Air Door	
P70	530		Outputs Cable 16-23	MOCON P13
TB1	M21-24		Probe, M-Fin, User Spare	
TB2	M25		User Spare	

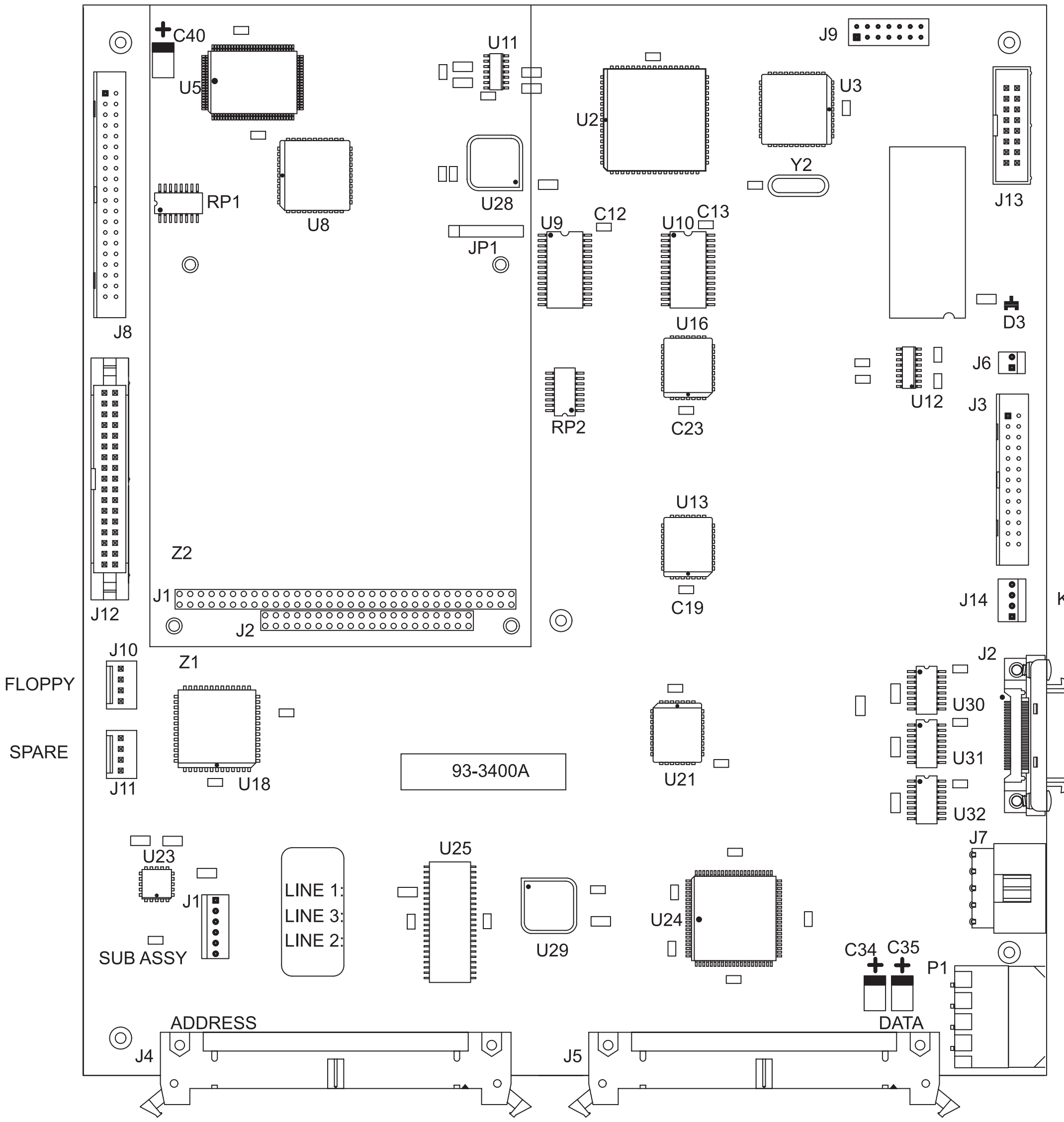
SERIAL KEYBOARD INTERFACE PCB WITH HANDLE JOG



PLUG#	CABLE#	⇨ TO ⇨	LOCATION	PLUG#
P1	700B		PROCESSOR	850
P2	—		KEYPAD	—
P3	700A		CYCLE START/ HOLD SWITCHES	—
P4	730		SP LOAD METER	—
P5	—			—
P6	—		AUX FPANEL	—
J1	—			—
J2	—		REMOTE JOG HANDLE	—
J3	750		MOCON	P18
J5	—		(MIKRON ONLY)	—
J7	—		EXTERNAL KEYBOARD	—
J12	860C		FT. PANEL FAN	—

* See "Keyboard Diagnostic" section of this manual for Troubleshooting information.

VIDEO & KEYBOARD PCB W/ FLOPPY DRIVE

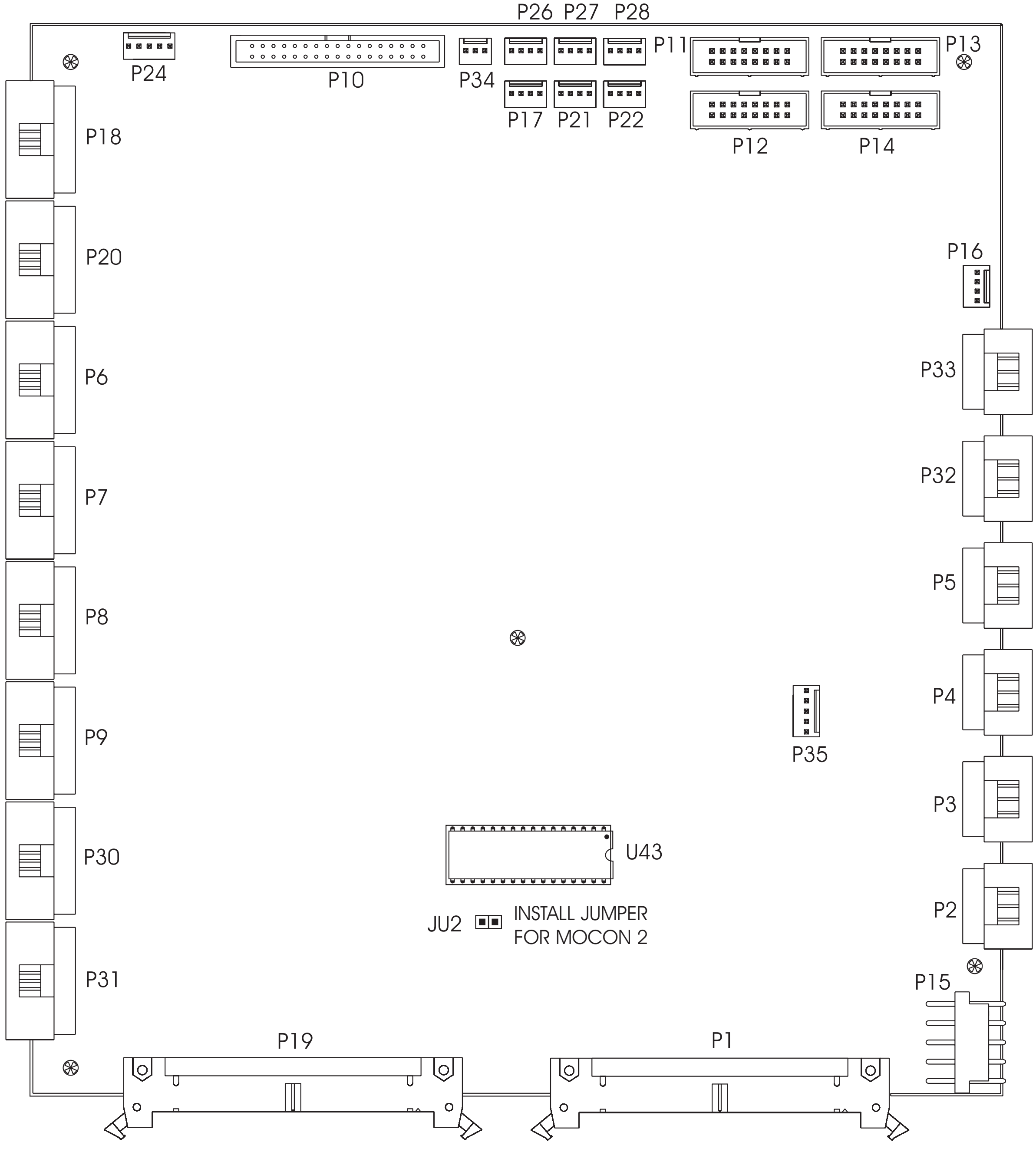


VIDEO

PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨	LOCATION	PLUG #
P1	860	LOW VOLTAGE		POWER SUPPLY PCB	——
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

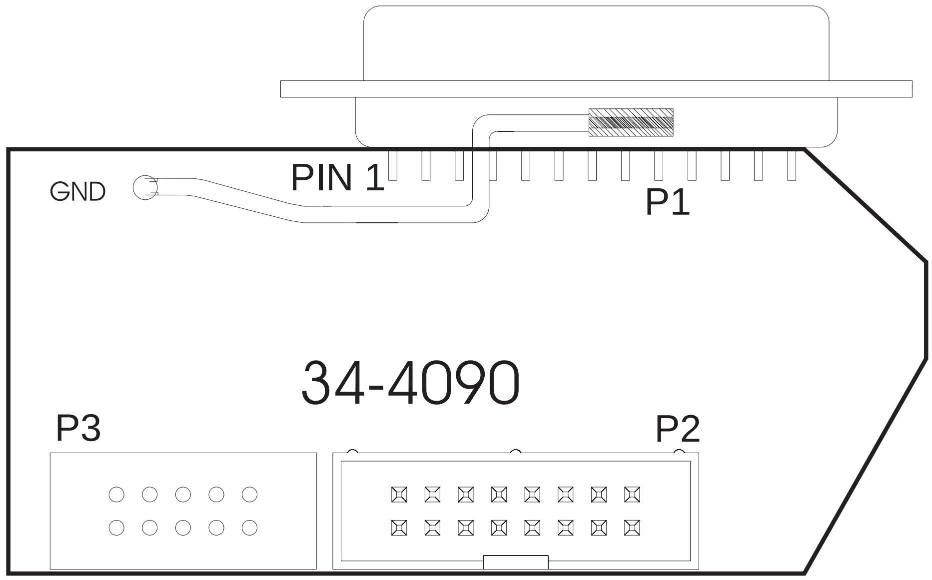
MOCON PCB



P26 P27 P28
P24
P10
P34
P11
P13
P17 P21 P22
P12
P14
P18
P20
P16
P6
P33
P7
P32
P5
P8
P4
P9
P35
P3
P30
U43
P2
JU2
INSTALL JUMPER
FOR MOCON 2
P31
P15
P19
P1

MOCON PCB
CABLE CONNECTIONS

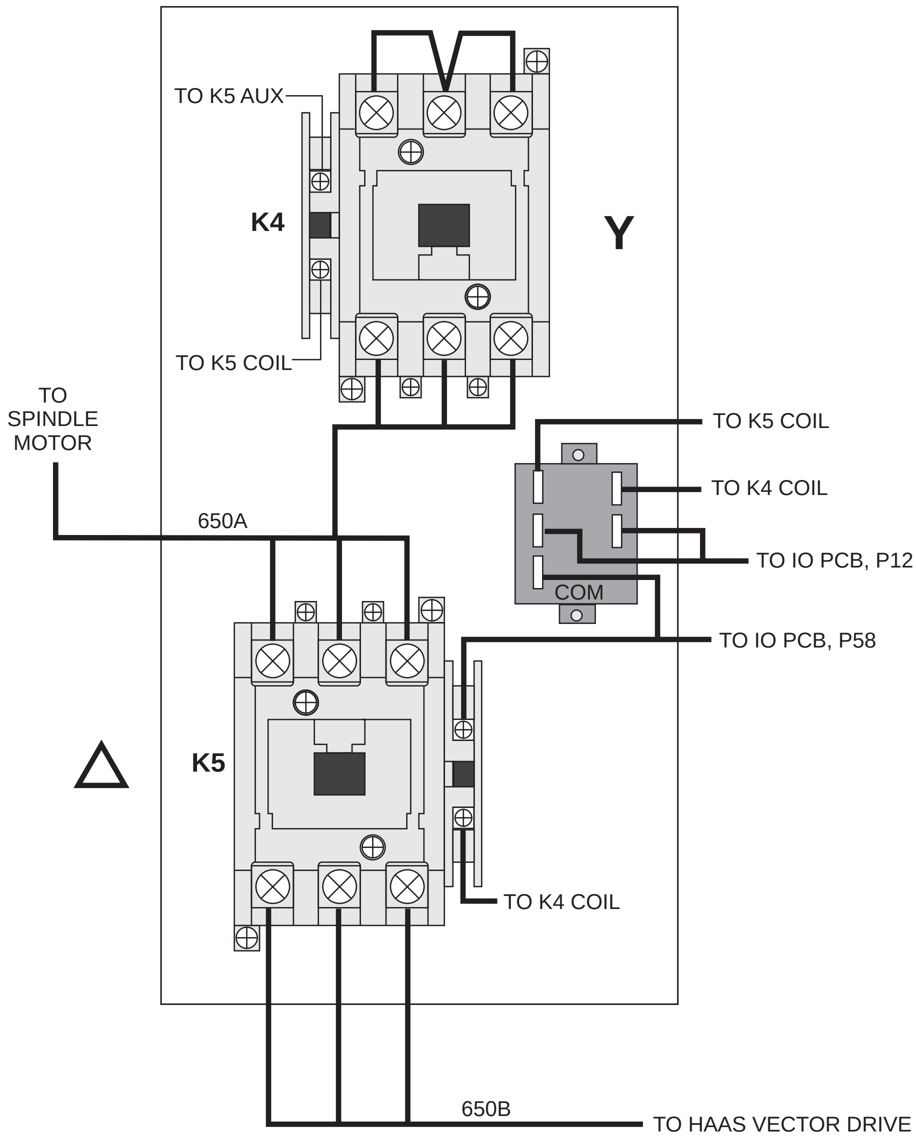
MOCON PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨	LOCATION	PLUG #
P1	——	DATA BUSS		VIDEO PCB	——
				MICRO PROC. PCB	——
P2	610	X DRIVE SIGNAL		X SERVO DRIVE AMP.	P
P3	620	Y DRIVE SIGNAL		Y SERVO DRIVE AMP.	P
P4	630	Z DRIVE SIGNAL		Z SERVO DRIVE AMP.	P
P5	640	A DRIVE SIGNAL		A SERVO DRIVE AMP.	P
P32	640B	B DRIVE SIGNAL		B SERVO DRIVE AMP.	P
P6	660	X ENCODER INPUT		X ENCODER	——
P7	670	Y ENCODER INPUT		Y ENCODER	——
P8	680	Z ENCODER INPUT		Z ENCODER	——
P9	690	A ENCODER INPUT		A ENCODER	——
P30	690B	B ENCODER INPUT		B ENCODER	——
				(BRUSHLESS TOOL CHANGER)	
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. LOAD METER		LOAD METER	——
P17	980	VOLTAGE MONITOR		N/A	N/A
P18	750	JOG ENCODER INPUT		JOG HANDLE	——
P19		ADDRESS BUSS		VIDEO PCB	——
				MICRO PROC. PCB	——
P20	1000	SP. ENCODER INPUT		SPINDLE ENCODER	——
P21		X-AXIS TEMP SENSOR			
P22	730B	SP. DRIVE LOAD		SPINDLE DRIVE	——
P24	990	HOME SENSORS		X, Y & Z LIMIT	——
P26		Y-AXIS TEMP SENSOR			
P27		Z-AXIS TEMP SENSOR			
P31	690C	C-AXIS ENCODER INPUT		SPINDLE MOTOR (lathe)	
P33	640C	VCTR DR CUR. CMD.		VECTOR DRIVE	J3

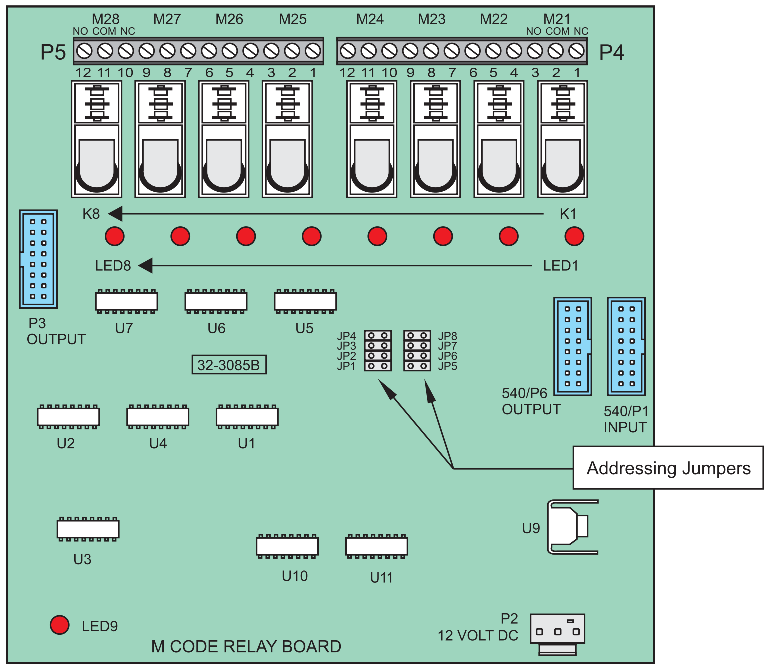


RS-232 PORT #1 PCB
CABLE CONNECTIONS

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

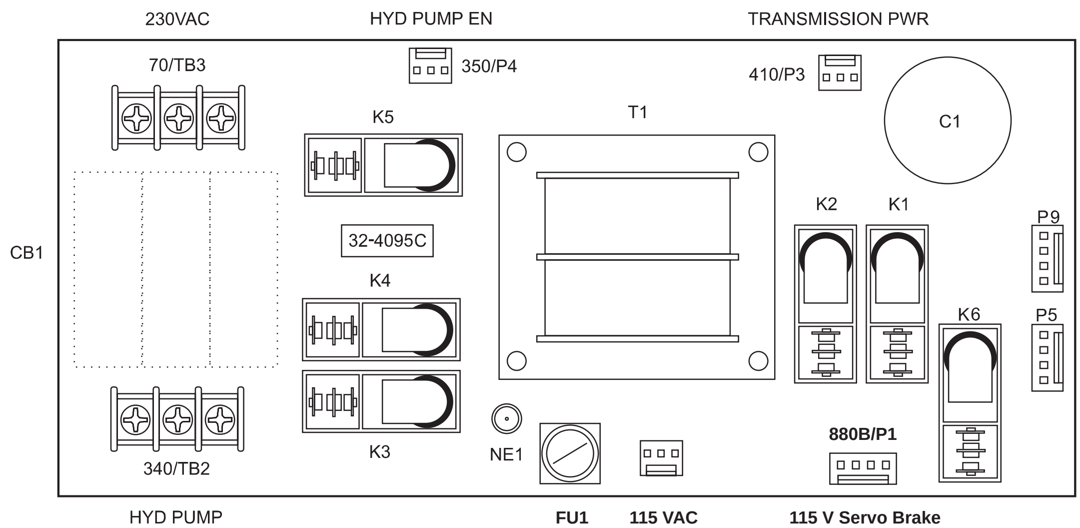
Y-DELTA SWITCH ASSEMBLY
P/N 32-5851B (40T 10HP)
P/N 32-5864A (SUPER SPEED AND 50T)





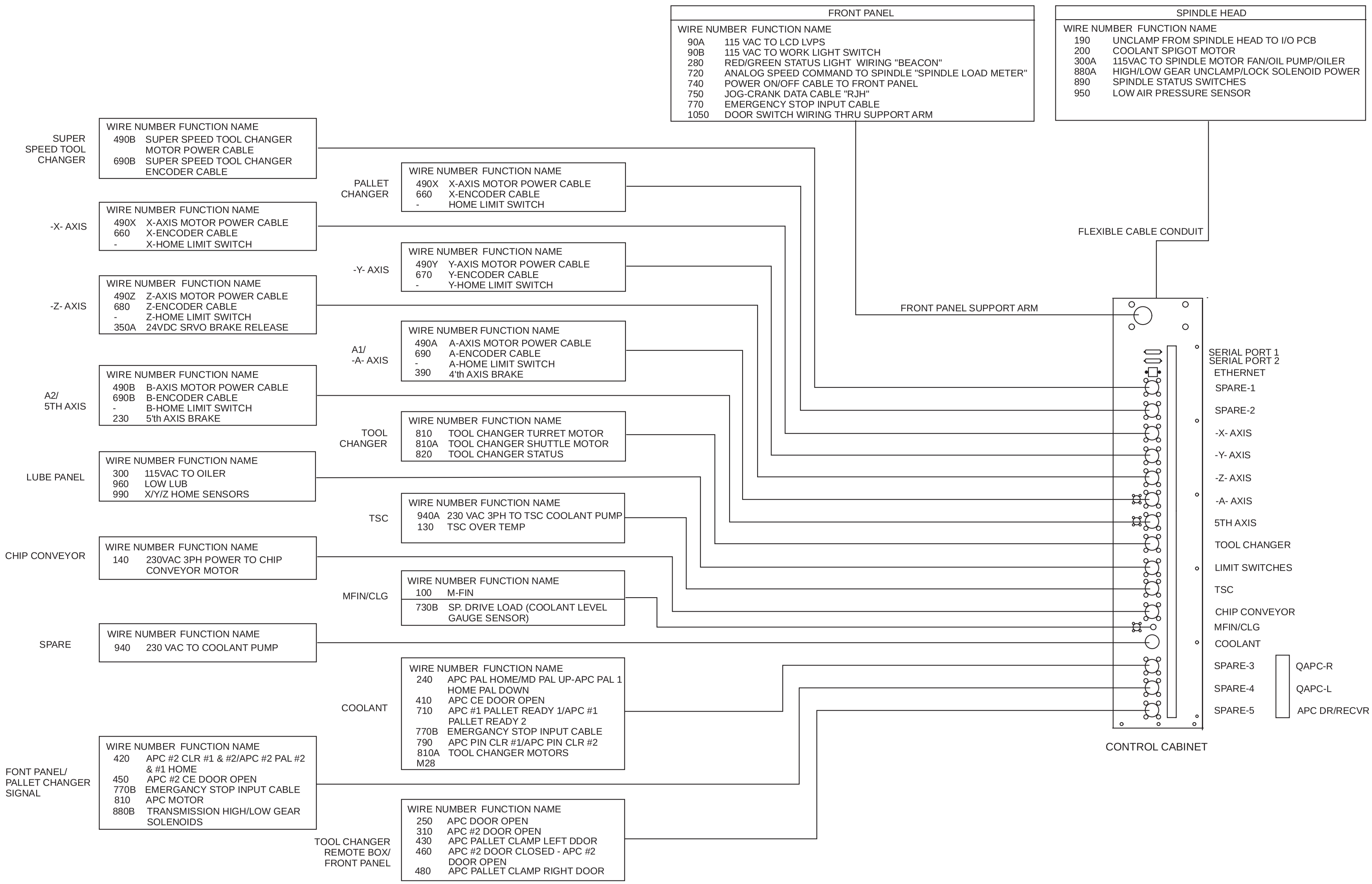
M CODE RELAY BOARD
CABLE CONNECTIONS

PLUG #	CABLE #	SIGNAL NAME ⇨ TO ⇨	LOCATION	PLUG #
P1	540	MOCON INPUT	IO PCB`	P62
P2	860A	12VD TO M-CODE PCBA	PSUP	P31
P3	540A	IOPCB OUTPUT		
P4	M21	M-FUNCTION		
	M22	PROBE OPTION		
	M24	spare		
P5	M25	spare		
	M26	spare		
	M27	spare		
P6	540B	M CODE OUTPUT	2nd MCD	P1



50T TRANSMISSION P.S. / HYDRAULIC C.B. PCB CABLE CONNECTIONS

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


FRONT PANEL
WIRE NUMBER FUNCTION NAME
90A 115 VAC TO LCD LVPS
90B 115 VAC TO WORK LIGHT SWITCH
280 RED/GREEN STATUS LIGHT WIRING "BEACON"
720 ANALOG SPEED COMMAND TO SPINDLE "SPINDLE LOAD METER"
740 POWER ON/OFF CABLE TO FRONT PANEL
750 JOG-CRANK DATA CABLE "RJH"
770 EMERGENCY STOP INPUT CABLE
1050 DOOR SWITCH WIRING THRU SUPPORT ARM
SPINDLE HEAD
WIRE NUMBER FUNCTION NAME
190 UNCLAMP FROM SPINDLE HEAD TO I/O PCB
200 COOLANT SPIGOT MOTOR
300A 115VAC TO SPINDLE MOTOR FAN/OIL PUMP/OILER
880A HIGH/LOW GEAR UNCLAMP/LOCK SOLENOID POWER
890 SPINDLE STATUS SWITCHES
950 LOW AIR PRESSURE SENSOR
FLEXIBLE CABLE CONDUIT
FRONT PANEL SUPPORT ARM
SUPER SPEED TOOL CHANGER
WIRE NUMBER FUNCTION NAME
490B SUPER SPEED TOOL CHANGER MOTOR POWER CABLE
690B SUPER SPEED TOOL CHANGER ENCODER CABLE
-X- AXIS
WIRE NUMBER FUNCTION NAME
490X X-AXIS MOTOR POWER CABLE
660 X-ENCODER CABLE
- X-HOME LIMIT SWITCH
-Z- AXIS
WIRE NUMBER FUNCTION NAME
490Z Z-AXIS MOTOR POWER CABLE
680 Z-ENCODER CABLE
- Z-HOME LIMIT SWITCH
350A 24VDC SRVO BRAKE RELEASE
A2/ 5TH AXIS
WIRE NUMBER FUNCTION NAME
490B B-AXIS MOTOR POWER CABLE
690B B-ENCODER CABLE
- B-HOME LIMIT SWITCH
230 5'th AXIS BRAKE
LUBE PANEL
WIRE NUMBER FUNCTION NAME
300 115VAC TO OILER
960 LOW LUB
990 X/Y/Z HOME SENSORS
CHIP CONVEYOR
WIRE NUMBER FUNCTION NAME
140 230VAC 3PH POWER TO CHIP CONVEYOR MOTOR
SPARE
WIRE NUMBER FUNCTION NAME
940 230 VAC TO COOLANT PUMP
FONT PANEL/ PALLET CHANGER SIGNAL
WIRE NUMBER FUNCTION NAME
420 APC #2 CLR #1 & #2/APC #2 PAL #2 & #1 HOME
450 APC #2 CE DOOR OPEN
770B EMERGANCY STOP INPUT CABLE
810 APC MOTOR
880B TRANSMISSION HIGH/LOW GEAR SOLENOIDS
PALLET CHANGER
WIRE NUMBER FUNCTION NAME
490X X-AXIS MOTOR POWER CABLE
660 X-ENCODER CABLE
- HOME LIMIT SWITCH
-Y- AXIS
WIRE NUMBER FUNCTION NAME
490Y Y-AXIS MOTOR POWER CABLE
670 Y-ENCODER CABLE
- Y-HOME LIMIT SWITCH
A1/ -A- AXIS
WIRE NUMBER FUNCTION NAME
490A A-AXIS MOTOR POWER CABLE
690 A-ENCODER CABLE
- A-HOME LIMIT SWITCH
390 4'th AXIS BRAKE
TOOL CHANGER
WIRE NUMBER FUNCTION NAME
810 TOOL CHANGER TURRET MOTOR
810A TOOL CHANGER SHUTTLE MOTOR
820 TOOL CHANGER STATUS
TSC
WIRE NUMBER FUNCTION NAME
940A 230 VAC 3PH TO TSC COOLANT PUMP
130 TSC OVER TEMP
MFIN/CLG
WIRE NUMBER FUNCTION NAME
100 M-FIN
730B SP. DRIVE LOAD (COOLANT LEVEL GAUGE SENSOR)
COOLANT
WIRE NUMBER FUNCTION NAME
240 APC PAL HOME/MD PAL UP-APC PAL 1 HOME PAL DOWN
410 APC CE DOOR OPEN
710 APC #1 PALLET READY 1/APC #1 PALLET READY 2
770B EMERGANCY STOP INPUT CABLE
790 APC PIN CLR #1/APC PIN CLR #2
810A TOOL CHANGER MOTORS
M28
TOOL CHANGER REMOTE BOX/ FRONT PANEL
WIRE NUMBER FUNCTION NAME
250 APC DOOR OPEN
310 APC #2 DOOR OPEN
430 APC PALLET CLAMP LEFT DDOR
460 APC #2 DOOR CLOSED - APC #2 DOOR OPEN
480 APC PALLET CLAMP RIGHT DOOR
SERIAL PORT 1
SERIAL PORT 2
ETHERNET
SPARE-1
SPARE-2
-X- AXIS
-Y- AXIS
-Z- AXIS
-A- AXIS
5TH AXIS
TOOL CHANGER
LIMIT SWITCHES
TSC
CHIP CONVEYOR
MFIN/CLG
COOLANT
SPARE-3
SPARE-4
SPARE-5
QAPC-R
QAPC-L
APC DR/RECVR
CONTROL CABINET

EC-300/EC-400

9. CABLE LIST

WIRE/ TERMINAL NUMBER	FUNCTION NAME:
	INCOMING POWER 195-260 VAC (353-480 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 195-260VAC CB1-4 TO K1-1
72	PROTECTED 195-260VAC CB1-5 TO K1-2
73	PROTECTED 195-260VAC CB1-6 TO K1-3
74	195-260VAC FROM K1-4 TO XFORMER T1
75	195-260VAC FROM K1-5 TO XFORMER T1
76	195-260VAC FROM K1-6 TO XFORMER T1
77	230VAC PHASE 1, FROM XFORMER T1 TO SPINDLE DRIVE/CHIP CONV
78	230VAC PHASE 2, FROM XFORMER T1 TO SPINDLE DRIVE/CHIP CONV
79	230VAC PHASE 3, FROM XFORMER T1 TO SPINDLE DRIVE/CHIP CONV
90	115 VAC FROM TB2 (CB2 OUTPUT) TO IOPCB P33 - SHIELD +3
91	115 VAC FROM TB2-1 TO IOPCB P33 PIN 1, #20
92	115 VAC FROM TB2-2 TO IOPCB P33 PIN 2, #20
93	115 VAC FROM TB2-3 TO IOPCB P33 PIN 3, #20
94	SHIELD DRAIN
-	115 VAC FROM XFORMER T1 TO TB1 (CB2 INPUT)
94	STEPPED-DOWN 115 VAC (FROM XFORMER T1) #14
95	STEPPED-DOWN 115 VAC (FROM XFORMER T1) #14
96	STEPPED-DOWN 115 VAC (FROM XFORMER T1) #14
90A	115 VAC TO CRT - SHIELD +2
91A	LEG 1 #16
92A	LEG 2 #16
93A	SHIELD DRAIN
90B	115 VAC CABINET DOOR FAN
91B	LEG 1 #16
92B	LEG 2 #16
93B	SHIELD DRAIN
90C	115 VAC TO CB4 - SHIELD +2
91C	LEG 1 #20
92C	LEG 2 #20
93C	SHIELD DRAIN
100	M-FUNCTION INPUT - SHIELD +2
101	SIGNAL #20
102	COMMON #20
103	SHIELD DRAIN

100A	M-FUNCTION OUTPUT M21 (MCD RELAY BOARD M21) -SHIELD +2
101A	UNSWITCHED LEG 1 #20
102A	SWITCHED LEG 2 #20
103A	SHIELD DRAIN
110	SPARE (115 VAC SERVO POWER)
140	230VAC 3PH POWER TO CHIP CONVEYOR MOTOR
141	PHASE A 230VAC
142	PHASE B 230VAC
143	PHASE C 230VAC
144	STARTING WINDING 230VAC
145	STARTING WINDING 230VAC
160	3PH 230VAC TO CHIP CONVEYOR CONTROLLER - SHIELD +3
161	PHASE A 230VAC #20
162	PHASE B 230VAC #20
163	PHASE C 230VAC #20
164	SHIELD DRAIN
170	AUTO OFF FUNCTION - SHIELD +2
171	UNSWITCHED LEG 1 #20
172	SWITCHED LEG 2 #20
173	SHIELD DRAIN
180 SPARE (COOLANT SPIGOT DETENT SWITCH)	
190	PALLET CHANGER OPERATOR STATION LOCK / FRONT DOOR
191	SIGNAL #20
192	RETURN #20
193	SHIELD DRAIN
200	SPARE (12 VDC COOLANT SPIGOT MOTOR)
210 DATA CABLE TO 3" FLOPPY DISK DRIVE (34 PINS)	
230	5’th AXIS BRAKE (PALLETS UP HS-1RP) - SHIELD +2
231	115VAC COMMON
232	115VAC SWITCHED
233	SHIELD DRAIN
240	PALLET CHANGER PALLET UP/DOWN
241	PALLETS UP #20
242	PALLETS DOWN #20
243	COMMON #20
244	SHIELD DRAIN
250	HTC SHUTTLE/MORI MANUAL TOOL RELEASE
251	LEG 1 #20
252	LEG 2 #20
253	SHIELD DRAIN
260	12 VDC RELAY OUTPUT TO PALLET READY LAMP - SHIELD +2
261	SWITCHED LEG 1 #20
262	UNSWITCHED LEG 2 #20
263	SHIELD DRAIN

270	115 VAC RELAY OUTPUT TO PURGE SOLENOID - SHIELD +2
271	UNSWITCHED LEG 1 #20
272	SWITCHED LEG 2 #20
273	SHIELD DRAIN
280	115 VAC RED/GREEN BEACON CABLE -SHIELD +3
281	RED LAMP 115VAC
282	GREEN LAMP 115VAC
283	COMMON 115VAC
284	SHIELD DRAIN
290	115VAC TO XFORMER T2 10VAC OUTPUT
291	LEG 1 PRIMARY
292	LEG 2 PRIMARY
293	CENTER TAPPED (GROUND)
294	LEG 1 SECONDARY
295	LEG 2 SECONDARY
300	115VAC TO SPINDLE MOTOR FAN/OILER PUMP - SHIELD +2
301	LEG 1 115VAC PROTECTED #20
302	LEG 2 115VAC PROTECTED #20
303	SHIELD DRAIN
310	PC PALLET CW/CCW
350	SPARE (115 VAC SERVO BRAKE)
390	115VAC TO 4'TH AXIS BRAKE - SHIELD +2
391	LEG 1 #20
392	LEG 2 SWITCHED #20
393	SHIELD DRAIN
410	TOOL CHANGER DOOR OPEN
420	PALLET CLAMPED / UNCLAMPED / CLAMP ERROR
430	PC PALLET UP
440	SMTC CAGE DOOR OPEN - MORI ARM OUT
450	MORI ARM CW/CCW
460	MORI SLIDE 1/2 WAY - MORI SLIDE LEFT
470	SMTC MOTOR STOP / ORIGIN / CLAMP / UNCLAMP
490	ALL BRUSHLESS AXIS SERVO MOTOR DRIVE POWER CABLE
491	A PHASE
492	B PHASE
493	C PHASE
494	GROUND
490A	325VDC FROM SPINDLE DRIVE TO THE AMPLIFIERS - SHIELD +2
491A	HIGH VOLT P1/+ RED #12
492A	HIGH VOLT N/- BLACK #12
493A	SHIELD DRAIN

490B	325VDC FROM AMPLIFIER TO SERVO POWER SUPPLY
491B	HIGH VOLT + RED #20
492B	HIGH VOLT - BLACK #20
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 (MoCon-P10) 34 WIRE RIBBON #24
570	LOW VOLTAGE BRUSHLESS AMPLIFIER POWER CABLE ASSEMBLY
571	+12 VDC #22
572	GROUND
573	-12 VDC #22
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	HAAS VECTOR DRIVE CURRENT COMMAND CABLE.(ALL#24)
640C-4	FAULT
640C-5	325 VDC VOLTAGE MONITOR
640C-6	A PHASE RETURN
640C-7	B PHASE RETURN
640C-8	DIGITAL GROUND
640C-9	FAULT RETURN
640C-10	ANALOG GROUND

650	230VAC, THREE PHASE POWER TO SPINDLE MOTOR-SHIELD+3
651	PHASE 1
652	PHASE 2
653	PHASE 3
654	SHIELD DRAIN
650A	230VAC, THREE PHASE POWER, CONTACTOR TO SPINDLE MOTOR (WYE-DELTA OPTION)
651A	PHASE 1
652A	PHASE 2
653A	PHASE 3
654A	SHIELD DRAIN
650B	230VAC, THREE PHASE POWER, CONTACTOR TO VECTOR DRIVE (WYE-DELTA OPTION)
651B	PHASE 1
651B	PHASE 2
651B	PHASE 3
660	X-AXIS 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 SWITCH
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)
690A	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	P-COOL / BF COLLET OPEN - BF COLLET CLOSE
711	SPARE
712	SPARE
713	SPARE
714	SPARE
715	SPARE

720	ANALOG SIGNAL FROM MOCON TO SPINDLE DRIVE TO LOAD MONITOR
721	0 TO +10 VOLTS SPEED COMMAND
722	COMMON
723	SHIELD DRAIN

740	POWER ON/OFF CABLE TO FRONT PANEL - SHIELD +4
741	POWER ON SWITCH LEG 1 (24 VAC) #20
742	POWER ON SWITCH LEG 2 #20 N.O.
743	POWER OFF SWITCH LEG 1 (24 VAC) #20
744	POWER OFF SWITCH LEG 2 #20 N.C.
745	SHIELD DRAIN

750 JOG-CRANK DATA CABLE (REM JOG SIDE CONNECTION)(ALL #24)

750-1	LOGIC RETURN (D GROUND) 0 VDC
750-2	ENCODER A CHANNEL
750-3	ENCODER B CHANNEL
750-4	+5 VDC
750-5	JUMPER TO 750-1 (0 VDC)
750-6	X-AXIS
750-7	Y-AXIS
750-8	ENCODER A* CHANNEL
750-9	ENCODER B* CHANNEL
750-10	JUMPER TO 750-4 (+5 VDC)
750-11	Z-AXIS
750-12	A-AXIS
750-13	X 10
750-14	X 1
750-15	SHIELD DRAIN
750-16	NOT USED

750A	JOG HANDLE DATA CABLE - SHIELD +4 (ALL #24)
751A	0 VDC
752A	A
753A	B
754A	+5 VDC
755A	SHIELD DRAIN

750B JOG HANDLE DATA CABLE-SHIELD (ALL#24)

750B	JOG HANDLE DATA CABLE SHIELD +6 (ALL#24)
750B-1	+5 VDC JOG HANDLE
750B-2	0VDC
750B-3	JOG HANDLE A CHANNEL
750B-4	JOG HANDLE A* CHANNEL
750B-5	JOG HANDLE B CHANNEL
750B-6	JOG HANDLE B* CHANNEL

760	MONITOR VIDEO DATA CABLE - SHIELD +7 (ALL #24)
	(FROM VIDEO P13 TO CRT)
770	EMERGENCY STOP INPUT CABLE - SHIELD +2
771	SIGNAL #20
772	RETURN (D GROUND) #20
773	SHIELD DRAIN
770A	SECOND E-STOP/COUNTER BALANCE - SHIELD +2
771A	SIGNAL #20
772A	RETURN (D GROUND) #20
773A	SHIELD DRAIN
780	SPARE
781	SPARE
782	SPARE
783	SPARE
784	SPARE
790	PALLET CHANGER CW/CCW - SHIELD +3 (ALL #20)
791	PALLET CW
792	PALLET CCW
793	COMMON
794	SHIELD DRAIN
800	10VAC TO PALLET READY LAMP - SHIELD +2
801	UNSWITCHED LEG 1 #20
802	SWITCHED LEG 2 #20
803	SHIELD DRAIN
800A	LAMP SWITCH JUMPER
801A	JUMPER TO 802A
801A	JUMPER TO 801A
810	+/-160 VDC TO LOAD STATION DRAWBAR MOTOR - SHIELD +2
811	MOTOR + #20
812	MOTOR - #20
813	SHIELD DRAIN
810A	+/-160 VDC TO MAIN DRAWBAR MOTOR - SHIELD +2
811A	MOTOR + #20
812A	MOTOR - #20
813A	SHIELD DRAIN
820	TOOL CHANGER AND MAIN DRAWBAR INPUT STATUS (ALL #20)
821	TOOL CHANGER IN SIGNAL
822	TOOL CHANGER OUT SIGNAL
823	MAIN DRAWBAR UP SIGNAL
824	MAIN DRAWBAR DOWN SIGNAL
825	COMMON (RETURN DATA GROUND)
826	SHIELD DRAIN
830	VECTOR DRIVE OVERHEAT THERMOSTAT - SHIELD +2
831	OVERHEAT SIGNAL #20
832	OVERHEAT RETURN (D GROUND) #20
833	SHIELD DRAIN

850	SERIAL PORT #1 INTERFACE CABLE (16 WIRE RIBBON #24) 33-0510
850A	SERIAL PORT #2 INTERFACE CABLE (16 WIRE RIBBON #24) 33-0510 - AUXILIARY PORT TO ROTARY CONTROLLER
860	+5V/+12V/-12V/Gnd FROM MAIN POWER SUPPLY (ALL #18)
861	+5 VOLTS
862	LOGIC POWER RETURN
863	LOGIC POWER RETURN
864	+12 VOLTS
865	-12 VOLTS
860A	12 VDC POWER TO M CODE RELAY BOARD - SHIELD +2
861	+12 VOLTS #20
865	LOGIC POWER RETURN (D GROUND) #20
863	SHIELD DRAIN
860C	12 VDC POWER TO MONITOR FAN - SHIELD +2
861C	+12 VOLTS #20
862C	LOGIC POWER RETURN #20
863C	SHIELD DRAIN
880A	115 VAC TO SPINDLE HEAD SOLENOIDS - SHIELD +6 (ALL #24)
881	WYE -DELTA SWITCH COMMAND
882	TOOL UNCLAMP
883	LOW GEAR
884	HIGH GEAR
885	115 VAC COMMON
886	SHIELD DRAIN
887	PRECHARGE
890	SPINDLE HEAD INPUT STATUS SWITCHES - SHIELD +6 (ALL #24)
891	HIGH GEAR SIGNAL
892	LOW GEAR SIGNAL
893	TOOL UNCLAMPED SIGNAL
894	TOOL CLAMPED SIGNAL
895	SPARE
896	COMMON (DATA GROUND)
897	SHIELD DRAIN
900	LOW THROUGH SPINDLE COOLANT STATUS - SHIELD +2
901	LOW COOLANT SIGNAL #20
902	RETURN (DATA GROUND) #20
910	115 VAC CIRCUIT BREAKER (CB4) TO SOLENOIDS - SHIELD +2
911	LEG 1 #20
912	LEG 2 #20
913	SHIELD DRAIN
910A	115 VAC TO PALLET CHANGER CW/CCW/AIR SOLENOIDS - SHIELD +2
911A	UNSWITCHED LEG 1 #20
912A	SWITCHED LEG 2 (FROM MCD RELAY BOARD M25, M26, M27) #20
913A	SHIELD DRAIN

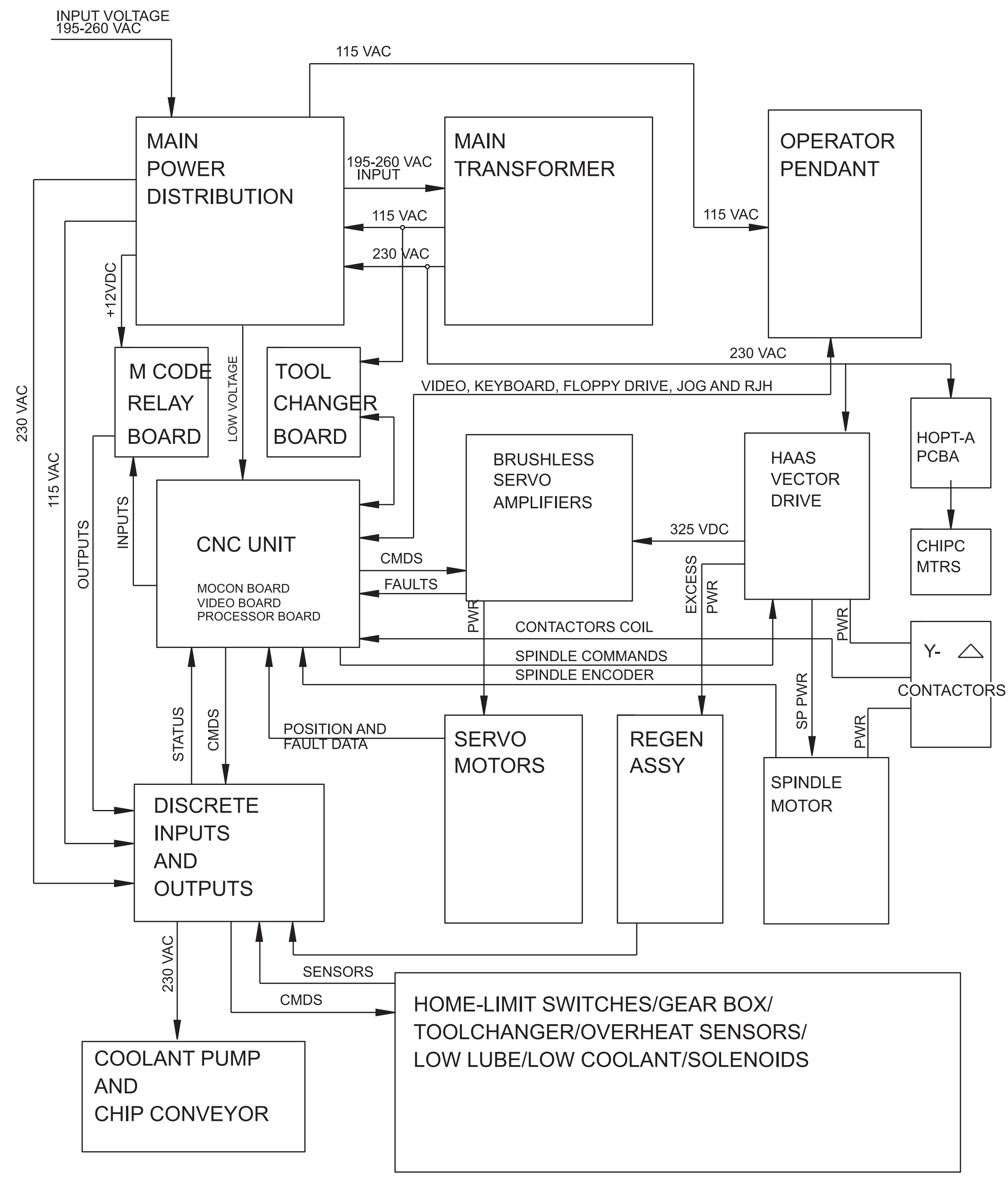
910B	115 VAC TO SERVO FAN - SHIELD +2
911B	LEG 1 #20
912B	LEG 2 #20
910C	115 VAC TO PURGE SOLENOID - SHIELD +2
911C	UNSWITCHED LEG 1 #20
912C	SWITCHED LEG 2 (FROM 270 IOPCB P48)
913C	SHIELD DRAIN
910D	115 VAC TO PALLET ALARM - SHIELD +2
911D	SWITCHED LEG 1 (FROM MCD RELAY BOARD M24) #20
912D	UNSWITCHED LEG 2 #20
913D	SHIELD DRAIN
930	230 VAC FOR COOLANT PUMP FROM CB3 - SHIELD +2
931	LEG 1 #20
932	LEG 2 #20
933	SHIELD DRAIN
940	230 VAC SINGLE PHASE POWER TO COOLANT PUMP
941	LEG 1 #20
942	LEG 2 #20
940A	230 VAC SINGLE PHASE POWER TO THROUGH SPINDLE COOLANT PUMP
941A	LEG 1 #20
942A	LEG 2 #20
950	LOW AIR PRESSURE/OIL LUBE SENSOR - SHIELD +3
951	LOW AIR SIGNAL #20
952	LOW OIL LUBE SIGNAL #20
953	COMMON (DATA GROUND) #20
954	SHIELD DRAIN
960	LOW TRANSMISSION OIL LUBE - SHIELD +2
961	LOW TRANSMISSION OIL LUBE SIGNAL #20
962	COMMON (RETURN DATA GROUND)#20
963	SHIELD DRAIN

970 VECTOR DRIVE OVER-VOLT SENSOR

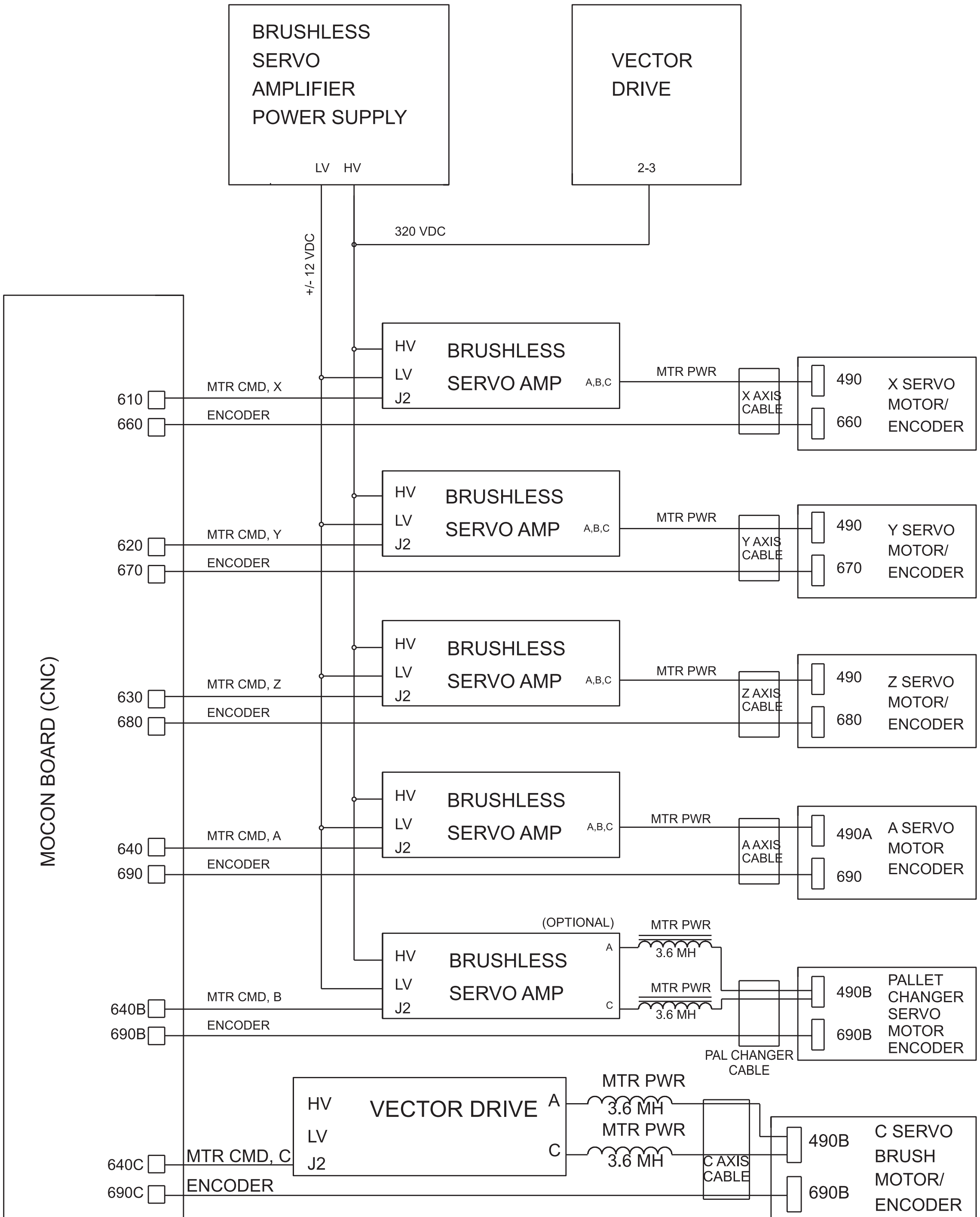
990	HOME SENSORS - SHIELD +4 (ALL #20)
991	COMMON (DATA GROUND)
992	X-AXIS HOME SWITCH
993	Y-AXIS HOME SWITCH
994	Z-AXIS HOME SWITCH

1000	SPINDLE ENCODER CABLE (MoCon SIDE CONNECTION) ALL #24
1000-1	LOGIC RETURN (D GROUND)
1000-2	ENCODER A CHANNEL
1000-3	ENCODER B CHANNEL
1000-4	+5 VDC
1000-5	ENCODER Z CHANNEL
1000-6	NOT USED
1000-7	SPINDLE MOTOR OVERHEAT SENSOR
1000-8	ENCODER A* CHANNEL
1000-9	ENCODER B* CHANNEL
1000-10	ENCODER Z* CHANNEL
1000-11	NOT USED
1000-12	NOT USED
1000-13	NOT USED
1000-14	NOT USED
1000-15	SHIELD DRAIN
1000-16	NOT USED
1010	AUX FRONT PANEL CABLE (HS-1R/RP) - SHIELD +6 (ALL #24)
1011	COMMON FOR CYCLE START AND FEED HOLD RETURN
1012	CYCLE START
1013	PART READY
1014	COMMON FOR PALLET ROTATE AND PART READY
1015	PALLET ROTATE
1016	FEED HOLD
1017	SHIELD DRAIN
1030	SPINDLE LOAD RESISTOR - SHIELD +2
1031	REGEN LOAD RESISTOR FOR SPINDLE DRIVE #18
1032	REGEN LOAD RESISTOR FOR SPINDLE DRIVE #18
1040	115 VAC TO MIKRON DOOR INTERLOCK SWITCH - SHIELD +2
1041	LEG 1 #20
1042	LEG 2 #20
1043	SHIELD DRAIN
1050	DOOR SWITCH INPUT - SHIELD +2
1051	DOOR SWITCH SIGNAL #20
1052	DOOR SWITCH RETURN (D GROUND) #20
1053	SHIELD DRAIN
1060	SPARE (GROUND FAULT DETECTION SENSE INPUT)
1070	PROBE INPUT (OPTION) - SHIELD +2
1071	PROBE SIGNAL #20
1072	LOGIC COMMON #20
1073	SHIELD DRAIN
1070A	PROBE OUTPUT (MCD RELAY BOARD M22) (OPTION) - SHIELD +2
1071A	UNSWITCHED LEG 1 #20
1072A	SWITCHED LEG 2 #20
1073A	SHIELD DRAIN

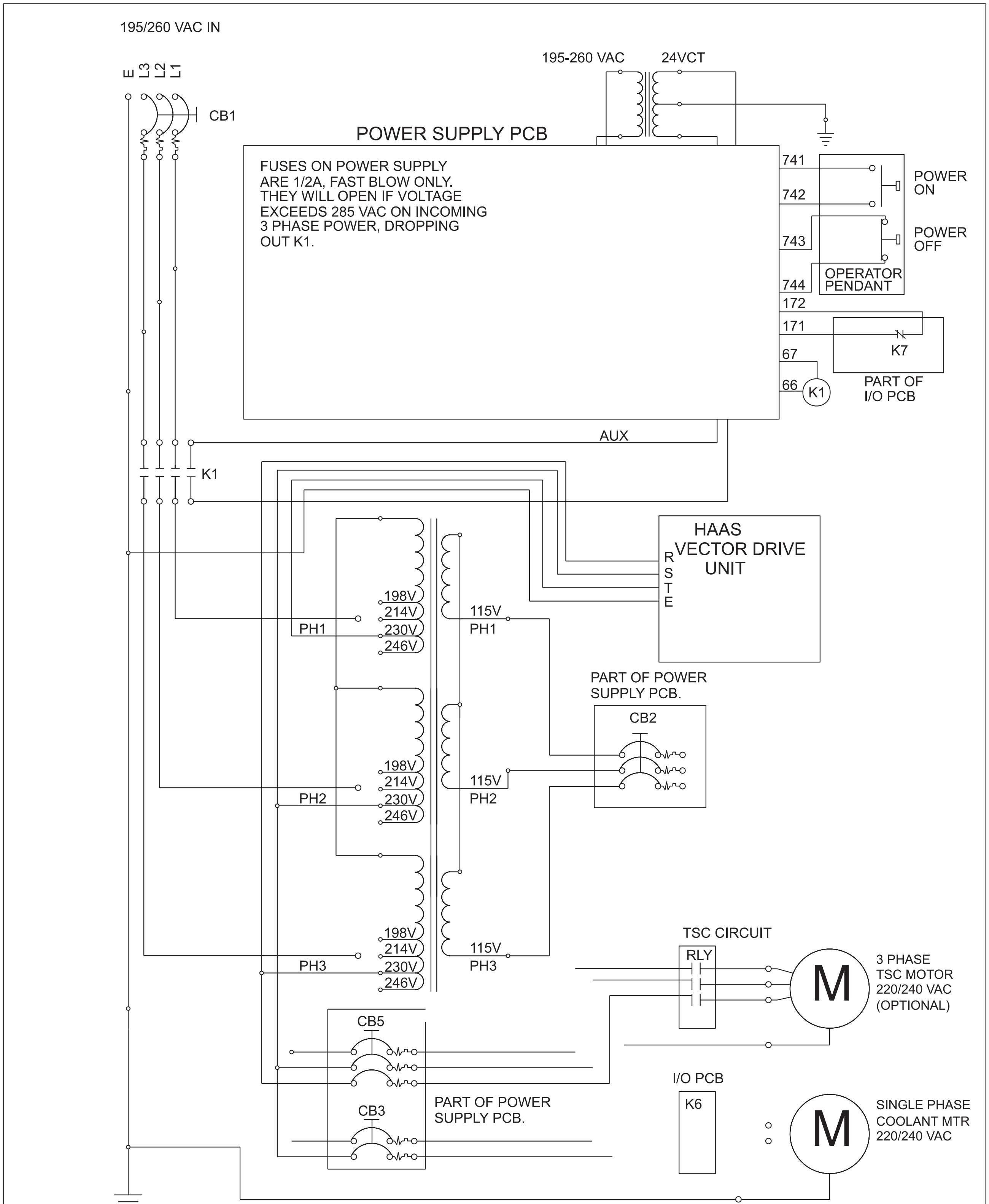
ELECTRICAL WIRING DIAGRAMS



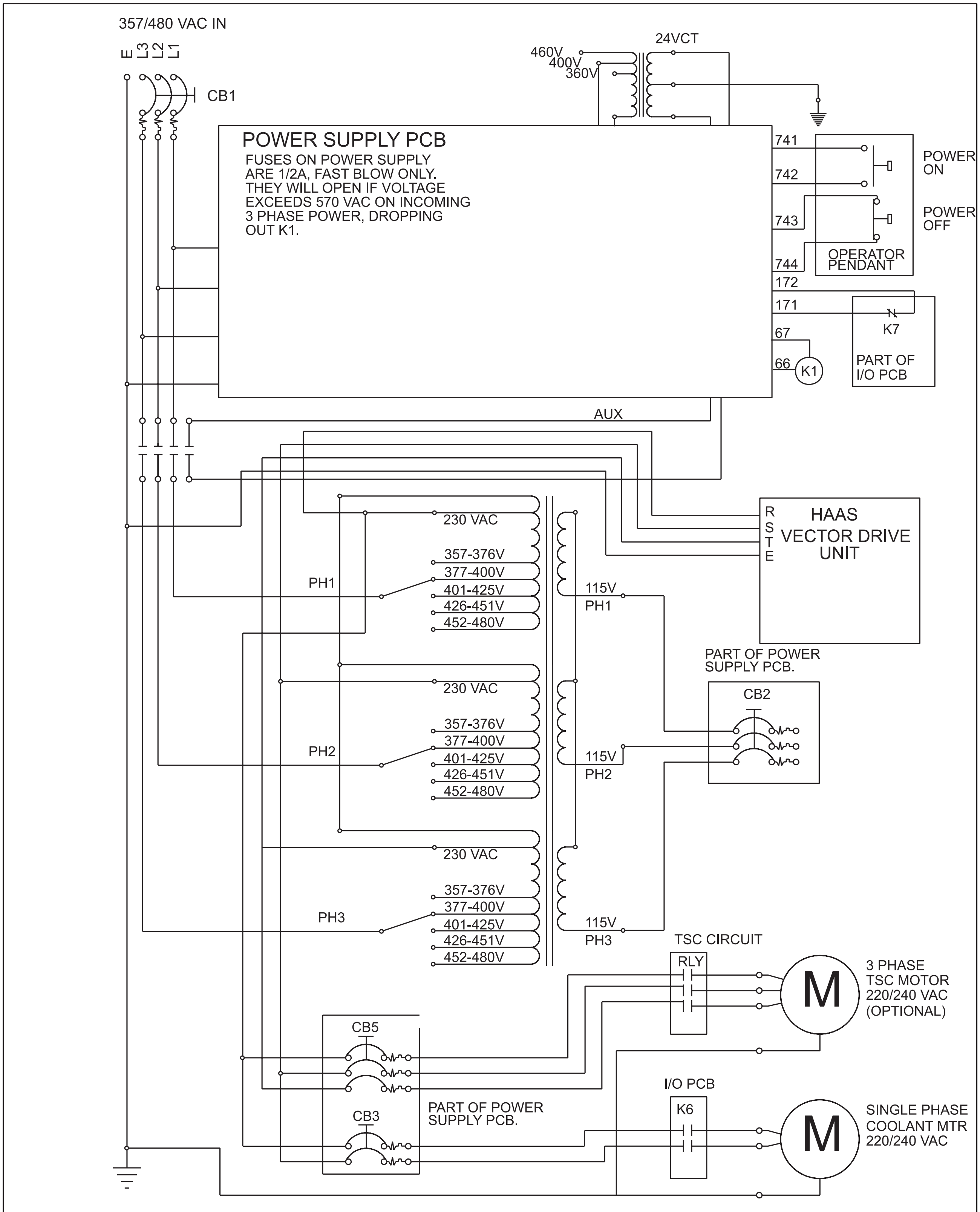
SYSTEM BLOCK DIAGRAM - LOW VOLTAGE



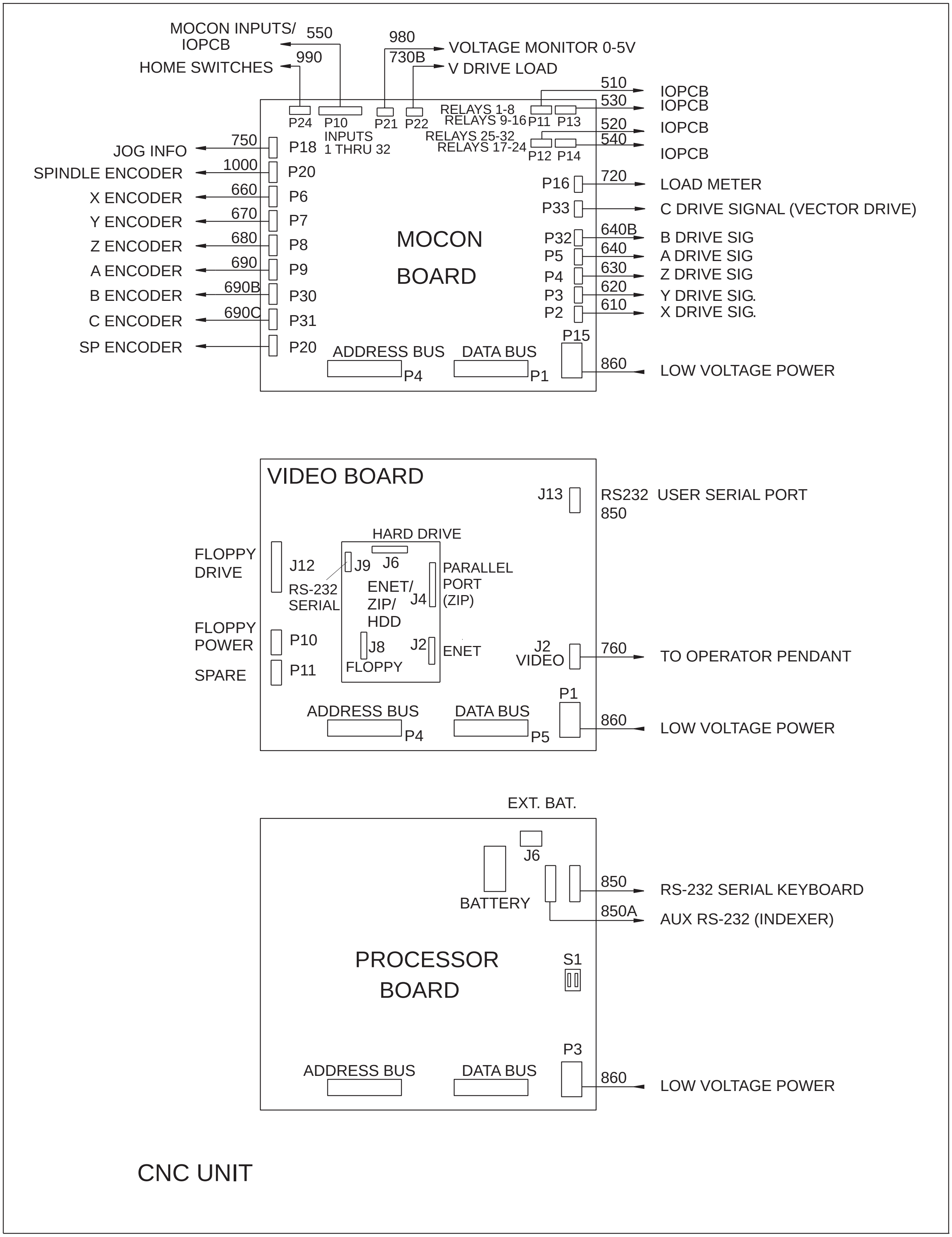
SERVO SYSTEM

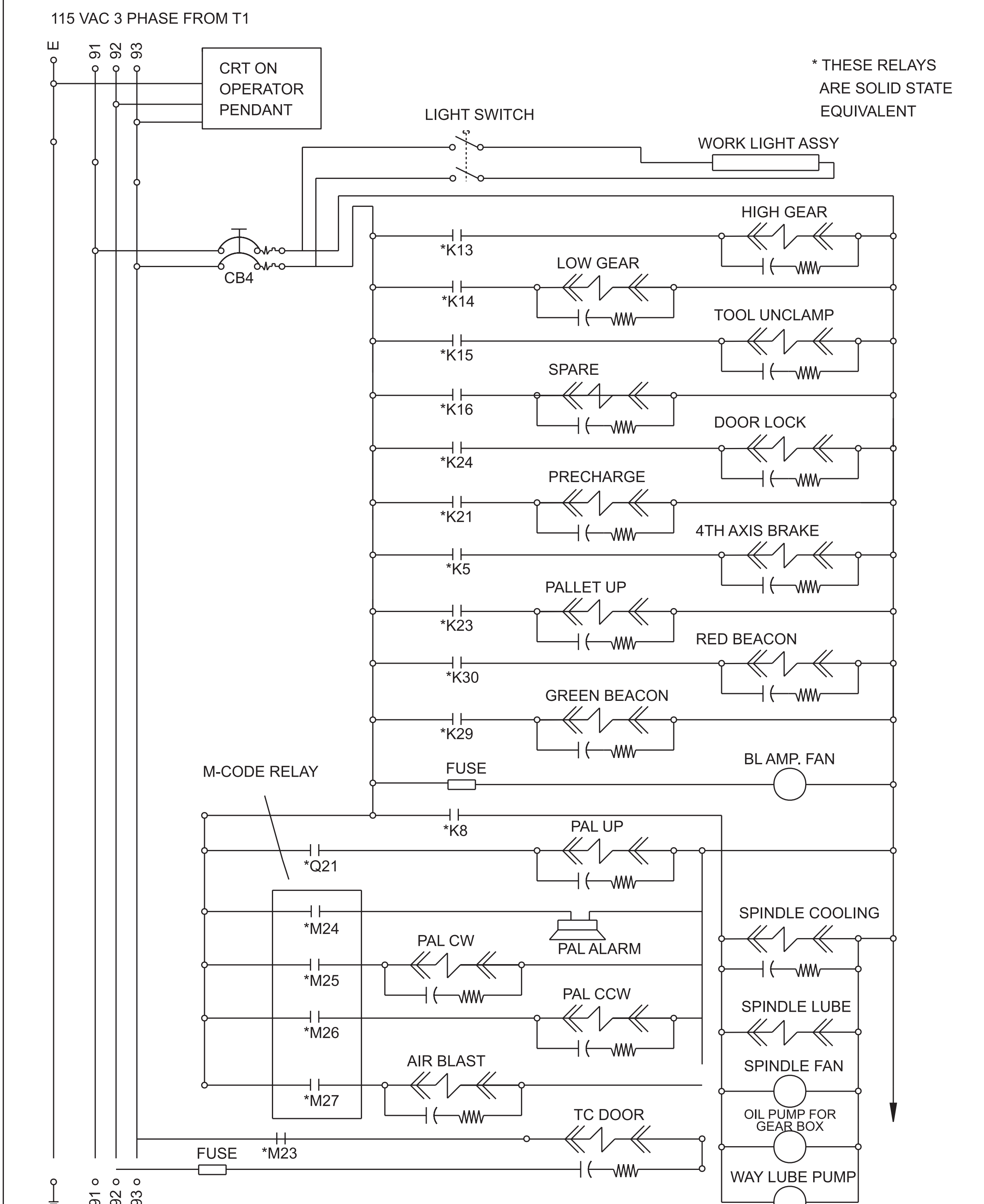


MAIN TRANSFORMER - LOW VOLTAGE

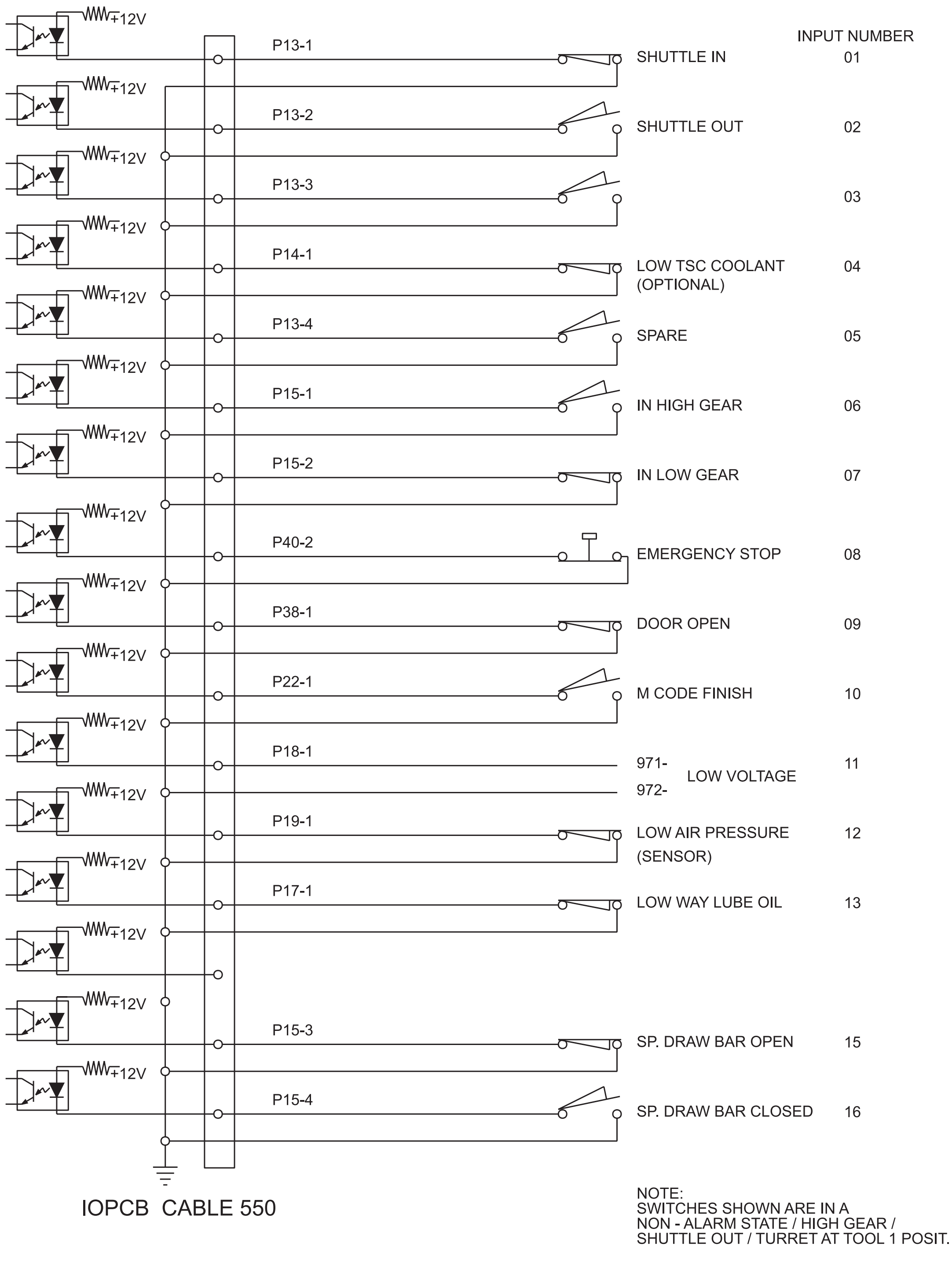


MAIN TRANSFORMER - HIGH VOLTAGE

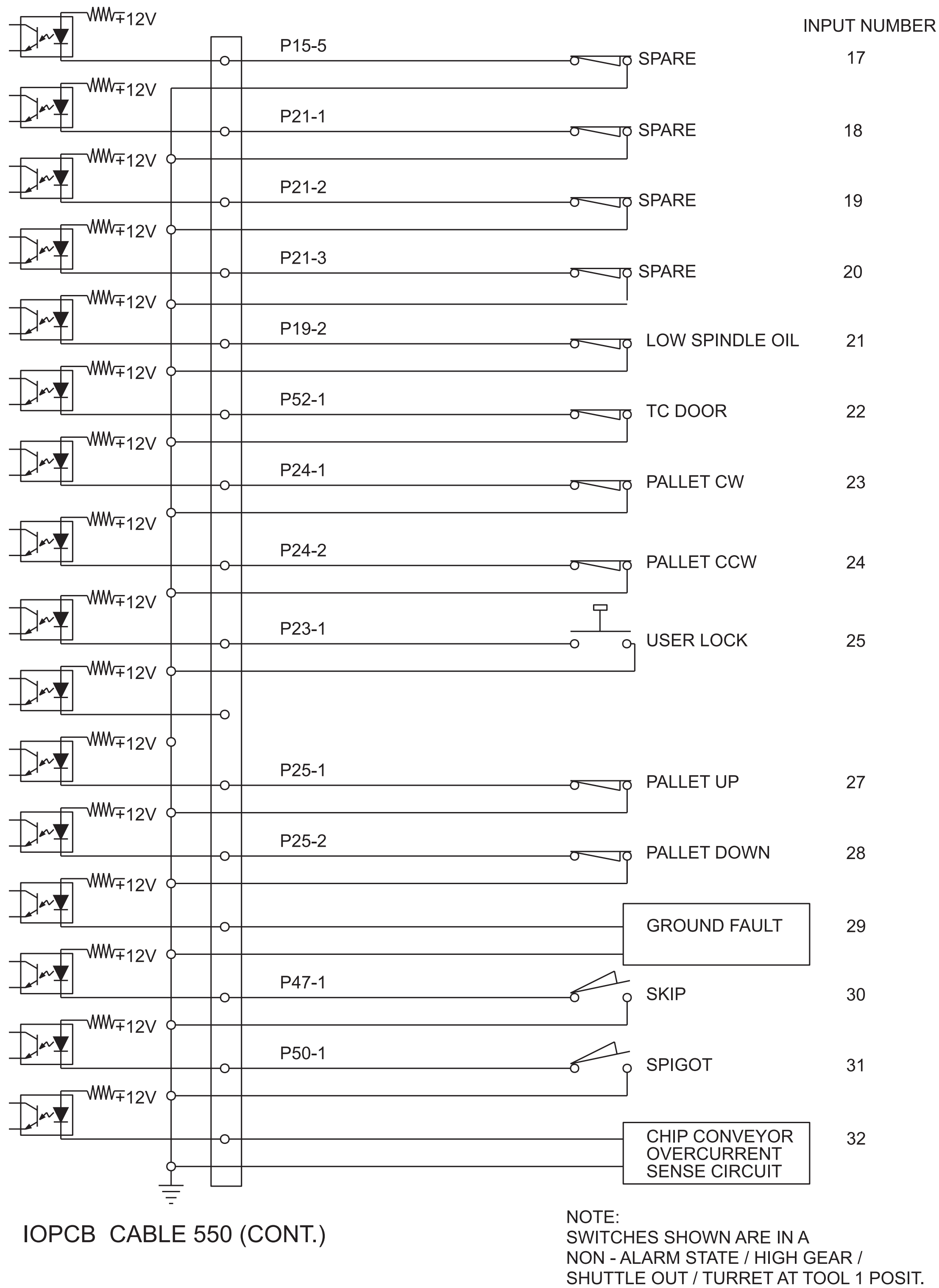

MOCON INPUTS/
IOPCB
HOME SWITCHES
550
990
980
730B
VOLTAGE MONITOR 0-5V
V DRIVE LOAD
510
530
520
540
IOPCB
IOPCB
IOPCB
IOPCB
P24
P10
INPUTS
1 THRU 32
P21
P22
RELAYS 1-8
RELAYS 9-16
RELAYS 25-32
RELAYS 17-24
P11
P13
P12
P14
JOG INFO
SPINDLE ENCODER
X ENCODER
Y ENCODER
Z ENCODER
A ENCODER
B ENCODER
C ENCODER
SP ENCODER
750
1000
660
670
680
690
690B
690C
P18
P20
P6
P7
P8
P9
P30
P31
P20
MOCON
BOARD
P16
P33
P32
P5
P4
P3
P2
720
640B
640
630
620
610
LOAD METER
C DRIVE SIGNAL (VECTOR DRIVE)
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
850
HARD DRIVE
FLOPPY
DRIVE
J12
J9
J6
RS-232
SERIAL
ENET/
ZIP/
HDD
J4
PARALLEL
PORT
(ZIP)
FLOPPY
POWER
P10
SPARE
P11
J8
FLOPPY
J2
ENET
J2
VIDEO
760
TO OPERATOR PENDANT
P1
ADDRESS BUS
DATA BUS
P4
P5
860
LOW VOLTAGE POWER
EXT. BAT.
J6
BATTERY
850
RS-232 SERIAL KEYBOARD
850A
AUX RS-232 (INDEXER)
PROCESSOR
BOARD
S1
P3
ADDRESS BUS
DATA BUS
860
LOW VOLTAGE POWER
CNC UNIT



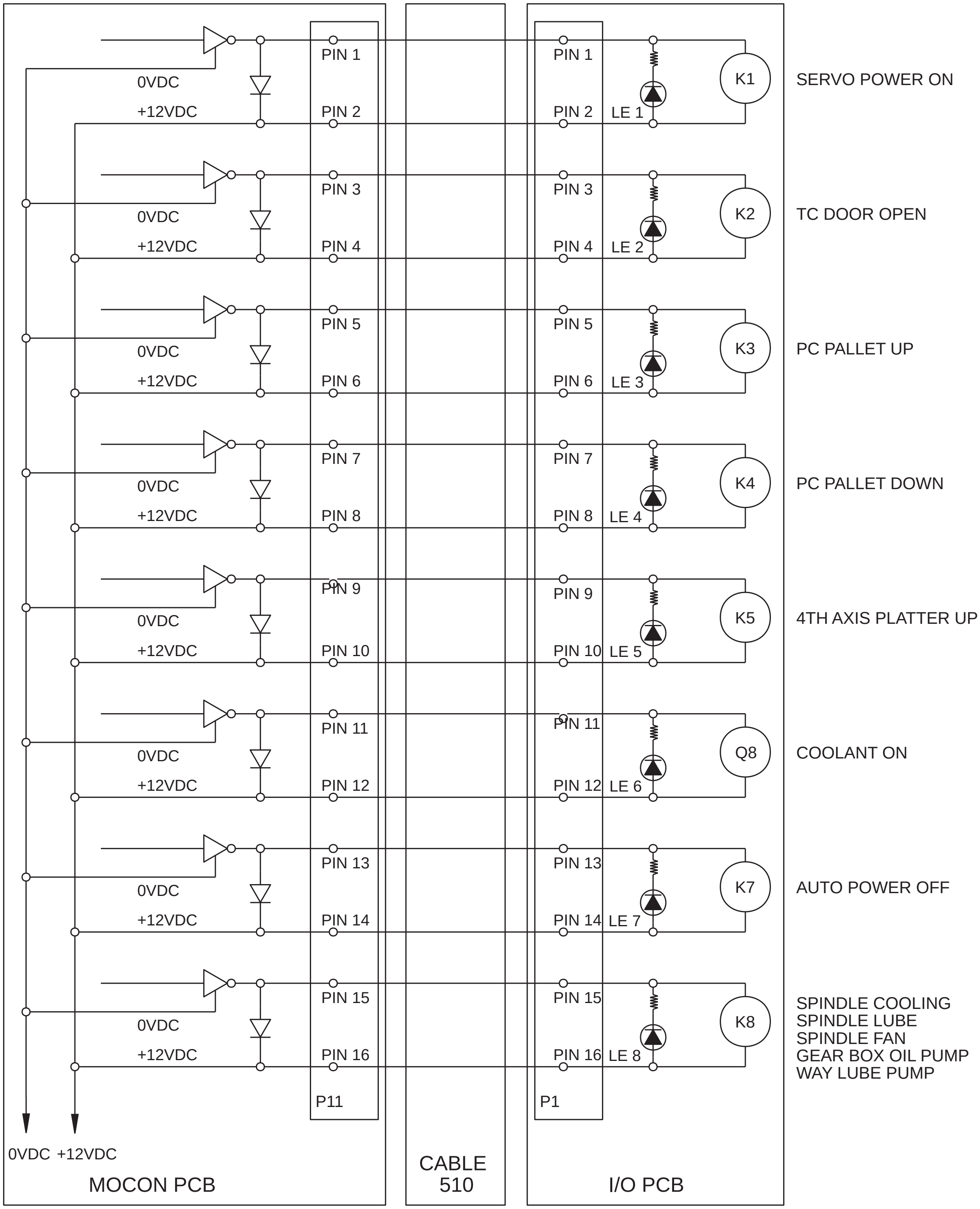
115 VAC CIRCUITS



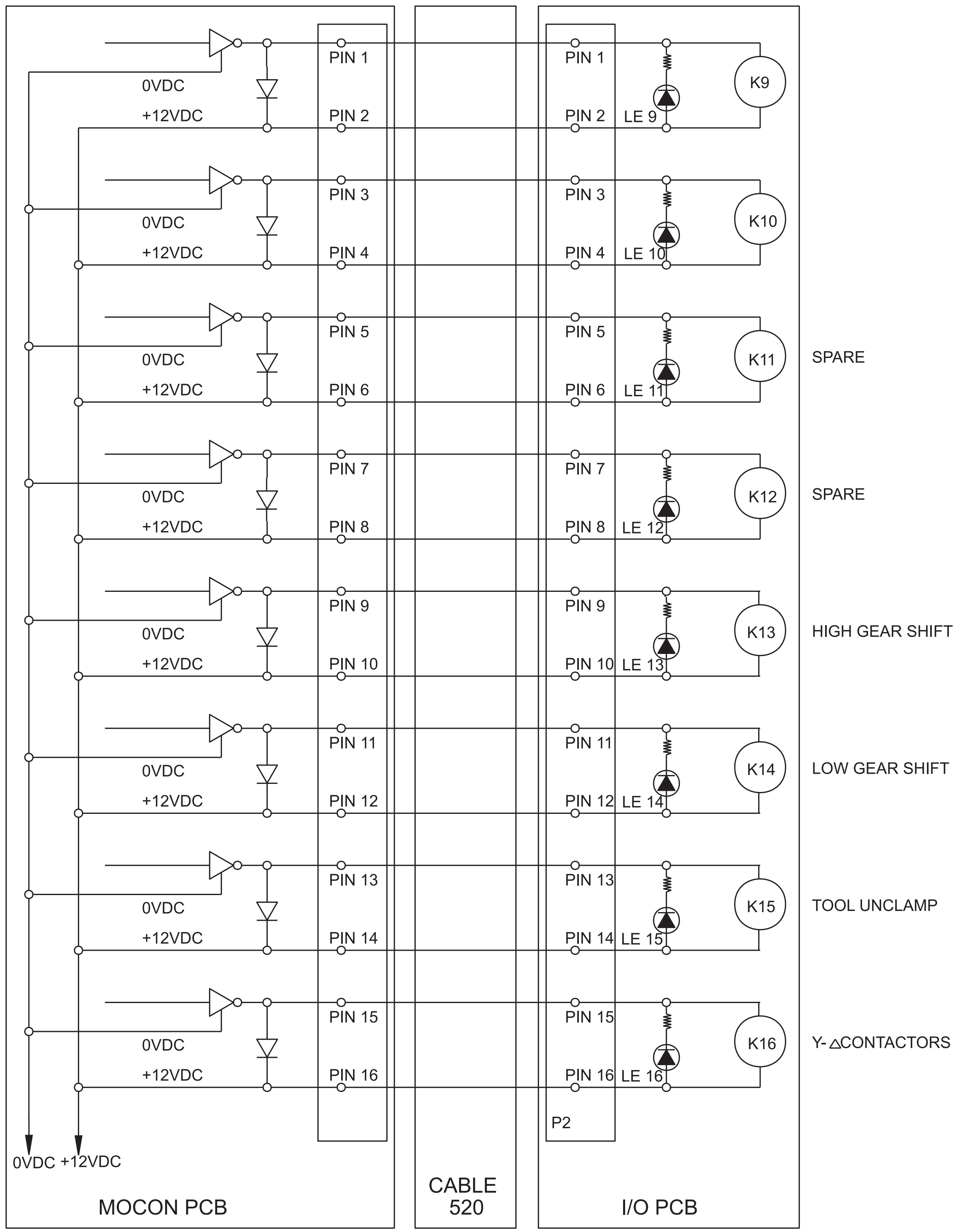
DISCRETE INPUTS 1 THROUGH 16



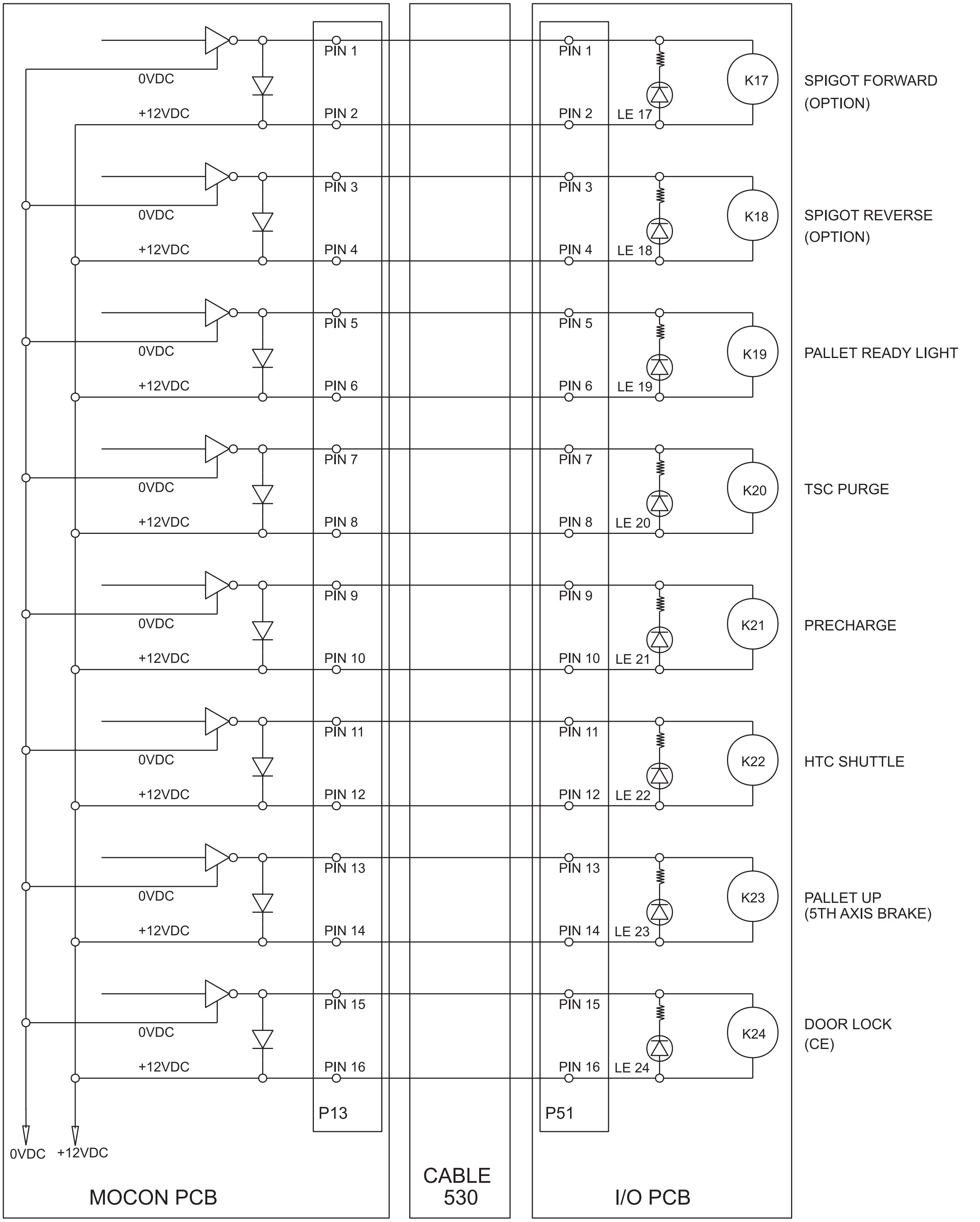
DISCRETE INPUTS 17 THROUGH 32



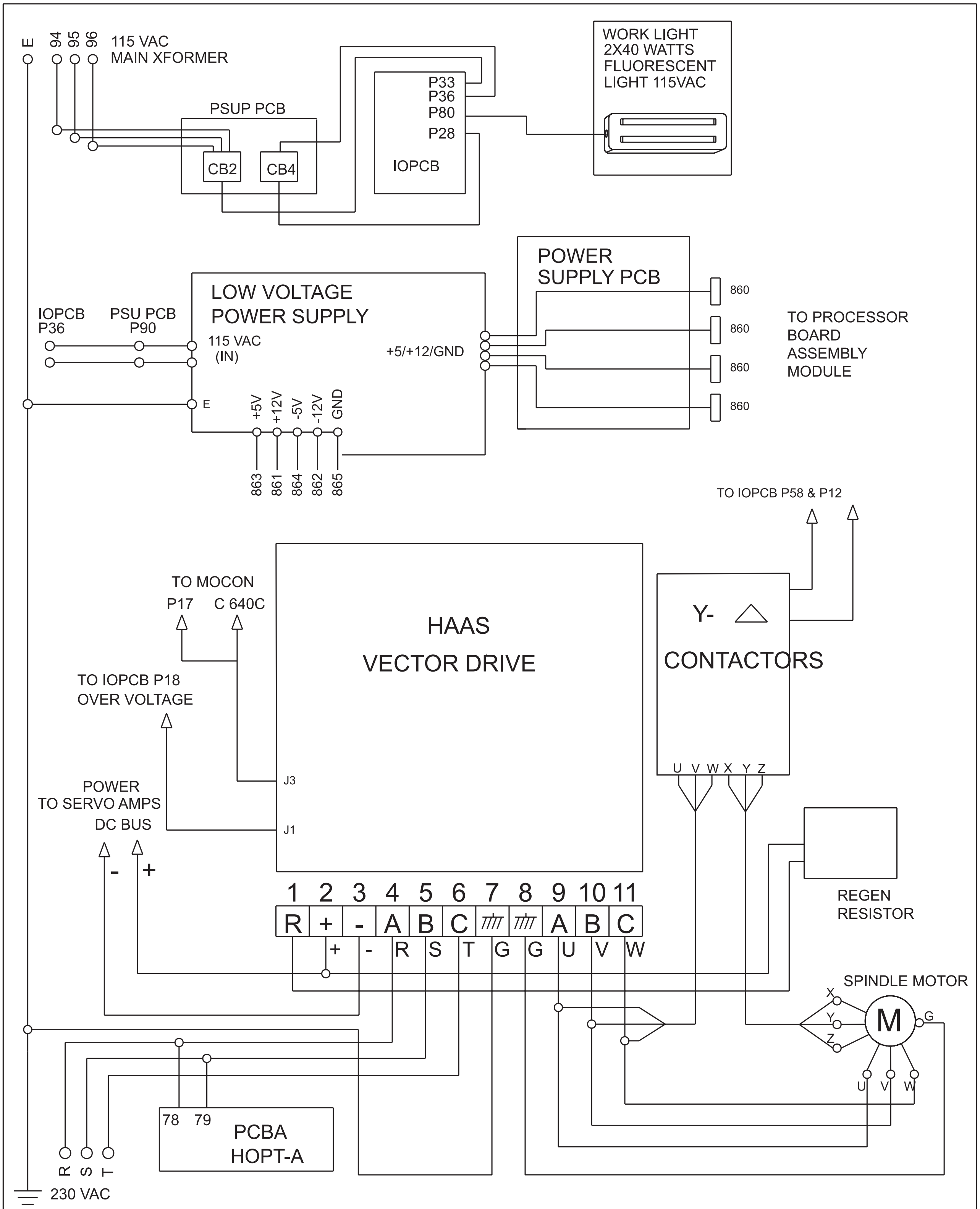
RELAY COIL DRIVERS, K1 THROUGH K8



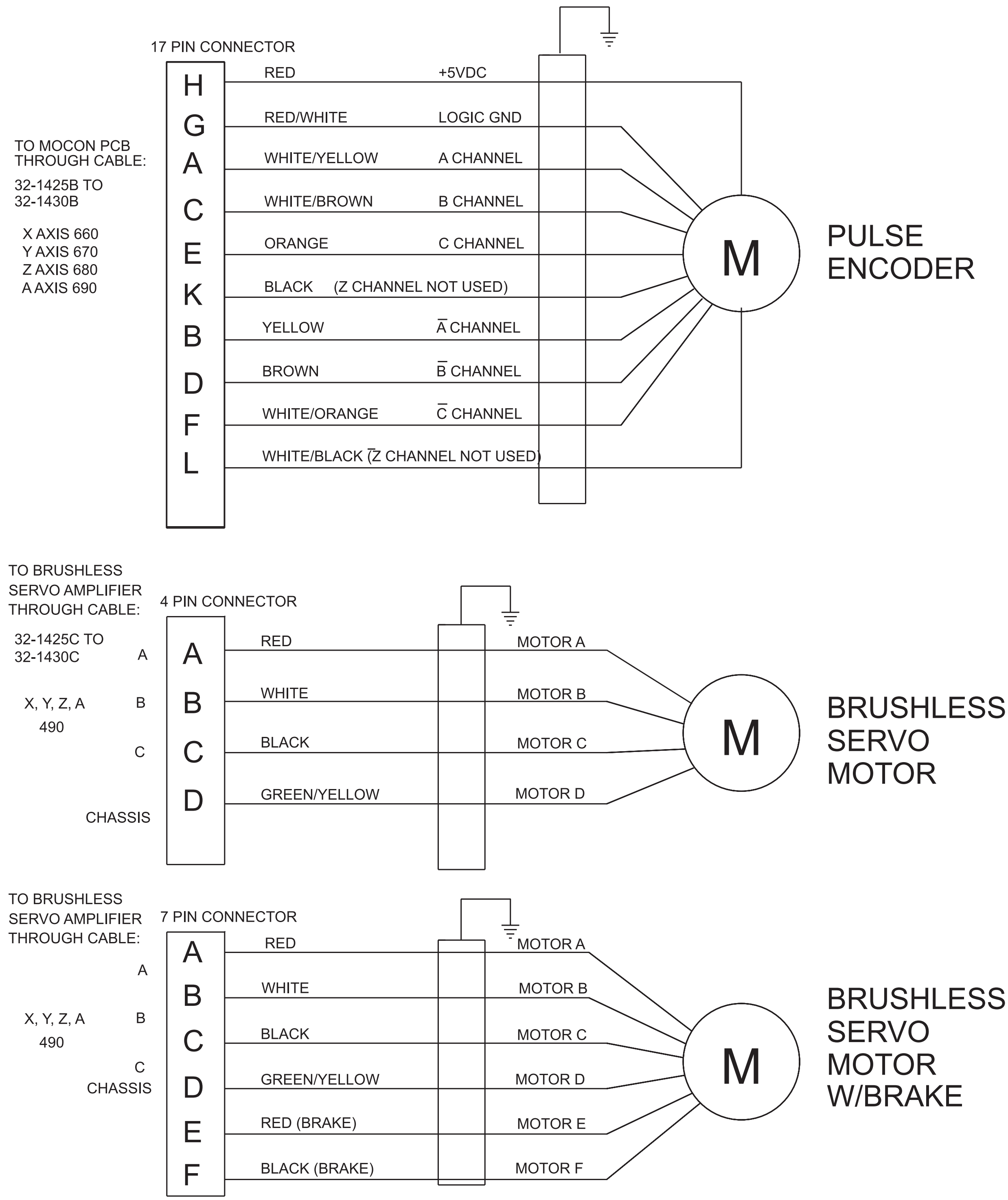
RELAY COIL DRIVERS, K9 THROUGH K16



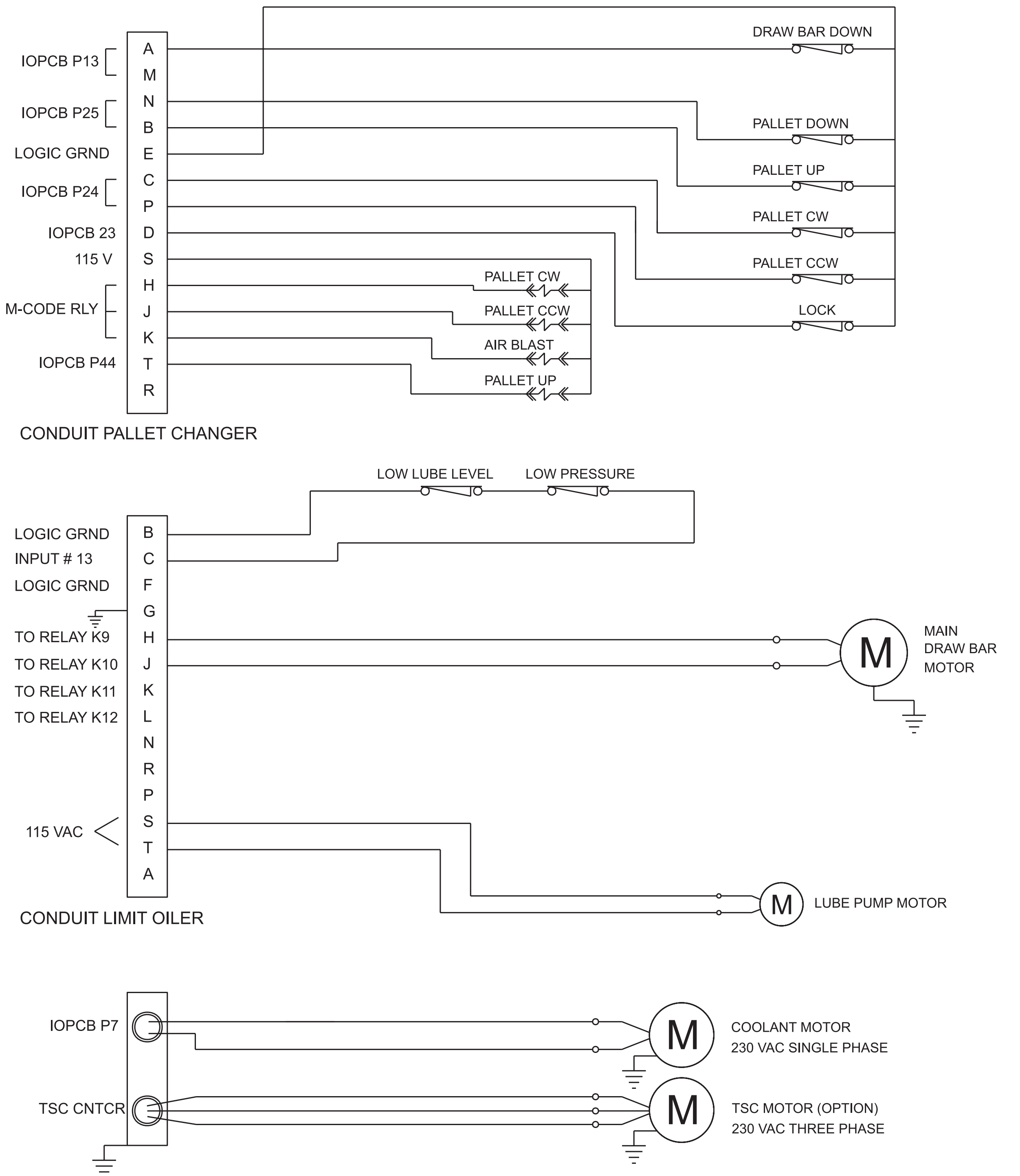
RELAY COIL DRIVERS, K17 THROUGH K24



HAAS VECTOR DRIVE UNIT

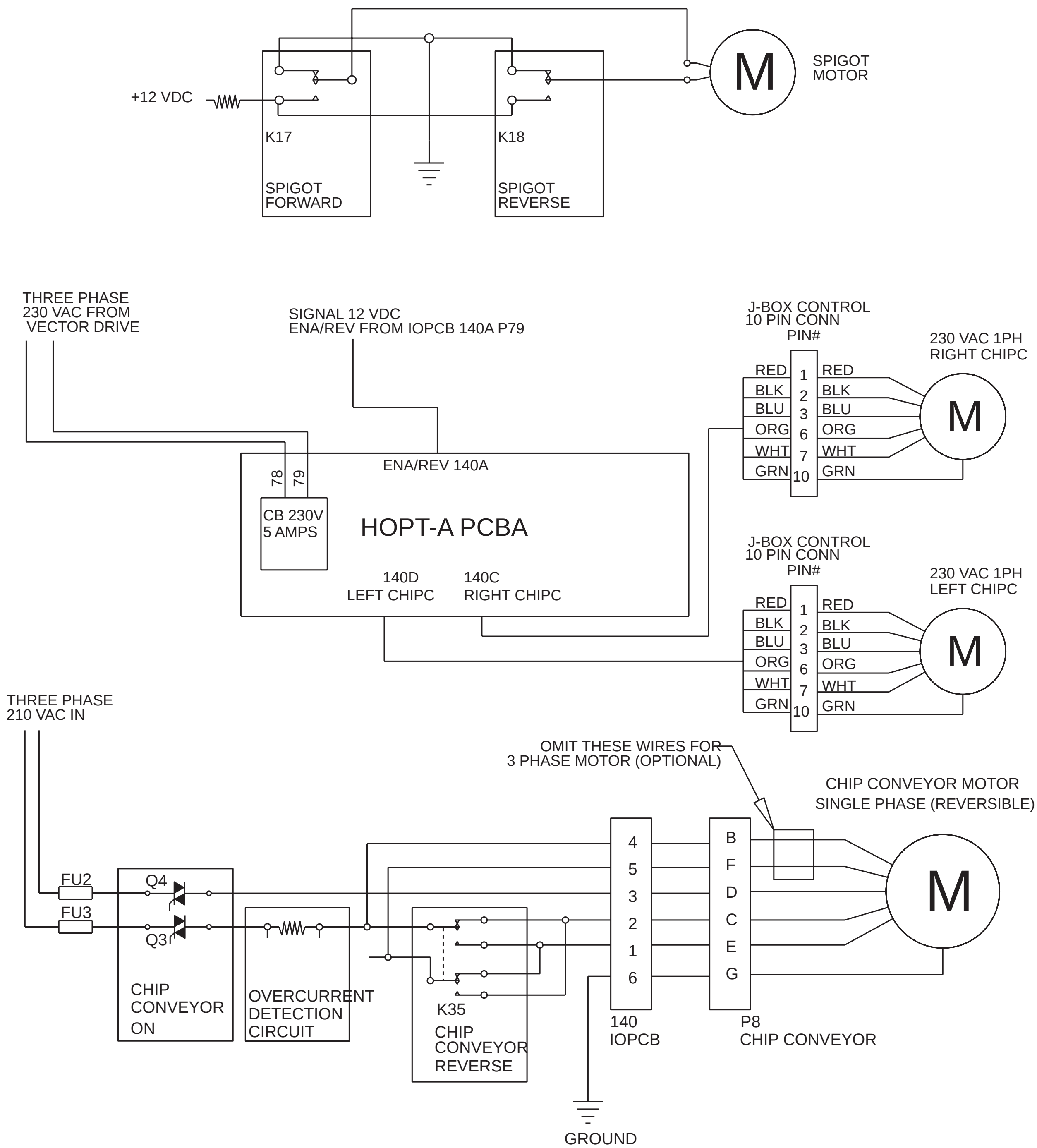


X, Y, Z, A AXIS MOTOR & ENCODER

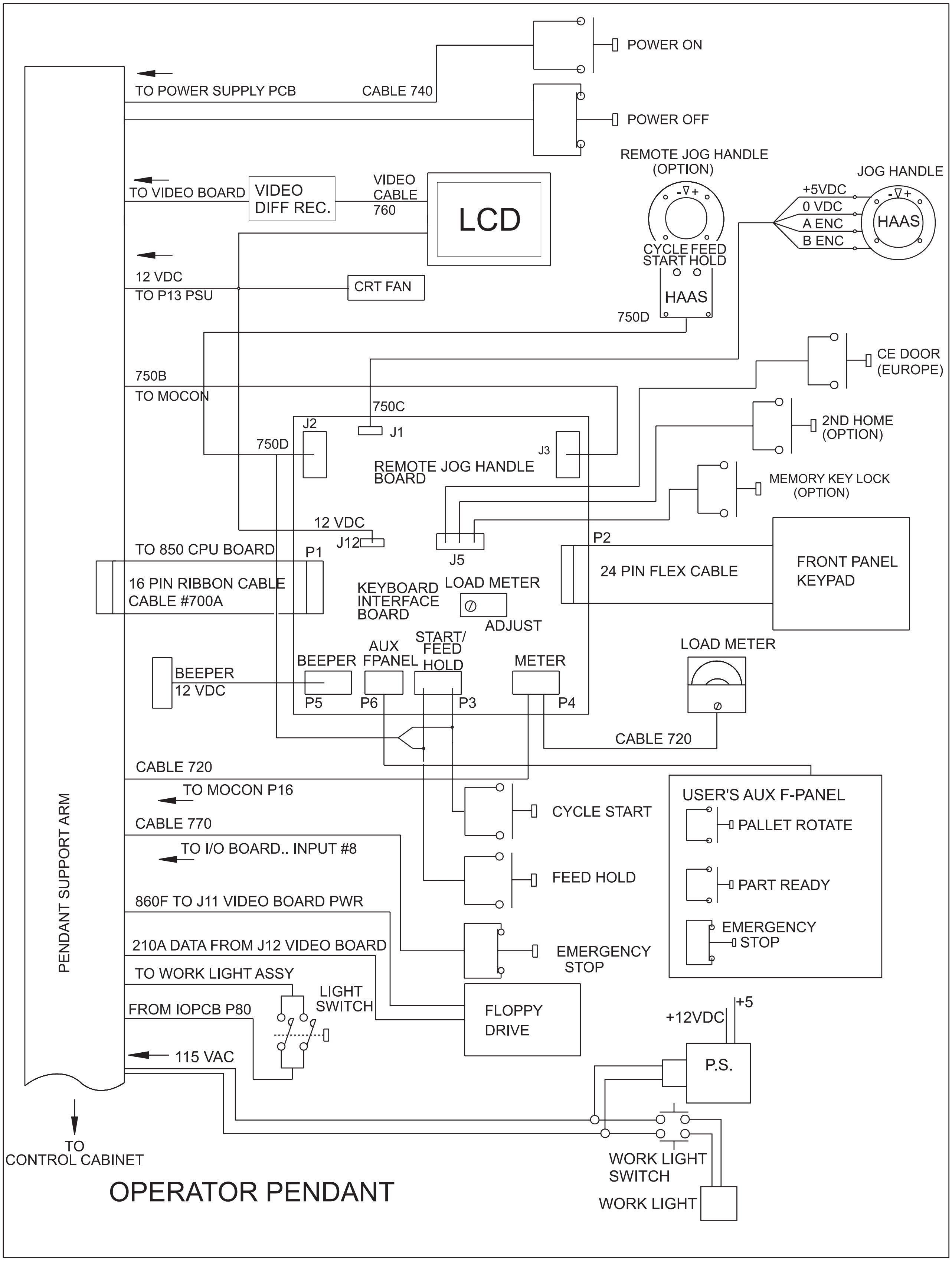


NOTE: CONNECTORS ARE LOCATED ON SIDE OF CONTROL CABINET.

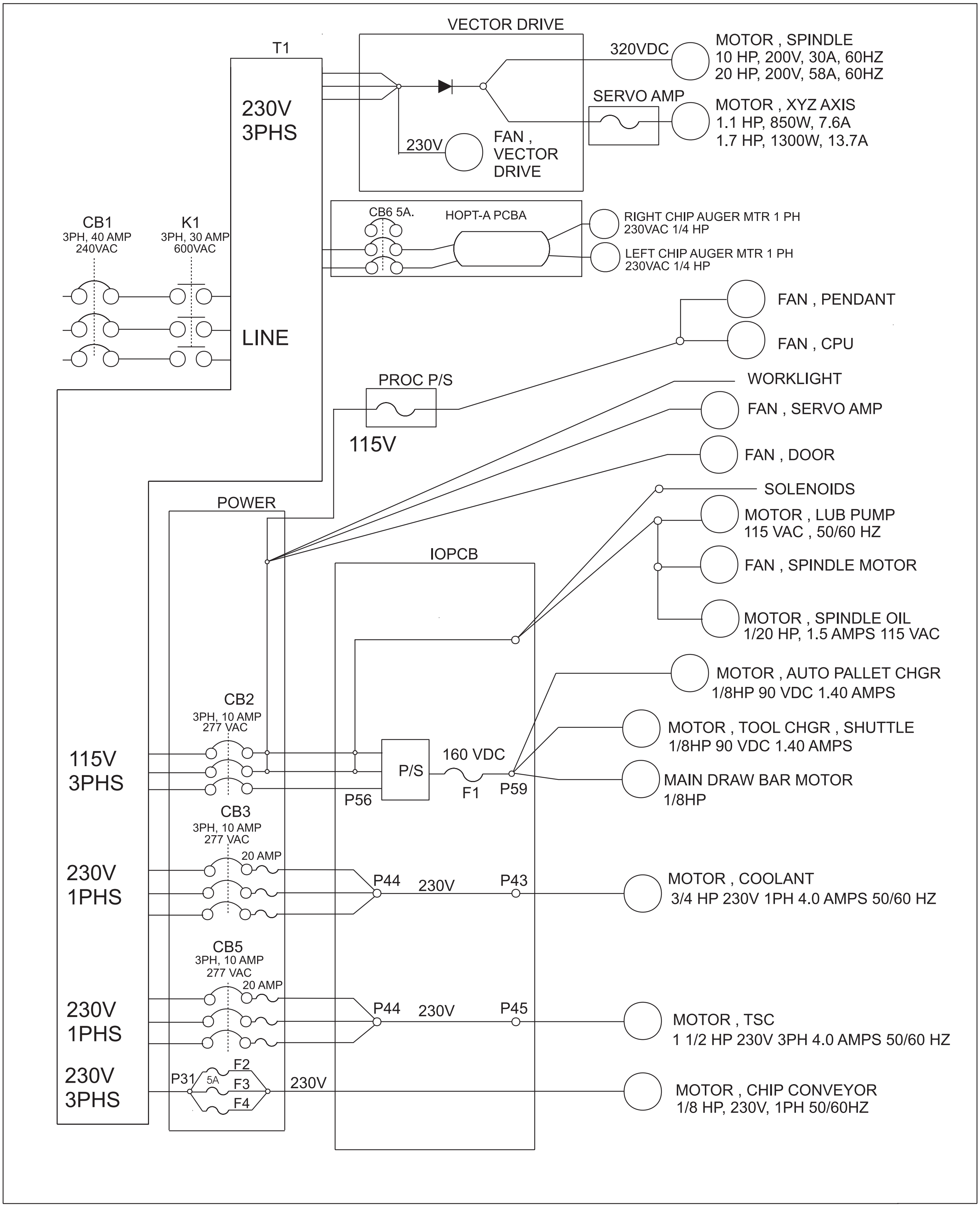
CABINET CONNECTORS



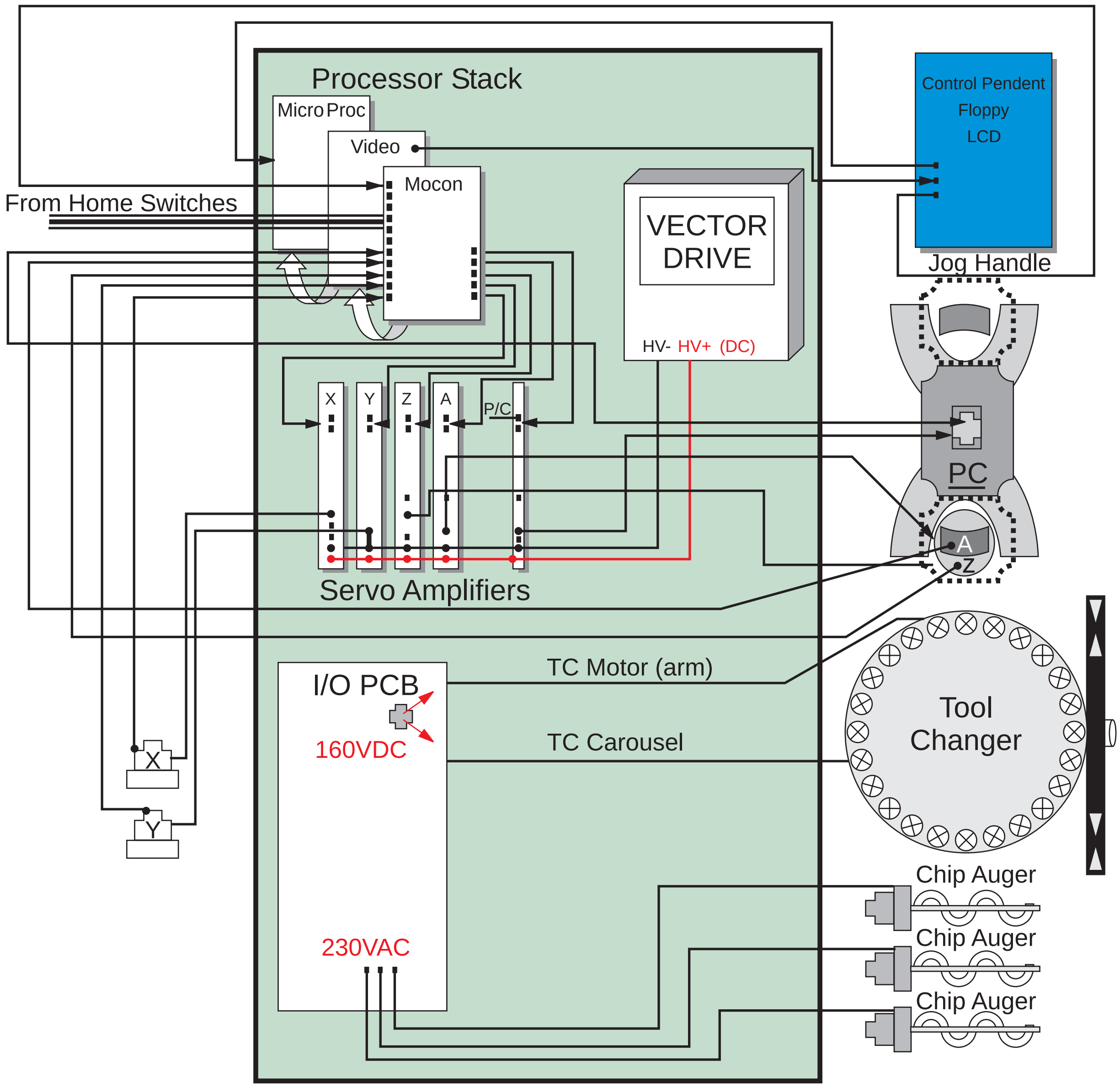
CHIP CONVEYOR AND SPIGOT MOTORS

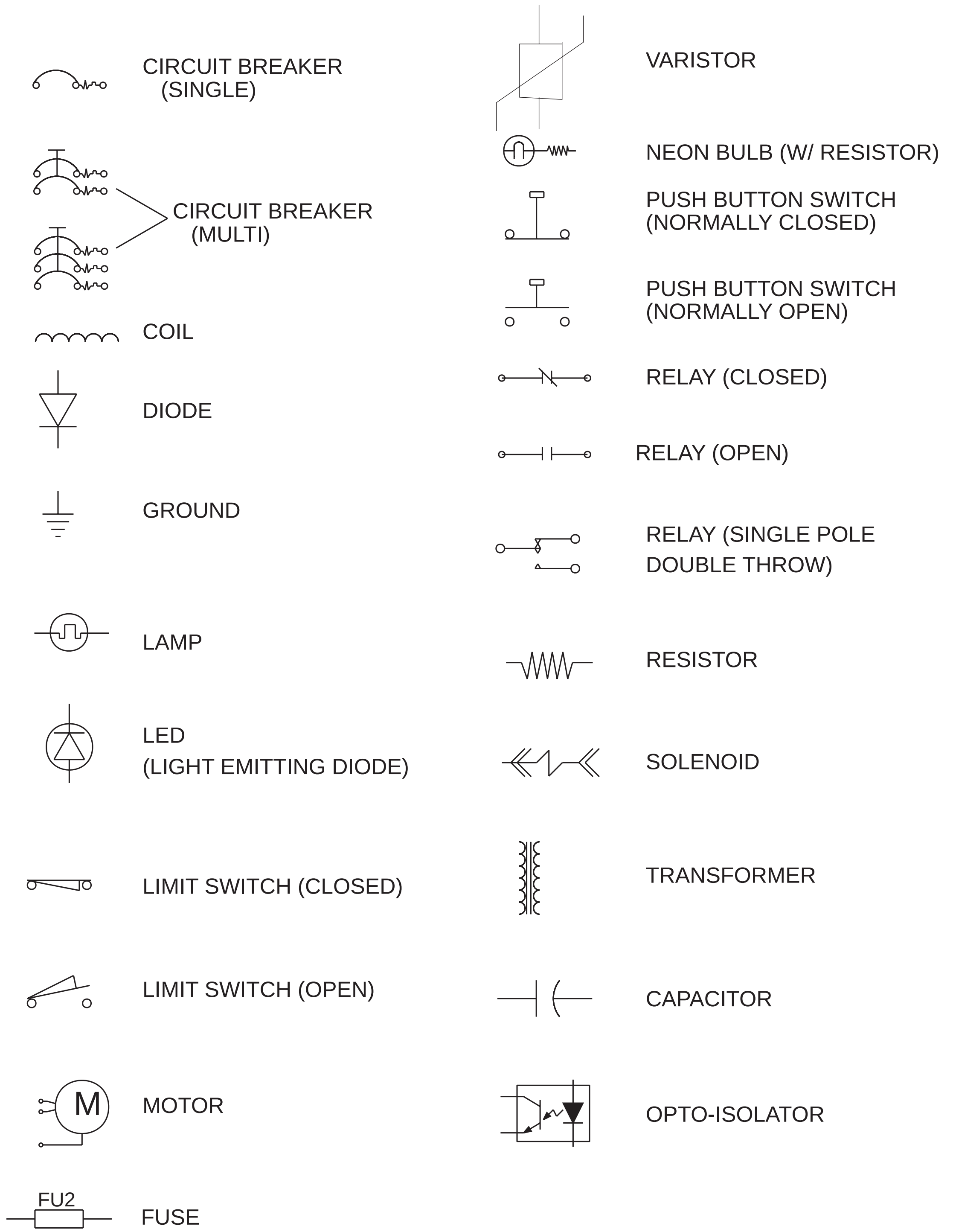


OPERATOR PENDANT


VECTOR DRIVE
T1
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
CB6 5A.
HOPT-A PCBA
RIGHT CHIP AUGER MTR 1 PH
230VAC 1/4 HP
LEFT CHIP AUGER MTR 1 PH
230VAC 1/4 HP
CB1
3PH, 40 AMP
240VAC
K1
3PH, 30 AMP
600VAC
LINE
FAN , PENDANT
FAN , CPU
PROC P/S
115V
WORKLIGHT
FAN , SERVO AMP
FAN , DOOR
SOLENOIDS
POWER
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
P/S
160 VDC
F1
P56
P59
MAIN DRAW BAR MOTOR
1/8HP
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
1/8 HP, 230V, 1PH 50/60HZ

EC-400 Block Diagram

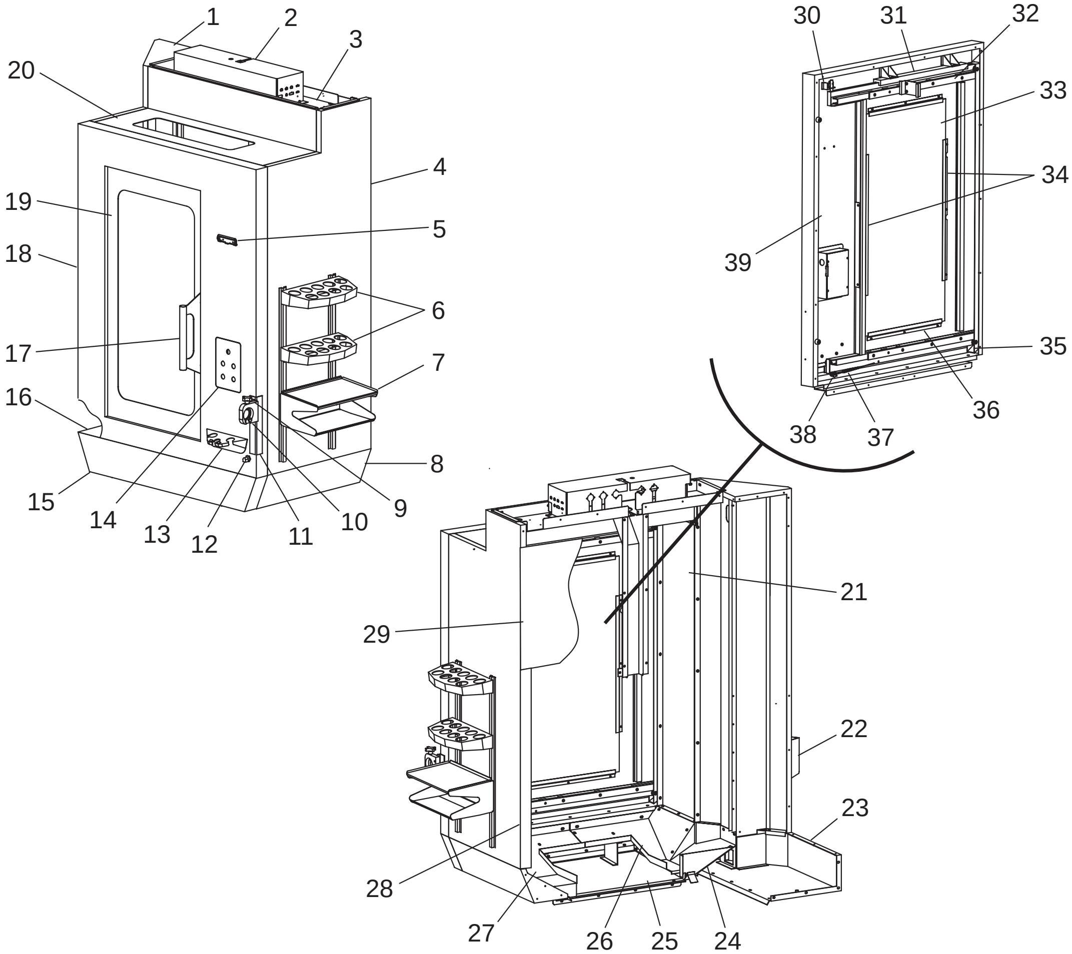




ELECTRICAL SYMBOLS

ASSEMBLY DRAWINGS AND PARTS LISTS

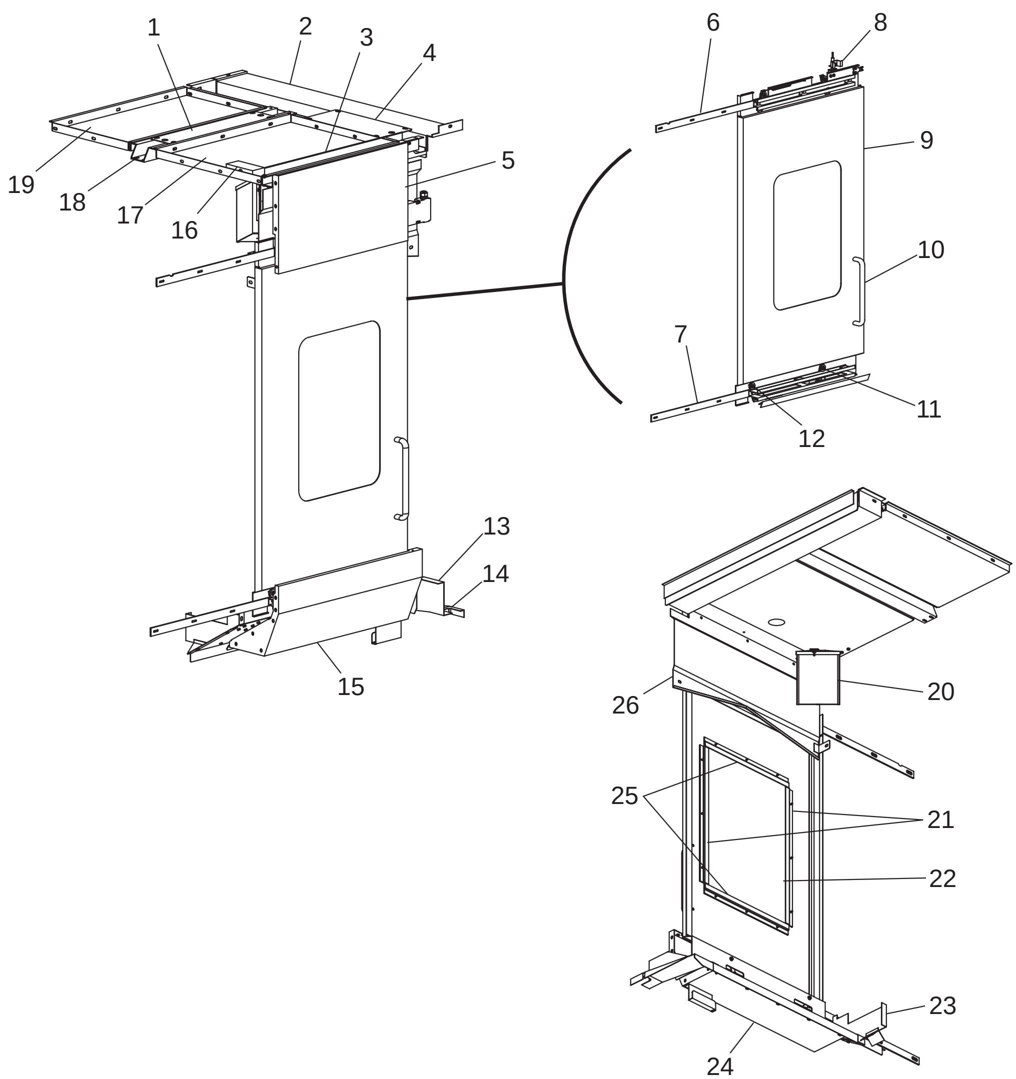
EC-300 Front Panels



View Rotated for Clarity

1. 25-5682 Tool Trays Panel
2. 25-5683 Intermediate J-Box Top Cover
3. 25-5681 Intermediate Top Cover
4. 25-5678 Front Right Panel
5. 59-0123 Sanders K 18 Wire Clip
6. 25-0440 Tool Tray (2x)
7. 25-6182 Front Table
8. 25-5740 Front Right Pan
9. 59-0278 Knob Head 3/8-16 x 1-1/4 Dog Point Screw
10. 20-1341 Tool holder Block
11. 25-0798 Tool Holder Bracket
12. 58-1671 Nipple 1/8 NPT x2
    58-3618 Street Elbow ¼, 90 degree
13. 25-5412 Nozzle Holder Bracket
14. 25-1257 Front Panel Switch Box
15. 25-5741 Front Center Pan
16. 25-5739 Front Left Pan
17. 25-1292 Door Handle
18. 25-5809 Center Front Panel
19. 30-7148 Front Door Assembly
20. 25-5680 Front Panel Top Cover
21. 25-5679 Front Left Panel
22. 25-0563 Tool Box Assembly
23. 25-5738 Left Intermediate Pan
24. 25-5786 Left Chip Shield Pan
25. 25-5742 Center Bottom Pan
26. 25-5784 Front Left Chip Shield Pan
27. 25-5785 Front Right Chip Shield Pan
28. 25-5806 Operator Door Tunnel
29. 25-5893 Panel Top Partition
30. 32-2300 Proximity Limit Switch –Door Open
31. 20-2696 Front Door Guide Bar
32. 20-2317 Rail Load Station (2x)
33. 28-0165 Front Door Window
34. 25-0668 Side Window Retainer (2x)
35. 59-6400A Guide Wheel
    49-2015 PTHS ¼-20x7/8
    49-0015 NVT
    45-16390 Washer
36. 25-0669 Top-Bottom Window Retainer (2x)
37. 59-9743 Front Door Spring
38. 30-2009 Lower Right Corner Roller Assembly
39. 25-5810 Front Door

EC-300 Operator Door Panels

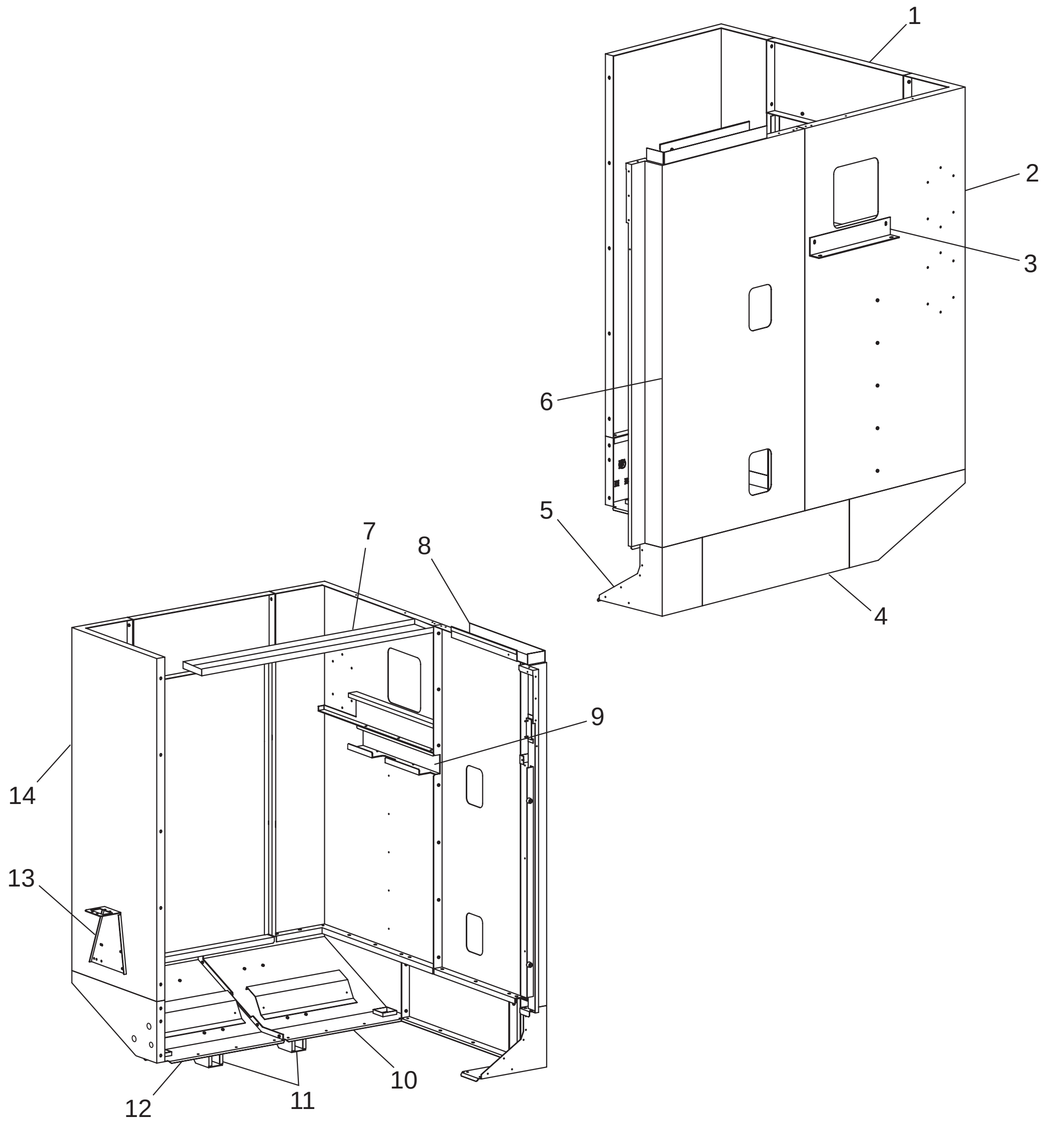


View Rotated 180° (Looking Up)

1. 25-5888 Center Channel Cover Plate
2. 25-5891 Cable Channel Cross Top
3. 25-5799 Top Operator Side Cables Tray
4. 25-5892 Cable Channel Cover Plate
5. 25-5792 Right Intermediate Top Panel
6. 20-2685 Operator Door Upper Door Rail
7. 25-2684 Operator Door Lower Door Rail
8. 25-5798 Operator Door Trip Bracket
9. 25-5791 Operator Door
10. 59-6210 Red Door Handle
11. 30-7359 Operator Door Right Roller Assembly (2x)
12. 30-7358 Operator Door Left Roller Assembly (2x)
13. 25-5796 Left End Hinge Assembly
14. 25-5926 Auger Motor Cable Tray
15. 25-5788 Right Intermediate Pan
16. 25-4521 Cover Lamp Connector
17. 25-5889 Operator Side Top Cover
18. 25-5887 Top Center Channel
19. 25-5890 Tool Changer Side Top Cover
20. 32-0227 Mylar Reflector Lamp Assembly
    25-4789 Adjust Work light Bracket
21. 25-5793 Operator Door Side Z-Frame
22. 28-0151 Operator Door Side Window
23. 25-5787 Right Chip Shield PC Wing
24. 25-5789 Operator Side Lower Chip Shield
25. 25-5228 Door Window Z-Frame (2x)

25-5800 Operator Side Top Chip Shield

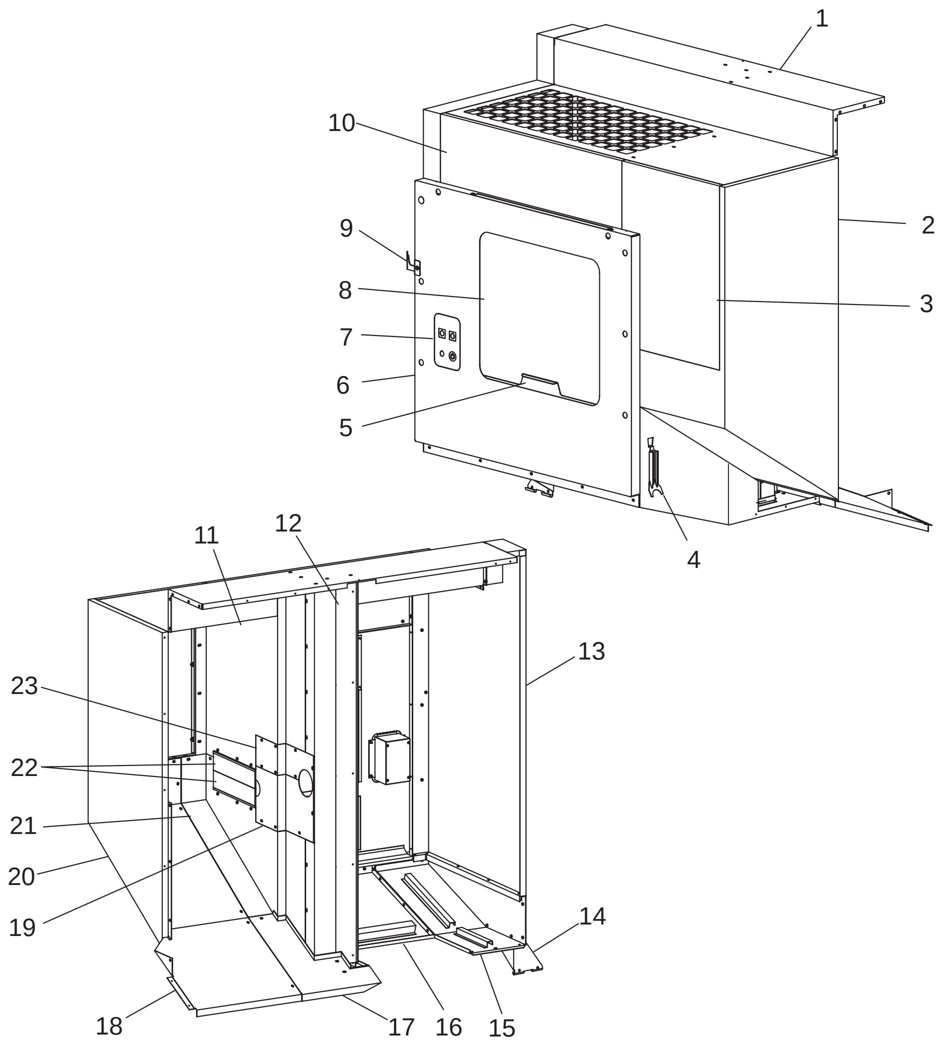
EC-300 Rear Panels



View Rotated 90° CCW

1. 25-5720 Rear Header
2. 25-5666 Rear Control Box Panel
3. 25-5722 Control Support Mounting Bracket
4. 25-5924 Control Intermediate Pan
5. 25-5665 Front Control Pan
6. 25-5667 Front Control Box Panel
7. 25-5721 Top Panel Support Brace
8. 25-5912 Control Top Panel Tray
9. 25-5896 Control Box Panel Tray
10. 25-5925 Rear Control Pan
11. 25-5897 Rear Panel support Bracket (2x)
12. 25-5664 Rear Left Pan
13. 25-7581 TSC Filter Bracket
14. 25-5718 Rear Left Panel

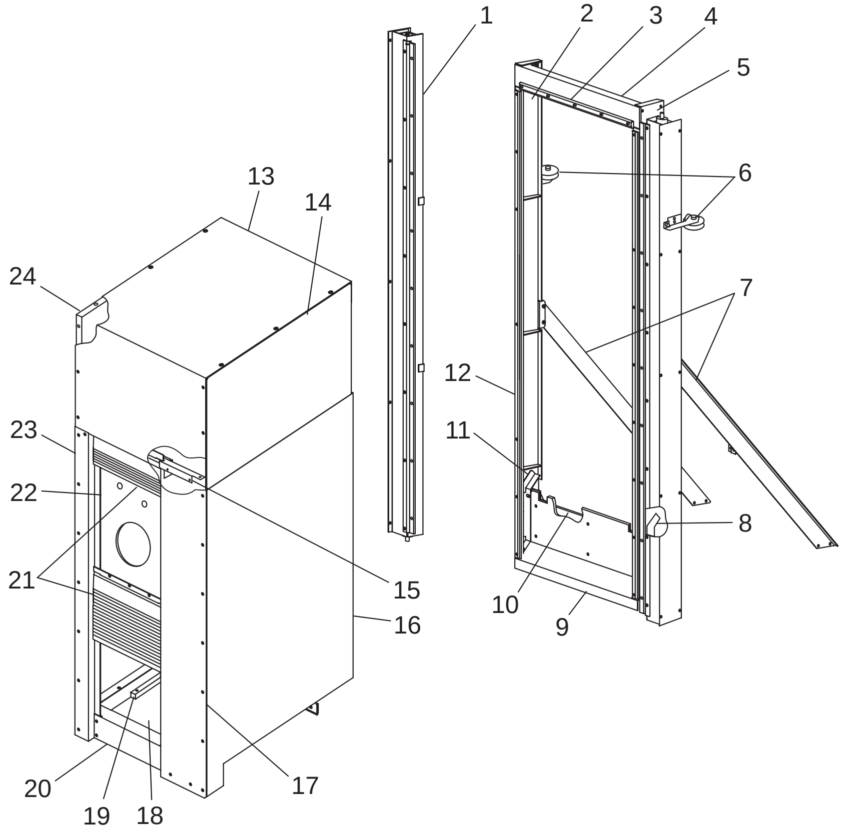
EC-300 Tool Changer Panels



View Rotated 90° CW

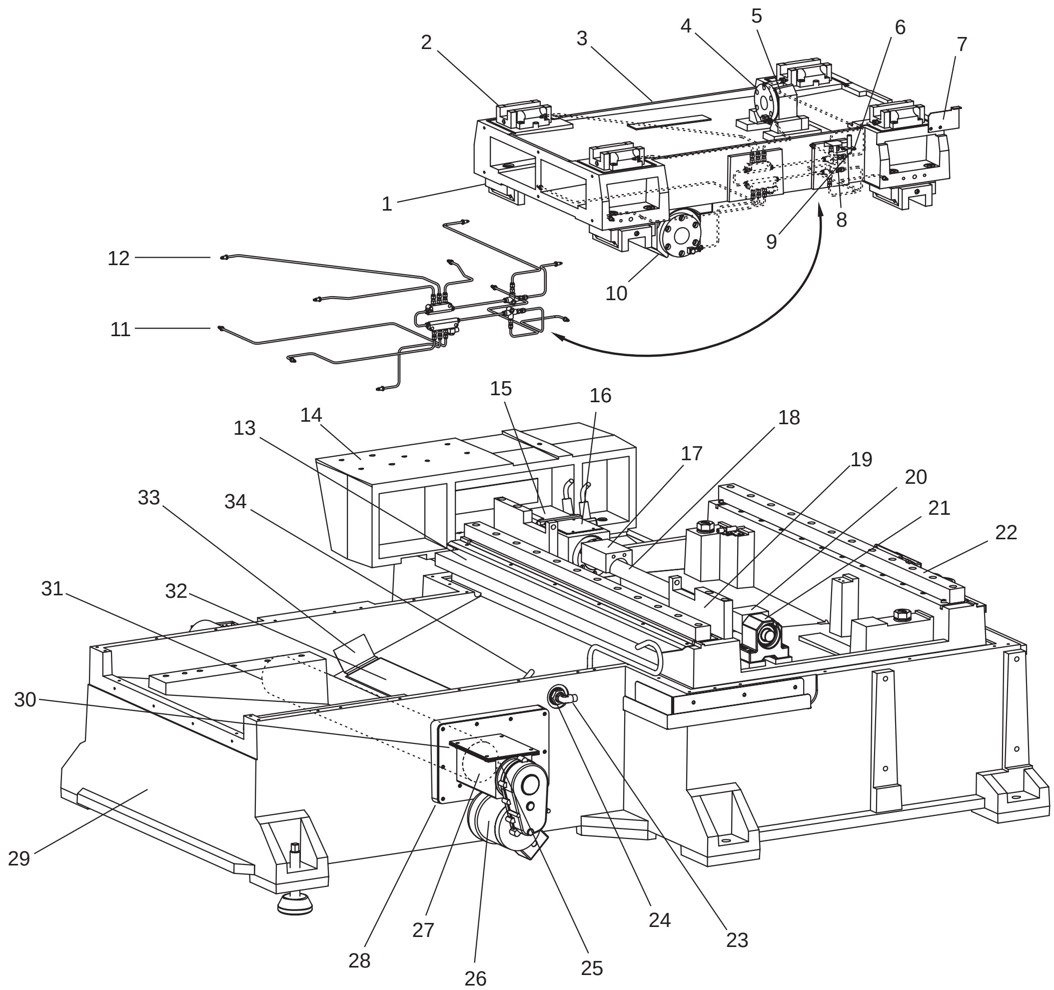
1. 25-5881 Tool Changer Top Cover
2. 25-5706 T.C. Front Panel
3. 25-5779 T.C. Side Panel
4. 25-6682 Removal Tool 40T Holder
5. 25-9248 Plate Window Handle
6. 25-5885 T.C. Access Panel
7. 32-0097 Remote Switch Box
8. T.C. Access Window
9. 25-9262 Wash Handle Holding Bracket
10. 25-5927 T.C. Header Panel
11. 25-5777 Top Bulkhead
12. 25-5778 Mounting Bulkhead
13. 25-5709 T.C. Rear Panel
14. 25-6730 Separator Return Line Bracket
15. 25-5705 T.C. Rear Pan
16. 25-5707 T.C. Front Pan
17. 25-5804 T.C. Top Chip Shield
18. 25-5716 T.C. Front Chip Shield
19. 25-5957 T.C. Access Bottom Bulkhead
20. 25-5706 T.C. Front Panel
21. 25-5776 Lower Bulkhead
22. 26-0155 Nylon Strip Brush (2x)
23. 25-5956 T.C. Access Top Bulkhead

EC-300 Column and Frame Panels



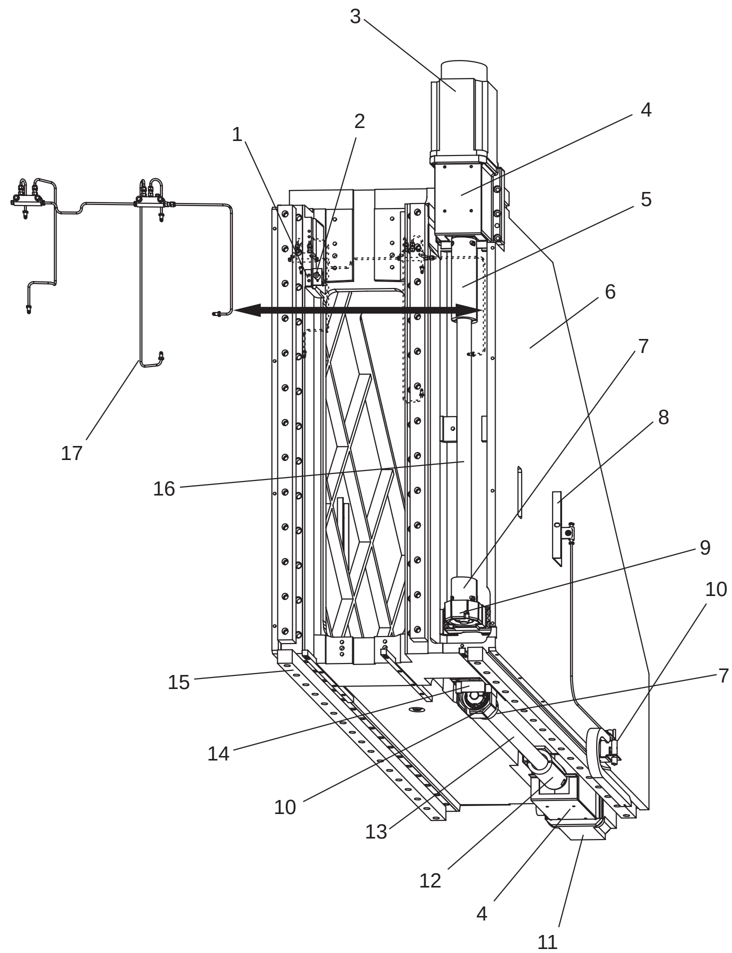
1. 59-0706 Shade Roller- 70.5" x 21" (2x)
2. 25-5833 Shade Roller Left Frame
3. 25-5837 Top Column Clamp Wiper
   26-0173 Top Column Wiper Felt
4. 25-5834 Shade Roller Top Frame
5. 25-5832 Shade Roller Right Frame
6. 30-7214 Column Frame Roller Assembly
7. 25-5773 Shade Roller Frame Brace (2x)
8. 25-5767 Right Corner Seal
9. 25-5765 Saddle Cover Front Seal
10. 25-5766 Wiper Backing Plate
    25-0169 Saddle Wiper Felt
11. 25-5768 Left Corner Seal
12. 25-5836 Column Felt Wiper Clamp (2x)
    26-0172 Column Felt Wiper
13. 25-5826 Column Top Cover
14. 25-5825 Column Top Side Cover
15. 25-5831 Gordillo Top Bracket
16. 25-5823 Column Right Cover
17. 25-5827 Gordillo Right Guide
18. 25-5829 Bottom Chip Cover Plate
19. 20-2615 Bottom Plate Bar (2x)
20. 25-5830 Bottom Gordillo Cover
21. 59-0714 Y-Axis Gordillo (2x)
22. 25-5911 Y-Axis Waycover Center Cover
23. 25-5828 Gordillo Left Guide
24. 25-5824 Column Left Cover

EC- 300 Base Assembly



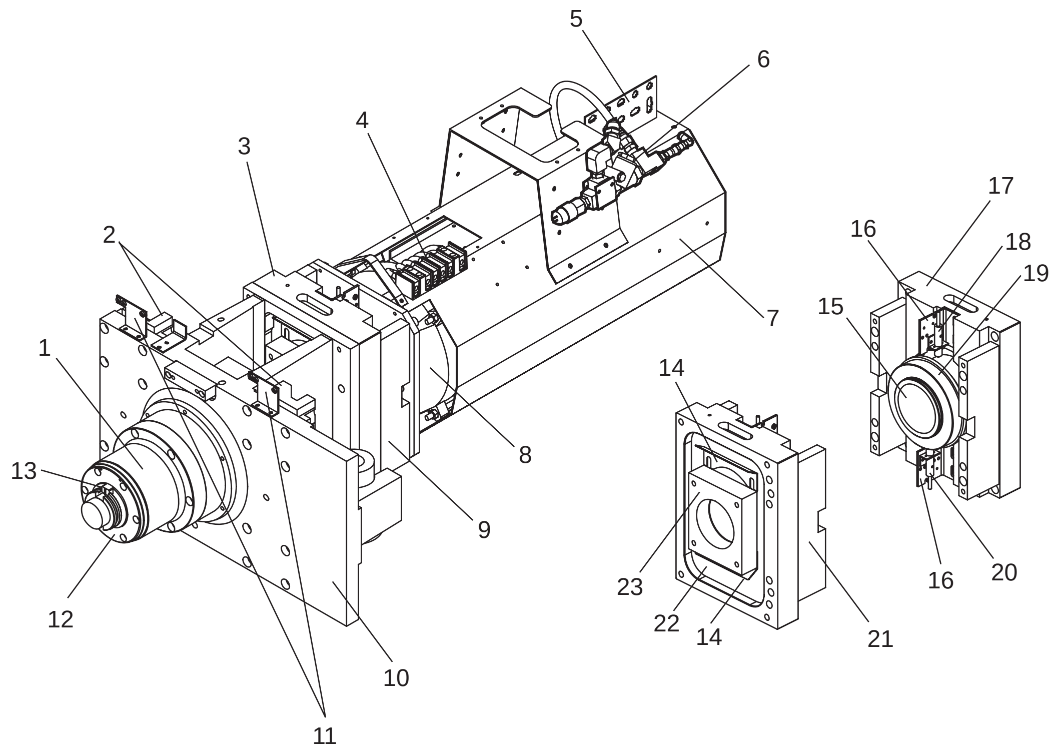
1. 50-9011 Linear Guide (truck)
2. 50-0017 Linear Guide (35mm truck)
3. 20-2587 Saddle Casting
4. 58-3600 3/8" Nipple
5. 20-7008 Nut Housing
6. 25-7267 Prox. Switch Bracket
7. 25-5780 Y-Axis Trip Bracket
8. 25-5919 Cable Carrier Bracket
9. 20-2593 Prox. Switch
10. 20-0150 Nut Housing
11. 30-7140 Base Lube Assembly
12. 30-7138 Saddle Lube Assembly
13. 25-5953 Chip Shield
14. 20-2687 ATC Mount
15. 62-0014 Servo Motor
16. 25-9203 Motor Mount Cover Plate
17. 20-2733 X-Axis Bumper
18. 30-3107 Ballscrew Assembly
19. 20-2593 X-Axis Ship Block
20. 20-2676 Ballscrew Bumper
21. 20-0152 Bearing Housing
22. 50-9011 Linear Housing
23. 58-1680 Parker Fitting
24. 58-0097 90° Fitting
25. 57-9265 Chip Conv. Bracket
26. 32-6626 Chip Conv. Motor
27. 25-5669 Auger Box
28. 57-0360 Box Gasket
29. 20-2586 Base Casting
30. 57-9265 Conveyor Gasket
31. 20-2592 Chip Auger
32. 25-5670 Auger Box Cover
33. 25-5673 Strainer Base
34. 58-0807 Coolant Nozzle Base

EC- 300 Clolumn Assembly



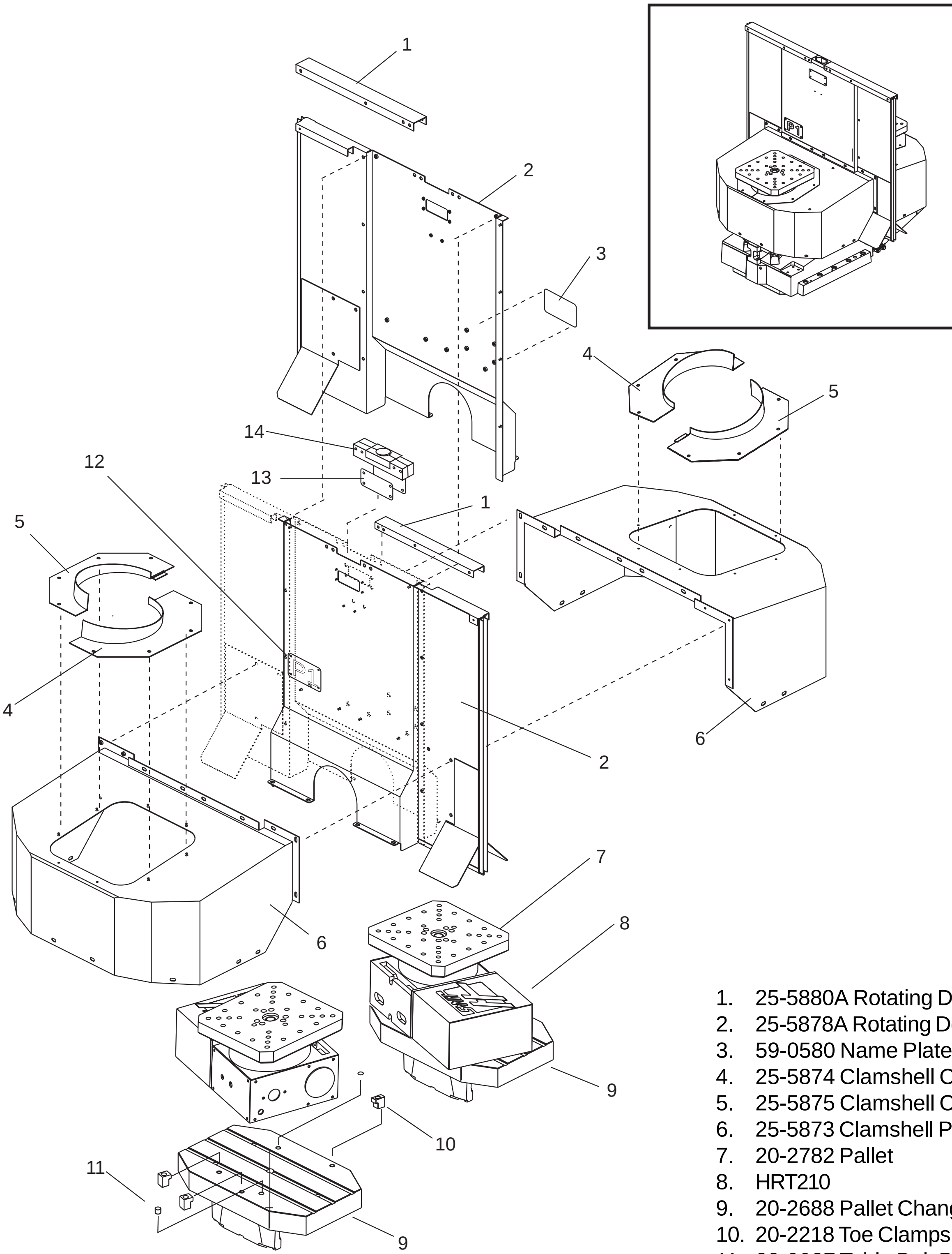
1. 25-2767 Mounting Bracket
2. 32-2130 Prox Switch
3. 62-0017 Servo Motor
4. 25-7042 Cover Plate
5. 20-2686 Ballscrew Bumper
6. 20-2588 Column Casting
7. 20-6361 Y-Axis Bumper
8. 25-5732 Column Cover
9. 20-7009 Bearing Housing
10. 21-2131 Prox Switch
11. 62-0014 Servo Motor
12. 20-2734 Bumper Cover
13. 24-0023 Ballscrew Assembly
14. 25-7080 Bracket
15. 50-3400 Linear Guides
16. 24-0041 Ballscrew
17. 30-6403 Y-Axis Lube Line Assembly

EC- 300 Spindle Head Assembly



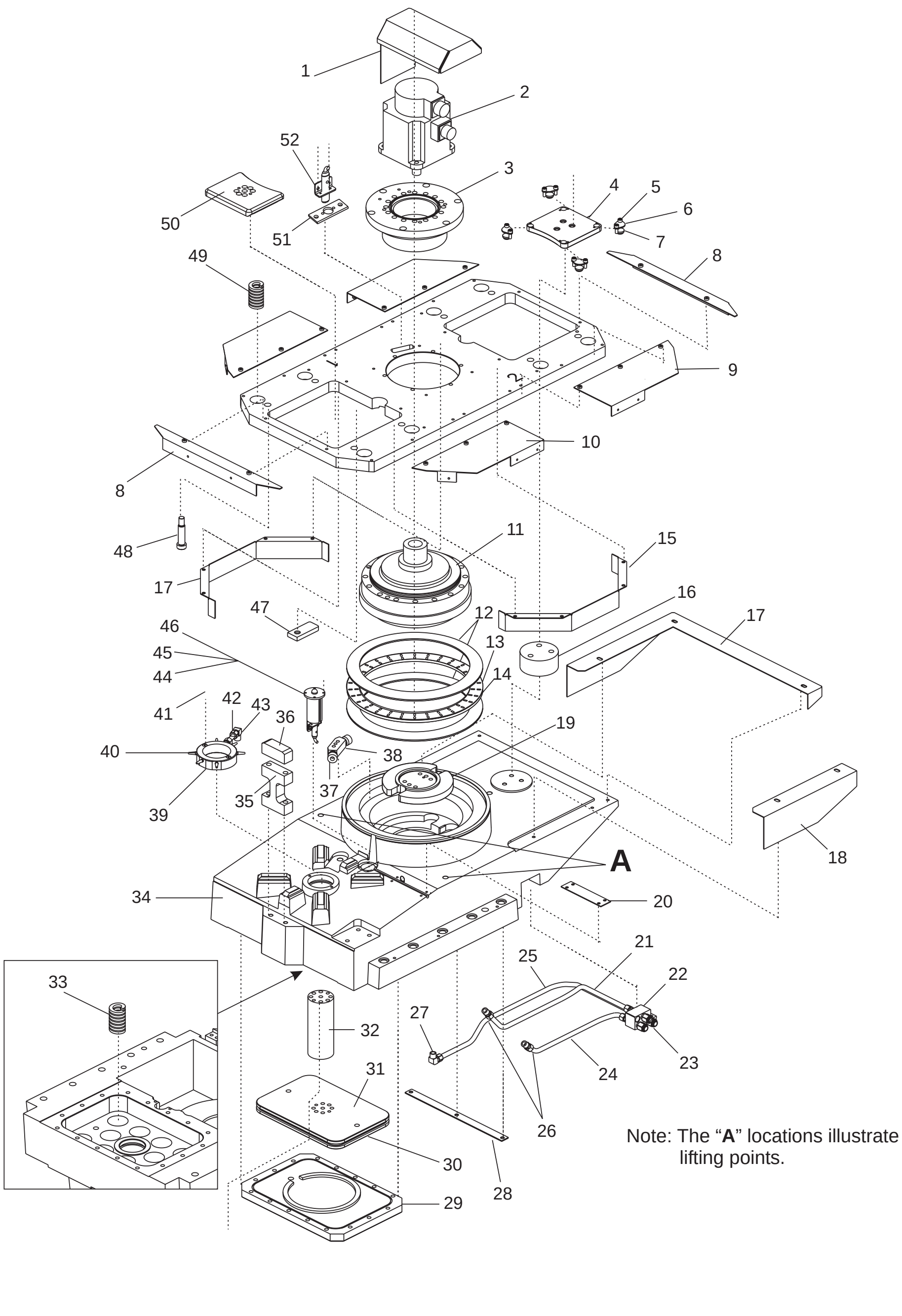
1. 20-7016 Spindle housing
2. 50-0017 Linear Guide (35mm truck)
3. 20-1693 TRP Incline Cylinder
4. 73-3055 Terminal Buss
5. 25-5242 Shroud Bracket
6. 30-6465 TSC Fitting Assembly
7. 25-5213 Motor Shroud
8. 62-3013 Spindle Motor
9. 20-2520 Stand Off
10. 20-2674 Spindle Head
11. 25-6592 Junction Bracket
12. 20-7022 Spindle Lock
13. 20-2512 Incline Spindle Shaft
14. 25-5970 Shim
15. 20-1691 Shaft Inline
16. 25-4648 Bracket Switch Mounting
17. 20-1693 Cylinder Inline
18. 30-2200 Prox Switch “Unclamp”
19. 20-1696 Spring Retain Inline
20. 30-2233 Prox Switch “Clamp”
21. 20-2520 Standoff Inline
22. 20-1692 Piston Inline
23. 20-2521 Striker Plate Inline

EC- 300 Pallet Changer



1. 25-5880A Rotating Door Cap
2. 25-5878A Rotating Door
3. 59-0580 Name Plate P2
4. 25-5874 Clamshell Cover Access
5. 25-5875 Clamshell Cover Access
6. 25-5873 Clamshell Pallet Cover
7. 20-2782 Pallet
8. HRT210
9. 20-2688 Pallet Changer Table
10. 20-2218 Toe Clamps
11. 22-9087 Table Bolt Plug (Dowel Pin)
12. 59-0579 Name Plate P1
13. 25-5883 Rotating Access Cover
14. 20-2695 Rotating Door Fairlead

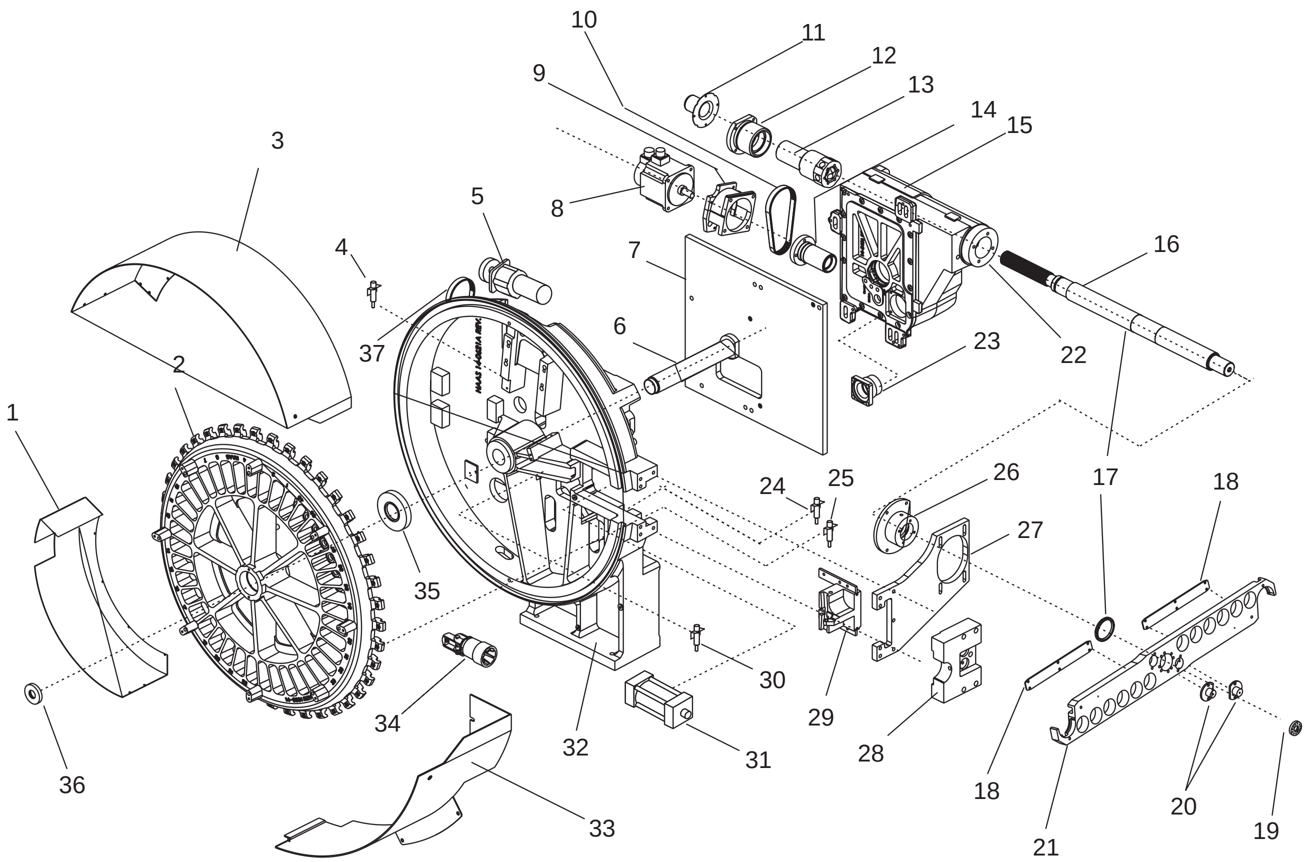
EC- 300 Pallet Changer



Note: The "A" location illustrate lifting points.

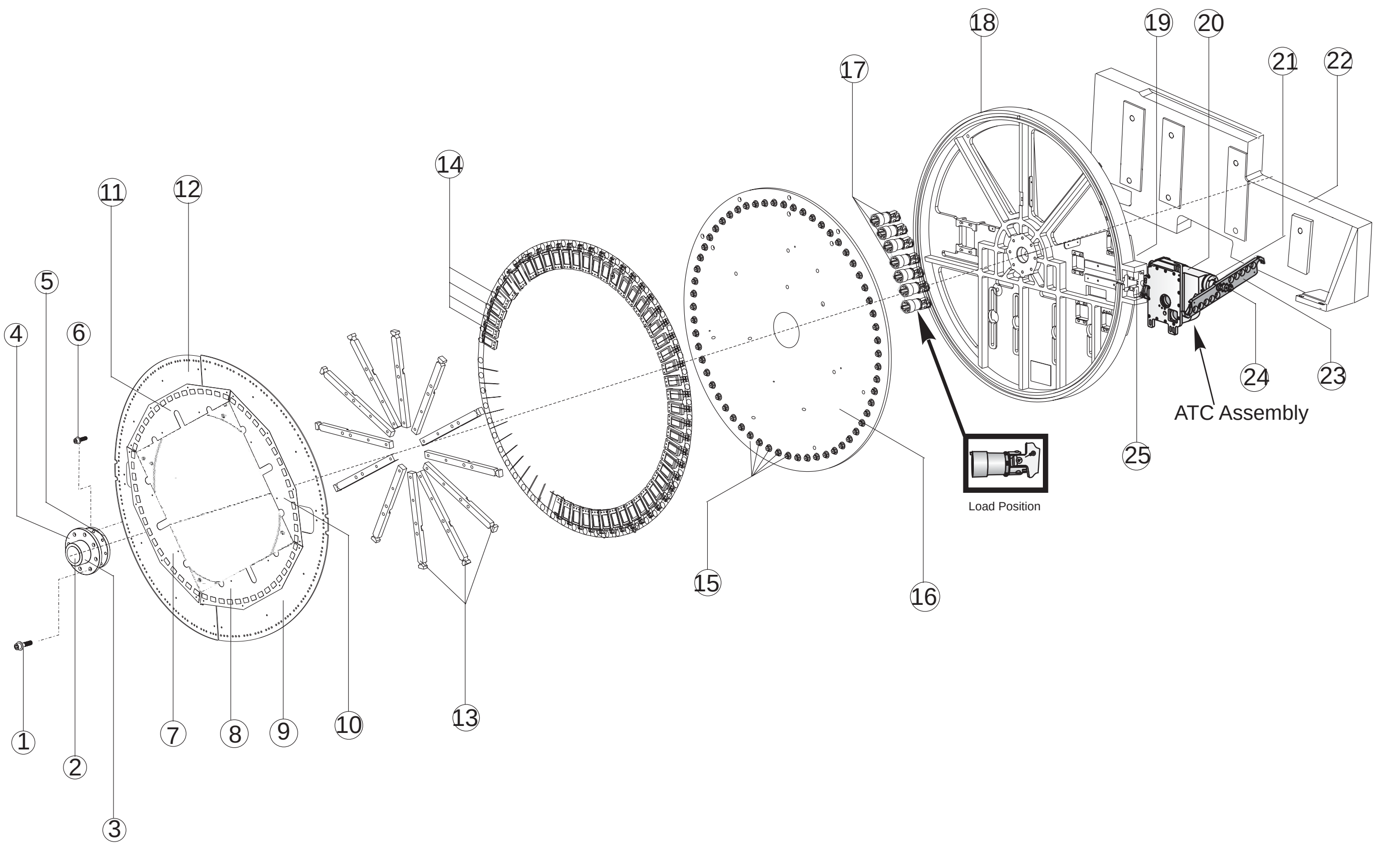
1. 25-6845 Motor Cover
2. 62-0014 Servo Motor
3. 20-2724 Motor Flange
4. 20-2812 Stabilizer Plate
5. 25-5934 Retainer Button
6. 40-1640 SHCS 10-32 x ½
7. 20-2814 Stabilizer Button
8. 20-2729 Pallet Support Frame (2x)
9. 25-5876 Clamshell Splash Shield
10. 25-5877 Clamshell Splash Shield
11. 59-0724 Harmonic Drive
12. 25-5916 Thrust Washer (2x)
13. 25-5915 Roller Cage
14. 51-0018 Bearing Roller
15. 25-5900A APC Skirt (2x)
16. 20-2813 Stabilizer Spacer
17. 25-6793 Right Clamp Shield
18. 25-6794 Left Clamp Shield
19. 20-2783 Drive Plate
20. 25-6827 Switch Cable Cover
21. 58-0779 Air Blast Tube
22. 20-2726 Bulkhead
23. 58-1693 LBO Fitting
24. 58-0778 Clamp Tube
25. 58-0777 Unclamp Tube
26. 58-3087 Comp Fitting
27. 58-3052 90° Comp Fitting
28. 25-5899 APC Cable Strap
29. 20-2719 Clamp Cylinder Cover
30. 57-2986 Piston “O” Ring
31. 20-2700 Pallet Clamp Piston
32. 20-2716 Pallet Clamp Shaft
33. 59-0727 Die Spring
34. 20-2690 Pallet changer Base
35. 20-2785 “H” Frame Pad
36. 20-2809 Frame Button
37. 59-0725 Bumper
38. 20-2728 Stop Block
39. 20-2727 Air Blast Ring
40. 20-2582 Air Blast Nozzle
41. 40-1705 FHCS
42. 58-2070 Hex Fitting
43. 58-0780 90° Fitting
44. 20-2699 Pallet Up Plunger
45. 20-3073 Clamp Switch Housing
46. 32-2236 Prox Switch Unclamp
47. 20-2698 Pallet Flag
48. 625 x 2 Shoulder Bolt
49. 59-0726 Pallet Support Spring
50. 20-2715 Pallet Clamp
51. 25-5903 Prox Pallet Mount
52. 32-2130 Prox Home 1.5’

EC- 300 40-40 Tool changer



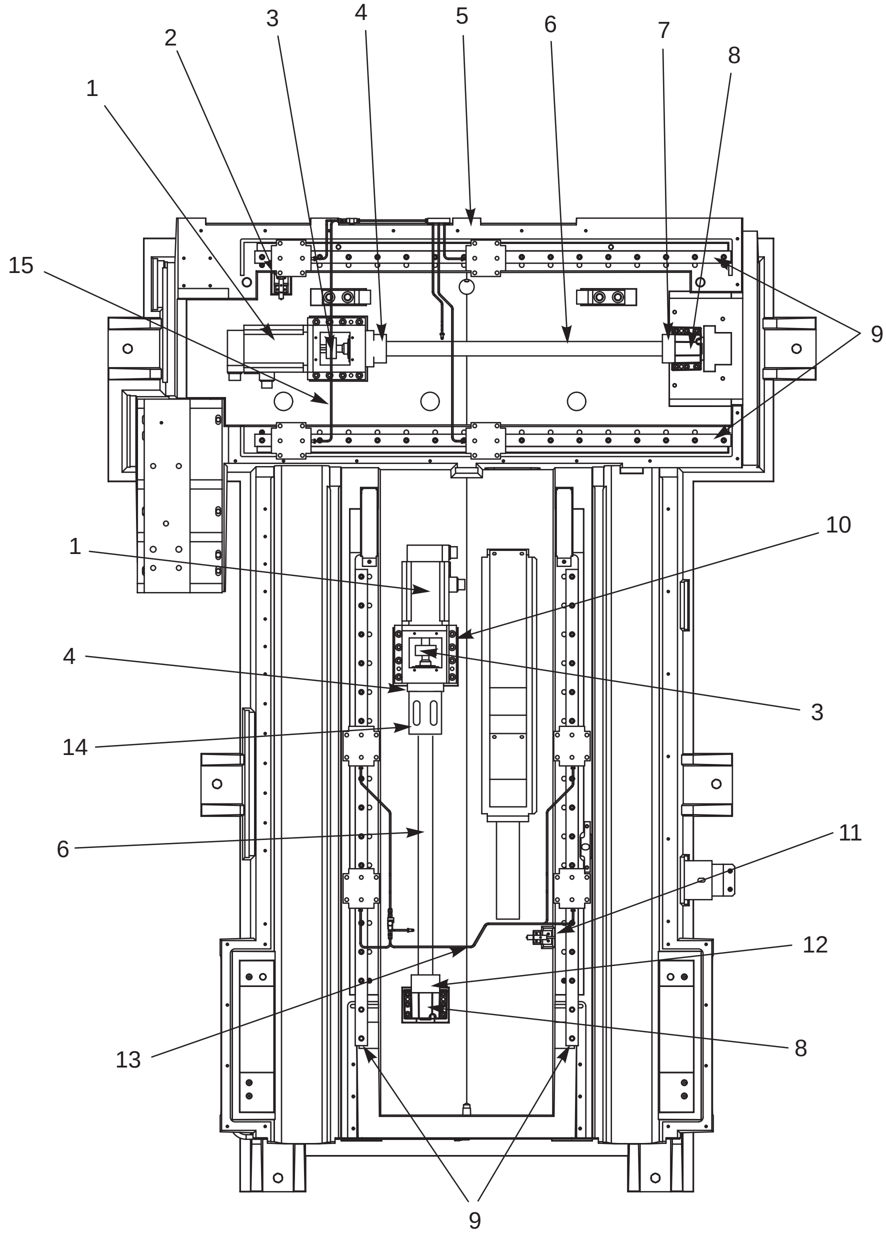
1. 25-4153 Rear Cover
2. 20-0731 Carousel
3. 25-4152 Front Cover
4. 32-2295 Prox Carousel Mark
5. 32-1875 Carousel Motor
6. 20-0809 Carousel Shaft
7. 20-2759 Mounting Plate
8. 62-0014 Servo Motor
9. 20-0772 Motor Mount
10. 54-0036 Drive Belt
11. 22-0001 Output Shaft Cad
12. 20-0224 Star Bearing Housing
13. 20-0223 Star Gear
14. 20-0225 Bearing Housing
15. 30-4008 Cam Box
16. 20-2694 Output Shaft
17. 57-0059 Seal
18. 25-5805 Cover Plate
19. 20-0240 Arm Hub
20. 20-0245 Arm Cap
    20-0246 Arm Cap
21. 30-7234 Double Arm Assy.
22. 20-0238 Bearing Cap
23. 20-0226 Bearing Housing
24. 32-2251 Prox Pocket Down
25. 32-2252 Prox Pocket Up
26. 20-2732 SMTC Shaft Support
27. 20-2731 SMTC Support Plate
28. 20-2730 Pocket Stop
29. 20-0807 Tool Pocket Slide
30. 32-2253 Prox Switch Tool One
31. 59-0078 Air Cylinder
32. 20-2735 ATC Housing
33. 25-0800 Shroud Corner
34. 20-0458 Tool Pocket
35. 59-0290 Lock Nut
36. 20-0392 Carousel Washer
37. 54-0045 Belt Drive

EC- 400 60-40 Tool changer



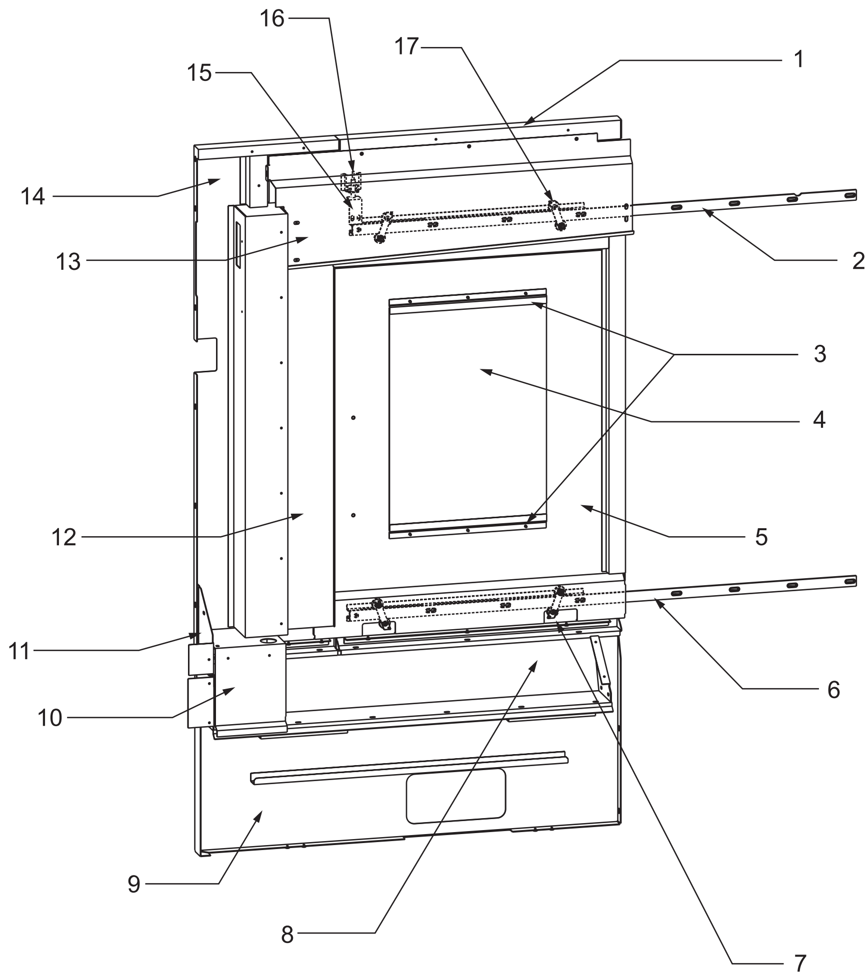
1. 40-0226 SHCS ¾”x3"
2. 59-0737 Plug Hole
3. 20-2911A Hub Index Plate
4. 20-2911A Hub Index Plate
5. 20-2868A Shaft Assembly
6. 40-1663 SHCS ½”-13x1¾”
7. 25-6029 Panel Tools (31-45)
8. 25-6030 Panel Tools (46-60)
9. 25-5998 Disk Section (1)
10. 25-6021 Panel Tools (1-15)
11. 25-6022 Panel Tools (16-30)
12. 25-5998 Disk Section (2)
13. 20-2966 Carousel Ribs
14. 20-2864A Pivot Packet
15. 51-0045 Cam Follower
16. 20-2913 Plate Index
17. 20-0458A Tool Pockets
18. 20-2828 Pocket Carousel
19. 30-0145 Cambox Assembly
20. 20-0455 ATC Cambox
21. 20-0238 Bearing Cap
22. 20-2825A Machining Mount
23. 20-2121 Double Arm
24. 20-0240F Hub Arm
25. 20-2867 Stop Pocket

EC-400 Base Casting



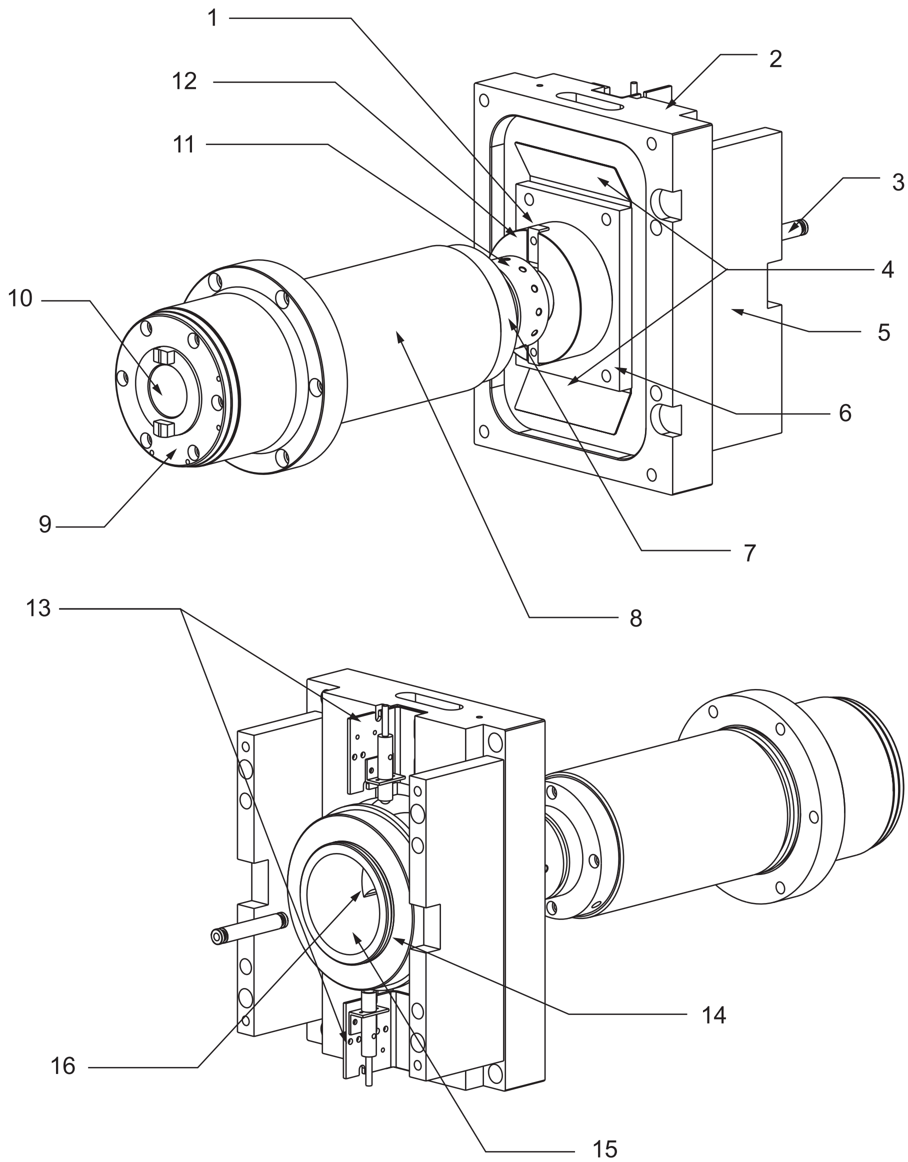
1. 62-0016 Motor
2. 32-2130 Limit Switch
3. 30-1215 Ball Screw Coupling
4. 20-9212 Bearing Housing
5. 20-2042 Casting
6. 24-0026 Ballscrew
7. 20-2084 Hard Stop X Axis
8. 20-0152 Bearing Housing
9. 50-3400 Linear Guides
10. 20-0151 Motor Mount Assy.
11. 32-2134 Limit Switch
12. 20-2450 Z Axis Bumper
13. 30-6336 Z Axis Lube Assy.
14. 20-1992 Bumper
15. 30-6337 X Axis Lube Assy.

EC-400 Operator's Door



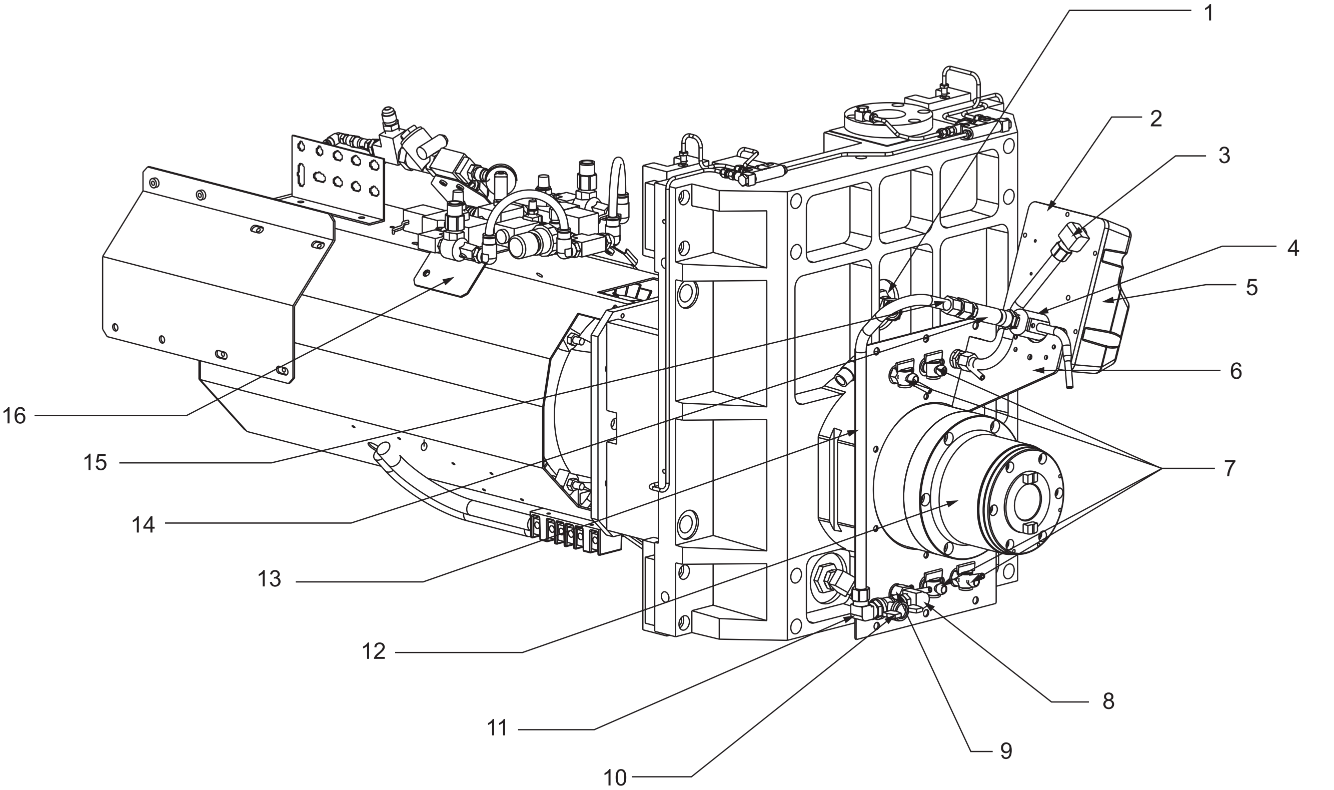
1. 25-4954 Header Side, Right
2. 20-2036 Door Track Upper Operator
3. 25-5228 Z-Frame TC/Operator's Door Window (x2)
4. 28-0151 Window TC Panels/Operator's Door
5. 25-4966 Operator Door
6. 20-2038 Door Track Lower
7. 25-5198 Panel Operator Lower
8. 25-4955 Pan Right, Intermediate
9. 25-4982 Apron Right Rear
10. 25-5246 Chip Shield
11. 25-5245 Chip Shield Lower Operator Panel
12. 25-5200 Chip Shield Rear Operator Door
13. 25-4973 Chip Shiel Header Operator Door
14. 25-4956 Panel Right Intermediate
15. 25-4990 Trip Bracket Operator Door
16. 32-2313 Operator Door Close Switch
17. 30-7653 Door Roller Assembly
    59-0604 Spring Operator Door

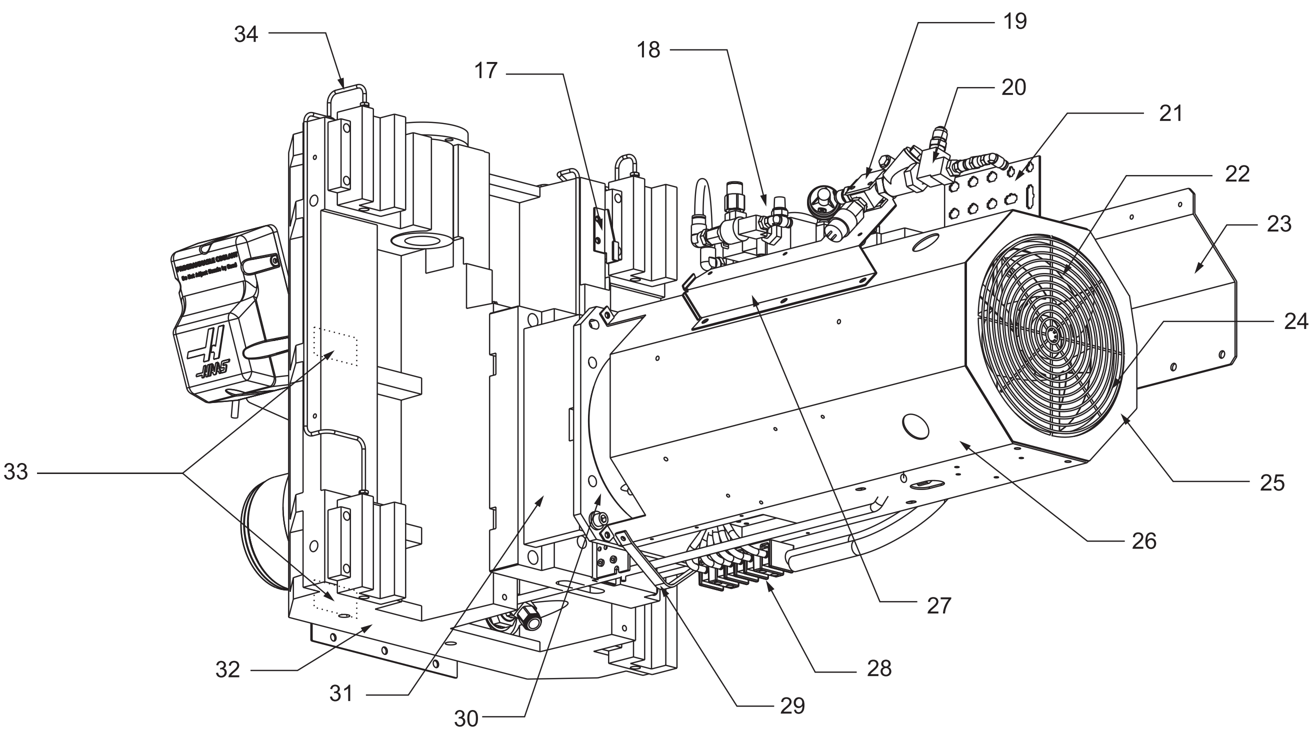
EC-400 In-Line Spindle Assmebly



1. 20-1686A Key Drawbar Inline
2. 20-1693B TRP Cylinder In-Line
3. 20-1688 Tranfer-tube In-line
4. 25-4761 Shim TRP In-Line
5. 20-1694A Standoff Motor In-Line
6. 20-1690 Striker plate Inline
7. 20-7422D Oil Injector Cover
8. 20-7016C Spindle Houseing 40T
9. 20-9763C Spindle Lock Tapered
10. 20-7018M Spindle Shaft 40T
11. 20-1684A Adaptor Shaft In-line
12. 20-1687A Guide Release In-line
13. 25-4648B Bracket Switch Mounting In-line Spindle
14. 20-1696A TRP Spirng Retain Inline
15. 20-1691 TRP Shaft In-Line
16. 52-0040 Shaft Coupling

EC-400 Spindle Head Assembly

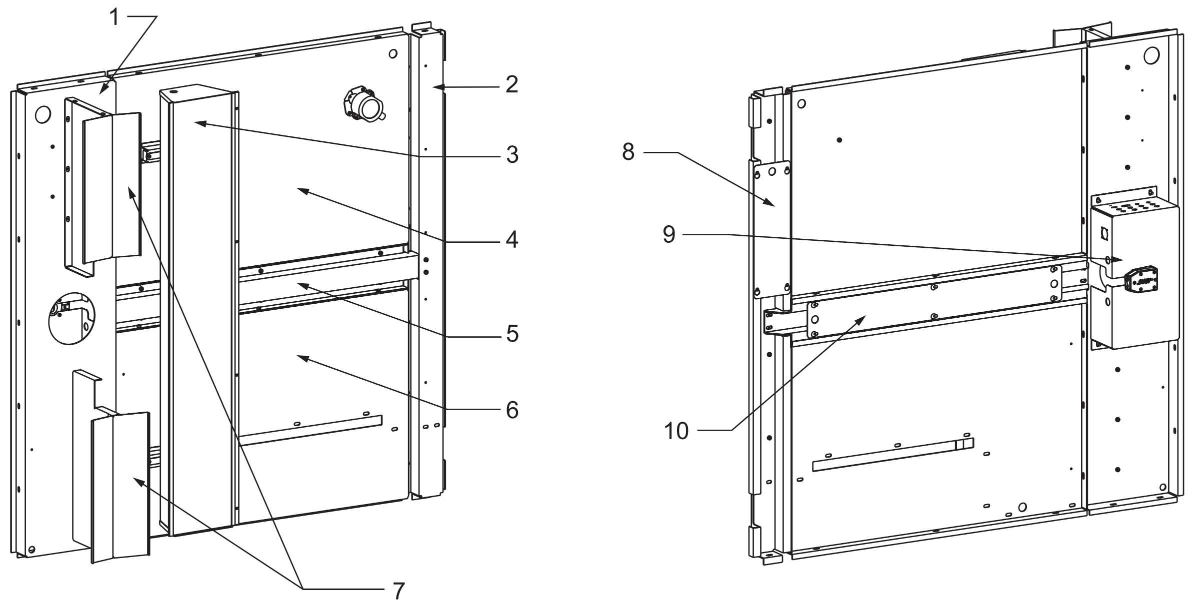




EC-400 Spindle Head Assmebly

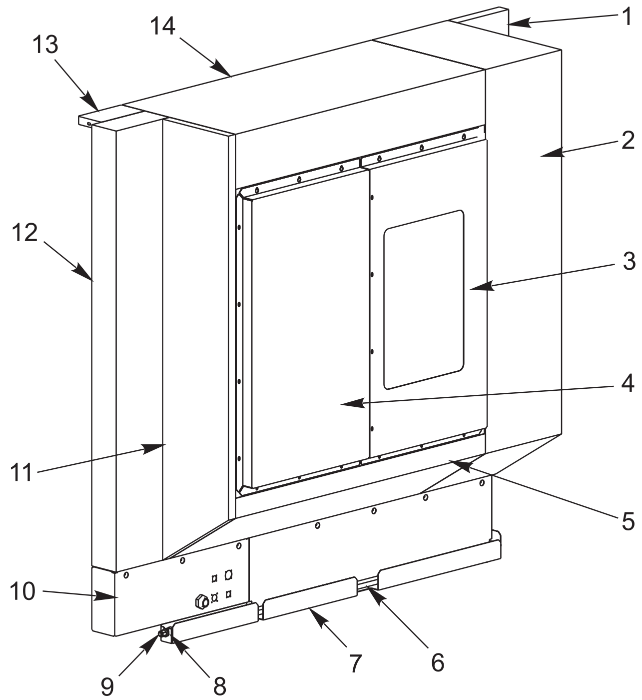
1. 58-1680 Fitting Bkhd NPT 1/2x1.125 dia
2. 20-7381A Plate, Prog Coolant
3. 32-0199 Condit Assembly P-Cool
4. 20-7384A Nozzle Body
5. 14-1905 P-Cool Cover
6. 25-5327 P-Cool Mounting Bracket
7. 58-3694 1/4 Valves Loc-Line
8. 58-1722 Fittin NPT 3/8F x NPT 3/8M 90 Degree
9. 58-1686 Fitting NPT 1/4M x NPT 3/8F
10. 58-0326 3/8 Full Pivot Ball Valve
11. 58-3052 Fitting Comp 1/2 x NPT 3/8M 90 Degree
12. 30-6460 Spindle Assmbly 12K in-Line
13. 58-0674 Tube Coolant P-Cool
14. 52-0035 P-Cool Hose
15. 58-3049 Fitting Comp 1/2xNPT 3/8 Str
16. 25-5366 Brkt Mounting Air Soleniod Assembly
17. 25-5012 Trip Bracket Y-axis
18. 30-4095 TRP Soleniod Assembly
19. 25-5241 Bracket Clamp TSC
20. 30-6465 TSC Switch Assembly
21. 25-5242 Bracket Shroud
22. 36-3035 Fan Assembly Spindle
23. 25-5264 Brkt Cable Carrier Y-Axis
24. 59-0144 Fan Guard 8.75 in.
25. 25-5215 Bracket Fan In-Line Spindle
26. 25-5213 Shroud motor In-Line
27. 25-5017 Cable tray Spindle Head
28. 73-3055 Therm Blk 6-Pole
29. 25-5216 Strap Spindle Motor Lift
30. 20-2248 Plate Motor
31. 20-1694A Stand Off Motor in-Line
32. 20-2044 Spindle Head Machined
33. 20-2063 Coolant Block
34. 30-6338A Oil Line Assembly Y-Axis

EC-400 Top Cover

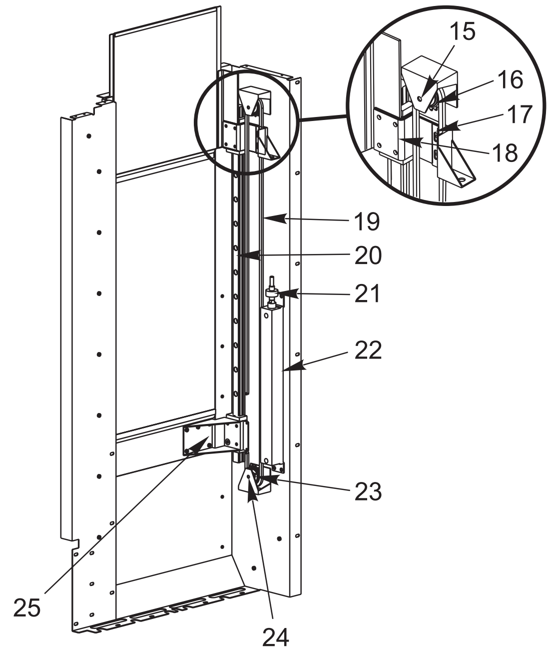


1. 25-4952 Top Cover Front
2. 25-4963 Brace Top Intermedite
3. 32-0196 Worklight Assembly
4. 25-4964 Top Cover Right
5. 25-4980 Wire ChannelTop Cover
6. 25-4965 Top Cover Left
7. 25-4983 Splash Shield Rotating
8. 25-5253 Cover Brace Top
9. 25-4953 J-Box Top Cover
10. 25-4984 Cover Wire Channel Top

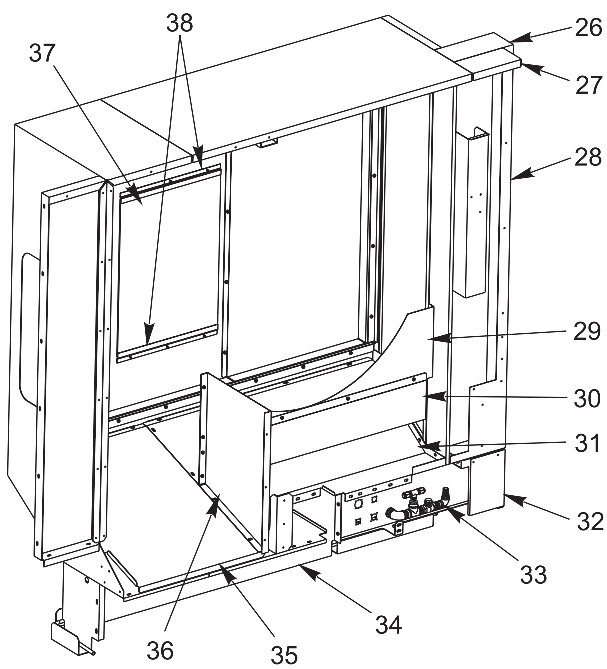
EC-400 Tool Changer Panels



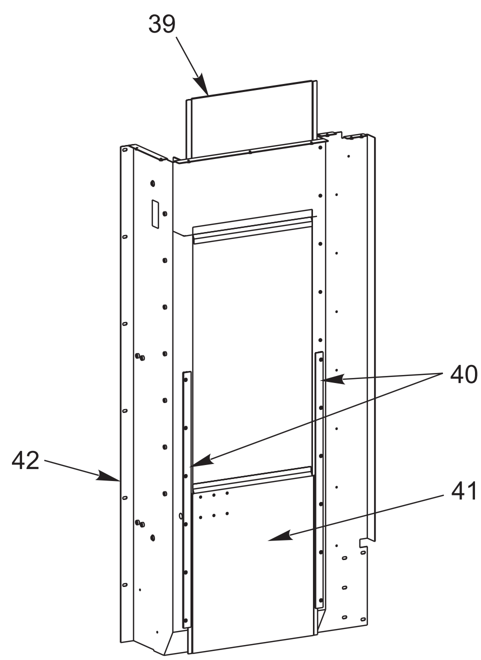
Left Side



TC Door Assembly



Left Side (Rotated 180°)

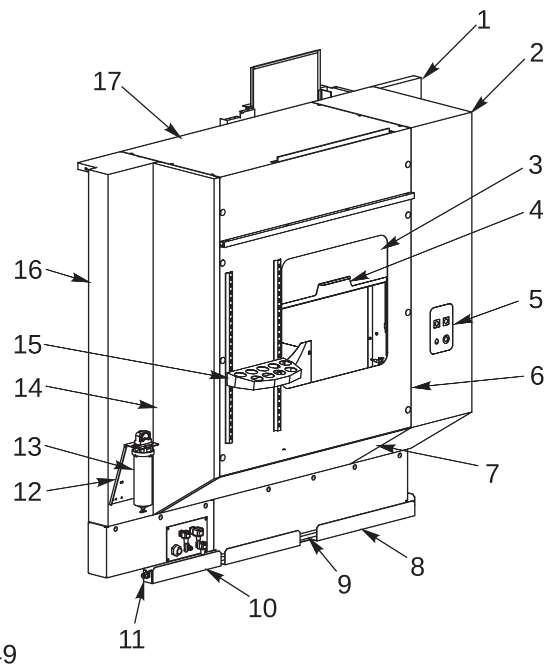


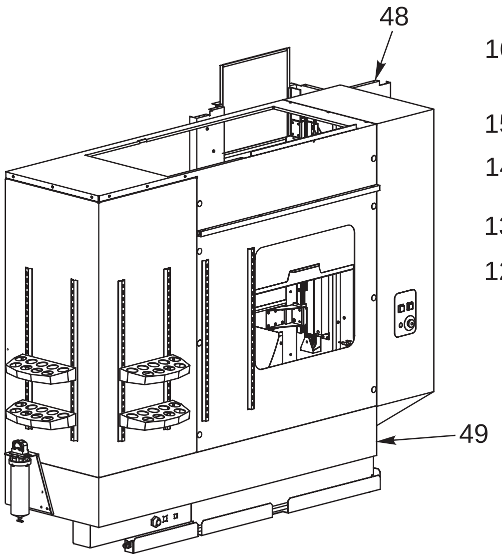
TC Door Assembly (Rotated 180°)

EC-400 Tool Changer Panels

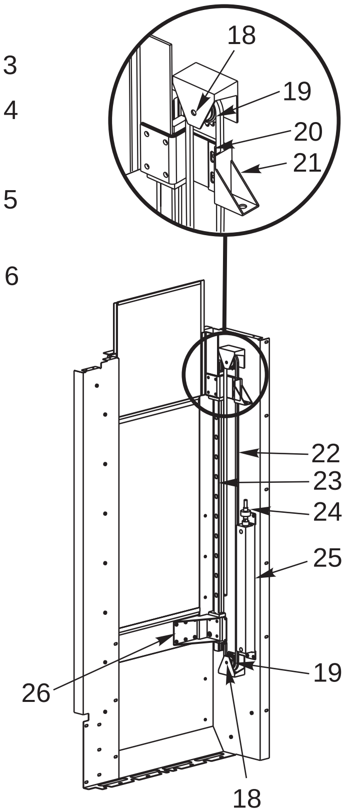
1. 25-4979 Panel Left Intermediate
2. 25-4962 Panel TC
3. 25-4975 Access Cover TC Front
4. 25-5195 Access Cover TC Rear
5. 25-4961 Pan TC
6. 58-0671 Coolant Drain Tube
7. 25-4972 Apron Left Rear
8. 58-1679 Fitting Bulkhead 3/8 x 1
9. 58-1693 (x2) Fitting Elbo 1/2 x 3/8 M Str
10. 25-5247 Apron TC Panel Front
11. 25-4978 Panel TC Rear
12.25-4959 Panel Left Rear
13. 25-4992 Stiffner Bracket Panel
14. 25-4960 Header TC Panel
15. 22-9673 Spacer
16. 30-2464 Idler Assembly
17. 25-0974 Retainer, Chain
18. 25-5032 Connect Bracket Top TC Door
19. 54-0072 Chain
20. 50-0012A Linear Guide
21. 59-0641 Cylinder Rod Aligner
22. 59-0612 Air Cylinder
23. 30-2464 Idler Assembly
24. 22-9673 Spacer
25. 25-5033 Connect Bracket Bottom TC Door
26. 25-4978 Panel TC Rear
27. 25-4992 Stiffner bracket Panel
28. 25-4959 Panel Left Rear
29. 25-5295 Chip Shield TC Felt
30. 25-4976 Coolant TC Drip Pan
31. 25-4961 Pan TC
32. 25-5247 Apron TC Panel
33. 30-6753 Fitting Assembly Apron/Coolant
34. 25-4972 Apron Left Rear
35. 25-4985 Chip Shield TC Panel
36. 25-5283 Chip Shield TC Front
37. 28-0151 Window TC Panel Operator Door
38. 25-5228 Z-frame TC Operator Door Window
39. 25-5030 Door Top
40. 20-2087 Door Guide
    25-5034 Door Guide Spacer
41. 25-5031 Door Button
42. 25-5029 Panel TC Internal

EC-400 60 and 70-Tool Tool Changer Panels

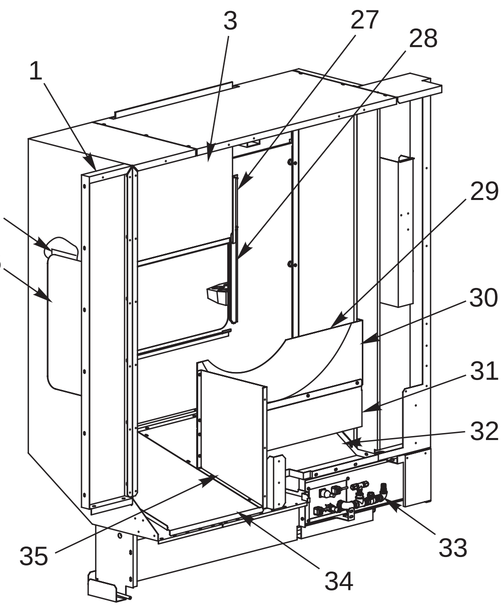


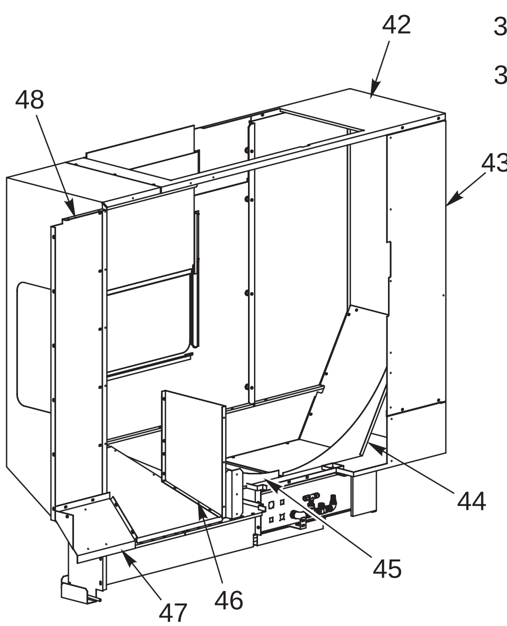


SMTC 60 Pocket Only

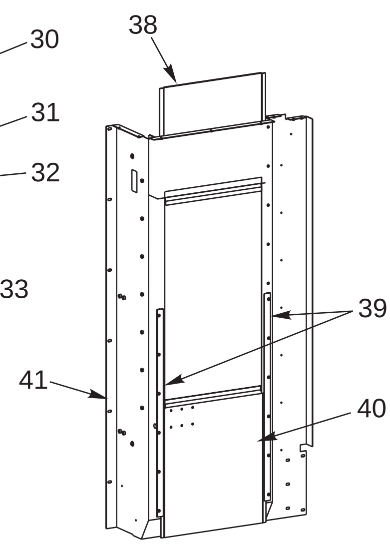


TC Door Assembly





SMTC 60 Pocket Only
(View Rotated 180°)



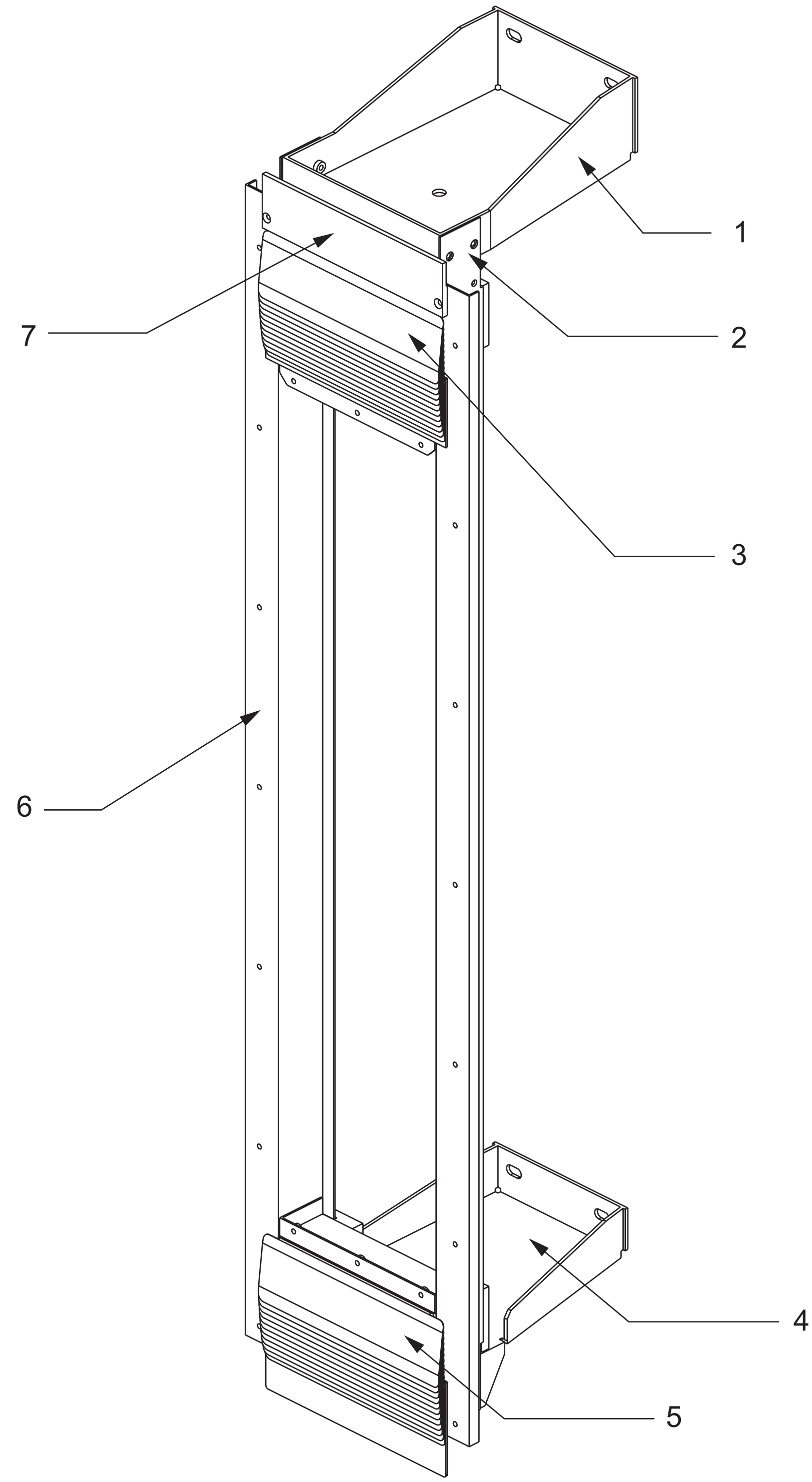
TC Door Assembly
(View Rotated 180°)

EC-400 60 and 70-Tool Tool Changer Panels

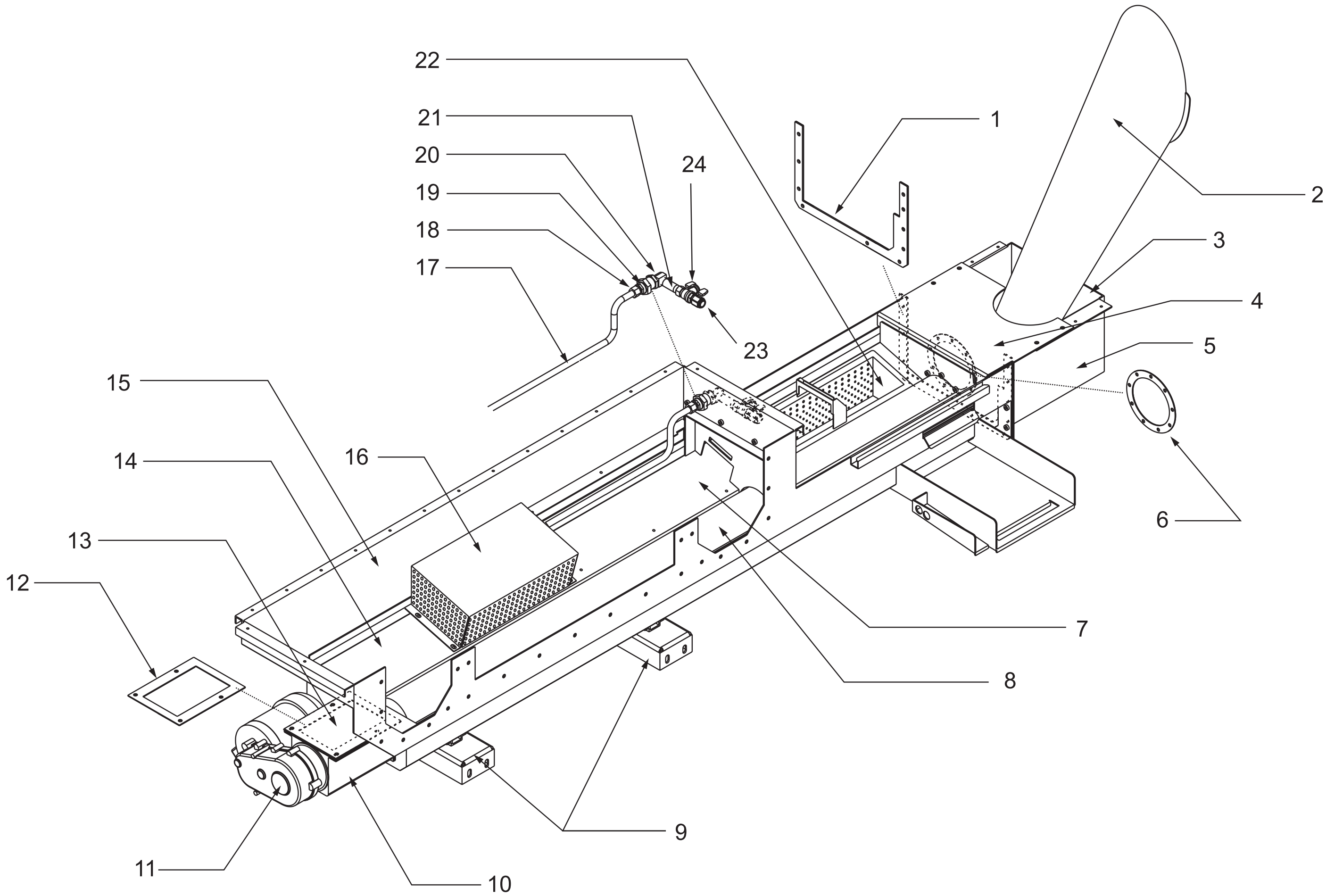
1. 25-4979 Left intermediate panel
2. 25-4962B Tool changer panel
3. 28-0168 TC access window
4. 25-9248 Plate window handle
5. 25-6718A SMTC switch box
   25-6719 SMTC side panel
6. 25-5991A SMTC side panel
7. 25-4961A TC pan
8. 25-4972 Left rear apron
9. 55-0671 Coolant drain tube
10. 25-5247 TC panel rear apron
11. 58-1679 Bulkhead fitting
    58-1693 LBO fitting (2)
12. 52-6042 TSC filter
13. 25-7581B TSC filter bracket
14. 25-4978A TC rear panel
15. 25-0440A Tool tray
16. 25-4959C Left rear panel
17. 25-4960B TC panel header
18. 22-9673 Spacer (2)
19. 30-2464 Idler assembly
20. 25-0974 Chain Retainer
21. 25-5032 TC door top connect bracket
22. 54-0072 Chain
23. 50-0012A Linear guide
24. 59-0641 Cylinder rod aligner
25. 59-0612 Air cylinder
26. 25-5033 TC door bottom connect bracket
27. 25-4221A Opposite window rest (2)
28. 28-0167 TC window extrusion (2)
29. 25-5284A TC left chip shield 24TL
30. 25-5295 TC left chip shield 40TL
31. 25-4976 TC coolant drip pan
32. 25-4961 TC pan
33. 30-6753 Coolant fitting assembly
34. 25-4985 TC panel lower chip shield
35. 25-5283 TC front chip shield
36. 28-0151 window TC panel operator door
37. 25-5228 TC operator door window Z-frame
38. 25-5030 Top door
39. 20-2087 Door guide
    25-5034 Door guide spacer
40. 25-5031 Bottom door
41. 25-5029 TC internal panel
42. 25-5992A SMTC60 top panel
43. 25-5994A SMTC70 rear panel
44. 25-5996A SMTC70 rear chip shield
45. 25-5995 SMTC60 front chip shield
46. 25-5283A TC front chip shield
47. 25-4987 Left lower panel chip shield
48. 25-4986 Left upper panel chip shield
49. 25-5993B SMTC70 bottom pan

EC-400 Y-Axis Frame Assembly

1. 25-5007 Bracket Frame Y-Axis Stop
2. 25-5001 Guide Right Y-Axis
3. 59-0605 Bellows Y-axis Upper
4. 25-5008 Bracket Frame Y-Axis
5. 59-0606 Bellow Y-Axis Lower
6. 20-2319 Plate Filler Y-Axis Frame
7. 25-5000 Guide Left Y-Axis



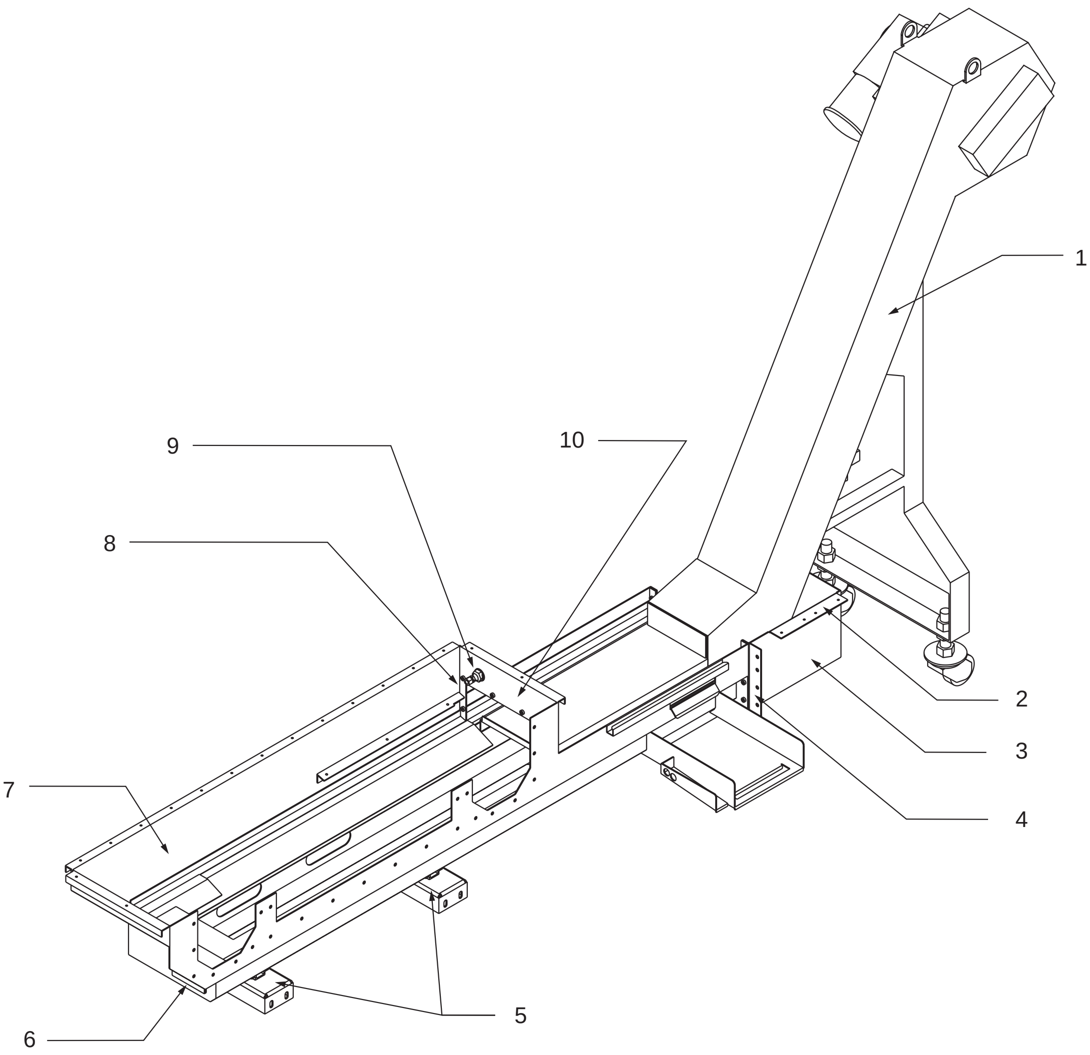
EC-400 Front Trough Assembly (Auger System)



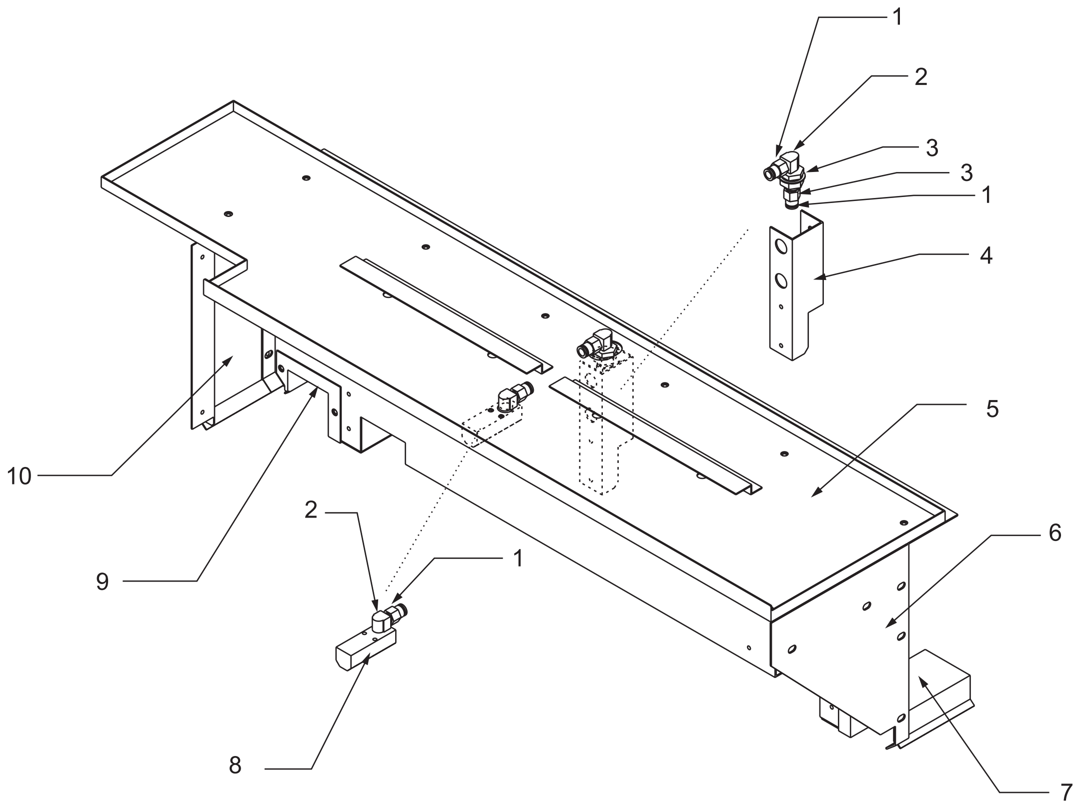
1. 57-0334A Gasket Coolant Trough
2. 25-0548 Chute Discharge
3. 25-5300 End Chute Cover
4. 25-5301 Coolant Trough Extension COver
5. 25-5025 Extension Box Front Trough
6. 57-9846C Gasket Discharge
7. 25-5297A Coolant Channel
8. 20-2039 Auger Front
9. 25-4944 (2X) Brace Auger Trough
10. 25-5289 Extension Box Auger Motor
11. 62-0050 Motor 115V 1/4HP 15 RPM
12. 57-0332 Gasket Extension Box Top
13. 25-5290 Extension Box Top
14. 25-5024A Front Auger Trough
15. 25-5288A Cooalnt Trough
16. 25-5299A Auger Trough Screen
17. 59-0661 Nozzle Assembly Screen Washdown
18. 58-2071 Fitting Comp 1/2 x NPT 1/2M
19. 58-1679 Fitting BKHD NPT 3/8 x 1 Dia
20. 58-1722 Fitting NPT 3/8F x NPT 3/8M 90 Brass
21. 58-3644 Nipple 3/8 NPT x 2 1/2 Brass
22. 25-5291A Chip Basket
23. 58-1693 Fitting LBO 1/2 NPT 3/8M STR
24. 58-1693 Fitting LBO 1/2 NPT 3/8M STR

EC-400 Front Trough Assembly (Chip Conveyor System)

1. 30-6477B Chip Conveyor
2. 25-5309 Extension Cover Chip Conveyor
3. 25-5025A Coolant Trough Extension
4. 57-0334A Gasket Coolant Trough
5. 25-4944 (x2) Brace Auger Trough
6. 25-5292 Motor Access Cover
   57-0333 Gasket Extension Box
7. 25-5288A Coolant Trough
8. 58-0336 Pipe Plug 3/8 Brass
9. 58-1679 Fitting Bulkhead NPT 3/8 x 1
10. 25-5308A Chip Shield Conveyor

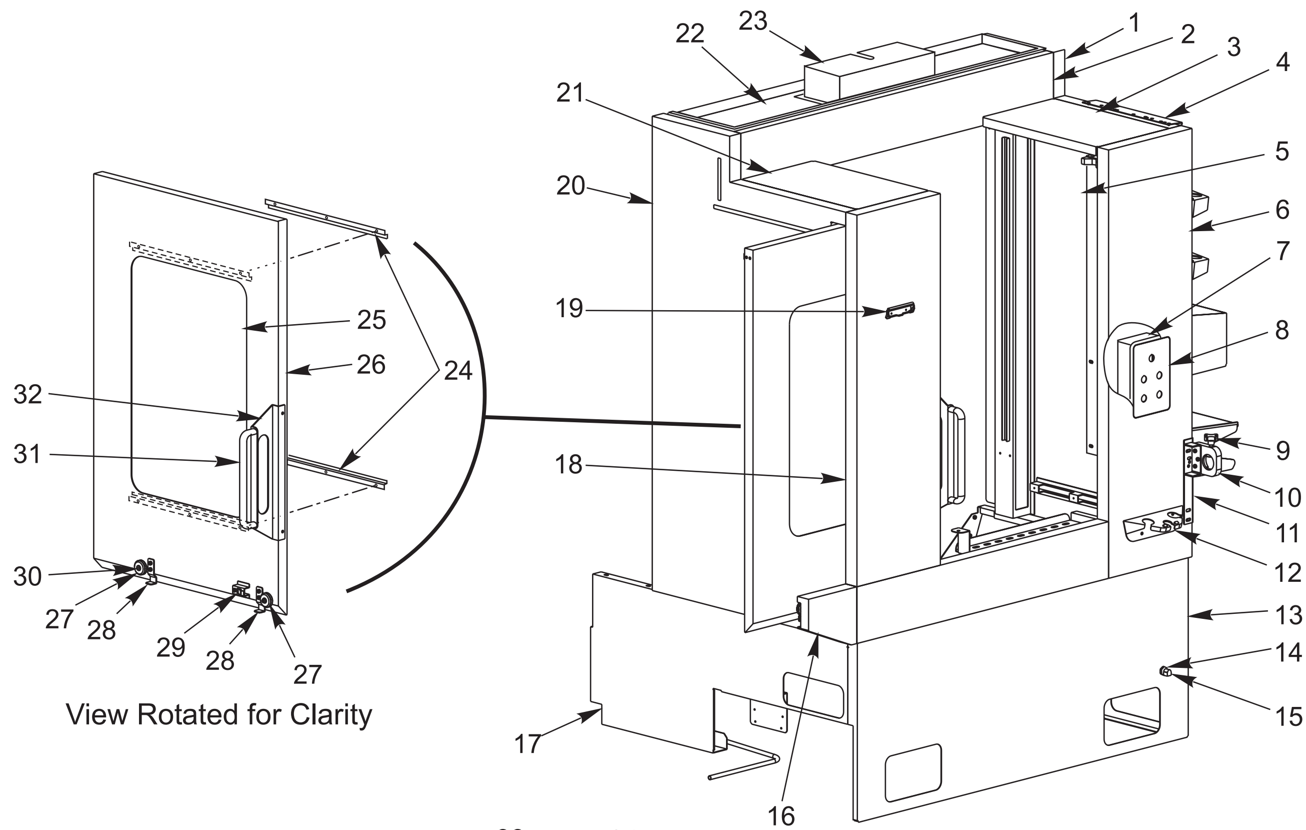


EC-400 Bulkhead

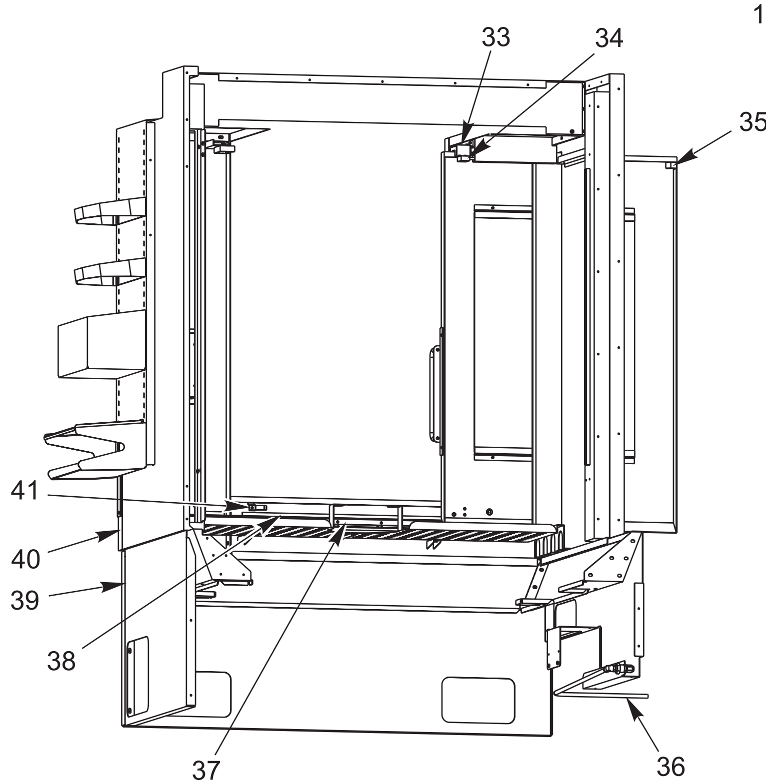


1. 58-3680 (x2) Fitting LBO 3/8 x NPT 1/4 M STR
2. 58-3618 Fiting NPT 1/4F x NPT 1/4M 90 Brass
3. 58-1677 Fitting BKHD NPT 1/4 x .750 Dia
4. 25-5009 Brkt Base Cover
5. 25-5006 Shield Bottom X-A0xis
6. 25-5003 Base Cover
7. 25-5004 Cover Trough Right
8. 20-6413A Manifold Washdown
9. 25-5005 Cover Trough Left
10. 25-5010 Shield Base Cover Left

EC-400 Front Assembly



View Rotated for Clarity

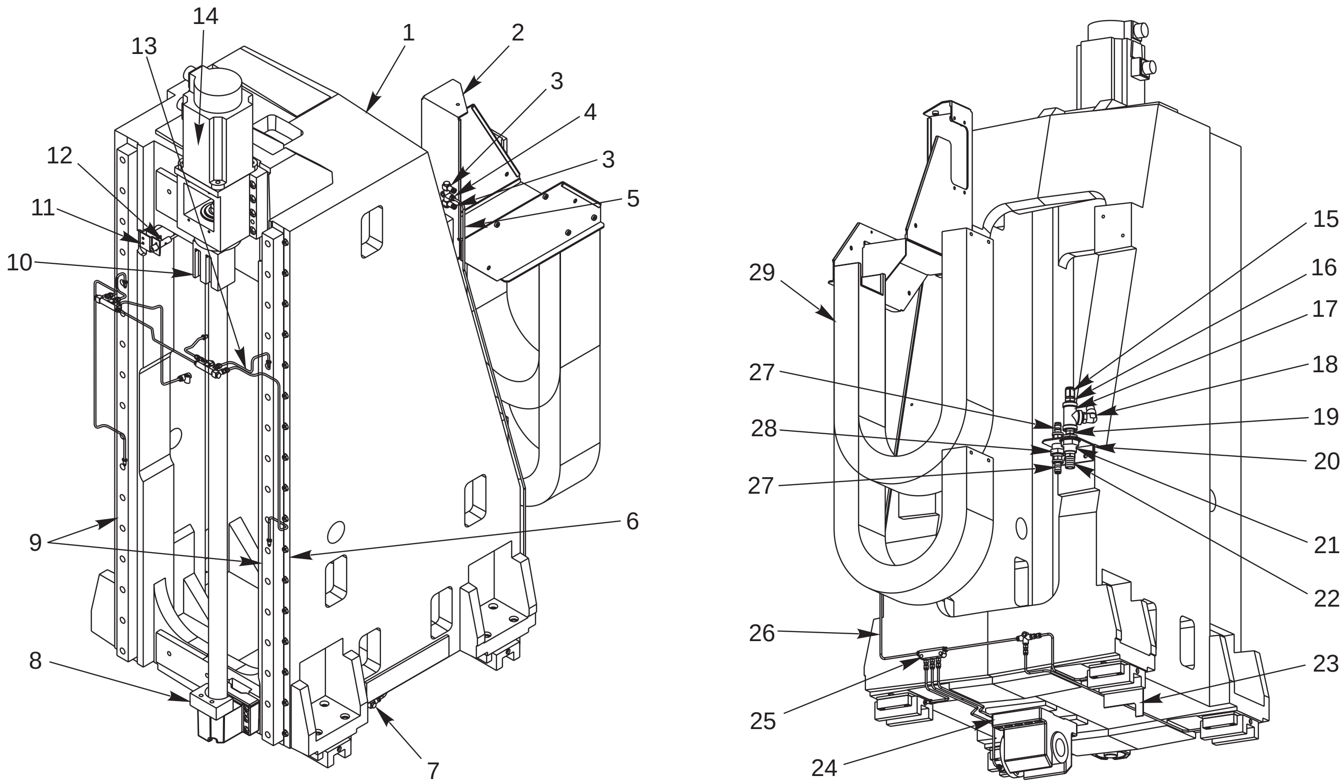


Back View (Looking Up)

EC-400 Front Assembly

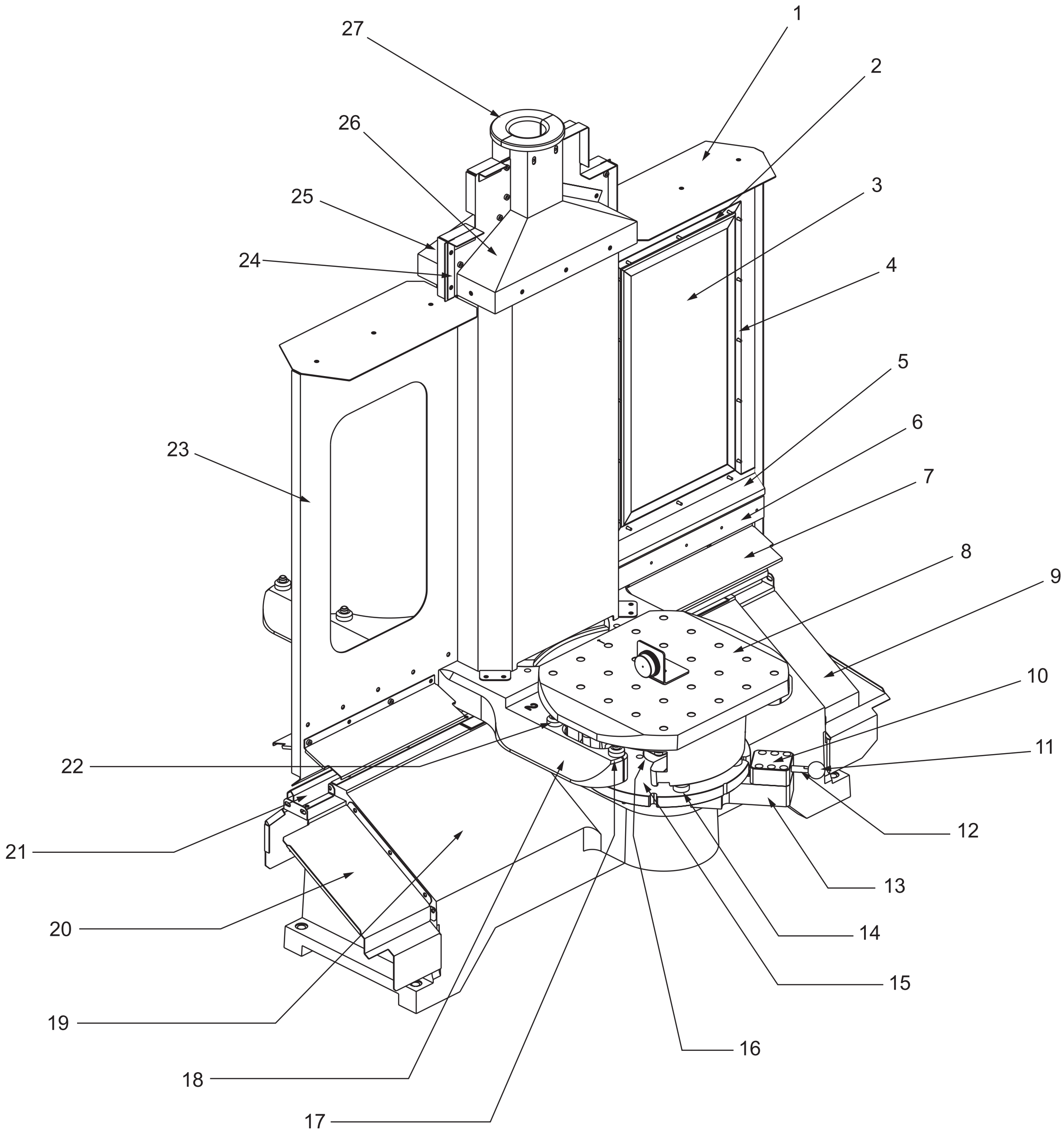
1. 25-4948 Panel Side Top Right
2. 25-4999A Header Enclosure
3. 25-4951A Stiffener Bracket
4. 25-4413 Rack Tool Tray
5. 25-4948 Panel Side Top Right
6. 25-4946A Panel Front Right
7. 25-1258 Cover Switch Box
8. 25-1257A Panel Front Switch Box
9. 59-0278 Knob and Screw
10. 20-1341 Tool Hodler Block
11. 20-0798 Bracket Tool Holder
12. 25-5412 Nozzle Holder Backet
13. 25-4946 Panel Front Right
14. 58-1677 Fitg bkhd NPT 1/4 x .750 dia
15. 58-3618 Fitg NPT 1/4F x NPT 1/4M 90 Brass
16. 25-4950B Pan Front Upper
17. 25-4971 Apron Left Front
18. 25-4947A Panel Front Left
19. 59-0123 Wire Clip
20. 25-4949A Panel Side Left Top
21. 25-5420 Stiffner brkt panel left
22. 25-4952 Top Cover Front
23. 25-4953 J-Box Top Cover
24. 25-5260 Z-Frame Front Door Window
25. 28-0152 Window Door Front
26. 25-4997A Door Front
27. 54-0030 Guide Wheel
28. 25-5402 Door Hook
29. 25-4043 Latch Spring
30. 20-0259 (4X) Bottom Door Spacer
31. 59-6210 Handle Door
32. 25-1292 Mount Door Handle
33. 25-5415 Door Guide Bracket
34. 32-5074A Front Door Clse Switch
35. 25-5416 Door Switch Dog
36. 58-0670A Coolant Drain Tube
37. 20-6016 Rail Spacer
38. 20-1433 V-Track Door
39. 25-4970 Apron Right Front
40. 25-4948 Panel Side Right Top
41. 25-4043 Latch Spring

EC-400 Column Assembly



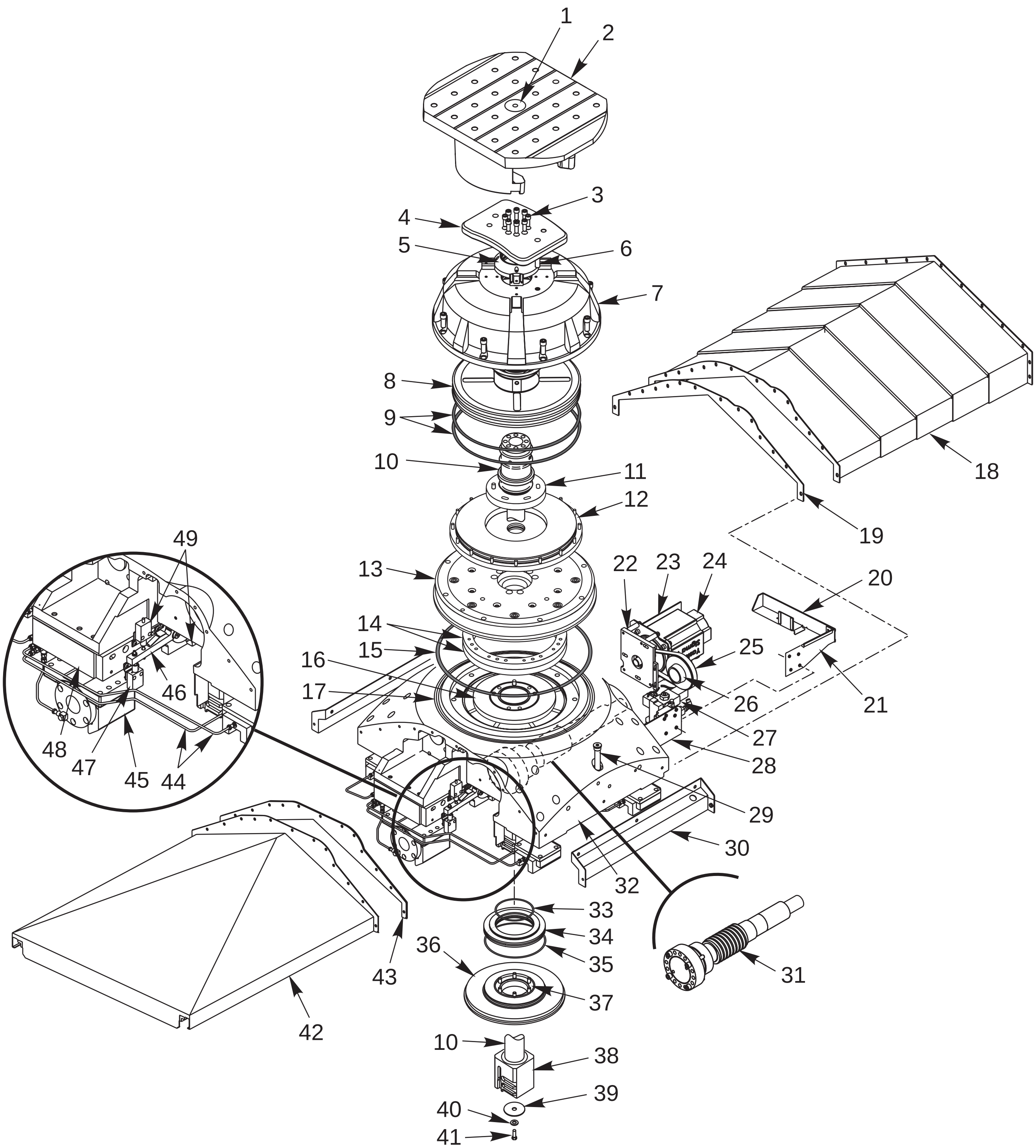
1. 20-2043 Column Machined
2. 25-4996 BRKT Carrier Column
3. 58-3045 Lube Fitg Adaptor
4. 58-3045 Lube Fitg Adaptor
5. 58-0634 Copper Tubing Column
6. 22-7458 Cam Linear Guide
7. 58-3031 Lube Fitg Adaptor
8. 20-0166 Bumper
9. 50-3400 Linear Guide
10. 20-2058 Hardstop Y-axis
11. 25-7267 Mounting Bracket
12. 32-2131 Home Switch
13. 30-6338A Lube Line Assy.
14. 62-0017 Servomotor YASK 13
15. 58-1693 Fitg LBO
16. 58-3625 Fitg Reducer
17. 58-3650 Fitg
18. 58-0097 Fitg LBO
19. 58-0287 Hex Nipple
20. 25-5294 Bracket TRP
21. 58-1680 Fitg Bkhd
22. 58-2066 Fitg Hose Barb
23. 25-4937 Trip Bracket X-Axis
24. 20-0150 Nut Housing
25. 30-6337 Oil Line Assembly X-Axis
26. 58-0634 Copper Tubing Column
27. 58-0029 Fitg Hose Barb
28. 58-1679 Fitg Bkhd
29. 59-0640 Cable Carrier Y-Axis

EC-400 Pallet Changer Assembly



1. 25-5238B Shade Rotating Door Top
2. 25-4149 Z-Frame Window SMTC
3. 28-0043A Window Partition
4. 25-1262A (2X) Z-Frame Partition Top
5. 25-5233A (2X) Z Channel Rotating Door
6. 20-2283A (2X) Support Bar Rotating Door
7. 25-5237 (4X) Shade Rotating Door Seal
8. 20-2048 Pallet
9. 25-5229 Chip Shield Bridge Right
10. 20-2254 Load Station Lock Housing
11. 59-6225 Knob
12. 20-2255 Load Station Lock Pin
13. 20-2253 Load Station Lock Mount
14. 20-2249 Load Station Pallet Pin
15. 20-2256 Load Station Index Disc
16. 20-2258 Load Station Shaft
17. 20-2257 Load Station Lock Plate
18. 20-2115 H-Frame APC
19. 20-2046 Bridge Machined
20. 25-5230 Chip Shield Bridge Left
21. 25-5235 Step Right Rotating Door Seal
22. 20-2154 Actuator Mount Block
23. 25-5232B (2X) Panel Rotating Door
24. 25-5239A Retainer Seal Rotating Door
25. 57-0330 (2X) Seal Rotating Door Cover
26. 25-5234B Rotating Door Cover
27. 20-2284B (2X) Cable Rotating Door

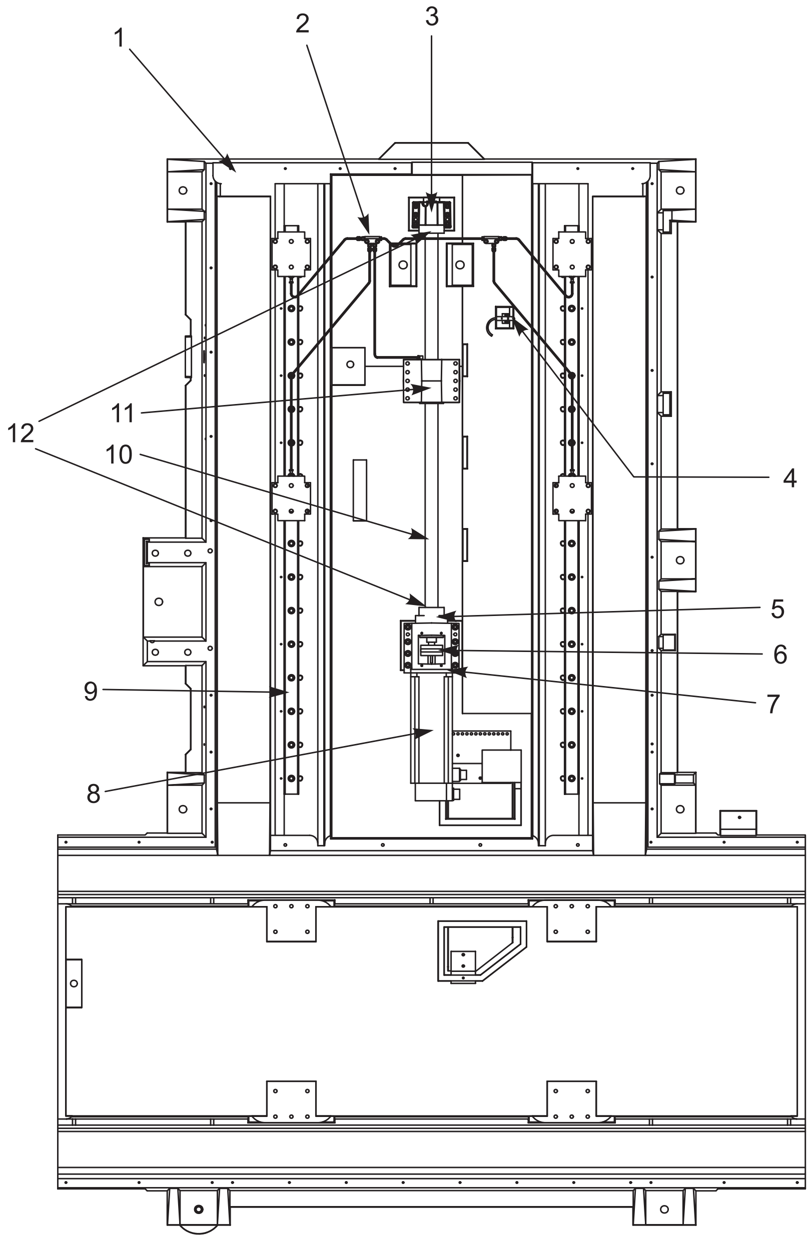
EC-400 Receiver Assembly



EC-400 Receiver Assembly

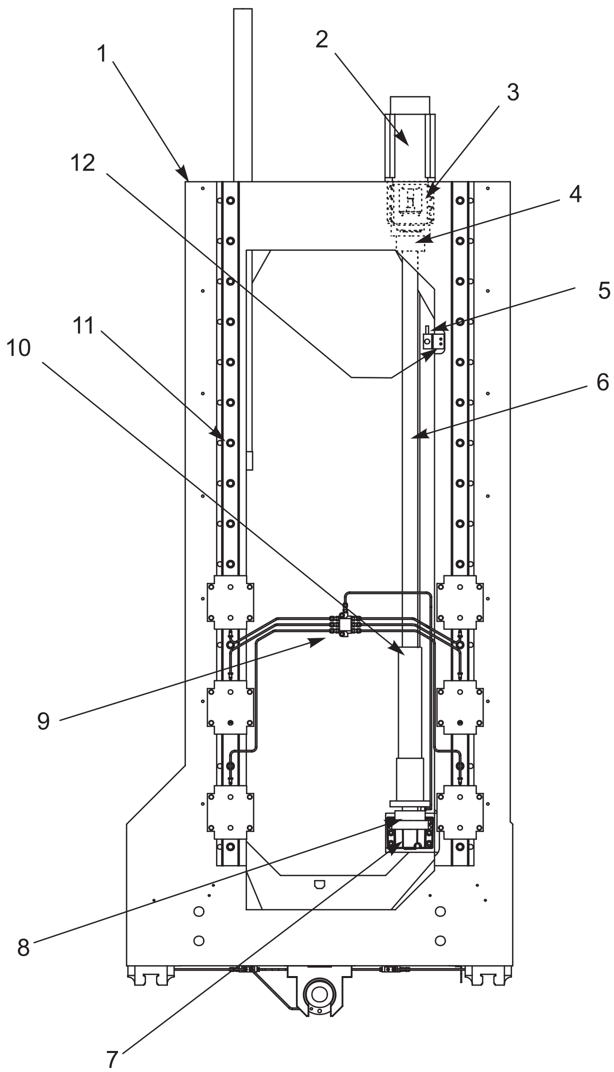
1. 20-1123A Pallet plug
   2-135 parker O-ring
2. 20-2048A Pallet machined
3. 40-1639 SHCS 3/8-16x1 (8)
4. 20-1995 Receiver clamp plate
5. 30-6551 Air blast assembly
6. 48-1667 Dowel pin 1/2x3 ½ (2)
7. 20-2041 Receiver body machined
   57-0328 O-ring 2-339 viton (2)
   25-5252 Receiver wear surface (2)
   57-0337 V-ring seal
   40-16575 SHCS (8)
8. 20-1994 Receiver piston
   25-5250 Piston wear surface
9. 57-0329 O-ring (2)
10. 20-1996A Receiver shaft
   57-0328 O-ring (3)
   57-5148 O-ring
11. 20-1997 Receiver nut
12. 20-1999A Receiver seal plate
   40-1500 SHCS (16)
13. 20-2022A Rotary table platter
   43-1600 SHCS (8)
   45-0114 Washer (8)
   40-1646 SHCS (8)
   45-0038 Washer (8)
14. 2-4285 Face Gear (2)
15. 57-0337 O-ring
16. 35-4284A Spindle gear assy
   48-0035 Dowel pin 3/8 x ¾
   57-2121 O-ring 2-161
17. 57-0337 O-ring
18. 25-5011 Right tele Z-axis way cover
19. 57-0326 Right tele way cover gasket
20. 25-6305 Z-axis Cable tray
21. 25-6304 Cable tray bracket
22. 20-2071 Rotary motor mounting plate
23. 25-5018A Receiver solenoid mount
24. 62-0016 Servo motor
25. 54-4505 Drive belt PGGT 5Mx15
26. 20-4506 Driven pulley 310-64T
   20-4229 Driven pulley lockring
27. 30-6774A Rotary index solenoid assy
28. 25-5027 Z-axis cable carrier bracket
29. 20-1991 Z-axis shipping pin
30. 25-4968 Rotary table side chip shield
31. 35-4210 Worm shaft assembly
32. 20-2045B Rotary table index machined
33. 57-4282 O-ring 2-248
34. 20-4286 Lift piston
   51-4285 Thrust washer (2)
   51-4286 Thrust bearing
35. 57-0139 O-ring 2-263
36. 20-4213 Disc brake
   57-2144 O-ring 2-256
   57-4288 Thrust bearing
37. 20-4236 Spindle spacer
   40-1636 SHCS (6)
38. 20-1998A Receiver rotary union
39. 20-2344 Rotary union lower washer
40. 45-0075 Steel washer 5/16
41. 43-0023 HHB 5/16-18x1 ½ pltd
42. 25-5231 Front way cover Z-axis
43. 57-0327 Fixed way cover gasket
44. 30-6336 oil line assy Z-axis
45. 20-0150 Ballnut housing machined
46. 20-2330B Rotary axis switch arm
47. 20-2473 Bar-spring mount assy
48. 20-2023A Ballnut spacer Z-axis
49. 69-1700 Proximity switch (2)

EC-1600 Base Assembly



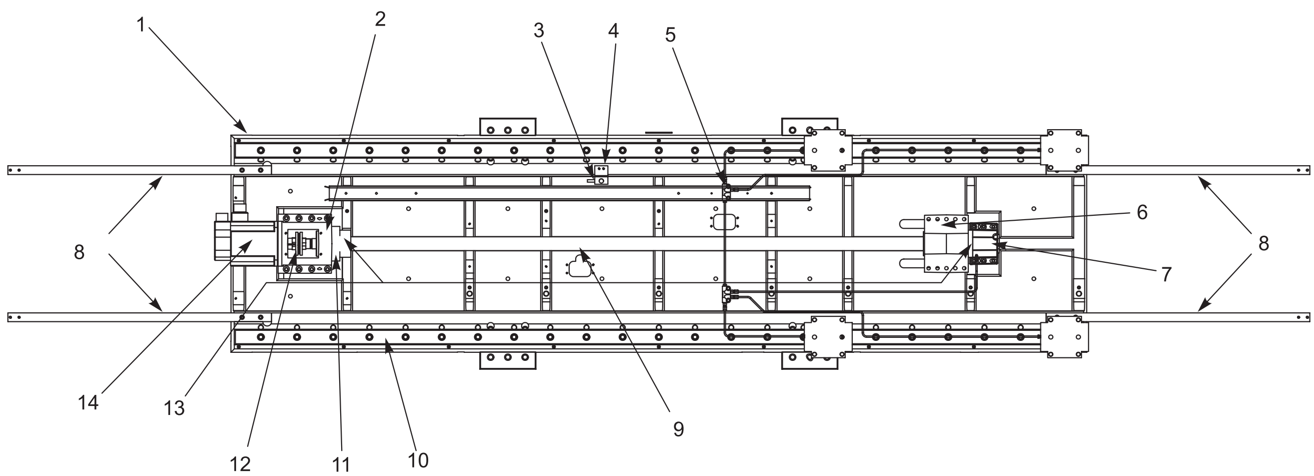
1. 20-2509 Casting
2. 30-6953 Lube Line Assy
3. 30-0472 Bearing Assy
4. 32-2133 Limit Switch
5. 30-1222 Bearing Assy
6. 30-3988 Coupling
7. 20-0151 Motor Mount Assy
8. 62-0008 Motor
9. 50-9010 Linear Guides
10. 24-9960a Ballscrew Assy
11. 20-0150 Nut Housing
12. 20-0156 Bumper

EC-1600 Column Assembly



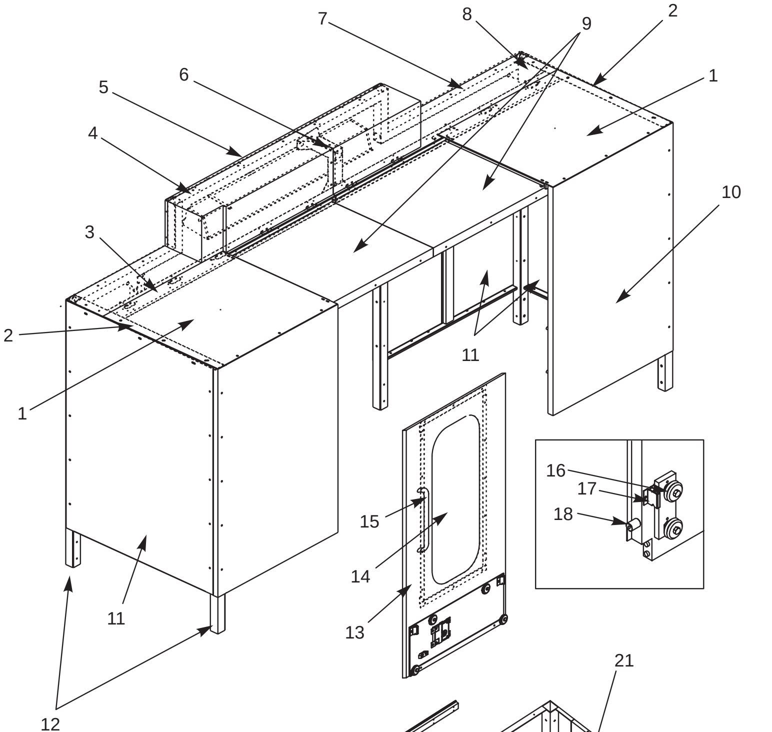
1. 20-2506 Casting
2. 62-0017 Motor
3. 30-1517 Coupling
4. 30-0764 Bearing
5. 32-2131 Limit Switch
6. 24-0003a Ballscrew
7. 30-0472 Bearing Assy
8. 20-0156 Bumper
9. 30-6954 Lube Line Assy
10. 20-2677 Bumper
11. 50-9010 Linear Guides
12. 25-7267 Switch Brkt

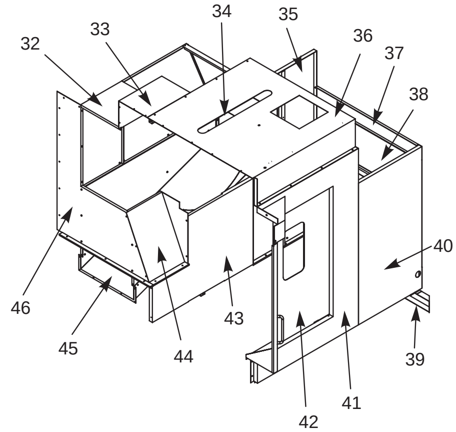
EC-1600 Saddle Assembly

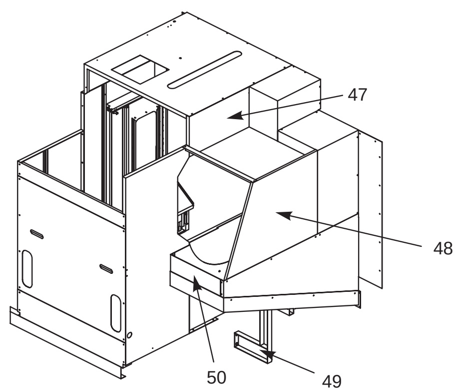


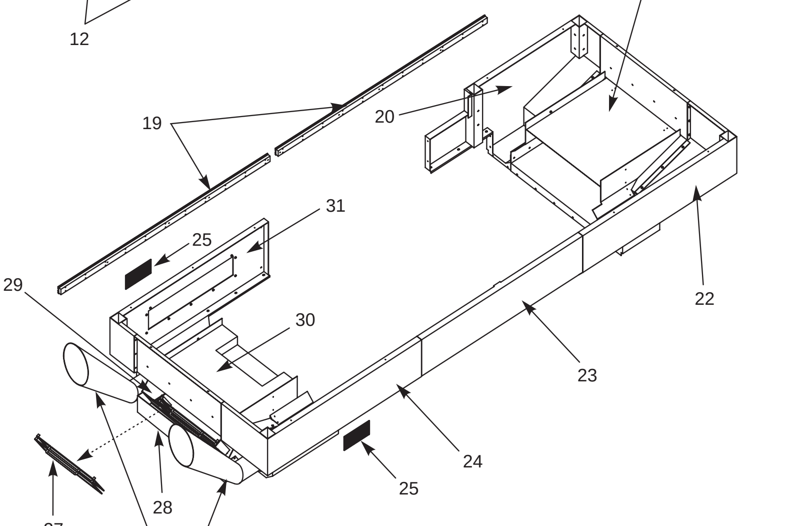
1. 20-2536 Casting
2. 20-0151 Motor Mount Assy
3. 32-2133 Limit Switch
4. 25-7267 Switch Brkt
5. 30-7410 Lube Line Assy
6. 20-0150 Nut Housing
7. 20-0152 Bearing Housing
8. 20-9822 Guide Bar
9. 24-9961c Ballscrew
10. 50-9806 Linear Guides
11. 30-1222 Bearing Assy
12. 30-1215 Coupling Assy
13. 20-0166 Bumper
14. 62-0016 Motor

EC-1600 Enclosure Assembly



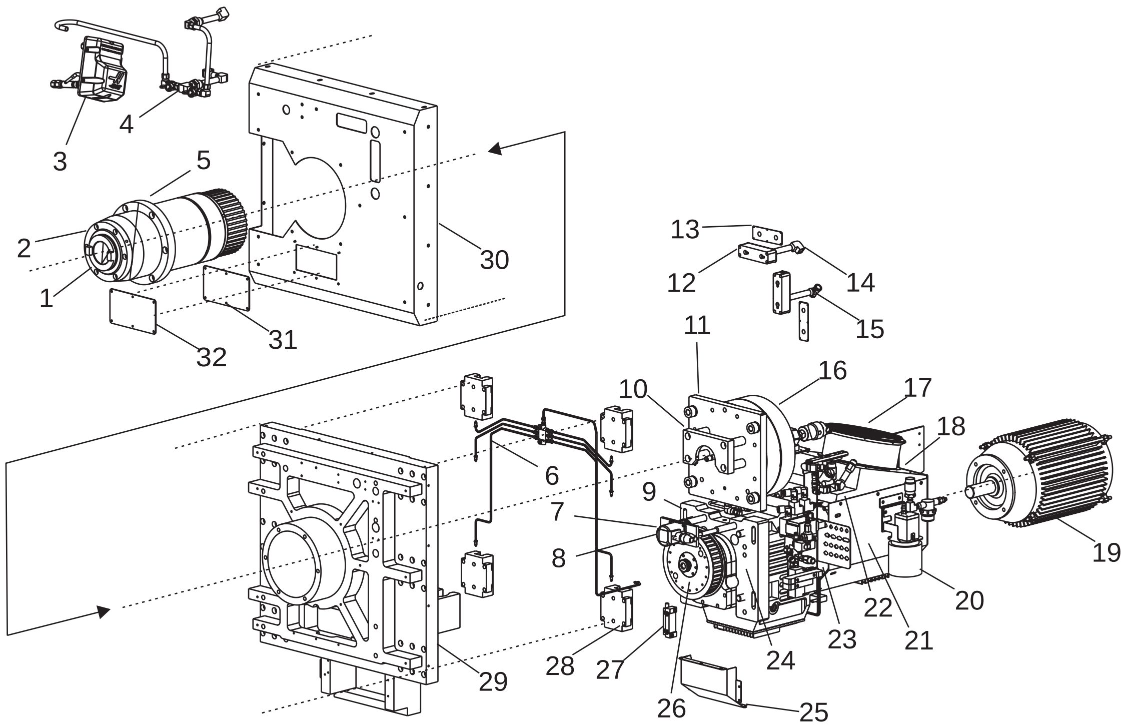






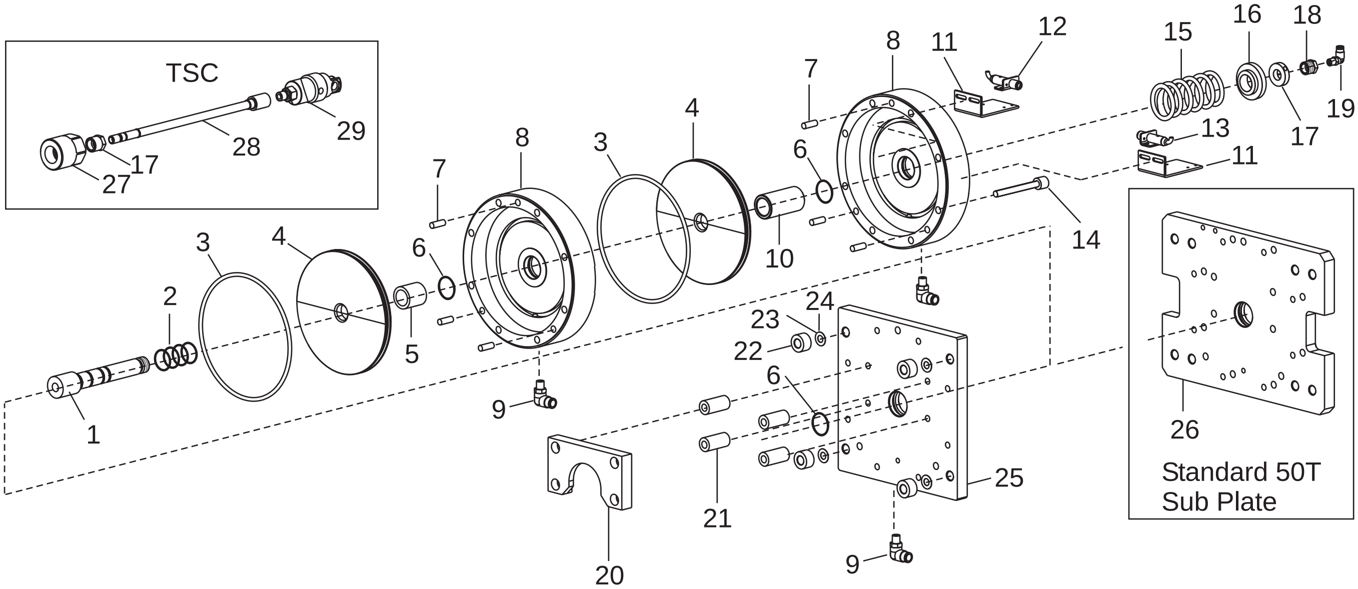
1. 25-5615 Panel Encl Top
2. 25-5621 Post Encl Top Cross
3. 25-5622 Track Encl Door Roll
4. 25-5623 Post Encl LT Top
5. 25-5625 Cover Encl Top LT
6. 25-5627 Cover Encl Top RT
7. 25-5624 Post Encl RT Top
8. 25-5629 Header Support
9. 25-5618 Panel Encl Top Door
10. 25-5614 Panel Encl Top
11. 25-5616 Panel Encl Side
12. 25-5617 Main Post Encl
13. 25-5619 Front Door
14. 28-0020 Window
15. 59-6210 Door Handle
16. 54-0030 Guide Wheel
17. 25-5653 Retainer
18. 20-2579 Stand-off Bumper
19. 20-2573 Track, Front Door
20. 25-5608 Saddle Back RT
21. 25-5638 Saddle End Cover
22. 25-5610 Saddle Front RT
23. 25-5611 Saddle Front Mid
24. 25-5612 Saddle Front LT
25. 25-5643 Silt Plate
26. 25-5640 Trough Drain
27. 25-0548 Discharge Chute
28. 19-8612 Screen, Chip Tray
29. 25-5639 Plenum Drain
30. 25-5609 Saddle End Cover LT
31. 25-5613 Saddle Back LT
32. 25-5597B Panel Encl
33. 25-5596B Panel Encl
34. 25-5585B Dip Pan T/C
35. 25-5601C Panel Encl L R
36. 25-5594B Panel Encl Top
37. 25-5588B Panel Encl R Upper
38. 25-5587C Panel Encl Rear Mid
39. 25-5590 Panel Cbl Encl
40. 25-5592B Panel Encl RT Rear
41. 25-5593A Panel Encl RT Side
42. 25-5591A Door, Operator
43. 25-5600B Panel Encl Left Side
44. 25-5599B Panel Encl LT Side F
45. 25-5582B Drip Pan T/C Bottom
46. 25-5598B Panel Encl R L
47. 25-5595B Panel Encl T/C Fillet
48. 25-5642B Panel T/C Back
49. 25-5586B Support, T/C D Pan
50 25-5581B Retainer

EC-1600 Spindle Assembly



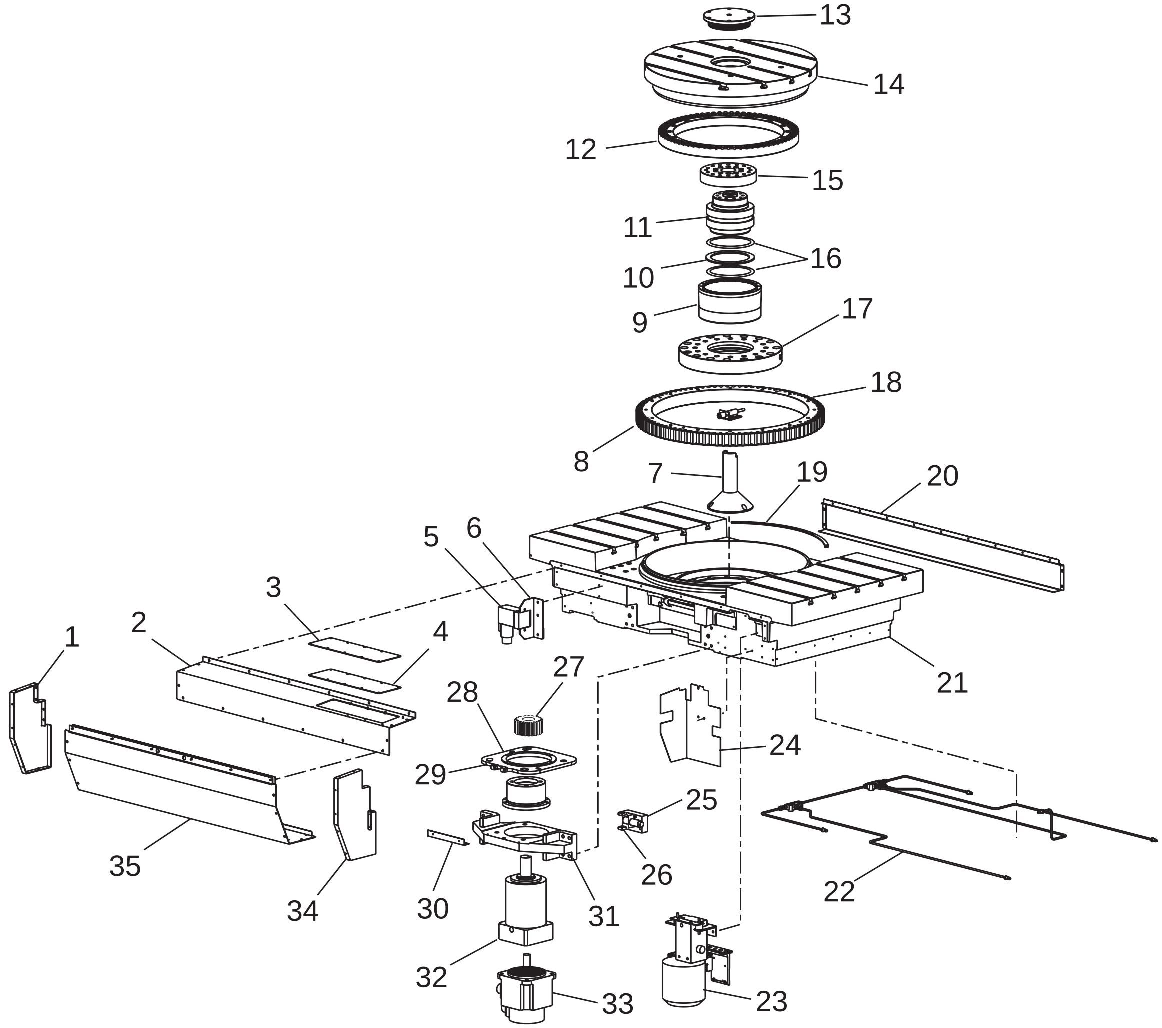
1. 20-0011A 50T Shaft Spindle
2. 20-0001A Spindle Lock
3. 30-7395 EC-1600 P Cool
4. 30-7394 Plumbing Assembly
5. 20-0004 50T spindle Housing
6. 30-6954 Lube Line Assembly-Y Axis
7. 32-1457 Encoder
8. 60-1813 Encoder M23 Short
9. 20-2965B Standoff Rod
10. 20-0726 Transmission Subplate
11. 20-0017 Air Cylinder Subplate
12. 20-6097 Coolant Manifold
13. 25-6096 Manifold Cover
14. 58-3062 3/8 NPT Elbow
15. 58-1725 3/8 NPT Tee
16. 30-0013 TRP Assembly
17. 59-0144 Fan Guard
18. 25-5649 Fan Mounting Shroud
19. 62-4010 20HP Spindle Motor
20. 30-3260C Gear Oil Pump Assembly
21. 25-5647 Spindle Motor Shroud
22. 30-7255 Check Value Assembly
23. 30-7280 TRP/TSC Solenoid Assembly
24. 20-2549 Trans Plate
25. 25-6292 Spindle Sound Shield
26. 20-1455 50T Pully
27. 20-2962 Read Head Mount
28. 50-9010 Linear Guide
29. 20-2507 Spindle Head
30. 57-0372 Head Cover
31. 57-0372 Encoder Cover Gasket
32. 25-5565 Encoder Cover

EC-1600 Tool Release Piston



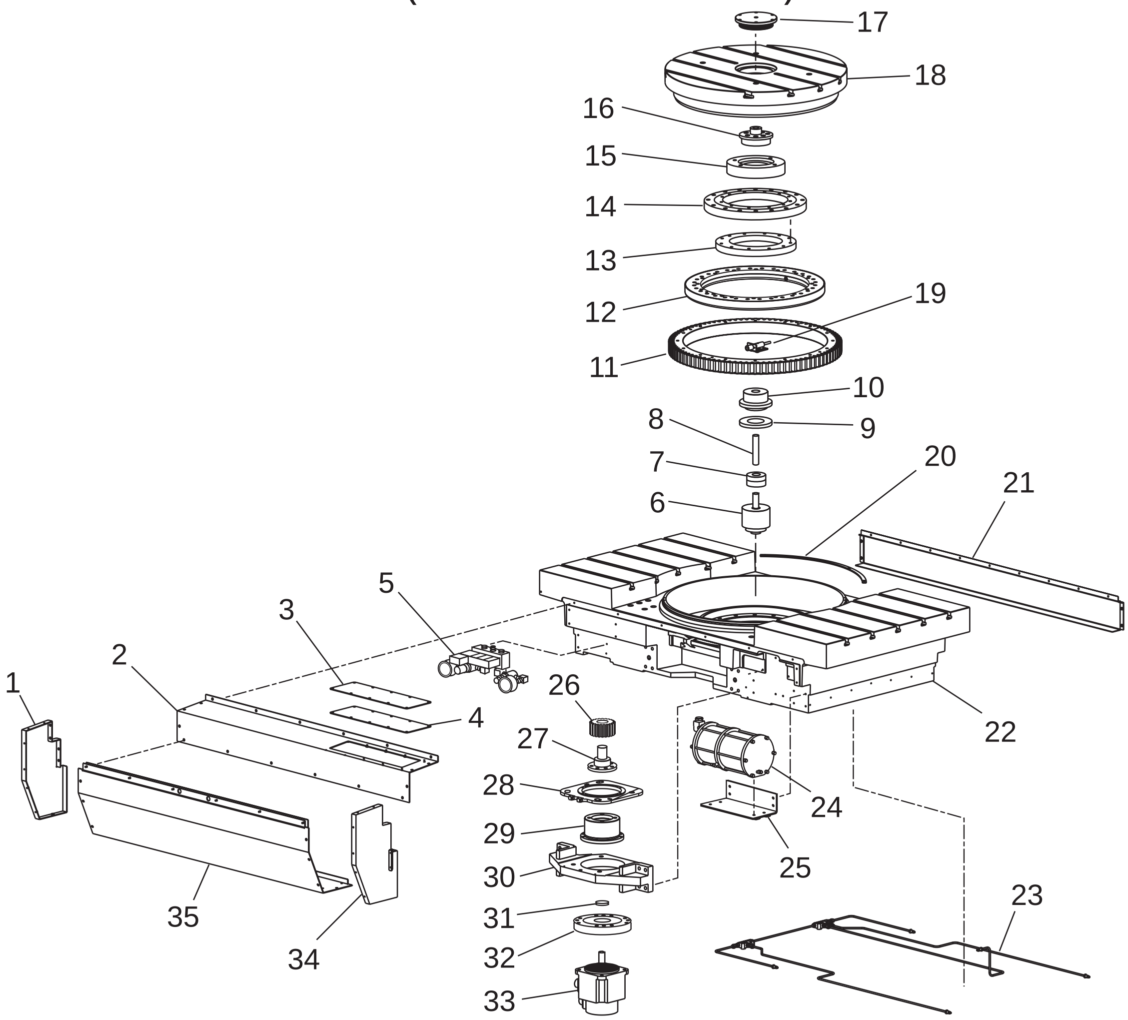
1. 20-0018 Air Cyl. Shaft
2. 57-0027 O Ring 2-121 (4X)
3. 57-0082 O Ring 2-448 (2X)
4. 20-0019 Air Cyl. Piston (2X)
5. 20-0020 Lower Air Cyl. Spacer
6. 57-0095 O Ring 2-327 (3X)
7. 48-1662 Dowel Pin (6X)
8. 20-0022 Air Cyl. Housing
9. 58-1695 90 Degree Elbow (3X)
10. 20-0021 Upper Air Cyl. Spacer
11. 25-0009 Switch Bracket (2X)
12. 32-2204 Clamp Prox Switch
13. 32-2203 Unclamp Prox Switch
14. 40-0006 SHCS ½-13x5 (8X)
15. 59-0049 Compression Spring
16. 20-1657 Spring Retainer
17. 52-0003 Shaft Clamp
18. 58-3631 Reducer
19. 58-3050 90 Elbow
20. 20-0015 Spindle Fork Lift
21. 20-0013 Spindle Fork Spacer (4X)
22. 20-0014 (22-0014) Spacer (4X)
23. 45-0014 Washer .010
24. 45-0015 Washer .018
25. 20-0017 Sub Plate (EC-1600)
26. 20-2988 Sub Plate
27. 20-7655 Bearing Holder
28. 20-7654 Extension Tube
29. 52-6200 Rotating Union

EC-1600 Table Assembly (5° Indexer)



1. 25-5541 Left Shroud
2. 25-5542 Top Shroud
3. 25-5544 Pump Cover Access
4. 57-0373 Pump Cover Gasket
5. 32-6929 Hydraulic Solenoid
6. 25-5546 Hydraulic Valve Bracket
7. 20-2528 Zero Ref. Sensor Mount
8. 20-6103 Ring Gear
9. 20-2523 Hydraulic Clamp Cylinder Housing
10. 51-0162 160mm Thrust Bearing
11. 20-2524 Hydraulic Clamp Piston
12. 20-2529 Face Gear
13. 20-0973 Table Cover Center
14. 20-2980 Indexing Platter
15. 20-2530 Piston Adapeter
16. 51-0168 Thrust Washer 160200 (2)
17. 20-2522 Hydraulic Clamp Cylinder Cap
18. 69-1700 Prox Sensor
19. 25-5538 Retainer Platter Seal
20. 25-9817 X-Axis Chip Guard
21. 20-2508 Table
22. 30-7410 Saddle Oil Line
23. 30-7510 Haskel Pump
24. 25-55545 Pump Sound Wall
25. 69-1700 Prox Sensor
26. 20-2532 Sensor Bracket
27. 20-2527 Pinion 22T Indexer
28. 20-1400 Backlash Plate
29. 20-2526 Indexer Mount
30. 25-5539 Shroud Support
31. 20-2531 Platter Drive Mount
32. 59-0695 Alpha Ip 120
33. 62-0024 Servo Motor
34. 25-5540 Right Shroud
35. 25-5543 Bottom Shroud

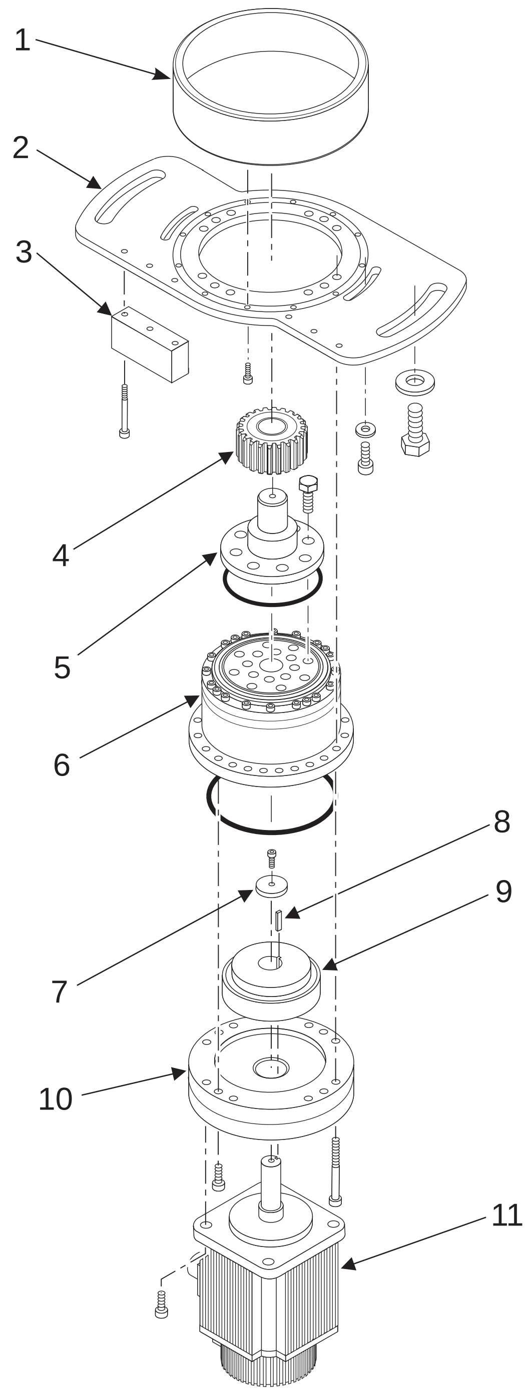
EC-1600 Table Assembly
(Full-Fouth Indexer)



1. 25-5541 Left Shroud
2. 25-5542 Top Shroud
3. 25-5544 Pump Cover Access
4. 57-0373 Pump Cover Gasket
5. 30-7398A Hydraulic Solenoid Assembly
6. 32-1459 Encoder Assembly
7. 52-4471 Coupling
8. 20-6115 Encoder Shaft
9. 20-6114B Encoder Mounting Plate
10. 20-6027 Coupling Tube
11. 20-6103 Ring Gear
12. 30-7754 Hydraulic Brake Assembly
13. 20-6113 Bearing Retainer Ring
14. 51-2038 Cross Roller Bearing
15. 20-2534 Encoder Shaft Plate Adaptor
16. 20-6116 Encoder Shaft Plate
17 20-0973 Table Cover Center
18. 20-2510A 4th Axis Platter Machined
19. 69-1700 Prox Sensor
20. 25-5538 Retainer Platter Seal
21. 25-9817 X-Axis Chip Guard
22. 20-2508 Table
23. 30-7410 Saddle Oil Line
24. 30-7881 Brake Booster Assembly (with Sensor)
    - 59-0216 Booster
    - 58-2267 Muffler
    - 58-0051 Connector
    - 58-1696 Elbow
    - 58-0315 “T”
    - 52-0014 Pressure Guage
    - 58-3658 Elbow (2x)
    - 58-1671 Nipple
    - 59-0047 Quick Exhaust Valve
25. 25-5547 Booster Mounting Bracket
26. 20-6102 Pinion Gear
27. 20-6100 Cooling Jacket Inlet Plate
28. 20-1400 Backlash Plate
29. 59-2930 Harmonic Drive (50:1)
30. 20-2531 Platter Drive Mount
31. 20-6110 Motor Shaft Spacer
32. 20-6109 Motor Adaptor
33. 62-0014 Motor

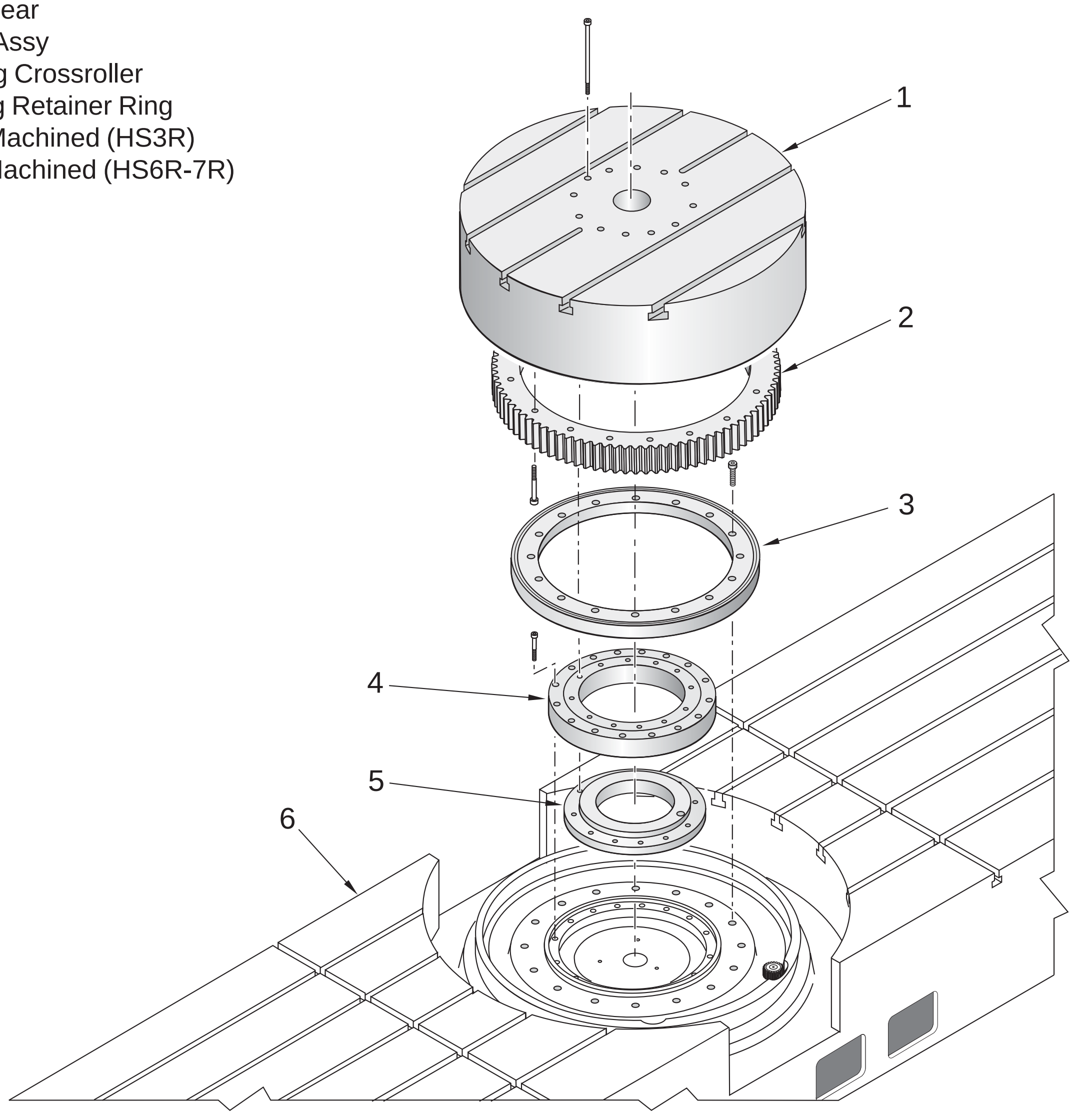
HS3-7R Harmonic Drive Assembly

1. 20-6047 Tube Backlash Adjuster (HS3R)
2. 20-6048 Cam Backlash Adjuster (HS3R)
3. 20-6005 Push Block (HS3R)
4. 20-6102 Pinion Gear (HS3R)
5. 20-6109 Sigma Adapter (HS3R)
6. 59-2930 Harmonic Drive
7. 20-6112 Shoulder Washer (HS3R)
8 22-2627 Yasakawa Motor Key
9. 59-2930 Harmonic Drive Assy
10. 20-6108 Gearbox Adapter (HS3R)
11. 62-0014 Yaskawa Sigma Motor

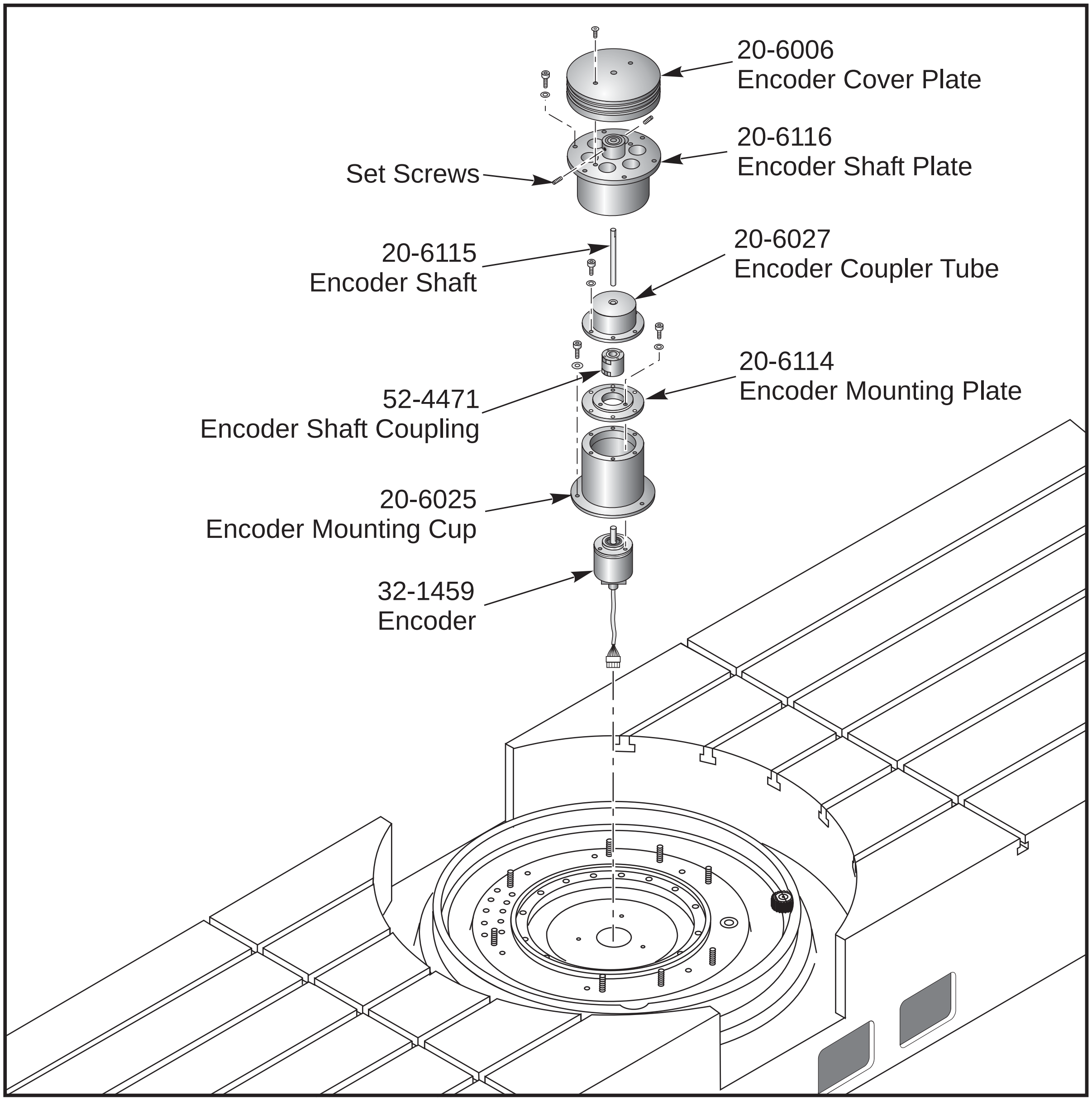


HS3-7R Table Assembly

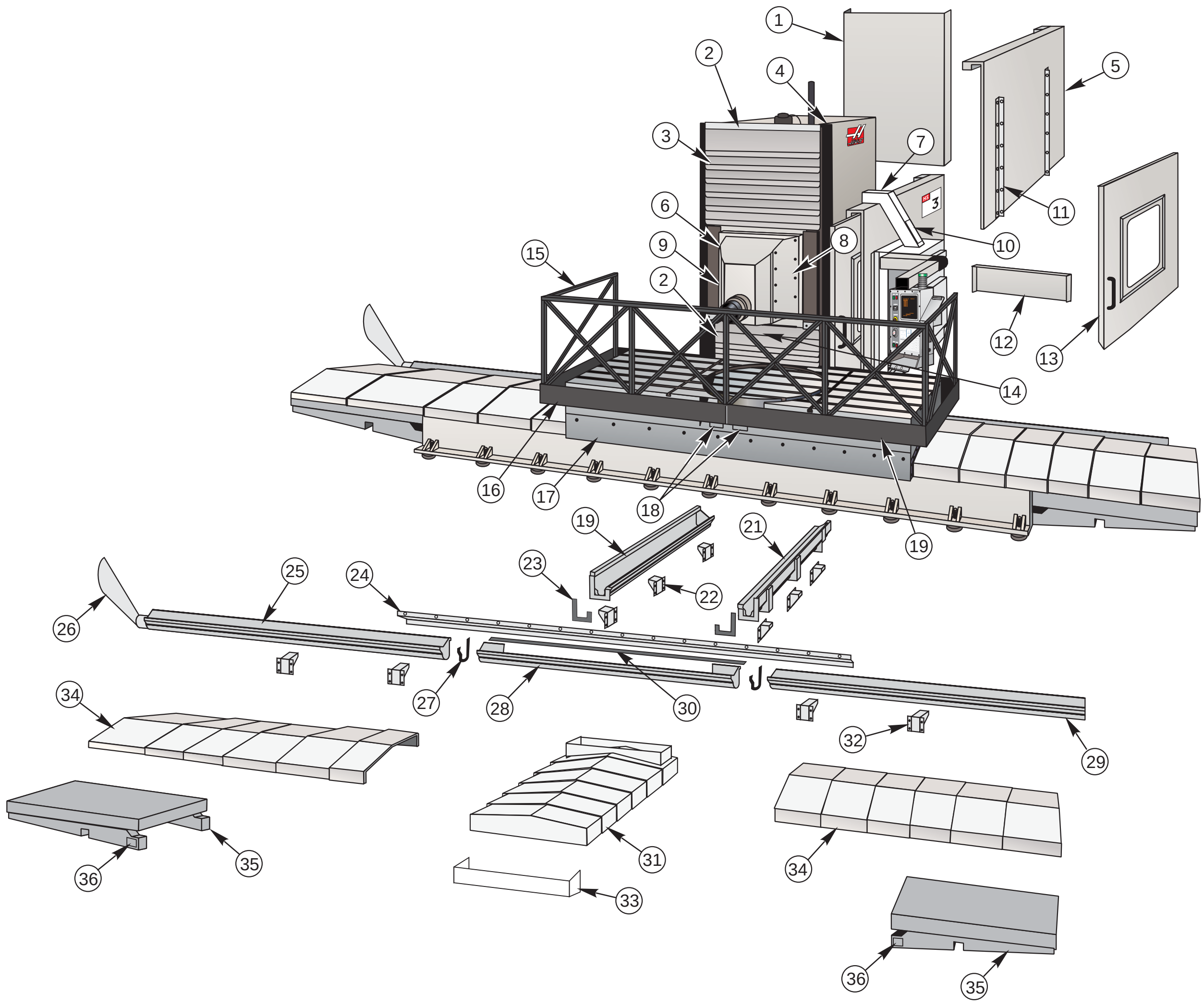
1. 20-6101 Machined Platter
2. 20-6103 Ring Gear
3. 30-7754 Brake Assy
4. 51-2038 Bearing Crossroller
5. 20-6113 Bearing Retainer Ring
6. 20-6100 Table Machined (HS3R)
   20-1511 Table Machined (HS6R-7R)



HS3-7R Encoder Assembly



HS-3 Sheet Metal and Parts List



1. 25-0528 Back panel sheet metal
2. 25-0163 Y-Axis bellows top edge cover
3. 59-0268 Y-Axis upper bellows
4. 25-6017 Y-Axis splash cover
5. 25-6051 Door enclosure
6. 25-6017 Y-Axis chip guard
7. 25-6057 Conduit enclosure
8. 25-6026 Head cover, right
9. 25-6025 Head cover, left
10. 25-6057 Conduit enclosure access plate.
11. 25-6571 “L” bracket
12. 25-0446 Center bottom sheet metal
13. 25-6052 Door
14. 59-0267A Y-Axis lower bellows
15. 22-6056 Fence panel (6)
16. 25-0626 Left table gutter
17. 25-0630 Front table cover
18. 25-6003 Access cover (2)
19. 25-0627 Right table gutter
20. 25-0448 Z-Axis chip conveyor tray, left
21. 25-0449 Z-Axis chip conveyor tray, right
22. 25-6043 Z-Axis chip conveyor brace (6)
23. 57-0085 Z-Axis chip conveyor tray gasket (2)
24. 25-6054 X-Axis splash guard
25. 25-0450 X-Axis chip conveyor tray, left
26. 25-0548 Chip conveyor chute
27. 57-0086 X-Axis chip conveyor tray gasket
28. 25-0451 X-Axis chip conveyor tray, middle
29. 25-0452 X-Axis chip conveyor tray, right
30. 57-0087 Center Trough Gasket
31. 25-6008 Z-Axis way covers
32. 25-6063 X-Axis chip conveyor brace (4)
33. 25-0447 Z-Axis way cover end support
34. 25-6007 X-Axis way covers (2)
35. 25-0645 X-Axis extension
36. 25-0679 X-Axis extension access cover

Pendant Leveling Assembly