Haas Technical Publications

Manual_Archive_Cover_Page Rev A
June 6, 2013

HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

HS-Series Service Manual 96-9010 English June 1998

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

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

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

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

COMMON ABBREVIATIONS USED IN HAAS MACHINES

AC	Alternating Current
AMP	Ampere
APC	Automatic Pallet Changer
APL	Automatic Parts Loader
ASCII	American Standard Code for Information Interchange
ATC	Automatic Tool Changer
ATC FWD	Automatic Tool Change Forward
ATC REV	Automatic Tool Changer Reverse
BHCS	Button Head Cap Screw
CB	Circuit Breaker
CC	Cubic Centimeter
CCW	Counter Clock Wise
CNC	Computerized Numeric Control
CNCR SPINDLE	Concurrent Spindle with axis motion
CRC	Cyclic Redundancy Check Digit
CRT	Cathode Ray Tube
CW	Clock Wise
DB	Draw Bar
DC	Direct Current
DGNOS	Diagnostic
DIR	Directory
DNC	Direct Numerical Control
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
IN	Inch
IOPCB	Input Output Printed Circuit Board
LB	Pound
LED	Light Emitting Diode
LO CLNT	Low Coolant
LOW AIR PR	Low Air Pressure
LVPS	Low Voltage Power Supply
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
NC	Numerical Control

NC	Normally Closed
NO	Normally Open
OD	Outside Diameter
OPER	Operator
PARAM	Parameter
PCB	Printed Circuit Board
PGM	Program
POR	Power On Reset
POSIT	Positions
PROG	Program
PSI	Pounds Per Square Inch
PWM	Pulse Width Modulation
RAM	Random Access Memory
REPT RIG TAP	Repeat Rigid Tap
RET	Return
REV CNVR	Reverse Conveyor
RJH	Remote Jog Handle
RPDBDN	Rotary Pallet Draw Bar Down
RPDBUP	Rotary Pallet Draw Bar Up
RPM	Revolutions Per Minute
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
SP	Spindle
T	Tool Number
TC	Tool Changer
TIR	Total Indicated Runout
TNC	Tool Nose Compensation
TRP	Tool Release Piston
TS	Tail Stock
TSC	Through The Spindle Coolant
VF	Vertical Mill (very first)
VF-E	Vertical Mill- Extended
VMC	Vertical Machining Center

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.
- Replace IOPCB (see "Electrical Service").
- Replace POWER PCB (see "Electrical Service").

Machine can be powered on, but turns off by itself

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

Machine turns on, keyboard beeps, but no CRT display

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

Any LED on Microprocessor PCB goes out (except HALT)

- Replace Microprocessor PCB (see "Electrical Service").
- Replace VIDEO PCB (see "Electrical Service").
- Replace MOTIF PCB (see "Electrical Service").

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

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

Constant E-Stop Condition (will not reset)

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

Vibration

Vibration is a subjective evaluation with perceptions varying among individuals, making it difficult to determine in mild cases if there is an actual problem. 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 is a tough one to call because machining practices come into play. Generally speaking, the least rigid element of a cut is the tool because it is the smallest part. Any cutter will vibrate if pushed beyond its tensile strength. In order to eliminate the machine as the source of the problem, you need to check the spindle and the backlash of the axes as described in the following sections. Once machining practices have been eliminated as the source of vibration, observe the machine in both operation and "cutting air." Move the axes (individually) without the spindle turning and then turn the spindle without moving the axes. Isolate whether the vibration comes from the spindle head or from an axis. Isolate the source of vibration per "Spindle", "Servo Motors/Lead 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 leadscrews (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).
- Check for backlash ("Servo Motors/Leadscrews" section).

Bored holes do not go straight through the workpiece.

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

Machine bores holes out-of-round.

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

Bored holes are out of round or out of position.

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

Machine mis-positions holes.

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

Machine leaves large steps when using a shell mill.

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

FINISH

Machining yields a poor finish

- Check for gearbox vibration. This is the most common cause of a poor finish.
- 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 Manual).

Poor Y-axis finish

Check the hydraulic counterbalance system pressure. If pressure is low, check for:

- abnormal noises from counterbalance system
- oil leaks (esp. at fittings and at filter at top of cylinder)
- bound cylinder

THERMAL GROWTH

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

Note: The leadscrew will always expand ***away*** from the motor end.

VERIFY THERMAL GROWTH

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

1. Home the machine. In MDI mode, press POSIT and PAGE DOWN to the OPER page.
2. Jog to an offset location on the table (example: X-15.0" Y-8.0"). Select the X axis and press the ORIGIN key to zero it. Select the Y axis and zero it.
3. Press the OFSET key, then scroll down to G110 (or any unused offset). Cursor to X and press PART ZERO SET twice. This will set X0, Y0 at this position.
4. Enter the following program. It will start at the new zero position, rapid 10 inches in the X direction, feed the final .25 inches at 10 inches/min., and then repeat the X movement.

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

5. In order to set up the indicator, run the program in SINGLE BLOCK mode, and stop it when X is at 10.25". Set the magnetic base on the table, with the indicator tip touching the spindle housing in the X-axis, and zero it.
6. Exit SINGLE BLOCK mode, and run the program for a few minutes. Enter SINGLE BLOCK mode again, stop the program when X is at 10.25", and take a final reading on the indicator. If the problem is thermal growth, the indicator will show a difference in the X position.

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

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

SOLUTIONS

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

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

1.2 SPINDLE

NOT TURNING

Spindle not turning

- If there are any alarms, refer to "Alarms" section.
- Check that the spindle turns freely when machine is off.
- If motor turns but spindle does not, see "Spindle Drive Belts" and "Transmission" sections.
- 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 MOTIF PCB ("Electrical Service").
- If spindle is still not turning, replace spindle drive ("Electrical Service").
- Check for rotation of the gearbox. If the gearbox operates, check the drive belts ("Spindle Drive Belts").
- Disconnect the drive belts. If the spindle will not turn, it is seized and must be replaced ("Spindle").

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

NOISE

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

Excessive noise coming from the spindle head area

First determine if the noise is related to the RPM of the motor or the RPM of the spindle. **For example:** If the noise appears at 2000 RPM in high gear, listen for a similar noise at 500 RPM in low gear. If the same noise persists, the problem lies within the gearbox. If the noise disappears, the problem could be either the gearbox or the spindle, and further testing is necessary.

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

- Check the drive belts’ tension.
  - ➢ If the noise persists, turn the drive belts over on the pulleys. If the noise is significantly different, the belts are at fault. Replace the belts ("Spindle Drive Belts").
  - ➢ If the noise does not change, remove the belts and go on to the next step.
- Run the gearbox with the drive belts disconnected. If the noise persists, the problem lies with the gearbox.

OVERHEATING

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

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

```
S300  M03        S4000  M03      S7500  M03
M97  P6G4        M97  P6040      M97  P6040
S1000   M03      S4500  M03      M99
M97  P6040       M97  P6040      N6040
```

```
S1500  M03
M97  P6040
S2000  M03
M97  P6040
S2500  M03
M97  P6040
S3000  M03
M97  P6040
S3500   M03
M97  P6040
S5000  M03
M97  P6040
S5500  M03
M97  P6040
S6000  M03
M97  P6040
S6500  M03
M97  P6040
S7000  M03
M97  P6040
G04  P900.
M05
G04  P900.
G04  P900.
M99
```

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

- Check the drive belt tension. Belts that are too tight will cause heating of the top bearing in the spindle housing.
- If at any time during this procedure the spindle temperature rises above 150 degrees, start the procedure over from the beginning. If the spindle temperature rises above 150 degrees a second time, it has failed and must be replaced.

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

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

If the spindle is accelerated and decelerated frequently, the regenerative load resistor inside the control may heat up. If this resistor heats beyond 100°C, a thermostat will generate an “overheat” alarm.

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

ORIENTATION

Spindle loses correct orientation

Non Vector Drive

- Check alarm history, looking for spindle overload and axis overcurrent alarms. These alarms mean the machine is not being properly operated.
- Check the orientation ring for tightness. Ensure the shaft on which the ring mounts is clean and is free of grease and oil.
- Check the orientation ring for cracks near the bolt holes or near the balancing holes. If there are cracks, replace the ring.
- Check the shot pin on the gearbox for binding, damage, and proper operation. Replace it if it is damaged.
- Check the switch on the shot pin against the Diagnostic display. Replace the switch if it is found to be faulty.

Vector Drive

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

TOOLS STICKING IN TAPER

Tool sticking in the taper keeps ATC from pulling the tool out, accompanied by a popping noise as the tool holder pops out of the spindle taper

Note: This problem may occur after loading a cold tool into a hot spindle (a result of thermal expansion of the tool holder inside the spindle taper). It may also occur due to heavy milling, milling with long tooling, or cuts with heavy vibration. If sticking only occurs during these situations, no service is necessary.

- 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 different tooling.
- Check the condition of the spindle taper. Look for damage caused by chips or damaged tooling. Also, look for damage such as deep gouges in the spindle taper caused by tool crashing.
- Duplicate the cutting conditions under which the deflection occurs, but do not execute an automatic tool change. Try instead to release the tool using the TOOL RELEASE key on the keypad. If sticking is observed, the deflection is not caused by improper ATC adjustment, but is a problem in the spindle head of the machine.
- Ensure the spindle is not running too hot.

1.3 SERVO MOTORS / LEAD SCREWS

NOT OPERATING

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

Servo motor is not functioning

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

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

Noise

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

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

Servo motor noise

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

Lead screw noise

- Ensure oil is getting to the lead screw through the lubrication system (See Air and Oil Diagram). 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 lead screw. Loosen the clamp nuts at both ends of the lead screw. If the symptom disappears, replace the bearing sleeve. Be certain to check for damage to the lead screw shaft where the bearing sleeve is mounted.

  ➢ If the noise persists, the lead screw is damaged and must be replaced. When replacing the lead screw in an older machine, always replace the bearing sleeve with the current angular contact design bearing sleeve.

- Check the lead screw for misalignment. If incorrect, perform alignment procedure in "Lead Screw" section.

- Misalignment in the lead screw itself will tend to cause the lead screw to tighten up and make excessive noise at both ends of the travel. The ballnut may get hot. Misalignment radially at the yoke where the lead screw ball nut mounts is indicated by heating up of the ball nut on the lead screw, and noise and tightness throughout the travel of the lead screw. Misalignment at the yoke where the ball nut mounts is indicated by noise and tightness at both ends of the travel of the lead screw. The ball nut may get hot.

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

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 it's full travel forward.

CHECKING X-AXIS:

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

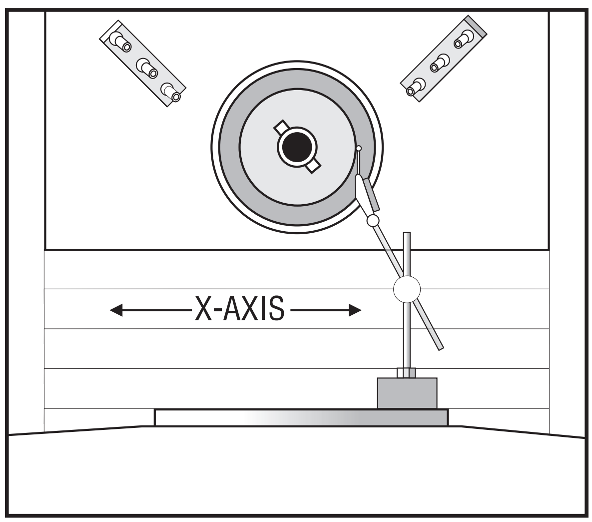


Figure 1-1. Dial indicator in position to check X-axis.

2. Set dial indicator and the "Distance to go" display in the HANDLE JOG mode to zero as follows:
   - Zero the dial indicator.
   - Press the MDI 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. 1-1 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. 1-2.

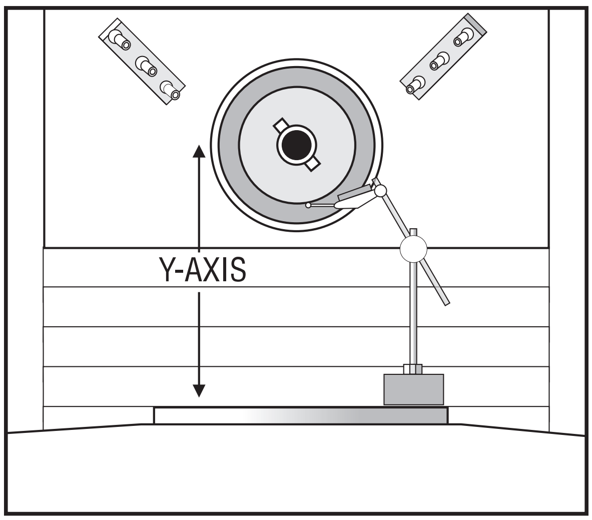


Figure 1-2. Dial indicator in position to check Y-axis.

2. Set dial indicator and the "Distance to go" display in the HANDLE JOG mode to zero as follows:
   - Zero the dial indicator.
   - Press the MDI 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. 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.

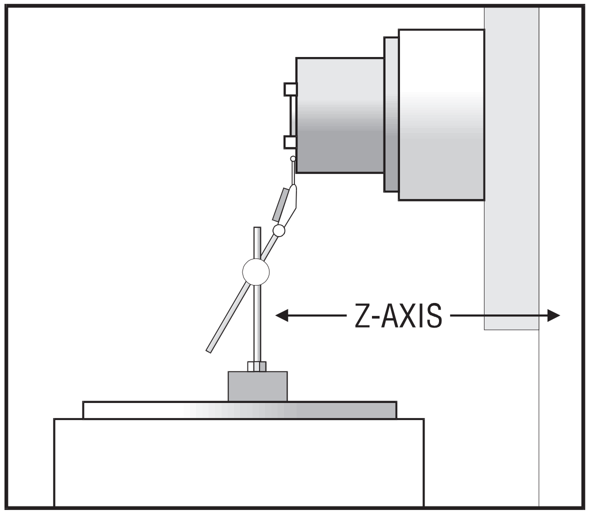


Figure 1-3. Dial indicator in position to check Z-axis.

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 and manually push the column forward and back 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.

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 "Lead 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 lead screw.

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 lead 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 Manual.
- Check motor wiring for shorts.
- Replace driver card ("Electrical Service").
- Replace servo motor ("Axis Motor").

1.4 AUTOMATIC TOOL CHANGER

DEFLECTION

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

During a tool change, ATC appears to be pushed out

- Check to see if pull studs on the tool holder are correct and tight.
- Check the adjustment of the “Y” offset (Parameter 211).
- Check to see if the carousel is set correctly ("Tool Changer Alignment" section in Mechanical Service).
- Ensure the tool holders are held firmly in place by the extractor forks.
- Ensure the balls on the drawbar move freely in the holes in the drawbar when the TOOL RELEASE button is pressed. If they do not move freely, the ATC will be pushed out about 1/4" before the tool holder is seated in the taper. Replace the drawbar.

Tool holder sticking in the spindle taper accompanied by a popping noise as the tool holder pops out of the spindle taper

Note: This problem may occur after loading a cold tool into a hot spindle (a result of thermal expansion of the tool holder inside the spindle taper. It may also occur in cuts with heavy vibration. If sticking occurs only during these circumstances, no service is necessary.

- Check the condition of the customer’s tooling, verifying the taper on the tool holder is ground and not turned. Look for damage to the taper caused by chips in the taper or rough handling. If the tooling is suspected, try to duplicate the symptoms with different tooling.
- Check the condition of the spindle taper. Look for damage caused by chips or damaged tooling. Also, look for damage such as deep gouges in the spindle taper caused by tool crashing. See "Spindle" section for spindle cartridge replacement.
- Duplicate the cutting conditions under which the deflection occurs, but do not execute an automatic tool change. Try instead to release the tool using the TOOL RELEASE key on the keypad. If sticking is observed, the deflection is not caused by improper ATC adjustment, but is a problem in the spindle head of the machine. See "Spindle" section for spindle cartridge replacement.

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

- Check the adjustment of the “Y” offset (Parameter 211).

Note: If the offset is incorrect, a tool changer crash has occurred, and a thorough inspection of the ATC is necessary at this time.

- Ensure the balls on the drawbar move freely in the holes in the drawbar when the TOOL RELEASE key is pressed. If they do not move freely, the ATC will be pushed out about 1/4" before the tool holder is seated in the taper. Replace the drawbar.

Tool holders twist against extractor fork during a tool change

- Check the alignment of the ATC in the Z axis ("Tool Changer Alignment" section in Mechanical Service).
- Check rotational alignment (Parameter 215).

Tool holders spin at all pockets of the ATC

- ATC is rotationally misaligned. Check the CAROUSEL OFFSET (Parameter 215). Realign the ATC ("Automatic Tool Changer")

Note: Observe the direction the tool holder rotates, as this will be the direction in which the X axis of the ATC needs to be moved.

Tool holders spin only at certain pockets of the ATC

- Check all of the extractor forks to ensure they are centered in the pocket of the ATC. Also, check the alignment and CAROUSEL OFFSET (Parameter 215). See "Extractor Fork Replacement", if necessary.

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

CRASHING

Crashing of the ATC is usually a result of operator error. The most common ATC crashes are outlined as follows:

ATC properly deposits a tool holder in the spindle, but the tools are dropped onto the machine table or Z-axis way cover

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

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

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

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

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

DAMAGED EXTRACTORS

Damage to the ATC is caused by either very hard or repeated crashes.

ATC extractor forks are damaged

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

SPINDLE OPERATION

ATC out of orientation with the spindle. Incorrect spindle orientation will cause the ATC to crash, and Alarm 113 to be generated.

- Check the orientation of the spindle.

ATC will not run

- Check to be sure that the tool changer has been defined as a Horizontal (Parameter 209, bit "HORIZONTAL" is set to 1.)
- In all cases where the tool changer will not run, an alarm is generated to indicate either a tool changer in/out problem or an auxiliary axis problem. These alarms will occur either on an attempt to change tools (ATC FWD) or zero return the machine (AUTO ALL AXES). Use the appropriate alarm to select one of the following problems:

ATC carousel will not rotate. Carousel motor is getting power.

- Command a tool change, and feel for power being applied to the servo motor.
  - If power is applied, but the carousel does not turn, check for binding between the servo motor and the reducer ("Automatic Tool Changer" section). Check for a damaged servo motor or bound reducer.

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

ATC carousel will not rotate; servo motor is not getting power

- Command a tool change, and feel for power being applied to the turret motor.
- Check for power supply to the tool changer single axis control (auxiliary axis control).
- Check for proper operation of the auxiliary axis control board.

1.5 GEARBOX AND SPINDLE MOTOR

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

NOISE

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

Excessive or unusual noise coming from the gearbox.

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

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

GEARS WILL NOT CHANGE

Machine will not execute a gear change.

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

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

LOW PRESSURE ALARM

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

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

1.6 PALLET CHANGER

ALARM	POSSIBLE CAUSES	COURSE OF ACTION
180 PALLET NOT CLAMPED Intended to keep the operator from machining on a pallet that is unclamped.	❶ Pallet change sequence interrupted by RESET, FEED HOLD, E-STOP, or POWER OFF before complete. Then, with the pallet not fully clamped, an attempt was made to run the spindle.	❶ Execute an M50 command (pallet change) in MDI mode, ensuring the sequence is completed this time.
1001 INDEX ST UNLOCKED Index station not in correct position for a pallet change.	❶ Load station not in 0^o position. ❷ Indexing handle jammed down. ❸ Load station switch: • unplugged • defective	❶ Orient the load station, then execute an M50 command (pallet change) ❷ Free indexing handle. ❸ Ensure switch is plugged in. If so, replace.
1002 PALLET LOCKED DOWN Pallets did not lift even though the main drawbar is fully unscrewed.	❶ Load station drawbar motor: • unplugged • not getting power • broken shaft • broken idler in gear train • carbon buildup on brushes ❷ Load station floating nut assembly spinning, not allowing drawbar to thread out of the pallet nut, due to: • damaged load station drawbar threads • contamination of floating nut assembly • weak springs in floating nut assembly ❸ Load station drawbar motor I/O board: • relays have failed (M22) • circuit resistors have failed (M22 output) ❹ Missing spring stack and/or nylon thrust washers on load station drawbar. ❺ Lift cylinder Up/Down limit switches installed incorrectly or plugged in incorrectly. ❻ Supply air pressure too low to lift pallets. ❼ Weight on pallet changer exceeds system capability.	❶ Replace motor if necessary. Check resistors on I/O board. Check M22 relay contacts on I/O board. ❷ Replace damaged component. Check drawbar threads. Check pallet nut threads. ❸ Replace I/O board. ❹ Install spring stack and/or nylon thrust washers. Check motor integrity. ❺ Reinstall limit switches. ❻ Check all hoses and solenoid valve connections, and system air pressure is adequate. ❼ Check system pressure. If correct, lessen the load on pallet changer.
1003 PALLETS JAMMED Pallet changer did not rotate, rotate fast enough, or lower fast enough.	❶ Obstruction to H-frame or pallet rotation ❷ CW/CCW limit switches unplugged or reversed on mounts ❸ Air lines disconnected or reversed on cylinder ❹ CW/CCW air solenoids not functioning or disconnected ❺ Air pressure too low to rotate load ❻ Too much air pressure on lift cylinder causing excessive resistance to rotation ❼ No signal from I/O PCB Pallet CW/CCW	❶ Check for physical obstructions. ❷ Ensure discrete inputs RP CW and RP CCW on the Diagnostics page are correct (correct one reads "1" while other reads "0"). ❸ Replace if necessary. ❹ Replace if necessary. ❺ Check supply air pressure. Check all air hoses and fittings. Check for failed pallet rotate cylinder. ❻ Lower supply air pressure at solenoid. ❼ Check connectors / wiring. Replace I/O board if necessary.

1004 CW/CCW SWITCH ILLEGAL CONDITION Limit switches erroneously indicate that the pallet changer is rotated fully CW and CCW at the same time.	❶ CW/CCW limit switch: ● defective ● erroneously tripped (by foreign object,etc.)	❶ Ensure discrete inputs RP CW and RP CCW on the Diagnostics page are correct (correct one reads "1" while other reads "0"). The failed switch will be the one not tripped when alarm occurs. Check for physical obstructions.
1007 UP/DOWN SWITCH ILLEGAL CONDITION Limit switches erroneously indicate that the pallet changer is fully lifted and lowered at the same time.	❶ UP/DOWN limit switch: ● defective ● erroneously tripped (by foreign object,etc.) ● wired incorrectly	❶ Ensure discrete inputs RP UP and RP DN on the Diagnostics page are correct (correct one reads "1" while other reads "0"). The failed switch will be the one not tripped when alarm occurs. Check for physical obstructions.
1008 MAIN DRAWBAR LOCKED IN UP POSITION The main drawbar will not unclamp the pallet.	❶ Main drawbar and/or pallet nut are damaged ❷ Main drawbar up limit switch: ● unplugged ● defective ❸ Main drawbar motor: ● unplugged ● broken output shaft at snap ring groove ● failure ● gear train failure ❹ Clutch failure: reverse drive pin spring in clutch hub has failed to push the pin out due to: ● dust contamination ● broken spring ❺ Broken drive belt between motor and drawbar ❻ Power supply relays (I/O board) failure (M21) ❼ Current limit circuit is set incorrectly (esp. if replaced I/O board)	❶ Replace damaged component ❷ Ensure discrete inputs RPDBDN and RPDBUP on the Diagnostics page are correct (both read "1" when main drawbar is up, and both read "0" when main drawbar if down). Replace switch if necessary. ❸ Replace motor or gear train components if necessary. ❹ Replace clutch assembly ❺ Replace drive belt ❻ If power supply relay has failed, replace. If motor directional relay, replace I/O board. ❼ Set current limit circuit correctly
1009 MAIN DRAWBAR LOCKED IN DOWN POSITION The main drawbar will not clamp the pallet.	❶ Main drawbar down limit switch: ● unplugged ● defective ❷ Main drawbar floating nut assembly spinning, not allowing drawbar to thread into the pallet nut, due to: ● damaged main drawbar threads ● contamination of floating nut assembly ❸ Main drawbar motor: ● unplugged ● broken output shaft at snap ring groove ● failure ● gear train failure ❹ Clutch failure: loss of torque ❺ Broken drive belt between motor and drawbar ❻ Contamination of drawbar splines preventing free motion ❼ Bearing sleeve bearings seized due to contamination ❽ Power supply relays (I/O board) failure	❶ Ensure discrete inputs RPDBDN and RPDBUP on the Diagnostics page are correct (both read "1" when main drawbar is up, and both read "0" when main drawbar is down). Replace switch if necessary. ❷ Replace damaged component ❸ Replace motor or gear train components if necessary. ❹ Replace clutch assembly ❺ Replace drive belt ❻ Replace drawbar and bearing sleeve assembly. Check for V-seals. Identify source of contamination. ❼ Replace bearing sleeve assembly. Check for V-seals. Identify source of contamination. ❽ If power supply relay has failed, replace. If motor directional relay, replace I/O board.

1010 MAIN DRAWBAR SWITCH ILLEGAL CONDITION Limit switches erroneously indicate that drawbar has tripped the down switch, but not the up switch.	❶ Main drawbar up/down limit switches: ● mounted in reversed positions ● plugged into wrong connectors on solenoid mounting bracket ● defective	❶ Ensure discrete inputs RPDBDN and RPDBUP on the Diagnostics page are correct (both read "1" when main drawbar is up, and both read "0" when main drawbar is down). Replace switch if necessary.
1011 MAIN DRAWBAR UNCLAMP TIMEOUT Main drawbar has unscrewed from pallet nut, but reached the down position too slowly.	❶ Main drawbar floating nut assembly spinning, not allowing drawbar to thread down, due to: ● damaged main drawbar threads ● contamination of floating nut assembly ● weak springs in floating nut assembly ❷ Main drawbar motor: ● unplugged ● broken output shaft at snap ring groove ● failure ● gear train failure (unlikely) ❸ Clutch failure: loss of torque ❹ Broken drive belt between motor and drawbar ❺ Power supply relays (I/O board) failure ❻ Current limit circuit is set incorrectly	❶ Replaced damaged component. Check drawbar threads. Check pallet nut threads. ❷ Replace motor or gear train components if necessary. ❸ Replace clutch assembly ❹ Replace drive belt ❺ Replace I/O board ❻ Set current limit circuit correctly
1012 MAIN DRAWBAR CLAMP TIMEOUT Main drawbar started to travel upward, but reached the up position too slowly.	❶ Main drawbar floating nut assembly spinning, not allowing drawbar to thread into the pallet nut, due to: ● damaged main drawbar threads ● contamination of floating nut assembly ● weak springs in floating nut assembly ❷ Main drawbar motor: ● unplugged ● broken output shaft at snap ring groove ● failure ● gear train failure (unlikely) ❸ Clutch failure: loss of torque ❹ Broken drive belt between motor and drawbar ❺ Current limit circuit is set incorrectly (esp. if replaced I/O board) ❻ Power supply relays (I/O board) failure (M21)	❶ Replaced damaged component. Check drawbar threads. Check pallet nut threads. ❷ Replace motor or gear train components if necessary. ❸ Clutch failure will usually be apparent from the clamp force and cut quality. Replace clutch assembly. ❹ Replace drive belt ❺ Set current limit circuit correctly ❻ If power supply relay has failed, replace. If motor directional relay, replace I/O board.
1119 (NO ALARM NAME)	❶ Corrupted pallet changer macro	❶ Reload macro
PALLET DOES NOT SIT CORRECTLY ON INDEXING PINS	❶ H-frame out of alignment ❷ Hardstops not adjusted correctly ❸ Excess weight causes the pallet to go out of alignment	❶ Refer to "H-frame alignment" section ❷ Refer to "Pallet Rotation Hardstop Adjustment" ❸ Check the load on the pallet changer. If it exceeds the weight capacity, reduce the loads.

EXECUTION OF AN M50 RESULTS IN A "RUNNING" MESSAGE, BUT NOTHING HAPPENS, AND NO ALARM IS GENERATED.	❶ Load station not properly oriented or, if M36 is being used, PART READY light not pressed.	❶ Ensure load station is properly oriented. If an M36 is being used, press the flashing PART READY light on the front switch box.
	❷ Pallet changer macro program was loaded before MACROS were enabled, or while Setting 23, "9xxxx PROGS EDIT LOCK", was ON.	❷ Press RESET. Go to Setting 74, "9xxxx PROGS TRACE", and turn it on. From MDI, execute an M50. If the program is executing very rapidly, but nothing is happening, turn off Setting 74 and reload the 09000 macro.

1.7 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 Dept. if machine is being used for this application.

Coolant Overflow

To begin troubleshooting, check the alarm history to determine the problem's cause before any action is taken.

Coolant pouring out of spindle head

- 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 with (58-2010) 5/32" OD nylon tubing.
- Check for TSC seal failure. If failure is found, replace the seal housing(30-3298). Refer to the appropriate steps in"TSC-Tool Release Piston Replacement" section for procedure.
- Check pre-charge pressure in accordance with TSC "Pressure 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 for high pressure TSC and 140 psi for old style TSC), with a standard (non-TSC) tool holder in spindle. If pump pressure is above 310 psi for high pressure TSC or above 140 psi for old style TSC, reset the pump relief valve in accordance with the "Setting TSC Pump Relief Valve".

Excessive coolant flow out of drain line

Pulsating flow through tool and drain line

- Check pre-charge pressure in accordance with TSC "Pressure 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. 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 for high pressure TSC and 140 psi for old style TSC), with a standard tool holder in spindle. If pump pressure is above 310 psi for high pressure TSC or above 140 psi for old style TSC, reset the pump relief valve in accordance with the "Setting TSC 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. Single phase motors have a built in thermal cut-out. Three phase motors have a thermal circuit that will interrupt power to the relay coil.
- If received at start-up, check that the breaker hasn't tripped and that the pump is turning. Check the electrical continuity of cables.
- Check for 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 intermittant 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.
- For the old TSC system, if the drawbar was replaced, check that the hole through the drawbar is 0.156 dia and not 0.190 dia. Replace the drawbar with the correct one if it is 0.190 dia.

COOLANT TIP WEAR

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

Coolant tip is wearing quickly and needs frequent replacement.

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

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

PRE-CHARGE FAILURE

Alarm 198, "Precharge Failure"

Note: This alarm only applies to the TSC system.

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

1.8 HYDRAULIC COUNTERBALANCE

MECHANICAL DIAGNOSIS

Important! Hydraulic counterbalance oil is dyed red for easier recognition.

Noise in the system

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

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

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

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

Over Current alarms

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

Over Current / Following errors

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

1.9 ELECTRICAL TROUBLESHOOTING

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

ELECTRICAL ALARMS

Axis Drive Fault Alarm

- Blown amplifier - indicated by a light at bottom of amplifier when power is on. Replace amplifier.
- Amplifier or MOCON is noise sensitive. If this is the case, the alarm can be cleared and the axis will run normally for a while.

  To check an amplifier, switch the motor leads and control cables between the amplifier and the one next to it. If the same problem occurs with the other axis, the amplifier must be replaced. If the problem stays on the same axis, either the MOCON or control cable. The problem could also be the axis motor itself, with leads either shorted to each other or to ground, which is very rare.

- Amplifier faulting out for valid reason, such as overtemp, overvoltage, or +/-12 volt undervoltage condition. This usually results from running a servo intensive program, or unadjusted 12 volt power supply. Replace amplifier.

  Overvoltage could occur if regen load is not coming on, but this does not usually happen. The problem could also be the axis motor itself, with leads either shorted to each other or to ground, which is very rare.

Axis Overload

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

Phasing Error

- The MOCON did not receive the proper phasing information from the motors. DO NOT RESET the machine if this alarm occurs. Power the machine down and back up. If the problem persists, it is probably a broken wire or faulty MOCON connectors.

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.

PROCESSOR STACK DIAGNOSTIC

(DISCONNECT CABLES FROM A NORMAL OPERATING SYSTEM)

Remove low voltage cable from Video & Keyboard PCB

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

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

- Processors LED’s Normal - then Run goes out

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

- Processors LED’s - CRT and Run are out

KEYBOARD DIAGNOSTIC

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

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

KEYBOARD GRID

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

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

Example

1. Pressing the **RESET** button will cause diodes 1 and 17 to conduct.
   - With the POWER OFF read across diode 1.
   - A typical reading is between .400-.700 ohms, note your reading.
2. Press and hold the **RESET** button. If the diode is conducting, the reading should drop about .03 ohms.
   - (If your reading was .486 and it dropped to .460, for a difference of .026; the diode is good)
   - The same will hold true for diode 17 in this example. If the reading stays the same or there is no change, the diode is not conducting. Pull P2 and read between pins 1 and 17.
   - Press and hold <**RESET**>. The meter should read a short (0 ohms) if not the keypad is bad.

2. ALARMS

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

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

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

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

Alarm number and text:		Possible causes:
101	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. Check cable connections and grounding.
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 EMER GENCY STOP, motor faults, tool changer problems, or power fail.
103	X Servo Error Too Large	Too much load or speed on X-axis motor. The difference between the motor position and the commanded position has exceeded a parameter. The 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	same as 103.
105	Z Servo Error Too Large	same as 103.
106	A Servo Error Too Large	same as 103.
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 but not much past them. It can also be caused by anything that causes a very high load on the motors.
109	Y Servo Overload	same as 108.
110	Z Servo Overload	same as 108.
111	A Servo Overload	same as 108.
112	No Interrupt	Electronics fault. Call your dealer.
113	Shuttle In Fault	During a tool change, the carousel did not move out all the way. This alarm can be caused by anything that stops motion of the carousel. Parameters 62 and 63 can adjust the time-out times.
114	Shuttle Out Fault	During a tool change, the carousel did not move in (retract) all the way. This alarm can be caused by anything that stops motion of the carousel. Parameters 62 and 63 can adjust the time-out times.
115	Turret Rotate Fault	Vertical mills only. Tool carousel motor not in position.
116	Spindle Orientation Fault	Spindle did not orient correctly. During a spindle orientation function, the spindle is rotated until the lock pin drops in; but the lock pin never dropped. Parameters 66, 70, 73, and 74 can adjust the time-out times. This can be caused by a trip of circuit breaker CB4, a lack of air pressure, or too much friction with the orientation pin.
117	Spindle High Gear Fault	Gearbox did not shift into high gear. During a change to high gear, the spindle is rotated slowly while air pressure is used to 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 solenoids circuit breaker CB4, 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 solenoids circuit breaker CB4, and the spindle drive.
119	Over Voltage	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 remains for 4.5 minutes, an automatic shutdown will begin.
120	Low Air Pressure	Air pressure dropped below 80 PSI for a period defined by Parameter 76. Check your incoming air pressure for at least 100 PSI and ensure that the regulator is set at 85 PSI.
121	Low Lub 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 the connector on the side of the control cabinet. Check that the lube lines are not blocked.

122	Control Overheat	The control internal temperature is above 150 degrees F. This can be caused by almost anything in the control overheating. But is usually caused by overheat of the two regen resistors for servos and spindle drive. This alarm will also 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 remains for 4.5 minutes, an automatic shutdown will begin.
123	Spindle Drive Fault	Overheat or failure of spindle drive or motor. The exact cause is indicated in the LED window of the spindle drive inside the control cabinet. This can be caused by a stalled motor, shorted motor, overvoltage, undervoltage, overcurrent, overheat of motor, or drive failure.
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 carousel not initialized at power on, CYCLE START or spindle motion com mand. This means that the tool carousel was not fully retracted to the Out position.
126	Gear Fault	Gearshifter is out of position when a command is given to 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 solenoids circuit breaker CB4, and the spindle drive.
127	No Turret Mark	Vertical mills only. Tool carousel motor not in position.
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, relays on the I/O assembly, the drawbar assembly, or in the wiring.
131	Tool Not Clamped	Tool Release Piston is not Home. This is a possible fault in the air solenoids, relays on the IO Assembly, the draw bar assembly, or wiring.
132	Power Down Failure	Machine did not turn off when an automatic power-down was commanded. Check wiring to POWIF card on power supply assembly, relays on the IO assembly, and the main contactor K1.
133	Spindle Locked	Shot pin did not release. This is detected when spindle motion is commanded. Check the solenoid that controls the air to the lock, relay 2-8, the wiring to the sense switch, and the switch.
134	Tool Clamp Fault	Tool did not release from spindle when commanded. Check air pressure and solenoid circuit breaker CB4. Can also be caused by misadjustment of drawbar assembly.
135	X Motor Over Heat	Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F. This can be caused by an extended overload of the motor such as leaving the slide at the stops for several minutes.

136	Y Motor Over Heat	same as 135.
137	Z Motor Over Heat	same as 135.
138	A Motor Over Heat	same as 135.
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 connectors at P1-P4.
140	Y Motor Z Fault	same as 139.
141	Z Motor Z Fault	same as 139.
142	A Motor Z Fault	same as 139.
143	Spindle Not Locked	Shot pin not fully engaged when a tool change operation is being performed. Check air pressure and solenoid circuit breaker CB4. This can also be caused by a fault in the sense switch that detects the position of the lock pin.
144	Time-out- Call Your Dealer	Time allocated for use prior to payment exceeded. Call your dealer.
145	X Limit Switch	Axis hit limit switch or switch disconnected. This is not normally possible as the stored stroke limits will stop the slides before they hit the limit switches. Check the wiring to the limit switches and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.
146	Y Limit Switch	same as 145
147	Z Limit Switch	same as 145
148	A Limit Switch	Normally disabled for rotary axis.
149	Spindle Turning	Spindle not at zero speed for tool change. A signal from the 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 **Z** is not either at machine home. 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 Through the Spindle Coolant option only. This alarm will shut off the spindle, feed, and pump all at once. Check for low coolant tank level, any filter or intake strainer clogging, or for any kinked or clogged coolant lines.
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 at the top left of the control. Call your dealer.
153	X-Axis Z Ch Missing	Broken wires or encoder contamination. All servos are turned off. This can also be caused by loose connectors at P1-P4.
154	Y-axis Z Ch Missing	same as 153.

155	Z-axis Z Ch Missing	same as 153.
156	A-axis Z Ch Missing	same as 153.
157	MOCON Watchdog Fault	The self-test of the MOCON has failed. Replace the MOCON.
158	Video/Keyboard PCB Failure	Internal circuit board problem. The VIDEO PCB in the processor stack is tested at power-on. This could also be caused by a short in the front panel membrane keypad. Call your dealer.
159	Keyboard Failure	Keyboard shorted or button pressed at power on. A power-on test of the membrane keypad has found a shorted button. It can also be caused by a short in the cable from the main cabinet or by holding a switch down during power-on.
160	Low Voltage	The line voltage to control is too low. This alarm occurs when the AC line voltage drops below 190 when wired for 230 volts or drops below 165 when wired for 208 volts.
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 a short distance into a mechanical stop. It can also be caused by a short in the motor or a short of one motor lead to ground.
162	Y-Axis Drive Fault	same as 161.
163	Z-Axis Drive Fault	same as 161.
164	A-Axis Drive Fault	same as 161.
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	Same as 165.
167	Z Zero Ret Margin Too Small	Same as 165.
168	A Zero Ret Margin Too Small	Not normally enabled for A-axis.
169	Spindle Direction Fault	Problem with rigid tapping hardware. The spindle started turning in the wrong direction.
170	Phase Loss	Problem with incoming line voltage between legs L1 and L2. This usually indicates that there was a transient loss of input power to the machine.
171	UNUSED	

172	UNUSED	
173	Spindle Ref Signal Missing	The **Z** channel pulse from the spindle encoder is missing for rigid tapping synchronization.
174	Tool Load Exceeded	The tool load monitor option is selected and the maximum load for a tool was exceeded in a feed. This alarm can only occur if the tool load monitor function is installed in your machine.
175	Ground Fault Detected	A ground fault condition was detected in the 115V AC supply. This can be caused by a short to ground in any of the servo motors, the tool change motors, the fans, or the oil pump.
176	Overheat Shutdown	An overheat condition persisted for 4.5 minutes and caused an automatic shutdown.
177	Overvoltage Shutdown	An overvoltage condition persisted for 4.5 minutes and caused an automatic shutdown.
178	Divide by Zero	Software Error; Call your dealer.
179	Low Pressure Transmission Oil	Spindle coolant oil is low or low pressure condition in lines.
180	Pallet Not Clamped	The pallet change sequence was not completed for some reason (press ing E-STOP, RESET, or FEED HOLD), and an attempt was made to run the spindle.
182	X Cable Fault	Cable from X-axis encoder does not have valid differential signals.
183	Y Cable Fault	Same as 182.
184	Z Cable Fault	Same as 182.
185	A Cable Fault	Same as 182.
186	Spindle Not Turning	Status from spindle drive indicates it is not at speed when expected.
187	B Servo Error Too Large	Same as 103.
188	B Servo Overload	Same as 108.
189	B Motor Overheat	Same as 135.
190	B Motor Z Fault	Same as 139.
191	B Limit Switch	Same as 148.
192	B Axis Z Ch Missing	Same as 153.
193	B Axis Drive Fault	Same as 161.
194	B Zero Ret Margin Too Small	Same as 168.
195	B Cable Fault	Same as 182.
196	Coolant Spigot Failure	Vertical mills only.
197	100 Hours Unpaid Bill	Call your dealer.

198	Precharge Failure	During Through the Spindle Coolant operation, the precharge failed for greater than 0.1 seconds. It will shut off the feed, spindle and pump all at once. If received, check all air lines and the air supply pressure.
199	Negative RPM	A negative spindle RPM was sensed.
201	Parameter CRC Error	Parameters lost 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 CRC Error 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 Program Error	Possible corrupted program. Save all programs to floppy disk, delete all, then reload. Check for a low battery and low battery alarm.
207	Queue Advance Error	Software Error; Call your dealer.
208	Queue Allocation Error	Software Error; Call your dealer.
209	Queue Cutter Comp Error	Software Error; Call your dealer.
210	Insufficient Memory	Not enough memory to store users program. Check the space available in the LIST PROG mode and possibly delete some programs.
211	Odd Prog Block	Possible corrupted program. Save all programs to floppy disk, delete all, then reload.
212	Program Integrity Error	Possible corrupted program. Save all programs to floppy disk, delete all, then reload. Check for a low battery and low battery alarm.
213	Program RAM CRC Error	Electronics fault; Call your dealer.
214	No. of Programs Changed	Indicates that the number of programs disagrees with the internal variable that keeps count of the loaded programs. Call your dealer.
215	Free Memory PTR Changed	Indicates the amount of memory used by the programs counted in the system disagrees with the variable that points to free memory. Call your dealer.
217	X Axis Phasing Error	Error occured in phasing initialization of brushless motor. This can be caused by a bad encoder, or a cabling error.
218	Y Axis Phasing Error	Same as above.

219	Z Axis Phasing Error	Same as above.
220	A Axis Phasing Error	Same as above.
221	B Axis Phasing Error	Same as above.
222	C Axis Phasing Error	Same as above.
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 count pulses in X axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF PCB.
225	Y Transition Fault	Same as above.
226	Z Transition Fault	Same as above.
227	A Transition Fault	Same as above.
228	B Transition Fault	Same as above.
229	C Transition Fault	Same as above.
231	Jog Handle Transition Fault	Same as 224.
232	Spindle Transition Fault	Same as 224.
233	Jog Handle Cable Fault	Cable from jog handle encoder does not have valid differential signals.
234	Spindle Enc. Cable Fault	Cable from spindle encoder does not have valid differential signals.
235	Spindle Z Fault	Same as 139.
236	Spindle Motor Overload	This alarm is generated in machines equipped with a Haas vector drive, if the spindle motor becomes 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).
240	Empty Prog or No EOB	DNC program not found, or no end of program found.
241	Invalid Code	RS-232 load bad. Data was stored as comment. Check the program being received.
242	No End	Check input file for a number that has too many digits.
243	Bad Number	Data entered is not a number.
244	Missing)	Comment must end with a ") ".
245	Unknown Code	Check input line or data from RS-232. This alarm can occur while editing data into a program or loading from RS-232.
246	String Too Long	Input line is too long. The data entry line must be shortened.
247	Cursor Data Base Error	Software Error; Call your dealer.
248	Number Range Error	Number entry is out of range.

249	Prog Data Begins Odd	Possible corrupted program. Save all programs to floppy disk, delete all, then reload.
250	Program Data Error	Same as 249.
251	Prog Data Struct Error	Same as 249.
252	Memory Overflow	Same as 249.
253	Electronics Overheat	The control box temperature has exceeded 145 degrees F. This can be caused by an electronics problem, high room temperature, or clogged air filter.
254	Spindle Overheat	This alarm is only generated in machines equipped with a Haas vector drive. The spindle temperature sensor sensed a high temperature for greater than 1.5 seconds.
257	Program Data Error	Same as 249.
258	Invalid DPRNT Format	Macro DPRNT statement not structured properly.
259	Bad Language Version	Call your dealer.
260	Bad 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. Indicates a loss of memory - call your dealer.
262	Parameter CRC Missing	RS-232 or floppy read of parameter had no CRC when loading from floppy or RS-232.
263	Lead Screw CRC Missing	Lead screw compensation tables have no CRC when loading from floppy or RS-232.
264	Rotary CRC Missing	Rotary table parameters have no CRC when loading from floppy or RS-232.
265	Macro Variable File CRC Error	Macro variable file has a CRC error. Indicates a loss of memory. Call your dealer.
267	Tool Door Out of Position	Alarm will be generated 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 to be closed, or closed after it was commanded to be open.
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.
270	C Servo Error Too Large	Same as 103.
271	C Servo Overload	Same as 108.
272	C Motor Overheat	Same as 135.
273	C Motor Z Fault	Same as 139.
274	C Limit Switch	Same as 145.
275	C Axis Z Ch Missing	Same as 153.
276	C Axis Drive Fault	Same as 161.

277	C Zero Ret Margin Too Small	Same as 165.
278	C Cable Fault	Same as 182.
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.
302	Invalid R In G02 or G03	Check your geometry. **R** must be less than or equal to half the distance from start to end within an accuracy of 0.0010 inches.
303	Invalid X, Y, or Z In G02 or G03	Check your geometry.
304	Invalid I, J, or K In G02 or G03	Check your geometry. Radius at start must match radius at end of arc within 0.0010 inches.
305	Invalid Q In Canned Cycle	**Q** in a canned cycle must be greater than zero.
306	Invalid I, J, K, or Q In Canned Cycle	**I**, **J**, **K,** and **Q** in a canned cycle must be greater than zero.
307	Subroutine Nesting Too Deep	Subprogram nesting is limited to nine levels. Simplify your program.
309	Exceeded Max Feed Rate	Use a lower feed rate.
310	Invalid G Code	**G** code not defined and is not a macro call.
311	Unknown Code	Possible corruption of memory by low battery. Call your dealer.
312	Program End	End of subroutine reached before M99. Need an M99 to return from subroutine.
313	No P Code In M97, M98, or G65	Must put subprogram number in **P** code.
314	Subprogram or Macro Not In Memory	Check that a subroutine is in memory or that a macro is defined.
315	Invalid P Code In M97, M98 or M99	The **P** code must be the name of a program stored in memory without a decimal point for M98 and must be a valid **N** number for M99.
316	X Over Travel Range	X-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.
317	Y Over Travel Range	same as 316.
318	Z Over Travel Range	same as 316.
319	A Over Travel Range	Not normally possible with A-axis.
320	No Feed Rate Specified	Must have a valid **F** code for interpolation functions.

321	Auto Off Alarm	A fault turned off the servos automatically; occurs in debug mode only.
322	Sub Prog Without M99	Add an M99 code to the end of program called as a subroutine.
324	Delay Time Range Error	**P** code in G04 is greater than or equal to 1000 seconds (over 999999 milliseconds).
325	Queue Full	Control problem; call your dealer.
326	G04 Without P Code	Put a **Pn.n** for seconds or a **Pn** for milliseconds.
327	No Loop For M Code Except M97, M98	**L** code not used here. Remove **L** Code.
328	Invalid Tool Number	Tool number must be between 1 and the value in Parameter 65.
329	Undefined M Code	That **M** code is not defined and is not a macro call.
330	Undefined Macro Call	Macro name O90nn not in memory. A macro call definition is in parameters and was accessed by user program but that macro was not loaded into memory.
331	Range Error	Number too large.
332	H and T Not Matched	This alarm is generated when Setting 15 is turned ON and an **H** code number in a running program does not match the tool number in the spindle. Correct the **Hn** codes, select the right tool, or turn off Setting 15.
333	X-axis Disabled	Parameters have disabled this axis. Not normally possible.
334	Y-axis Disabled	same as 333.
335	Z-axis Disabled	same as 333.
336	A-axis Disabled	An attempt was made to program the A-axis while it was disabled (DISABLED bit in Parameter 43 set to 1).
337	Line Referenced By **P**, Not Found	Subprogram is not in memory, or **P** code is incorrect.
338	Invalid IJK and XYZ in G02 or G03	There is a problem with circle definition; check your geometry.
339	Multiple Codes	Only one **M**, **X**, **Y**, **Z**, **A**, **Q**, etc. allowed in any block or two **G** codes in the same group.
340	Cutter Comp Begin With G02 or G03	Select cutter compensation earlier. Cutter comp. must begin on a linear move.
341	Cutter Comp End With G02 or G03	Disable cutter comp later.
342	Cutter Comp Path Too Small	Geometry not possible. Check your geometry.

343	Display Queue Record Full	A block exists that is too long for displaying queue. Shorten title block.
344	Cutter Comp With G18 and G19	Cutter comp only allowed in XY plane (G17).
345	Diff Step Ratio On G17 Plane	Parameters 5 and 19 must be same value.
346	Diff Step Ratio On G18 Plane	Parameters 5 and 33 must be same value.
347	Diff Step Ratio On G19 Plane	Parameters 19 and 33 must be same value.
348	Motion Not Allowed In G93 Mode issued.	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
349	Prog Stop W/O Cancel Cutter Comp	Cutter Compensation has been cancelled without an exit move. Potential damage to part.
350	Cutter Comp Look Ahead Error	There are too many non-movement blocks between motions when cutter comp is being used. Remove some intervening blocks.
351	Invalid P Code	In a block with G103 (Block Lookahead Limit), a value between 0 and 15 must be used for the P code.
352	Aux Axis Power Off	Aux **B**, **C**, **U**, **V**, or **W** axis indicate servo off. Check auxiliary axes. Status from control was OFF.
353	Aux Axis No Home	A ZERO RET has not been done yet on the aux axes. Check auxiliary axes. Status from control was LOSS.
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	Tool changer disabled by bit in Parameter 57. Not a normal condition.
361	Gear Change Disabled	Gear change disabled by bit in Parameter 57. Not a normal condition.
362	Tool Usage Alarm	Tool life limit was reached. To continue, reset the usage count in the Current Commands display and press RESET.

363	Coolant Locked Off	Override is off and program tried to turn on coolant.
364	No Circ Interp	Only rapid or feed is allowed with aux axes. Aux Axis
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 restrictions to DNC.
374	Missing XYZA in G31 or G36	G31 skip function requires an **X**, **Y**, **Z**, or **A** move.
375	Missing Z or H in G37	G37 automatic tool length measurement function requires **H** code, **Z** value, and tool offset enabled. **X**, **Y**, and **A** values not allowed.
376	No Cutter Comp In Skip	Skip G31 and G37 functions cannot be used with cutter compensation.
377	No Skip in Graph/Sim	Graphics mode cannot simulate skip function.
378	Skip Signal Found	Skip signal check code was included but skip was found when it was not expected.
379	Skip Signal Not Found	Skip signal check code was included but skip was not found when it was expected.
380	X, Y, A, or G49 Not Allowed in G37	G37 may only specify Z-axis and must have tool offset defined.
381	G43 or G44 Not Allowed in G36 or G136	Auto work offset probing must be done without tool offset.
382	D Code Required in G35	A **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	If block buffering has been limited, Cutter comp cannot be used. Allowed With G103
388	Cutter Comp Not Allowed With G10	Coordinates cannot be altered while cutter comp is active. Move G10 outside of cutter comp enablement.
389	G17, G18, G19 Illegal in G68	Planes of rotation cannot be changed while rotation is enabled.
390	No Spindle Speed	**S** code has not been encountered. Add an **S** code.
391	Feature Disabled	An attempt was made to use a control feature not enabled by a parameter bit. Set the parameter bit to 1.
392	B Axis Disabled	Same as 336.
393	Invalid Motion In G74 or G84	Rigid Tapping can only be in the Z minus G74 or G84 direction. Make sure that the distance from the initial position to the commanded Z depth is in the minus direction.
394	B Over Travel Range	Same as 316.
395	No G107 Rotary Axis Specified	A rotary axis must be specified in order to perform cylindrical mapping (G107).
396	Invalid G107 Rotary Axis Specified	The rotary axis specified is not a valid axis, or has been disabled.
397	Aux Axis In G93 Block	This alarm is generated if a G-code block specifies any form of interpolated motion that involves BOTH one or more of the regular axes (X, Y, Z, A, B, etc...) AND one or more of the auxiliary axes (C, U, V, W).
398	Aux Axis Servo Off	Aux. axis servo shut off due to a fault.
403	RS-232 Too Many Progs	Cannot have more than 200 programs in memory.
404	RS-232 No Program Name	Need name in programs when receiving ALL; otherwise has no way to store them.
405	RS-232 Illegal Prog Name	Check files being loaded. Program name must be **Onnnn** and must be at beginning of a block.
406	RS-232 Missing Code	A receive found bad data. Check your program. The program will be stored but the bad data is turned into a comment.
407	RS-232 Invalid Code	Check your program. The program will be stored but the bad data is turned into a comment.
408	RS-232 Number Range Error	Check your program. The program will be stored but the bad data is turned into a comment.

409	RS-232 Invalid N Code	Bad Parameter or Setting data. User was loading settings or parameters and something was wrong with the data.
410	RS-232 Invalid V Code	Bad parameter or setting data. User was loading settings or parameters and something was wrong with the data.
411	RS-232 Empty Program	Check your program. Between **%** and **%** there was no program found.
412	RS-232 Unexpected End of Input	Check your program. An ASCII EOF code was found in the input data before program receive was complete. This is a decimal code 26.
413	RS-232 Load Insufficient Memory	Program received doesn't fit. Check the space available in the LIST PROG mode and possibly delete some programs.
414	RS-232 Buffer Overflow	Data sent too fast to CNC. This alarm is not normally possible as this control can keep up with even 38400 bits per second.
415	RS-232 Overrun	Data sent too fast to CNC. This alarm is not normally possible as this control can keep up with as much as 38400 bits per second.
416	RS-232 Parity Error	Data received by CNC has bad parity. Check parity settings, number of data bits and speed. Also check your wiring.
417	RS-232 Framing Error	Data received was garbled and proper framing bits were not found. One or more characters of the data will be lost. Check parity settings, number of data bits and speed.
418	RS-232 Break	Break condition while receiving. The sending device set the line to a break condition. This might also be caused by a simple break in the cable.
419	Invalid Function For DNC	A code found on input of a DNC program could not be interpreted.
420	Program Number Mismatch	The **O** code in the program being loaded did not match the **O** code entered at the keyboard. Warning only.
429	Flpy Dir Insufficient Memory	Floppy memory was almost full when an attempt was made to read the floppy directory.
430	Floppy Unexpected End of Input	Check your program. An ASCII EOF code was found in the input data before program receive was complete. This is a decimal code 26.
431	Floppy No Prog Name	Need name in programs when receiving ALL; otherwise has no way to store them.
432	Floppy Illegal Prog Name	Check files being loaded. Program must be **Onnnn** and must be at the beginning of a block.
433	Floppy Empty Prog Name	Check your program. Between % and % there was no program found.
434	Floppy Load Insufficient Memory	Program received doesn't fit. Check the space available in the LIST PROG mode and possibly delete some programs.

435	Floppy Abort	Could not read disk.
436	Floppy File Not Found	Could not find floppy file.
501	Too Many Assignments In One Block	Only one assignment "=" is allowed per block. Divide block in error 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 Paren. In Expression	Unbalanced brackets, "[" or "]", were found in an expression. Add or delete a bracket.
505	Value Stack Error	The macro expression value stack pointer is in error. Call your dealer.
506	Operand Stack Error	The macro expression operand stack pointer is in error. Call your dealer.
507	Too Few Operands On Stack	An expression operand found too few operands on the expression stack. Call your dealer.
508	Division By Zero	A division in a macro expression attempted to divide by zero. Re-configure expression.
509	Illegal Macro Variable Use	See "Macros" section for valid variables.
510	Illegal Operator or Function Use	See "Macros" section for valid operators.
511	Unbalanced Right Brackets	Number of right brackets not equal to the number of left brackets.
512	Illegal Assignment Use	Attempted to write to a read-only macro variable.
513	Var. Ref. Not Allowed With N Or O	Alphabetic addresses N and O cannot be combined with macro variables. Do not declare N#1, etc.
514	Illegal Macro Address Reference	A macro variable was used incorrectly with an alpha address. Same as 513.
515	Too Many Conditionals In a Block	Only one conditional expression is allowed in any WHILE or IF-THEN block.
516	Illegal Conditional Or No Then	A conditional expression was found outside of an IF-THEN, WHILE, or M99 block.
517	Exprsn. Not Allowed With N Or O	A macro expression cannot be concatenated to N or O. Do not declare O[#1], etc.
518	Illegal Macro Exprsn Reference	An alpha address with expression, such as A[#1+#2], evaluated incorrectly. Same as 517.w

519	Term Expected	In the evaluation of a macro expression an operand was expected and not found.
520	Operator Expected	In the evaluation of a macro expression an operator was expected and not found.
521	Illegal Functional Parameter	An illegal value was passed to a function, such as SQRT[or ASIN[.
522	Illegal Assignment Var Or Value	A variable was referenced for writing. The variable referenced is read only.
523	Conditional Reqd Prior To THEN	THEN was encountered and a conditional statement was not processed in the same block.
524	END Found With No Matching DO	An END was encountered without encountering a previous matching DO. DO-END numbers must agree.
525	Var. Ref. Illegal During Movement	Variable cannot be read during axis movement.
526	Command Found On DO/END Line	A G-code command was found on a WHILE-DO or END macro block. Move the G-code to a separate block.
527	= Not Expected Or THEN Required	Only one Assignment is allowed per block, or a THEN statement is missing.
528	Parameter Precedes G65	On G65 lines all parameters must follow the G65 G-code. Place parameters after G65.
529	Illegal G65 Parameter	The addresses G, L, N, O, and P cannot be used to pass parameters.
530	Too Many I, J, or K's In G65	Only 10 occurrences of I, J, or K can occur in a G65 subroutine call. Reduce the I, J, or K count.
531	Macro Nesting Too Deep	Only four levels of macro nesting can occur. Reduce the amount of nested G65 calls.
532	Unknown Code In Pocket Pattern	Macro syntax is not allowed in a pocket pattern subroutine.
533	Macro Variable Undefined	A conditional expression evaluated to an UNDEFINED value, i.e. #0. Return True or False.
534	DO Or END Already In Use	Multiple use of a DO that has not been closed by and END in the same subroutine. Use another DO number.
535	Illegal DPRNT Statement	A DPRNT statement has been formatted improperly, or DPRNT does not begin block.
536	Command Found On DPRNT Line	A G-code was included on a DPRNT block. Make two separate blocks.

537	RS-232 Abort On DPRNT	While a DPRNT statement was executing, the RS-232 communications failed.
538	Matching END Not Found	A WHILE-DO statement does not contain a matching END statement. Add the proper END statement.
539	Illegal Goto	Expression after "GOTO" not valid.
540	Macro Syntax Not Allowed	A section of code was interpreted by the control where macro statement syntax is not permitted.
613	Command Not Allowed In Cutter Comp.	A command (M96, for example) in the highlighted block cannot be executed while cutter comp. is invoked.

End Of List

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

THE FOLLOWING ALARMS APPLY ONLY TO THE HS-1RP:

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 it's 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 it's 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 it's self-test.
1011	Main Drawbar Unclamp Timeout	The main drawbar has disengaged from the pallet nut, but did not reach the main drawbar down switch.
1012	Main Drawbar Clamp Timeout	The main drawbar has begun to travel upward, but did not reach the fully raised position within 15 seconds.

3. MECHANICAL SERVICE

RECOMMENDED TORQUE VALUES FOR MACHINE FASTENERS

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

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

3.1 WAY COVERS

UPPER Y-AXIS 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 left and right intermediate shields (five SHCS each) at the top of the Y-axis (behind the tool changer cover).

4. Remove the four SHCS that attach the upper way cover to the vertical guides.

5. Remove the seven SHCS that the attach the way cover to the spindle head.

6. Lift the bottom of the way cover to collapse it. Lift the cover up until it is above the top of the column. Pull up on one side of the way cover and slip it out from between the vertical guide and the tool changer.

INSTALLATION-

1. To install a new upper Y-axis way cover, strap both ends with nylon tie wraps (through the holes in the end mounting plates that are closest to the leaves of the cover) while the cover is fully collapsed. Ensure that the slots are aligned.

2. Carefully install cover into Y-axis vertical guides without damaging cover or guides. Once the cover is in place, cut and remove the tie-wraps.

3. Install the four SHCS at the top of the way cover. Slide the bottom of the way cover up and down to ensure it moves freely. Also, pull each leaf of the cover gently away from the column to be certain the tabs are in the guide slots.

4. Install the left and right intermediate shields at the top of the way cover with five SHCS each.

5. Install the bottom seven SHCS and tighten evenly.

Lower Y-Axis Way Cover

REMOVAL-

1. Zero return all axes.

2. POWER OFF the machine.

3. Remove the seven SHCS that attach the top of the lower Y-axis way cover to the spindle head casting. Collapse the way cover down fully.

4. Remove the X-axis chip guard (seven SHCS) that is directly below the lower Y-axis way cover.

5. Remove the four SHCS that attach the bottom of the way cover to the left and right vertical guides.

6. Remove the way cover from the bottom.

INSTALLATION-

1. To install a new lower Y-axis way cover, strap both ends with nylon tie wraps (through the holes in the end mounting plates that are closest to the leaves of the cover) while the cover is fully collapsed. Ensure that the slots are aligned.

2. Carefully install cover into Y-axis vertical guides without damaging cover or guides. Once the cover is in place, cut and remove the tie-wraps.

3. Install the four SHCS at the bottom of the way cover, and tighten evenly.

4. Attach the top of the way cover to the spindle head casting with seven SHCS. Slide the bottom of the way cover up and down to ensure it moves freely. Also, pull each leaf of the cover gently away from the column to be certain the tabs are in the guide slots.

5. Replace the X-axis chip guard and attach with seven SHCS.

3.2 TOOL RELEASE PISTON (TRP)

Tool Release Piston Replacement

TOOLS REQUIRED

- ✓ **2.5" diameter, 2.5' long steel tube**
- ✓ **Magnetic base indicators (2)**
- ✓ **TRP alignment tool, TSC (T-1519)**

REMOVAL-

1. Remove the rear enclosure panel (seven SHCS).

2. **IMPORTANT!** Jog the X-axis all the way to the operator side of the machine. Place the steel tube through the 3" diameter holes (second from bottom) on either side of the column. Ensure the tube passes completely through the column and extends out an equal distance from each side. This tube will prevent the spindle head from falling in the event of an accident.

3. Jog the Y-axis down until the bottom of the motor is approximately 1/2" above the steel tube.

4. If machine is equipped with Through the Spindle Coolant (TSC), place a tool holder in the spindle.

5. POWER OFF the machine.

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

7. Remove the seven 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.

8. Disconnect the air lines at the tool unclamp solenoid and precharge line. If machine is equipped with TSC, also remove the precharge air hose and coolant hose from the tool release spring.

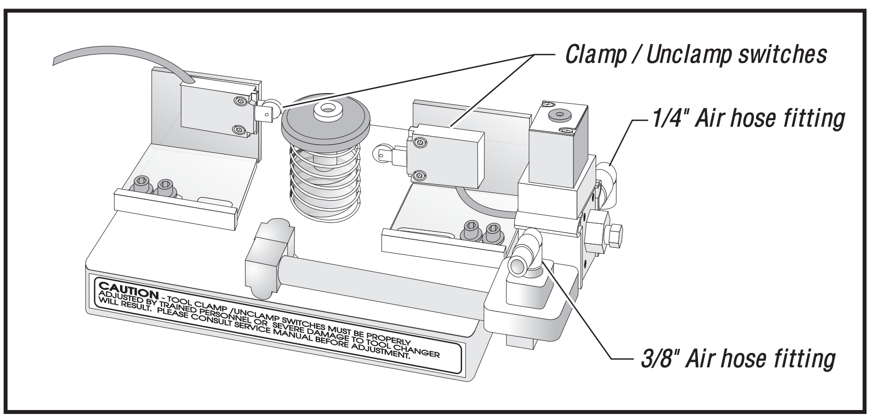


Figure 3-1. TRP assembly.

8. Disconnect clamp/unclamp cables (quick disconnect and solenoid wiring located on the solenoid bracket on top of the transmission).

9. Remove the two SHCS and two HHB holding the tool release piston assembly to the head casting.

10. Remove the entire tool release piston assembly.

Note: Step 11 applies only to machines with TSC.

11. Remove the seal housing from the tool release piston.

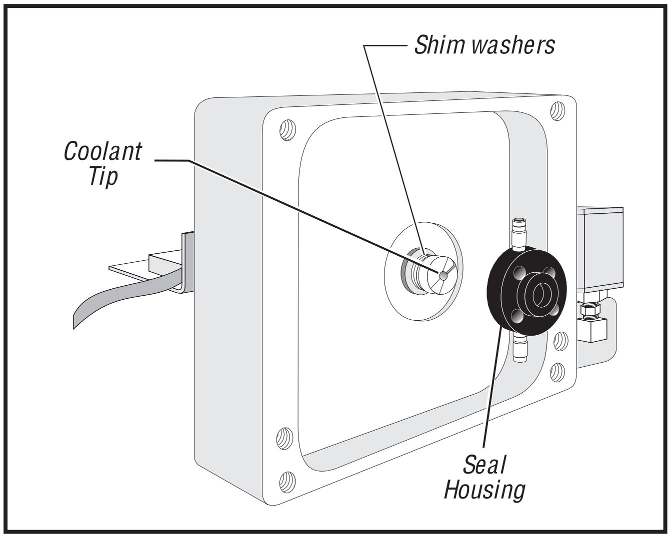


Figure 3-2. TSC tool release piston.

INSTALLATION-

1. Ensure spindle, drawbar and spindle drive belt are properly in place.

2. Loosely reinstall the tool release piston with two SHCS at the bottom and two HHB (with spacer) at the top.

3. Reconnect clamp/unclamp cables (quick disconnect and solenoid wiring located on the solenoid bracket).

4. Reconnect air lines at the tool unclamp solenoid and precharge line. If machine is equipped with TSC, also reconnect the precharge air hose and coolant hose.

5. If machine is equipped with TSC, install the coolant hose (3/8" diameter x 27" long plastic tubing) and precharge line.

6. Refer to the “Tool Clamp/Unclamp Switch Adjustment” section to verify the tool clamp/unclamp switch has been properly adjusted and the drawbar height properly set.

Note: Steps 7 through 13 apply only to machines with TSC. Steps 9-11 apply only to those machines that have a modified TSC Housing, starting with mach. serial number 50250.

7. Install the seal housing on the tool release piston (use Loctite on the screws). Connect the 5/32" drain line to the lower connector of the seal housing. The drain line connector should point toward the bottom of the machine. Connect the purge line to the top connector of the seal housing.

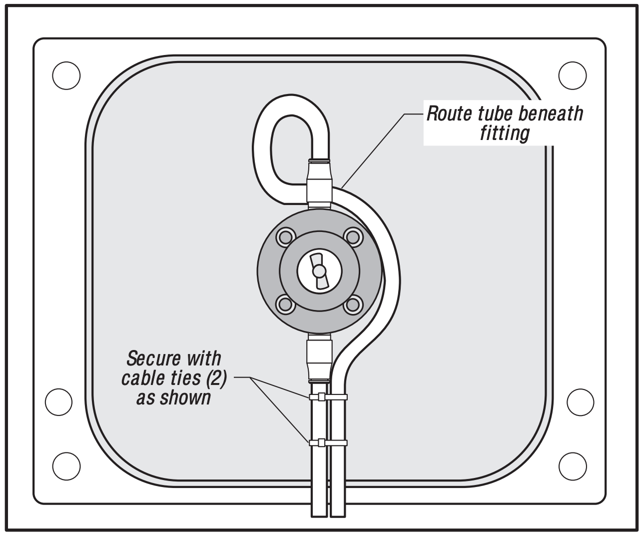


Figure 3-3. Purge line routing.

Note: The drain line must run straight through the cable tie loop on the transmission, and must not interfere with the pulley or belts.

8. Allow the bore of the seal housing to rest on the drawbar. Tighten the TRP mounting screws slightly. If you are working on a TSC system without a modified housing go to Step 12.

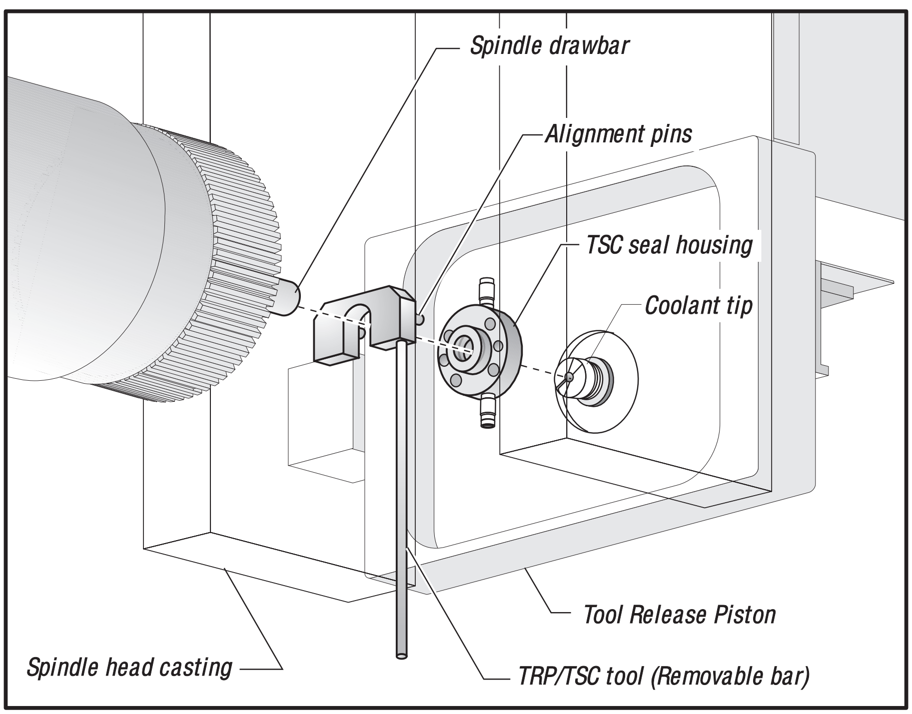


Figure 3-4. TSC Alignment Tool.

Steps 9-11 apply to machines with modified TSC housing. If not applicable, skip to Step 12.

9. Place the alignment tool (T-1519) on top of the drawbar with the pins facing the TRP.

10. Lift the TRP assembly slightly and push the pins into the TSC Housing.

11. Finish tightening the four SHCS that mount the TRP to the Spindlehead. Go to step 14.

12. Jog the spindle head upward. Place two magnetic bases on the column below the TRP. Set their indicators on opposite ends of the bottom face of the TRP housing. Set both indicator dials to zero.

13. Carefully move the TRP upward a distance of 0.005 on each indicator.

14. Tighten down the two mounting SHCS and two HHB alternately until all are completely tight.

15. Slide the lower Y-axis way cover up into place and tighten the seven SHCS.

16 **IMPORTANT!** Remove the steel tube from the column. **CAUTION!** This step must be followed or the machine will be seriously damaged.

17. Replace the rear enclosure panel with seven SHCS.

Setting Pre-Charge

CAUTION! Do not perform this procedure on machines equipped with Through the Spindle Coolant (TSC). It will damage the machine. Refer to the "TSC Adjustments" section.

1. POWER ON the machine.

2. Remove the rear enclosure panel (seven SHCS).

3. Turn the air pressure regulator down (located on top of the transmission) to zero (0). The knob must be pulled out to unlock before adjusting.

Note: At "0" pressure on the pre-charge regulator, the adjustment knob is out as far as it will turn.

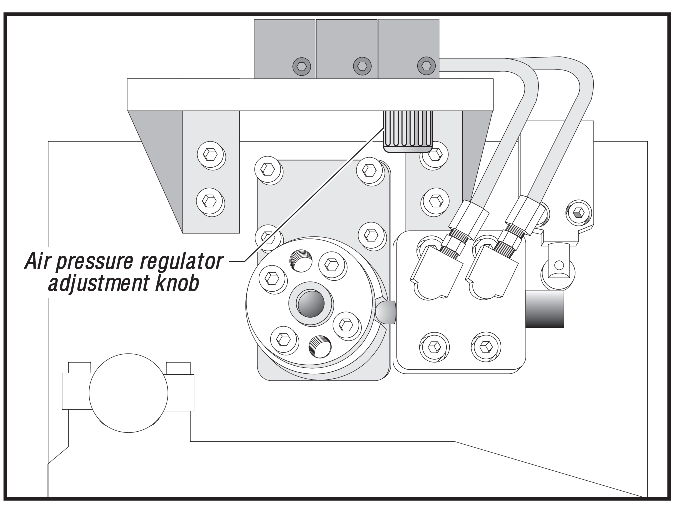


Figure 3-5. Air pressure regulator adjustment knob.

4. Go to "Parameters" page of CRT and ensure PRE-CHARGE DELAY is set to 300. If not, set it at this time.

5. Press the TOOL RELEASE button on control panel. A banging noise will be heard as the tool release piston contacts the drawbar.

6. Turn the air pressure regulator ½ turn in. Execute a tool change and listen for the banging noise. If it is heard, repeat this step until no noise is heard. There should be no noise with or without a tool in the spindle.

CAUTION! Only increase the pressure to the point where tool changes become obviously quiet. Any further pressure increases are not beneficial. Excessive pressure to the pre-charge system will cause damage to the tool changer and tooling in the machine.

3.3 SPINDLE DRIVE BELTS

Please read this section in its entirety before attempting to replace the drive belts.

TOOLS REQUIRED

- ✓ **2.5" diameter, 2.5' long steel tube**
- ✓ **Lift fixture (T-1491)**
- ✓ **Belt tensioning fixture (T-1511)**

BELT REMOVAL

Note: For easier belt removal, place transmission in high gear (M42) before beginning.

Note: When servicing drive belts, always replace BOTH belts.

1. Remove the rear enclosure panel (seven SHCS).

2. **IMPORTANT!** Jog the X-axis all the way to the operator side of the machine. Place the steel tube through the 3" diameter holes (second from bottom) on either side of the column. Ensure the tube passes completely through the column and extends out an equal distance from each side. This tube will prevent the spindle head from falling in the event of an accident.

3. Jog the Y-axis down until the bottom of the motor is approximately 1/2" above the steel tube.

4. Remove the tool release piston assembly in accordance with "Tool Release Piston Assembly Removal".

5. Remove the steel tube, and jog the Y-axis down to where the six transmission mounting SHCS can be accessed.

6. Slightly loosen and hand tighten each of the six transmission mounting SHCS, one at a time.

7. Move the transmission down (if it is not already) by shaking it from the back of the motor, until there is slack in the spindle drive belts. Remove the belts from the spindle and drive pulleys.

Note: DO NOT bend or kink the belts in any way; damage to the fibers in the belt may result, and it will fail soon after installation.

BELT INSTALLATION

1. From the rear of the machine, install the new belts onto the top (drive) pulley. From the front of the machine, place the belts on the bottom pulley.

Note: Be careful not to damage the inside of the belts.

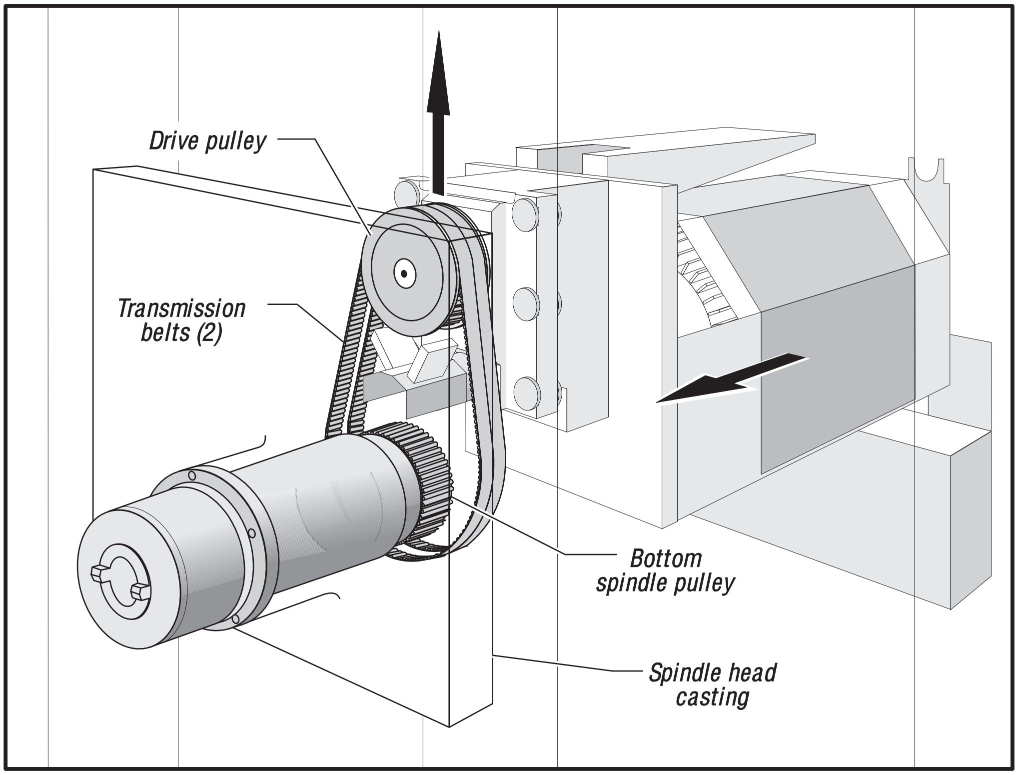


Figure 3-6. Spindle drive belt replacement.

2. Install the tool release piston assembly in accordance with appropriate section, and reconnect all switches and air lines.

3. Loosen the top two transmission mounting SHCS about 1-1/2 turns.

4. Refer to the "Belt Tension" section and tension the belts.

5. Reset the spindle orientation in accordance with the appropriate section.

Note: The following step is necessary only if the spindle or transmission was exchanged prior to belt replacement.

6. Double-check the spindle sweep to assure that nothing has moved during the previous steps. If sweep is within tolerance, continue; if not, sweep must be readjusted.

Note: Drive belt tension must be adjusted after every installation.

7. Slide the lower Y-axis way cover up into place and tighten the seven SHCS.

8. **IMPORTANT!** Remove the steel tube from the column. **CAUTION!** This step must be followed or the machine will be seriously damaged.

9. Replace the rear enclosure panel (seven SHCS).

BELT TENSION ADJUSTMENT

Note: The drive belt's tension should be adjusted after every service on the transmission or spindle of the machine.

1. Place the lift fixture onto the transmission (Figure 3-7). Attach to the motor mounting plate with two SHCS.

2. Place the two bars (3/4" diameter) of the belt tensioning fixture through the top two holes (1" diameter) in the column. Set the fixture plate in place on the two bars, with the eyeholes facing downward.

3. Hook the three springs into the eyeholes of the fixture plate. Jog the Y-axis up into place, then hook the other end of the springs into the eyebolts of the lift fixture.

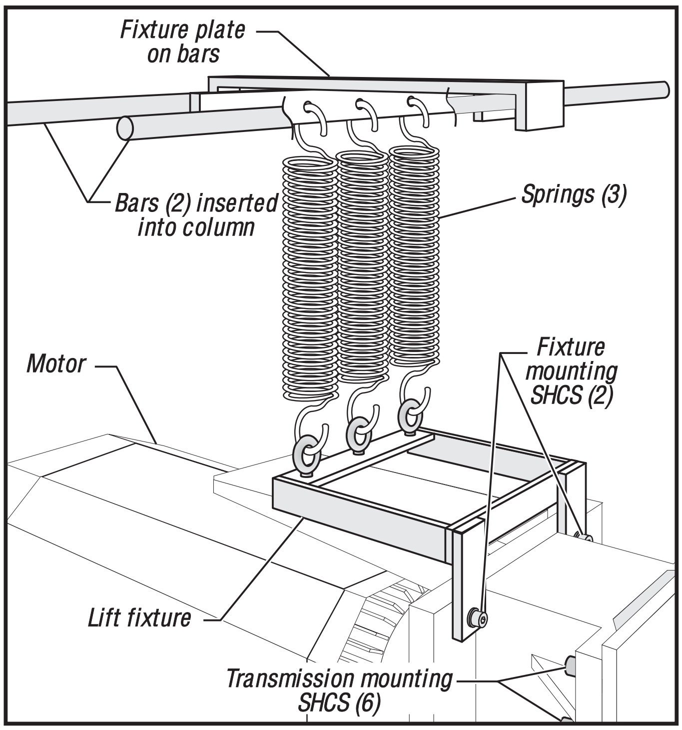


Figure 3-7. Belt tensioning fixture shown in place.

4. Jog the Y-axis down until the spring hooks are just touching the top of the eyebolts on the lift fixture.

5. Zero the POSITION display screen in the control. Jog the Y-axis down exactly 8.5 inches. Monitor the screen to verify the position. The belt is correctly tensioned.

Note: A belt that is correctly tensioned will whine slightly, and requires approximately 12 hours of break-in time.

6. Tighten down the six transmission mounting SHCS, beginning with the bottom two.

7. Run the spindle at various speeds and listen for any unusual noise or vibration. If there are any problems, examine the belts for damage, and replace if necessary.

CAUTION! Ensure all parts of the belt tensioning fixture and transmission lift fixture are removed before running the machine. Serious machine damage could occur if any of these are left on the machine.

3.4 SPINDLE

TOOLS REQUIRED
✓ **2.5" diameter, 2.5' long steel tube**

SPINDLE CARTRIDGE

REMOVAL-

1. Remove the rear enclosure panel (seven SHCS).

2. **IMPORTANT!** Jog the X-axis all the way to the operator side of the machine. Place the steel tube through the 3" diameter holes (second from bottom) on either side of the column. Ensure the tube passes completely through the column and extends out an equal distance from each side. This tube will prevent the spindle head from falling in the event of an accident.

3. Jog the Y-axis down until the bottom of the motor is approximately 1/2" above the steel tube.

4. Remove tool release piston assembly in accordance with appropriate section.

5. Remove spindle drive belts in accordance with appropriate section.

6. Remove quick disconnect air line (1/4" O.D., 3/16" I.D.) at back side of spindle cartridge.

7. Remove the six SHCS that mount the spindle to head casting.

8. 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. Increase the air pressure to clear out any contamination in the lubrication line. Once the line is cleaned out, return pressure to 3 psi.

3. Carefully install new spindle into bored sleeve of head casting. Apply grease to the inside of the through bore in the spindle head (see Figure 3-8).

NOTE: Spindle is a grease-packed cartridge.

CAUTION! The spindle nose has a drain hole at the front and should be pointed down.

4. Evenly tighten the six mounting SHCS on the front side of the spindle in a cross pattern until all bolts are completely tight.

5. Install spindle drive belts in accordance with appropriate section.

6. Connect the air line at the rear of the spindle cartridge. Check the pressure gauge at the rear of the lube/air panel. It should be 3 psi.

7. Install the tool release piston assembly in accordance with appropriate section. Adjust for proper tool push and switch settings.

8. Reset spindle orientation and check the tool changer adjustment.

9. Refer to the "Spindle - Overheating" section of "Troubleshooting" and run the spindle break-in program. Verify that spindle temperatures are acceptable.

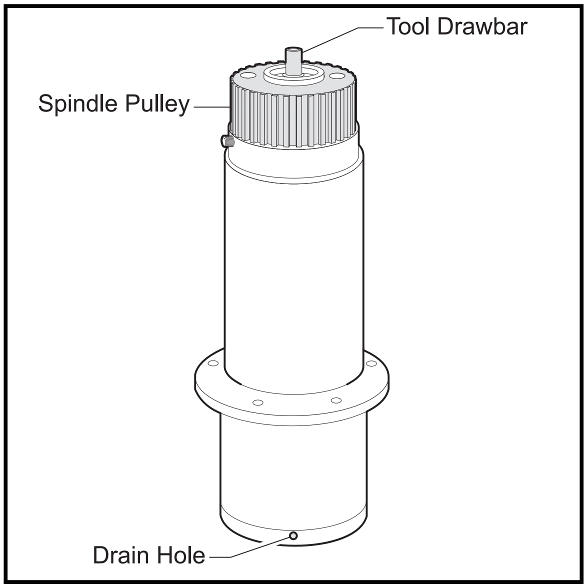


Figure 3-8. Spindle cartridge.

10. **IMPORTANT!** Remove the steel tube from the column. **CAUTION!** This step must be followed or the machine will be seriously damaged.

11. Replace the rear enclosure panel with seven SHCS.

Spindle Orientation

1. Remove the rear enclosure panel (seven SHCS).

2. In MDI mode, press the ORIENT SPINDLE key.

3. Loosen the four SHCS on the orientation ring (Figure 3-9). Remove two of these screws and insert them into the two threaded holes in the ring. Evenly tighten these two screws until the taper lock is broken free from the shaft.

4. Remove the two screws and place them into their original holes. Tighten them finger tight, then 1/2 turn more. Ensure that the orientation ring is snug, but not tight.

5. Set up a magnetic base with a 0.0005" indicator on the table. Zero the indicator on the spindle dogs parallel to the Y-axis travel.

6. Jog the spindle dogs across the indicator and note the indicator reading. The spindle dogs should be parallel to the Y axis within 0.010". If the reading is acceptable, skip to Step 8.

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

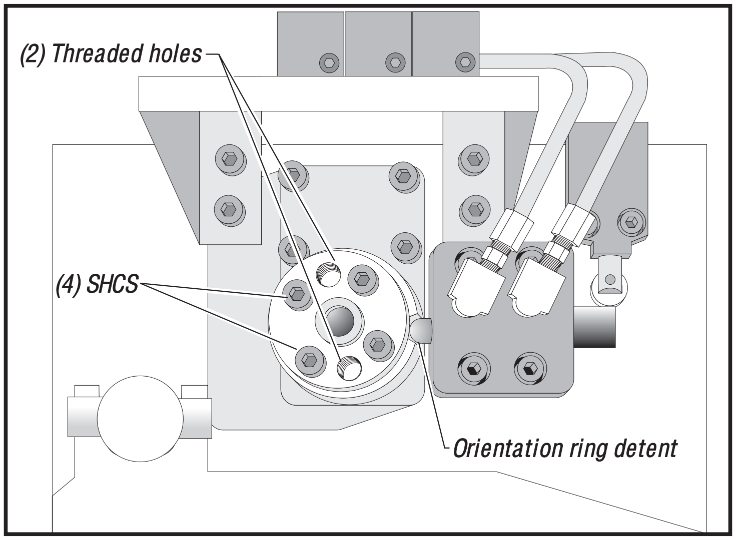


Figure 3-9. Rear view of spindle orientation components.

7. Using an open end wrench, rotate the spindle until the appropriate alignment is attained. If the spindle is very difficult to rotate, STOP and return to Step 3.

8. Tighten the orientation screws evenly to 15 ft-lbs. Verify that spindle alignment has not changed.

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

9. Make at least 100 tool changes to test the spindle orientation.

10. If the spindle is found to be out of alignment, check all tool changer alignments.

11. Replace the rear enclosure panel with seven SHCS.

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" tool 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.

Orientation - Vector Drive

1. Place the machine in low gear.

2. Adjust Parameter 257, "SPINDL ORIENT OFSET", until the spindle dogs are parallel to the X-axis. Ensure that the dogs are within 0.030" using a dial indicator. See *Figure 3-10.*

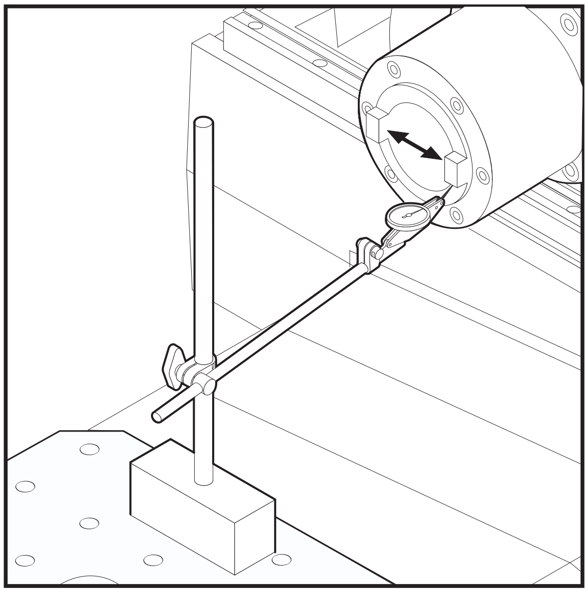


Figure 3-10

3.5 DRAWBAR REPLACEMENT

TOOLS REQUIRED

✓ **2.5" diameter, 2.5' long steel tube**

REMOVAL-

1. Remove the rear enclosure panel (seven SHCS).

2. **IMPORTANT!** Jog the X-axis all the way to the operator side of the machine. Place the steel tube through the 3" diameter holes (second from bottom) on either side of the column. Ensure the tube passes completely through the column and extends out an equal distance from each side. This tube will prevent the spindle head from falling in the event of an accident.

3. Jog the Y-axis down until the bottom of the motor is approximately 1/2" above the steel tube.

4. Place an empty tool holder in the spindle.

5. Remove the tool release piston in accordance with the appropriate section.

6. Remove the snap ring from the top of the spindle shaft.

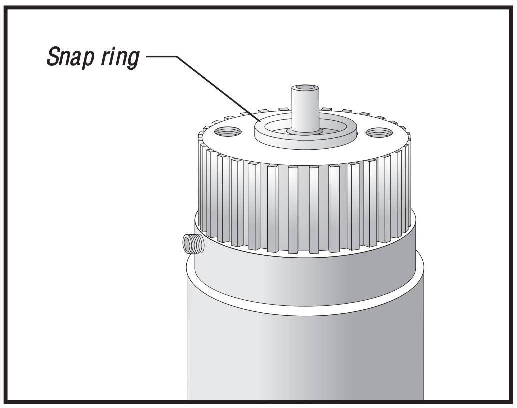


Figure 3-11. Snap ring removal.

7. Remove the tool holder from the spindle.

8. Remove the spindle in accordance with the "Spindle Cartridge" section.

9. Remove the drawbar from the spindle assembly.

INSTALLATION-

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

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

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

3. Install the spindle cartridge. Reinstall the tool release piston in accordance with the appropriate section.

4. Install a tool holder without a cutter into the spindle taper.

5. Remove the tool release piston.

6. Install the snap ring on the spindle shaft.

7. Reinstall the tool release piston.

8. Complete installation of the spindle.

9. Refer to the appropriate sections and set the drawbar height, and clamp and unclamp switches.

NOTE: Step 10 must be followed or damage to the Automatic Tool Changer will result.

10. Set the spindle orientation.

11. **IMPORTANT!** Remove the steel tube from the column. **CAUTION!** This step must be followed or the machine will be seriously damaged.

12. Replace the rear enclosure panel with seven SHCS.

13. Test-run the machine and adjust the ATC as necessary.

3.6 TOOL CLAMP/UNCLAMP SWITCH ADJUSTMENT

TOOLS REQUIRED

- ✓ **Right angle plate**
- ✓ **Machined aluminum block (2"x4"x4")**
- ✓ **Flexible ruler**
- ✓ **1" diameter pipe or pry bar**

Tool Clamp/Unclamp Switch Adjustment - Initial Preparation

1. Remove the rear enclosure panel (seven SHCS). Disconnect the lower Y-axis way cover from the bottom of the spindle head and collapse it downward.

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

3. Place a sheet of paper on the table for protection, then 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.

8. The clearance from the tool holder to the block should be zero (0). To accomplish this, set the jog increments to .001 and jog in the negative (-) Z direction a few increments at a time. Between these moves, push the TOOL RELEASE button and feel for movement by placing your finger between the tool holder and the spindle. ***Do this until no movement is felt.*** You are now at zero (0).

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

Setting Drawbar 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 washers that must be added to the tool release bolt (or coolant tip for TSC). Refer to the "Shim Washers" 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 are the amount of shim washers that must be removed from the tool release bolt (or coolant tip for TSC). Refer to the "Shim Washers" section.

Shim Washers

1. To add or subtract shim washers, remove the tool release piston assembly in accordance with the "Tool Release Piston" section.

Note: Shims may need replacement when the spindle cartridge, tool release piston assembly, or drawbar is replaced.

2. Remove the tool release bolt. If the machine is equipped with TSC, loosen the three set screws and remove the coolant tip.

3. Add or subtract the required number of shim washers (from previous section).

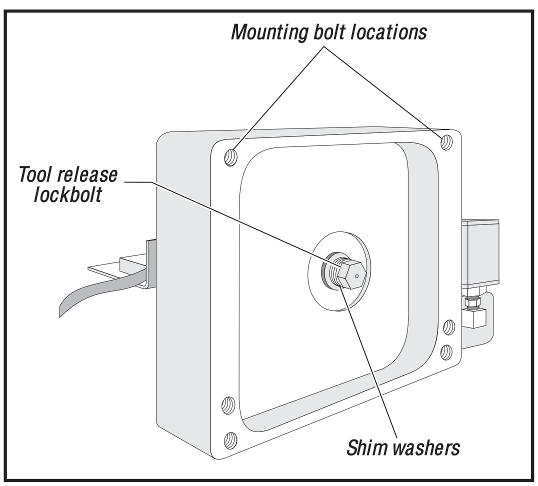


Figure 3-12 Shim location (without TSC).

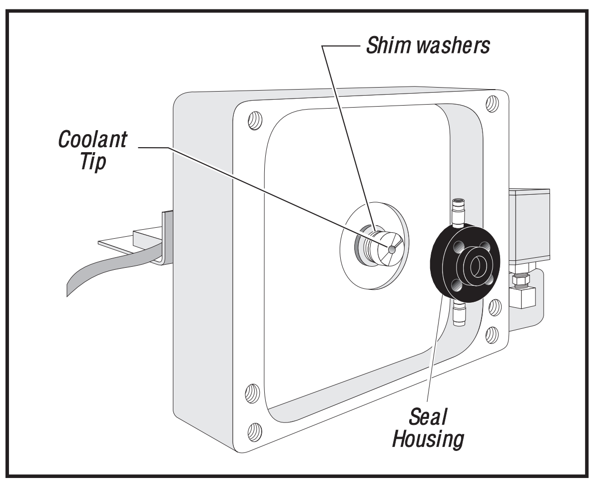


Figure 3-13. Shim location (with TSC).

4. Put a drop of serviceable (blue) Loctite® on the threads of the tool release bolt and install. If replacing tool release coolant tip, put a drop of Loctite® on the threads of the three set screws before installing.

5. Install the tool release piston assembly and recheck settings. If within specifications, continue; if not, readjust.

LOWER (UNCLAMP) SWITCH

1. Push the PARAM/DGNOS button (top center) twice. You are now in diagnostics mode. Look at the bottom left corner of the page and you should see DB OPN 0 (tool unclamped) and directly under that, DB CLS 1 (tool clamped). If not, push PAGE DOWN until you do. A "1" means that particular switch is being tripped. A "0" means it is not being tripped.

2. With the tool holder resting on the block and set at zero ("Setting Drawbar Height" section), jog Z-axis in the positive (+) direction .06.

3. Press the tool release button and hold it. DB OPN should change from a "0" to a "1". If it does not, slightly loosen the two ¼-20 x ½" SHCS holding the unclamp switch bracket (switch on right) to the tool release assembly.

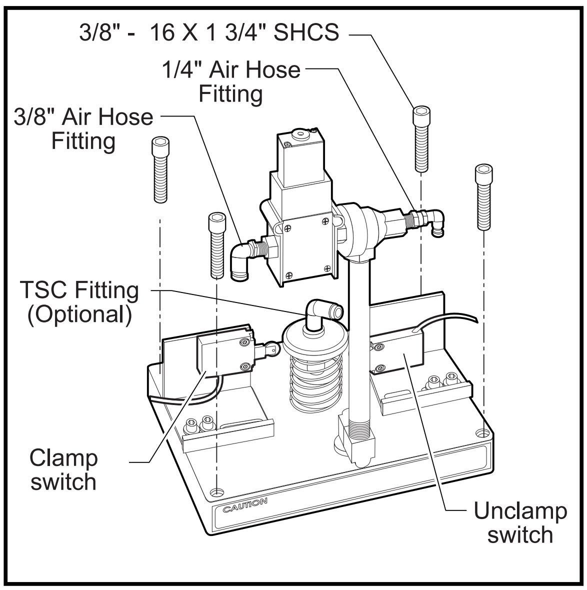


Figure 3-14. Tool release piston assembly.

4. While activating tool release, tap unclamp switch assembly towards spring retainer until it just trips. Switch must trip at .060 +/- .010.

THIS ADJUSTMENT IS VERY IMPORTANT FOR PROPER TOOL CHANGER OPERATION, AND MUST BE PROPERLY SET!

5. Check the adjustment by setting the jog handle at .06 and activating the tool release. The DB OPN signal should be a "1". If the adjustment is not correct, adjust until it is within specifications. You may have to readjust the switch several times. Set jog handle at 0.050 and activate tool release DB OPN signal should be a "0".

UPPER (CLAMP) SWITCH

CAUTION! Remove the tool holder from the spindle before performing the upper (CLAMP) switch adjustment. Failure to remove it could result in damage to the tool holder, the mill table, or cause severe personal injury.

6. Place a shim (approximately .020 thick), or the flexible ruler, between the tool release piston adjustment bolt and the drawbar. For TSC equipped machines, this step must be done with the seal housing removed.

7. Move the tool release piston in so the shim is pressed against the drawbar. This can be done in one of the following two ways:

- Using the pipe or pry bar as a lever, ***carefully*** push on the piston until it contacts the drawbar and the shim is held in place. Push the piston down until it contacts the drawbar and the shim is held in place. Monitor the "Tool Unclmp" status in the Diagnostics display.

IMPORTANT! Use extreme care when performing this procedure on TSC equipped machines, or the pipe fitting will break off the top of the TRP shaft.

- If the machine is equipped with the "MACROS" option: in MDI, program #1120=1 and execute. This will energize the pre-charge solenoid, bringing the TRP in contact with the drawbar (no prying is necessary). To de-energize the solenoid, press RESET.

8. While the tool release piston is against the shim, move the switch bracket all the way in and check for "Tool Unclmp" status on the CRT (DB OPN=0, DB CLS=0), and tighten the bracket bolts. If not, move the switch out until "Tool Unclmp" status appears on the CRT and then tighten the bolts.

9. Check the switch several times. This is done by moving the piston in and out to ensure that the "Tool Unclmp" status appears when the piston makes contact with the shim and drawbar, and does not appear when it is in the retracted position. "Tool Unclmp" status appears on the screen as (DB OPN=0, DB CLS=0).

Note: For TSC equipped machines refer to "Tool Release Piston Replacement" section for proper installation and alignment of seal housing.

10. Replace the rear enclosure panel with seven SHCS. Replace the lower Y-axis way cover in accordance with the appropriate section.

3.7 TRANSMISSION

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

TOOLS REQUIRED

- ✓ **Transmission removal kit, includes:**
  - **transmission removal fixture (T-1482)**
  - **transmission lift fixture (T-1491)**
- ✓ **Chain hoist**

REMOVAL-

1. Remove the rear enclosure panel (seven SHCS).

2. Press RESET. Jog the Z-axis all the way back, and the X-axis to the center of it's travel. This will allow easier access to the motor from the rear of the machine.

3. **IMPORTANT!** Jog the X-axis all the way to the operator side of the machine. Jog the Y-axis all the way up. Place the steel tube through the 3" diameter holes (second from bottom) on either side of the column. Ensure the tube passes completely through the column and extends out an equal distance from each side. This tube will prevent the spindle head from falling in the event of an accident.

4. Jog the Y-axis down until the bottom of the motor is approximately 1/2" above the steel tube. EMERGENCY STOP the machine.

5. Loosen (but DO NOT REMOVE) the six SHCS holding the transmission to the spindle head. Gently shake the motor from the back to make sure there is slack between the spindle drive belts and pulleys.

6. Remove the seven SHCS that attach the lower Y-axis way cover to the spindle head, and collapse it downward. It is easiest to reach the tool release piston and motor wires through the front of the machine.

7. Remove the two SHCS and two HHB that hold the tool release piston to the head casting, but DO NOT disconnect the air hoses and switches.

8. Remove both spindle drive belts. Replace the tool release piston and hand tighten the two SHCS and two HHB.

9. **IMPORTANT!** Remove the steel tube from the column. **CAUTION!** This step must be followed or the machine will be seriously damaged.

10. Press RESET. Jog the Z-axis all the way back, and the X-axis to the center of it's travel. This will allow easier access to the motor from the rear of the machine.

11. Jog the Y-axis until the two lower holes in the column and the corresponding holes in the spindle head are aligned (at approx. Y=16.25"). Place two of the original shipping lockbolts (5/8-11 x 4" SHCS) through the two holes and snug tighten. **CAUTION!** This step must be followed to keep the spindle head from moving during service. If this is not done, serious injury could occur.

12. POWER OFF the machine and disconnect the main air line.

13. Disconnect all electrical lines and air lines from the transmission solenoid bracket.

Note: The motor wires can be disconnected from the front of the machine.

Disconnect the electrical and oil lines from the oil pump. Plug the oil lines to prevent contamination. Most of the lines should be marked and identified. If not marked, do so as it is removed.

If machine is equipped with the Through the Spindle Coolant option, remove the pressure regulator, check valve assembly, and bracket from the old transmission, so they can be installed later on the new transmission.

14. Place the lift fixture onto the transmission (Figure 3-15). Attach to the motor mounting plate with two SHCS (1/2-13 x 1-1/4).

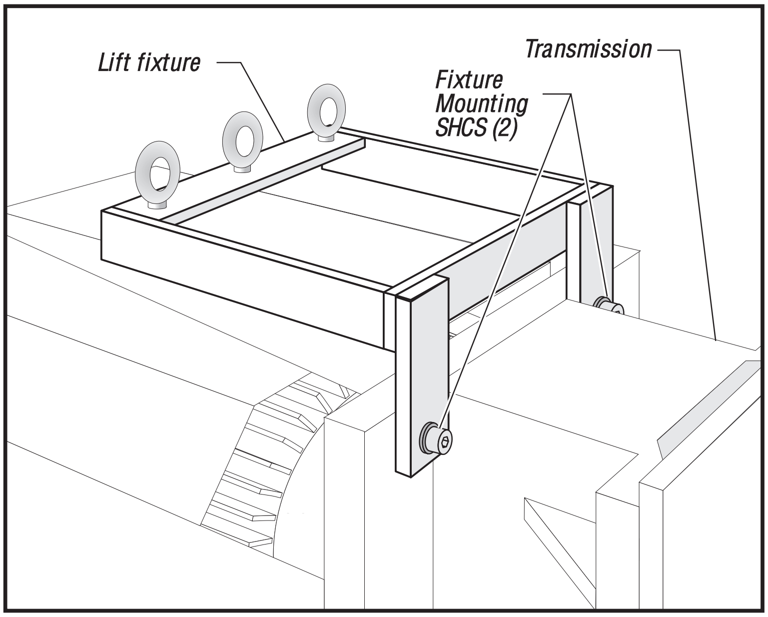


Figure 3-15. Transmission lift fixture.

15. Secure the transmission removal fixture support bracket to the back of the column with four SHCS.

16. Assemble the support arms (3) of the transmission removal fixture by placing a thrust washer at the bottom of each joint and inserting the dowel pins from the top side (Figure 7-2). Grease the joints to ensure smooth arm movement.

17. Hook the chain hoist onto the transmission removal fixture, then attach the chain's hook onto the center eyebolt of the lift fixture.

18. Remove **ALL** slack in the hoist's chain, then remove the six transmission mounting SHCS. **CAUTION!** The transmission might swing out when the mounting screws are removed, so hold it in place and ***carefully*** swing the transmission out of the back of the machine. Lower the transmission to the ground or a pallet.

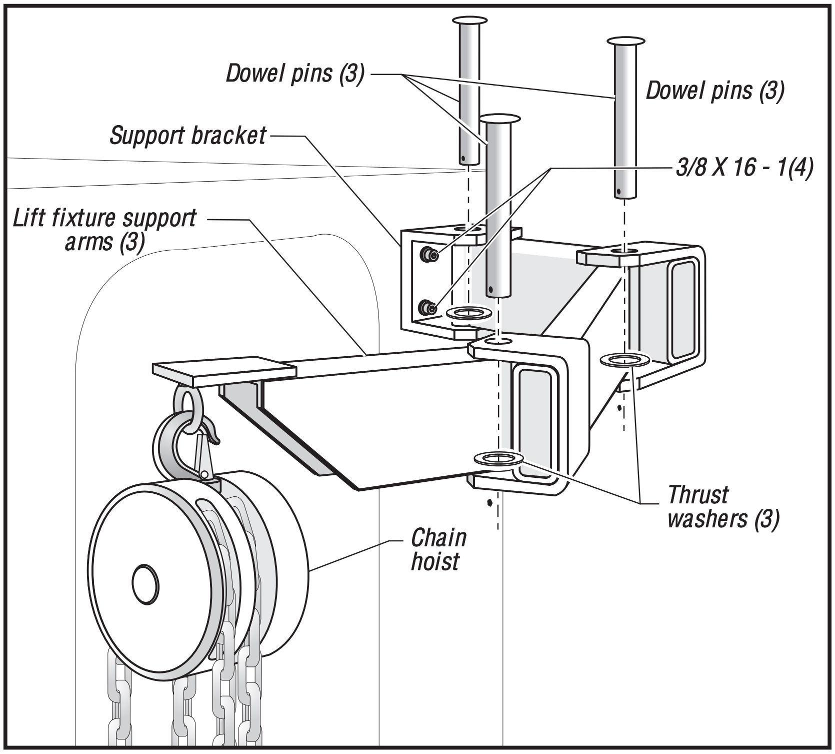


Figure 3-16. Transmission removal fixture and chain hoist.

INSTALLATION-

1. If machine is equipped with Through the Spindle Coolant option, reinstall the pressure regulator, check valve assembly, and bracket onto the new transmission.

2. Remove the lift fixture from the old transmission and place it on the new transmission.

3. Hook the chain hoist onto the transmission removal fixture, then attach the chain's hook onto the center eyebolt of the lift fixture.

4. Hoist the transmission into place. Only lift the transmission high enough to clear the enclosure and to swing into place.

5. Grease the rubber vibration isolators on the new transmission with general purpose grease.

6. Lift the new transmission up close to the spindle head, and secure it with six SHCS. Make sure the transmission is all the way down in the clearance holes. Tighten the two top transmission mounting SHCS.

7. Remove the transmission lift fixture from the transmission, and the transmission removal fixture from the column.

8. **IMPORTANT!** Isolate the three motor wires, which are to be connected later. This keeps the wires from getting shorted out.

9. Reconnect all electrical and fluid lines. Replace any leaking or kinked lines at this time, if necessary.

10. **IMPORTANT!** Remove the two shipping lockbolts from the column and spindle head.

CAUTION! Serious machine damage will occur if the axes are moved with the lockbolts in place.

11. Zero return the machine. Jog the Y-axis all the way up.

12. **IMPORTANT!** Insert the steel tube in place through the column, as described in the "Removal" section. Connect the three motor wires and the ground wire to the motor.

13. Remove the tool release piston in accordance with the appropriate section.

14. Install the drive belts in accordance with the "Spindle Drive Belts - Belt Installation" section.

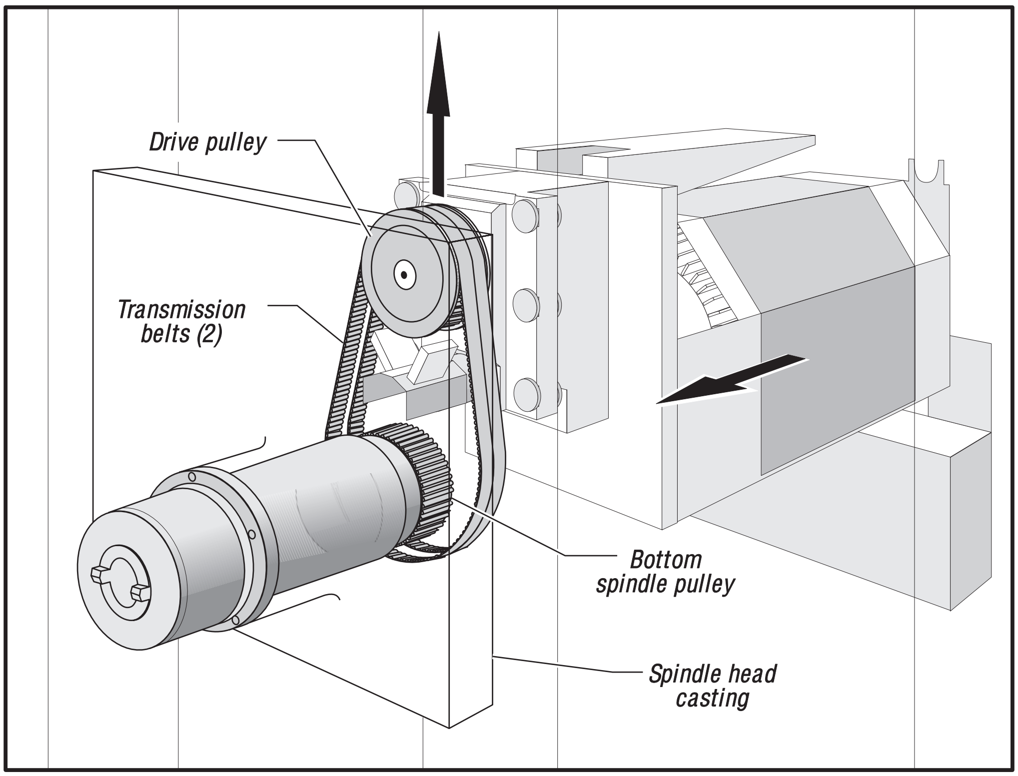


Figure 3-17. Drive belt replacement (after transmission replacement).

15. **IMPORTANT!** Remove the steel tube from the column. **CAUTION!** This step must be followed or the machine will be seriously damaged.

16. Replace the rear enclosure panel with seven SHCS. Slide the lower Y-axis way cover into place and replace the seven SHCS.

3.8 TOOL CHANGER ASSEMBLY

CT-Extractor Replacement

REMOVAL -

1. Zero return all axes and remove any tooling.

2. Rotate the carousel into position by pressing M39 T_ (Enter the tool position number that needs replacement.)

3. Jog the Y-axis down, away from the tool changer.

4. POWER OFF the machine.

5. Retract the carousel door and clamp open. **CAUTION!** The door spring is under high tension.

6. Remove one SHCS that fastens the extractor to the carousel. **CAUTION!** The extractor spring is under high compression. Once it is removed, one extractor and the spring should come out. Remove the other SHCS to remove the extractor clip and block.

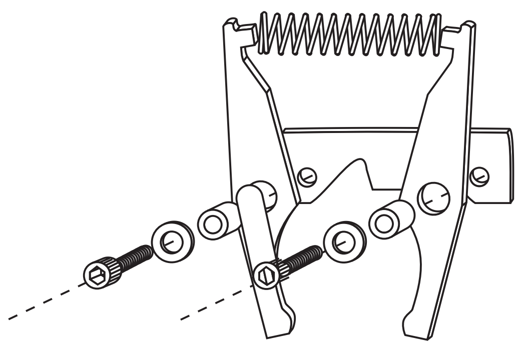


Figure 3-18. C-T Extractor Assembly.

INSTALLATION-

Assembly Parts:

(2) extractor clips
(2) extractor sleeves
(2) screws and (2) washers
(1) extractor block
(1) compression spring

NOTE: Be sure to check for proper extractor assembly orientation.

7. Insert sleeve into pivot hole of each extractor and assemble each extractor with a SHCS and hard washer (round edge facing head of screw). Before mounting the assembly to the carousel, apply a small amount of semi-permanent Loctite® to each screw, then thread the screws just a few turns.

8. Place one end of the spring onto the top notch of the extractor and pivot the opposite extractor until both ends are firmly seated.

9. Evenly tighten the extractor screws to the carousel housing.

10. Verify the extractor assembly is properly oriented for the tool type.

CAROUSEL MOTOR

REMOVAL-

1. POWER OFF the machine.

2. Disconnect the carousel wire harness at carousel motor junction box.

3. Remove the four bolts mounting motor to carousel reduction transmission.

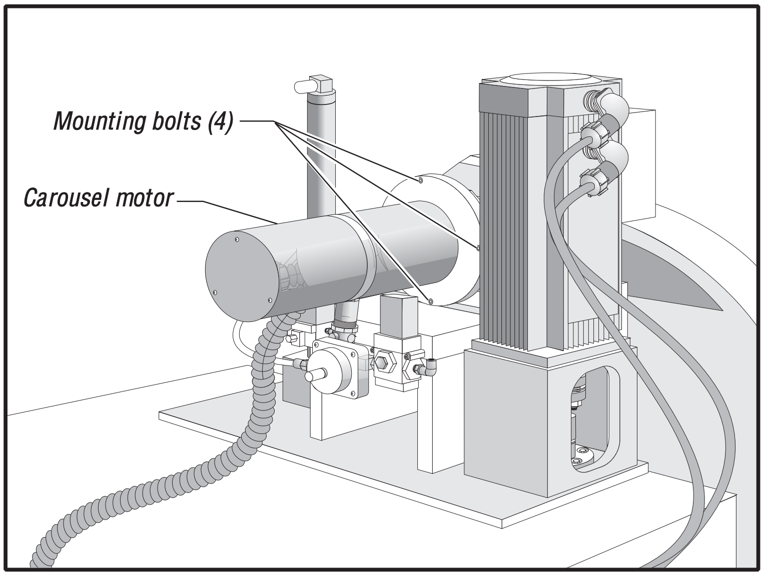


Figure 3-19. Tool changer carousel motor.

4. Motor output shaft locates on a keyway and will pull directly out.

INSTALLATION-

5. Line up keyway with output shaft and slide motor into place.

6. Tighten the four motor mounting bolts to the carousel transmission box.

7. Reconnect the wire harness to the carousel motor.

8. Check that the carousel indexing alignment is correct by doing a ZERO RET / AUTO ALL AXES. Adjust the rotational offset, Parameter 215, according to the "Tool Changer Alignment" section.

TOOL CHANGER DOOR

REMOVAL-

1. Disconnect the air supply to the machine.

2. Disconnect the door spring.

3. Remove the rubber bumper and door return spring from the back side of the carousel cover.

4. Remove the air door cylinder swivel mount from the cylinder front mount.

NOTE: The air door cylinder is under spring tension.

5. Remove the cylinder front mount from the door, being careful not to lose the small spring or nylon door slider.

6. Rotate the trap door clockwise past the "closed" position. Continue rotating and gently pull down on the door. It will slide down once it has been rotated far enough.

INSTALLATION-

1. Clean the washer contact surface of the tool changer cover, and apply a thin coat of grease.

2. With the door rotated to the right slightly, lift the door up between the carousel cover and the tool changer front plate, making sure the door nylon washer is between the door and the cover.

3. With the door in the up position, rotate the door counterclockwise past it's normal "closed" position to it's normal "open" position to assure smooth operation.

4. Replace the rubber bumper on the back side of the carousel cover.

5. Apply a small coat of grease to the inside of the carousel cover, just above the door opening. Also apply grease to the nylon door slider and small spring.

6. Install the cylinder front mount, being sure the nylon door slider and spring are in place.

7. Install the cylinder swivel mount onto the cylinder front mount.

8. Install the door return spring on the back of the carousel.

9. Check for smooth operation and adjust the air door regulator (located on top of the tool changer) to assure adequate opening of the door.

TOOL CHANGER CAROUSEL REPLACEMENT

REMOVAL-

1. Center the X-axis. Jog the Y-axis all the way down.

2. Manually open the tool changer door and brace it open.

3. Turn off the three circuit breakers on the Power PCB.

Note: This allows no power to the motors and keeps the lights on.

CAUTION! Make sure that fingers are clear of carousel while performing the following:

4. Press the carousel "IN" solenoid and hold it while someone places a 4 x 4 to hold the carousel in the "IN" position.

5. With the 4x4 in place and all fingers clear, release the "IN" solenoid.

6. Remove the four SHCS that mount the gearbox to the top mounting plate. (Fig. 3-20 #1)

7. Tilt the motor forward and remove the belt.

8. Remove the four SHCS that secure the (2) switch brackets and place them clear of the large pulley (Fig. 3-20, #2).

CAUTION! Make sure that fingers are clear of carousel while performing the following:

9. While someone holds the 4x4 (fingers clear), press the turret "IN" solenoid and hold while the 4x4 is removed.

10. After the 4x4 is removed, release the "IN" solenoid.

11. Remove the six SHCS that mount the clyinder cap to the carousel. (Fig. 3-20, #3)

12. Remove the hex nut that attaches the shock absorber to the cylinder cap (Fig 3-20, #5)

13. Remove the cylinder cap.

14. Remove the six SHCS that attach the locking cap to the shaft assembly(Fig 3-20, #6)

15. Slide the carousel assembly off.

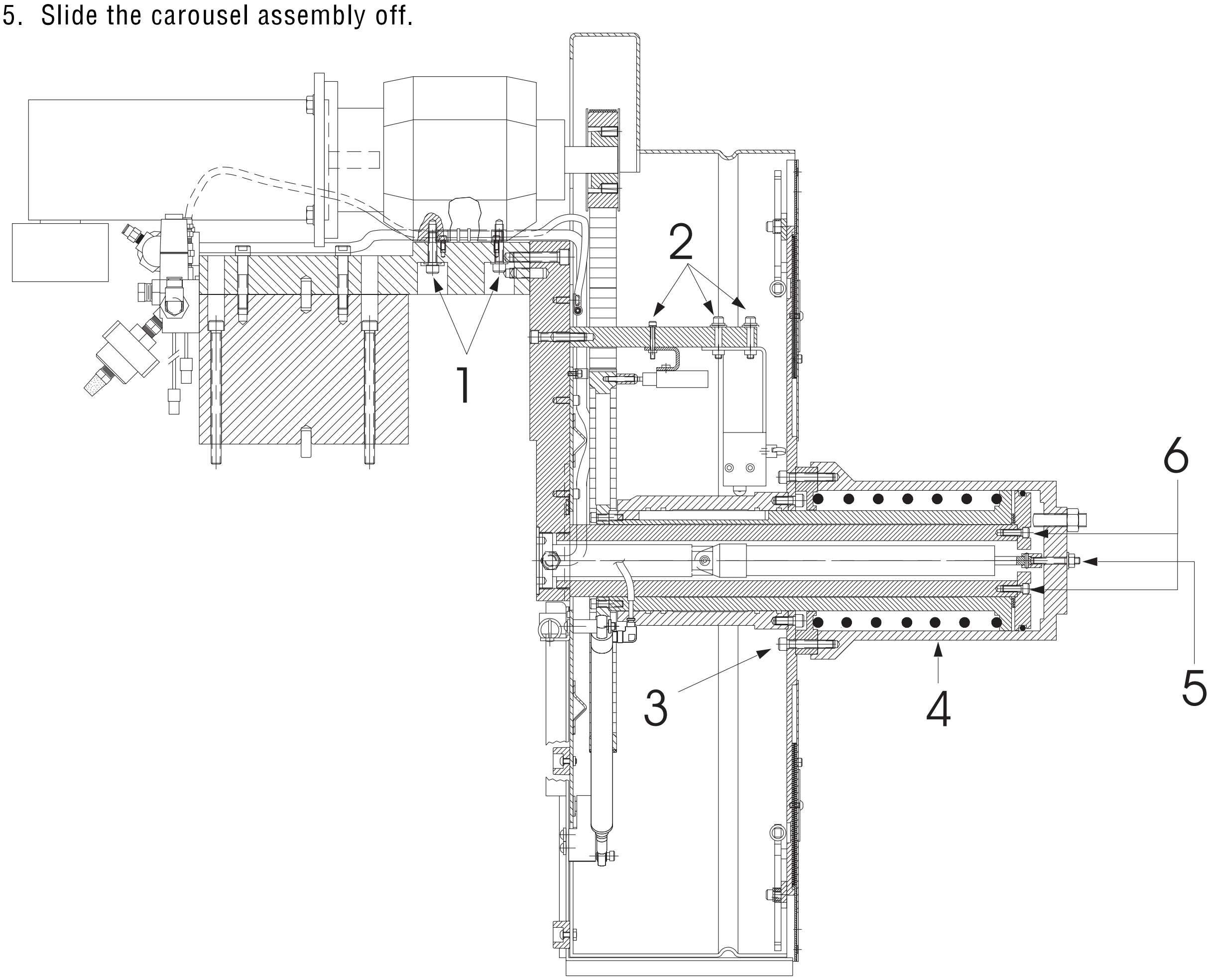


Figure 3-20. Carousel replacement.

INSTALLATION-

1. Grease the tool changer shaft.

2. Ensure the drive belt is in place before installing the carousel. Slide the carousel assembly on the shaft.

3. Place the belt on the drive pulley.

4. Install the locking cap. (Fig. 3-20, #6)

5. Install the cylinder cap. Pull the shaft of the shock absorber through the front hole of the cylinder cap.

6. Install the shock absorber nut. (Fig. 3-20, #5)

7. Install the six SHCS that attach the cylinder cap to the carousel.(Fig. 3-20, #3)

CAUTION! Make sure that fingers are clear of turret while performing the following:

8. Carefully press the turret "IN" solenoid and hold while someone places a 4x4 to hold the turret in the "IN" position.

9. With the 4x4 in place and all fingers clear, release the "IN" solenoid.

10. Install the switch bracket and four SHCS. (Fig. 3-20, #2)

11. Tilt the motor forward and mount the belt to the pulley.

12. Install the four SHCS that mount the gearbox to the top mounting plate. (Fig. 3-20, #1)

13. While someone holds the 4x4 (fingers clear), press the turret "IN" solenoid and remove the 4 x 4.

14. Release the "IN" solenoid.

15. Turn the three circuit breakers on the Power PCB back on.

16. Go to the next section and perform all aligment procedures under Tool Changer Alignment.

TOOL CHANGER ALIGNMENT PROCEDURES

Carousel In/Out Procedure:

1. Check that the main air regulator is set at 85 psi.

2. Zero return all axes.

3. In MDI mode, type "T1" and press ATC FWD. Turn Setting 7 off.

4. Select the ALARM page. Type "debug" and press the WRITE key.

5. Press the ORIENT SPINDLE key.

NOTE: Ensure the tool pushout switch adjustment for tool clamp/unclamp adjustment has been completed.

6. Manually open and secure the air door.

7. In HANDLE JOG mode, select the Y axis. Slowly move the Y axis up towards the spindle until the extractor on station #1 is close to engaging the tool holder.

8. Ensure that the tool carousel in/out adjustment is correct by checking the centerline of the tool extractor groove in reference to the extractor centerline.

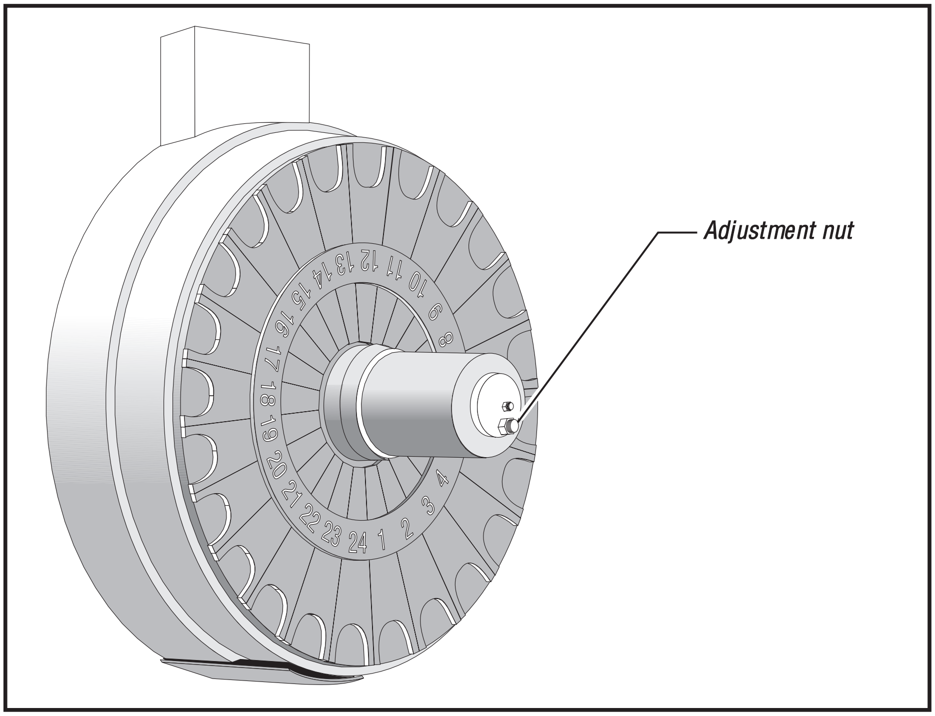


Figure 3-21. Tool Changer IN/OUT adjustment nut

NOTE: Do not loosen the 1/4" nut located at center. Tighten the 1/2" locknut without turning the adjustment screw.

Adjustments are made by loosening the 1/2" locknut located at the nose of the actuation cylinder, and turning the setscrew clockwise or counterclockwise.

NOTE: Do not loosen the 1/4" nut located at center. Tighten the 1/2" locknut without turning the adjustment screw.

9. After completing the carousel adjustment, the switch adjustments for carousel in/out must be done.

NOTE: On the Diagnostics page, TC OUT must be 1 and TC IN must be 0.

SETTING PARAMETER 215

IF YOUR MACHINE IS OPERATING WITH 9.20 SOFTWARE OR LATER SKIP TO STEP 15.

10. Loosen the two 1/4" SHCS on top of the switch bracket, inside the tool carousel. Adjust the bracket until the TC OUT switch reads 1. Manually override the shuttle solenoid to shuttle out the carousel and release it. The TC OUT switch must always trip.

11. Manually override the shuttle solenoid to bring the shuttle out. Check that the TC IN switch trips to 1 and the TC OUT switch trips to 0.

NOTE: Verify the tool changer is empty for the next step.

12. Jog the spindle (with tool holder) towards the tool changer. When the tool changer extractor is close to engaging the tool holder, confirm that the carousel rotation is in line with the tool side-to-side engagement.

If the carousel is too far in the clockwise direction, Parameter 215, "Carousel Offset", must be set to a lower value. Increase the value if the carousel is too far counterclockwise.

On machines before software version 9.14, the carousel offset number must **not** be 15,000 or an even multiple of it (30,000; 45,000; etc.). This is because 15,000 (9,000 for **HS-2**) is the exact distance between pockets. Machines with software version 9.14 or later do allow the use of these numbers.

NOTE: The ZERO RET key must be pressed EVERY TIME Parameter 215 is changed.

13. Jog the Y-axis up slowly until the extractors have fully engaged the tool, ensuring that the spindle orientation is still correct. Ensure the extractor is fully engaged, but not overloading the servo motor.

NOTE: There should be a small amount of clearance to prevent the extractor from knocking when the Y-axis moves into position. Parameter 211, "Y-Axis Tool Change Offset", will adjust this distance.

14. **IMPORTANT!** Once you have completed this procedure, type "debug" on the ALARMS page, then press the WRITE key to exit. Turn Setting 7 on.

15. Press "POWER UP RESTART", the tool changer will align to tool number #1.

STEPS 15-21 OF THIS PROCEDURE ARE FOR SETTING PARAMETER 215 AND ONLY APPLY TO MACHINES OPERATING WITH 9.20 SOFTWARE OR LATER.

16. Go to parameter 215 and set it to zero

17. Enter "DEBUG" mode and go to the POSITION page and page up to "POS RAW-DAT" SCREEN.

18. ENTER "W" and HANDLE JOG

19. Slowly turn the jog handle and observe how the carousel rotates as a normal axis. Be careful not to turn the jog handle too fast or else the carousel will begin to oscillate.

20. The screen will display a "**CO**" and a number. This stands for **C**)arousel **O**)ffset.

21. Rotate the carousel to tool ZERO (on the HS-1 this is pocket #24, HS-2 is #40) This number is then entered in Parameter 215.

22. Press "POWER UP RESTART" and the tool changer will align to tool #1.

Setting Parameter 211

Note: For machines equipped with macros: In MDI Mode type #1126=1 (air door open), but do not execute the program yet.

For machines not equipped with macros, manually open the toolchanger air door.

1. Go to the alarms page and enter DEBUG Mode.

2. Execute the MDI program to open the air door.

3. Orient the spindle.

4. Manually load a tool into the spindle.

5. Slowly jog the Y-axis up past the HOME position, into the tool change position.

6. Visually watch for the tool carousel fingers to expand over the tool and close in around it.

7. Continue jogging up slowly just until the tool applies slight pressure upwards on the carousel.

8. Go to the POSITION DISPLAY and page up to "POS-RAW DAT" page and read the actual Y-axis position.

9. Enter the number from the Y-axis from the actual position then put in Parameter 211. The controls default setting is 780000.

10. Handle jog down past the home switch into the normal operating envelope.

11. Exit DEBUG.

12. In MDI execute a tool change by pressing ATC FWD.

13. Note the reaction of the carousel as the tool enters the extractor fingers:
    If the **carousel deflects up** then **decrease** the number in Parameter 211.
    If the **tool deflects down** as it enters the carousel then **decrease** the number in Parameter 211.
    If the **tool deflects up** as it is pulled out of the spindle by the carousel, then **decrease** the number in Parameter 211.

Side Mount Tool Changer Alignment (HS-2RP)

1. Remove the tool changer's shipping retainer bolt. Refer to *Figure 3-22.*

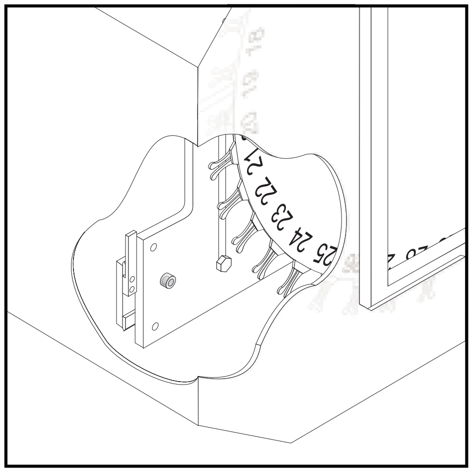


Figure 3-22.

2. There are four tool changer cable connectors that must be plugged in before the tool changer is operable.

Cables shipped in the tool changer enclosure include:

Cable 1 (Carousel Drive Motor Cable). The cable is encased in flexible conduit and supplied with an amphenol connector. This cable must be routed around the back of the machine under the apron and connected to the "**Tool Changer**" connector on the side of the control panel.

Cable 2 (Shuttle Motor Drive Cable). The cable is routed around the back of the machine and is supplied with a connector bracket, found at the right rear corner of the machine behind an access panel. The connector bracket is labeled **TC IN/OUT** for this cable connector.

Cable 3 (Shuttle-In) **TC IN, #820B** / **Cable 4** (Shuttle-Out) **TC OUT, #820** limit switch cables. The connections for these cables are located near the base of the tool changer. The wiring for the connectors are located behind the side apron, near the tool changer's base support tube. Remove the factory-installed shuttle out jumper, before plugging the shuttle-out connector on the tool changer to its matching connector from the machine.

NOTE: Keep the shuttle-out jumper, as it will be used later in the tool changer alignment procedures.

3. **POWER-UP** the machine.

4. Press the **RESET** button to clear the alarm message.

5. Press the **ZERO RET** and then the **AUTO ALL AXES** button. The machine will move the spindle to its home position (Zero X, Y, Z, A and W).

6. Go to the **SETTINGS** screen. Cursor to Setting 51, **DOOR HOLD OVERRIDE**. Toggle the **DOOR HOLD OVERRIDE** to "**ON**". With the setting toggled to "ON", press the **WRITE/ENTER** button to enter this value into the control. With this setting set to "ON" the operator side door can be open during the next steps without generating an alarm.

7. Command the shuttle door to open. Move to the **MDI** screen. Enter value #1126="**1**" from the keypad, then press **INSERT**. Press **RESET** and then **CYCLE START**. The tool changer door will open.

8. Move to the **SETTING** screen. Cursor to Setting **(7) PARAMETER LOCK**. Toggle the **PARAMETER LOCK** to "**OFF**", then press the **WRITE/ENTER** button to enter this value.

9. Press the **E-STOP** button.

10. Go to the **PARAMETER** screen, cursor to Parameter **215**. This parameter controls the position of the "zero" pocket for the tool changer carousel. Record the value for this parameter, set the Parameter to zero by entering "**0**" and press the **WRITE/ENTER** button.

NOTE: Check Parameter Settings after all procedures have been completed and machine POWER-UP/RE-START(ed).

11. Enter **DEBUG** Mode. Move to the **POS-RAW DAT** screen.

12. The lower right hand area of the screen will display "**CO**" and a number. The **C**)arousel **O**)ffset number will be used to orient the tool changer carousel's rotational position. Turn the **E-STOP** off and press the **RESET** button three times to clear the alarm message(s).

13. Enter "**W**" and then press the **HANDLE/JOG** button. Slowly turn the **HANDLE/JOG** control in ½ turn increments and observe the rotation of the carousel. The carousel will alternate between counterclockwise and clockwise motion but will eventually stop. Continue to rotate the carousel until tool pocket **#40** (designated ZERO tool) is at or near the three o'clock position.

14. Install two ¼-20 x 2 in. shoulder bolts into threaded holes on the face of the carousel as shown in *Figure 3-23.* Place a 48" bubble level or a flat bar with a torpedo level across the two shoulder bolts.

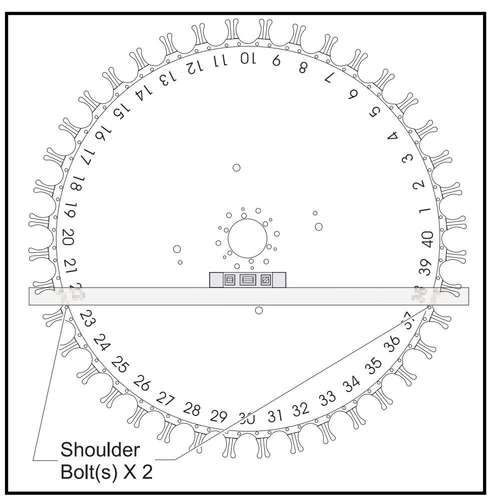


Figure 3-23.

15. Continue to handle jog the tool changer's carousel to achieve a level condition. Record the Carousel Offset number given on the **POS-RAW DAT** screen. Move to the **PARAMETER** screen. Enter the recorded Carousel Offset value into **PARAMETER 215.**

16. Remove the leveling tools.

17. Command shuttle door to close. Move to the **MDI** screen. Cursor to number "1", enter "**0**" from the keypad and press the **ALTER** button. Press **RESET** and then **CYCLE START**. The tool changer door will close.

18. Press the **ZERO RET** button and then the **AUTO ALL AXES** button. The machine will move to its home position (zero X, Y, Z, A and Tool Changer Carousel).

19. Press the **POWER UP RESTART** button and the tool changer will align to tool #1.

20. Command Shuttle Door to open, again. Move to the **MDI** screen. Cursor to the number "0", enter "**1**" from the keypad and press the **ALTER** button. Press **RESET** and then **CYCLE START**. The tool changer door will open.

21. Press the **E-STOP** button.

22. Disconnect the **TC IN** limit switch connector (#820B) and the **TC OUT** limit switch connector (#820) located at the base of the tool changer. Re-install the previously removed jumper into the **TC IN** connector on the wiring coming from the machine-side.

23. Disconnect the tool changer's shuttle motor cable connector, behind the rear access panel on the control box side of the machine. See *Figure 3-24.*

24. The next step requires the tool changer carousel to be manually shuttled into the machine enclosure. To shuttle the carousel out, its shuttle arm must be fully rotated. First, reach in through the tool changer's window, push up on the cam follower bolt (as shown in *Figure 3-25.*) and then move the carousel to its fully extended position in the enclosure. Verify that it is fully extended by inspecting the location of the cam follower bolt. The cam follower bolt should bottom out at the end of the guide slot.

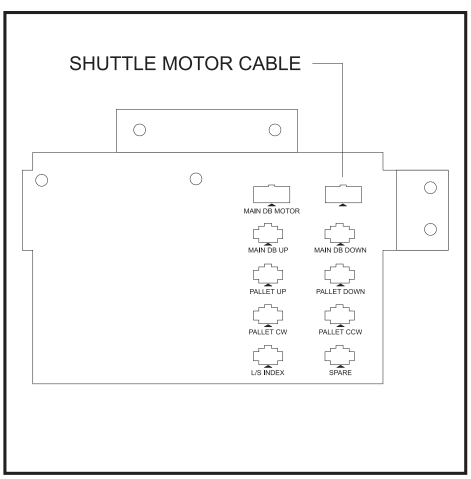


Figure 3-24.

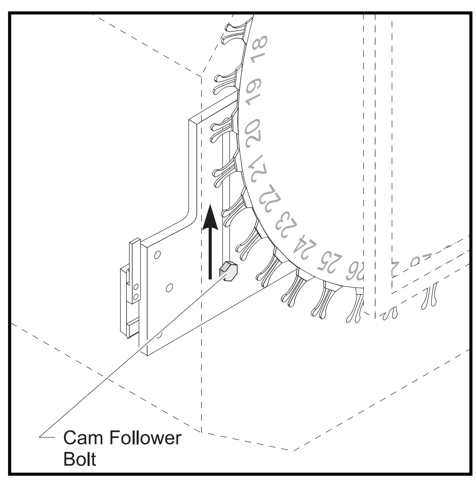


Figure 3-25.

25. Next, move to **PARAMETERS** screen. Record the values for the Settings #**210** (X-axis), #**211** (Y-axis) and #**64** (Z-axis). After recording the values for these Parameters, enter "**0**" for their values.

26. Go to **ALARMS** page, enter "**DEBUG**" from the keypad and press **WRITE/ENTER.** Move to the **POSITION** screen to enter the **POS-RAW DAT** screen.

27. Handle jog the X, Y and Z axes as necessary to place the spindle centerline inline with the centerline of the tool changer's extractor fingers. Align the spindle centerline with the center of the tool changer's fingers in the X , Y plane only.

NOTE: As an alignment aid, a 2.325" diameter disk mounted into a tool holder may be used (Refer to *Figure 3-26).* Handle jog as necessary to bring the disk in line with the center of the tool changer's fingers.

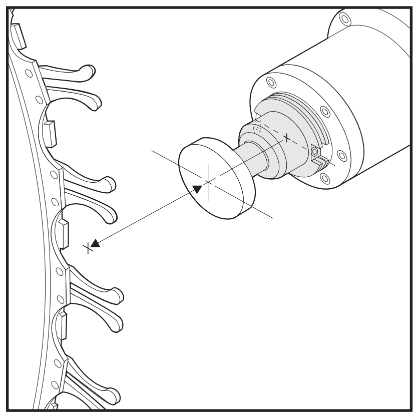


Figure 3-26.

28. Record the values in the **ACTUAL** column for the position of the X and Y-axes given on the **POS-RAW DAT** screen.

Enter the position value for the X-axis in **Parameter 210**.

NOTE: this number is entered without the decimal point and must be the same sign as that given on the **POS-RAW DAT** screen. For example –0.7094 would be entered as –7094, and –278.8854 would be –2788854.

Enter the position value for the Y-Axis in **Parameter 211**.

29. Align the **Z-axis.** Line up the finger groove in the tool holder with the extractor fingers on the carousel. Handle jog the spindle in +Z direction (towards the rear of the machine). Then handle jog the -X direction (towards the control panel). Stop when it is clear that the tool holder groove can be jogged towards the front of the machine without hitting the extractor fingers.

NOTE: It should not be necessary to move the Y-axis during this exercise.

30. Handle Jog the spindle in the -Z direction (towards the front of the machine) and align the tool changer's fingers with the groove in the tool holder. Handle jog the spindle in the +X direction (towards the tool changer) and slowly move the tool holder into the extractor fingers. **STOP AND RE-ALIGN IF ANY MISALIGNMENT IS FOUND**. Continue to move the tool holder into the fingers until the drive notch on the side of the tool holder is approximately 0.050 in. from bottoming out on the carousel's alignment key. Refer to *Figure 3-27.*

31. Record the values for the position of the Z-axis given on the **POS-RAW DAT** screen.

Enter the position value for the Z-Axis in **Parameter 64**.

32. Move the spindle in the –X direction to extract the tool holder from the tool changer's extractor fingers. Jog the spindle as necessary to move it clear of the tool changer. Remove the tool holder from the spindle.

33. Manually pull the carousel out of the machine enclosure, into its retracted position.

34. Close the tool changer door. Press **MDI/DNC,** move to **PROGRAM** screen. Toggle the cursor to the number 1 after the equal sign. Enter "**0**" and press **ALTER** button. Next press **RESET** and **CYCLE START**. The tool changer door will close.

35. Press **ZERO RET** button and then **AUTO ALL AXES** button, to move the machine spindle to its home position.

36. Remove the jumper installed in the **TCIN** limit switch connector (#820B) at the base of the tool changer and reconnect the previously disconnected limit switch cables.

37. **POWER OFF**, then **POWER ON** the machine. Press **RESET** button to clear any alarm messages.

NOTE: Verify all **Parameter Value(s)** have been recorded.

38. Press the **ZERO RET** and then **AUTO ALL AXES** button.

39. Install a tool holder into the spindle. See *Figure 3-27.*

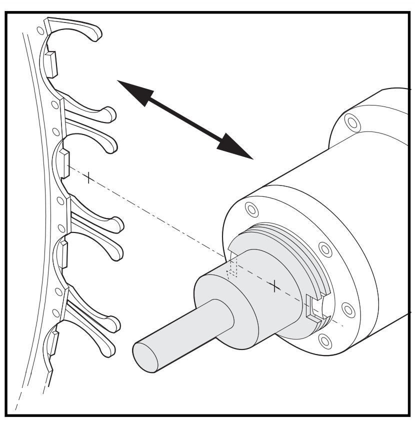


Figure 3-27.

40. Press the **MDI/DNC** button, then **ATC FORWARD** button. Repeat step 22, to manually move the carousel into the machine enclosure.

NOTE: The spindle will move to its tool change position and the machine will fault-out and display a **SHUTTLE FAULT ALARM**. This is due to the shuttle motor cable disconnection.

Move the carousel into the tool holder and verify that proper extractor finger alignment has been made. (Repeat steps 23 through 30 as necessary to align the tool changer extractor fingers to the tool holder.)

43. Once alignment has been verified, pull the tool changer carousel out of the enclosure, close the shuttle door and reconnect the shuttle motor cable connector at the rear of the machine.

44. Press the **MDI/DNC** button and then press the **ATC FORWARD** button to verify proper operation of the tool changer.

45. Go to the **SETTING 7**, toggle **PARAMETER LOCK** to “**ON**” . With the setting toggled to “ON”, press **WRITE/ENTER** button to enter this value.

3.9 AXIS MOTOR

Please read this section in its entirety before attempting to remove or replace the axis motors.

X-Axis Motor

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 it's travel. Jog the X-axis away from the motor.

3. Remove the rear enclosure panel (seven SHCS).

4. POWER OFF the machine.

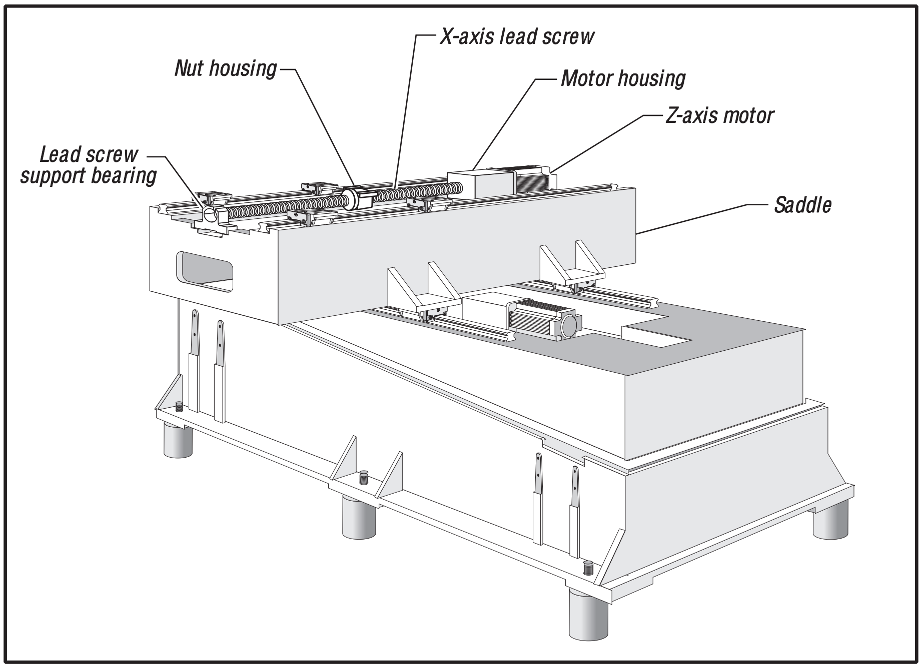


Figure 3-28. X-axis motor and lead screw assembly.

5. On the top of the motor housing, remove the four BHCS and remove the cover plate.

6. Loosen the SHCS on the motor coupling at the lead screw.

7. On the motor housing, loosen the four SHCS and remove the motor from the housing.

8. Disconnect all wiring from the motor and remove.

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 leads 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 lead screw into the motor coupling.

4. Reinstall and tighten down the four SHCS that hold the motor to the housing.

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

6. Replace the cover plate and fasten with four BHCS.

7. Replace the rear enclosure panel with seven SHCS.

8. Check for backlash in the X-axis lead screw ("Troubleshooting" section) or noisy operation, and grid offset.

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 (seven SHCS).

3. Jog the X-axis until the Y-axis lead screw can be easily accessed from the rear.

4. Jog the Y-axis until the two upper holes in the column and the corresponding holes in the spindle head are aligned. Place two of the original shipping lockbolts (5/8-11 x 4" SHCS) through the two holes and tighten. **CAUTION!** This step must be followed to keep the spindle head from moving during service. If this is not done, serious injury could occur.

5. POWER OFF the machine.

6. Loosen the four SHCS and remove the upper bellows guide from the X-axis way bellows supports so the motor can be pulled up from the motor mount.

7. Loosen the SHCS on the motor coupling at the lead screw.

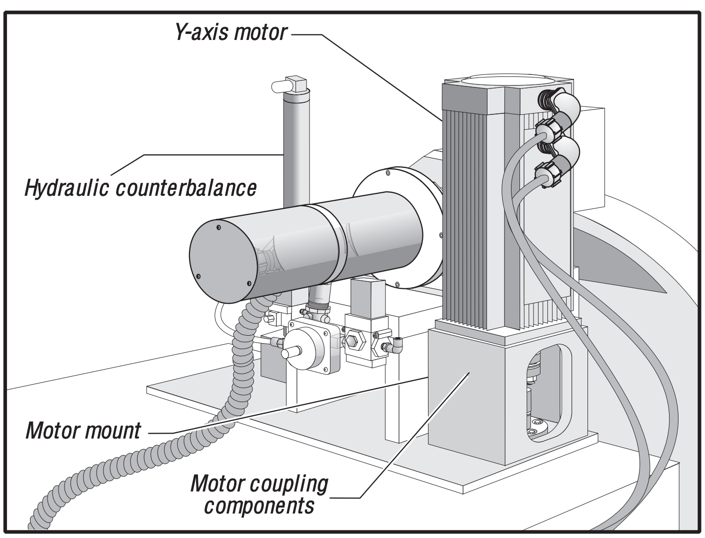


Figure 3-29. Y-axis motor and coupling.

8. Loosen the four SHCS and remove the motor from the motor mount.

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 leads 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 lead screw into the motor coupling.

4. Reinstall and tighten down the four SHCS that hold the motor to the housing.

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

6. **CAUTION!** Remove the shipping lockbolts from the column and spindle head. Failure to remove these will cause severe damage to the machine.

7. Replace the rear enclosure panel with seven SHCS.

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

9. Check that Parameter 211, "Y-Axis Tool Change Offset", is set correctly, and adjust if necessary.

10. Check the grid offset after the new motor has been installed.

Z-Axis Motor

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 it's travel. Jog the Z-axis all the way towards the back of the machine.

3. Remove the thirteen SHCS that attach the Z-axis way cover to the table, and collapse it back towards the saddle.

4. POWER OFF the machine.

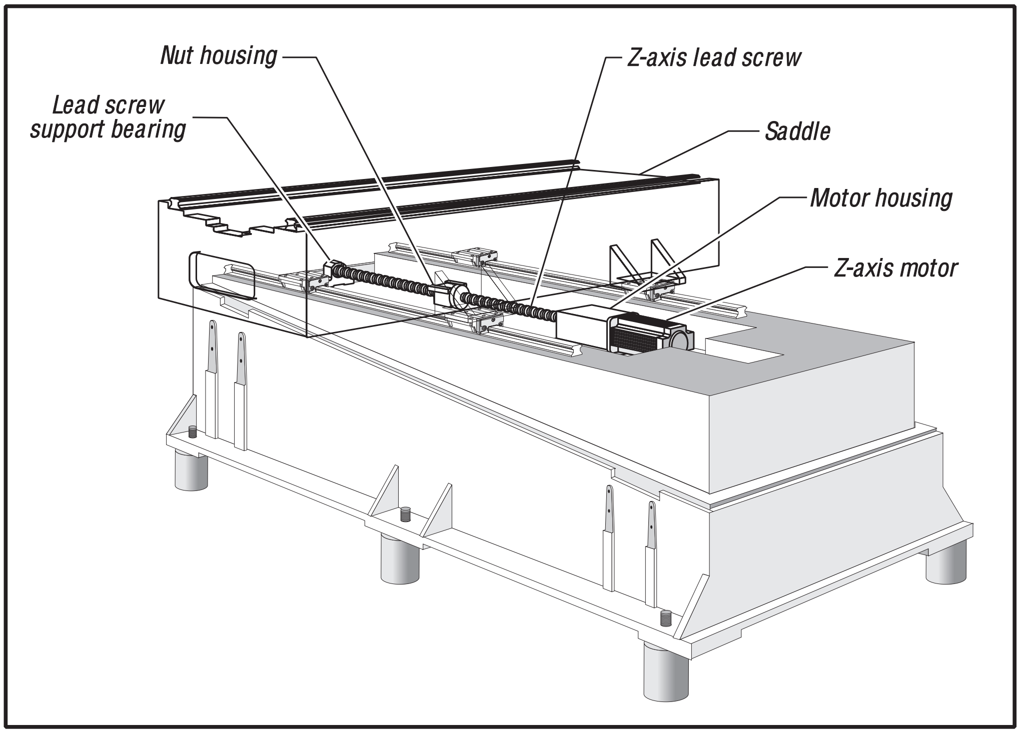


Figure 3-30. Z-axis motor and lead screw assembly.

5. On the motor mount, loosen the four BHCS and remove the cover plate.

6. Loosen the SHCS on the motor coupling at the lead screw.

7. Loosen the four SHCS and remove the motor from the mount.

8. Disconnect all wiring from the motor and remove.

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 leads 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 lead screw into the motor coupling.

4. Reinstall and tighten down the four SHCS that hold the motor to the housing.

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

6. Replace the cover plate and fasten with four BHCS.

7. Replace the Z-axis way cover with thirteen SHCS.

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

9. Check 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.

NOTE: It will not be necessary at this time to completely remove the motor. Do not disconnect the electrical components.

2. Completely loosen the two SHCS on the two coupling clamp rings and remove the coupling.

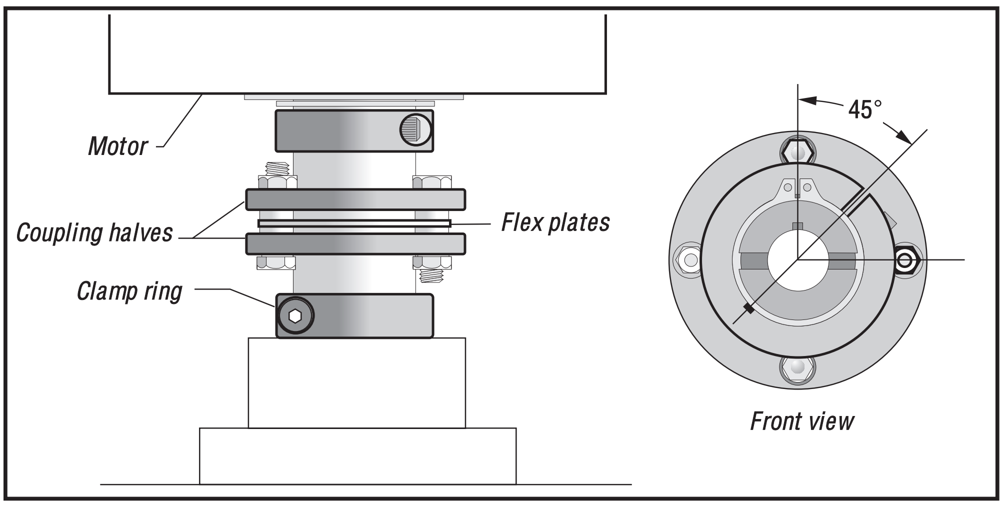


Figure 3-31. Motor coupling components.

INSTALLATION-

3. Slide the new coupling onto the motor shaft until the coupling half is flush to the end of the shaft.

NOTE: The slot in the locking collar must be positioned 45 degrees between the bolt hole pattern of the coupler. If improperly aligned, the coupler will not have enough clamping force on the leads screw or motor shaft.

4. Tighten the two SHCS on the coupling's clamp ring. Before tightening, add one drop of blue Loctite® to each screw.

5. Reinstall the axis motor.

3.10 BEARING SLEEVE

Please read this section in its entirety before attempting to remove or replace the bearing sleeve.

X-Axis 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 (seven SHCS).

3. Jog the Y-axis to the bottom of it's travel. Jog X-axis away from bearing support.

4. POWER OFF the machine.

5. Remove the hardstop bracket from bearing support end.

6. Remove the clampnut.

7. Manually screw the column over in order to access the motor.

CAUTION! Do not screw the column too far over since the hardstops are removed!

8. Remove the X-axis motor in accordance with "X-Axis Motor - Removal".

9. Remove the coupling.

NOTE: The motor's electrical connections do not need to be removed for this operation. After removing the motor from the motor mount, set it aside.

10. Loosen the SHCS on the clamp nut at the motor end of the lead screw, and remove the clamp nut.

11. Loosen the six SHCS and remove the bearing sleeve from the motor mount. Push on the column or the opposite end of the lead screw to loosen.

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

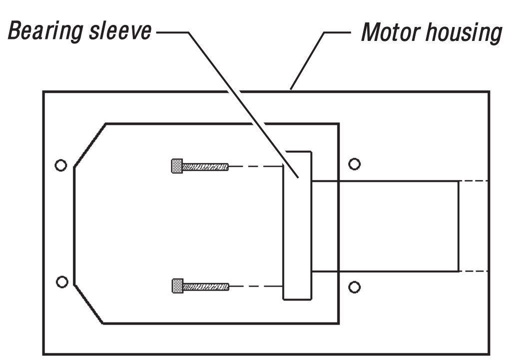


Figure 3-32. Bearing sleeve mounting location.

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. With the column all the way to the left, place the bearing sleeve in the motor mount. It may be necessary to align the bearings in the sleeve to facilitate mounting on the lead screw.

3. Install the six SHCS on the bearing sleeve, and torque to 15 ft-lbs. (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.

CAUTION! Do not screw the column too far over since the hardstops are removed!

Screw the clamp nut on the bearing support end of the lead screw two or three turns, but do not tighten.

5. Screw the clamp nut on the motor end of the lead 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-lbs. DO NOT SKIP THIS STEP. It ensures the lead screw is installed and runs parallel and flat to the linear guides and the saddle.

7. Tighten the lead screw against the clamp nuts as follows:

   - Tighten the clamp nut on the motor housing end of the lead screw to 15 ft-lbs.
   - Tighten the SHCS on the clamp nut.
   - Place a spanner nut over the clamp nut on the support bearing end of the lead screw and slowly tighten to 4 inch-lbs. 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 X-axis motor as described in "X-Axis Motor - Installation".

10. Check for backlash in the X-axis lead screw ("Troubleshooting" section), or noisy operation.

11. Replace the rear panel enclosure with seven SHCS.

Y-Axis Bearing Sleeve

REMOVAL-

1. POWER ON the machine. Zero return all axes and put machine in HANDLE JOG mode.

2. Remove the seven SHCS attaching the lower Y-axis way cover to the head casting, and collapse it downward in order to access the support bearing.

3. Remove the rear enclosure panel (seven SHCS).

4. Jog the X-axis until the Y-axis lead screw can be easily accessed from the rear.

5. Jog the Y-axis until the two upper holes in the column and the corresponding holes in the spindle head are aligned. Place two of the original shipping lockbolts (5/8-11 x 4" SHCS) through the two holes and tighten.

CAUTION! This step must be followed to keep the spindle head from crashing down during service. If this is not done, serious injury could occur.

6. POWER OFF the machine.

7. Remove the axis motor in accordance with "Y-Axis Motor - Removal".

8. Loosen the SHCS and remove the clamp nut on the lead screw bearing plate end.

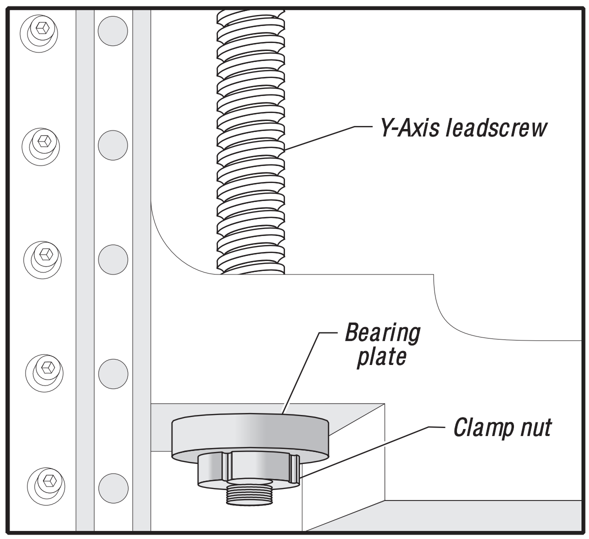


Figure 3-33. Y-axis lead screw bearing support end clamp nut.

9. Loosen the SHCS and remove the clamp nut on the motor end of the lead screw.

10. Loosen the six SHCS and remove the bearing sleeve from the top of the column.

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

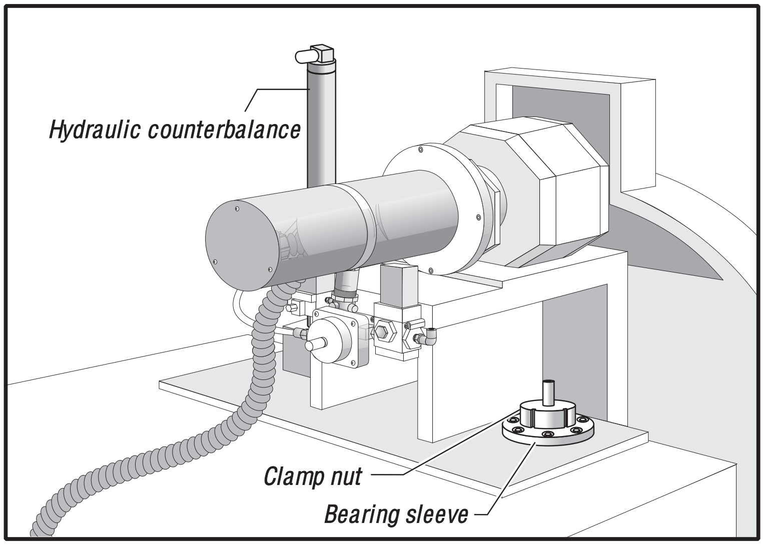


Figure 3-34. Y-axis lead screw motor end clamp nut and bearing sleeve.

INSTALLATION-

1. Ensure all mating surfaces on the bearing sleeve, motor housing, top of column, 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. Install the bearing sleeve on top of the column with six SHCS. (Place a drop of blue Loctite on each of the SHCS before inserting.) Tighten down to 15 ft-lbs. It may be necessary to align the bearings in the sleeve to facilitate mounting on the lead screw.

3. Screw the clamp nut on the motor end of the lead screw two or three turns, but do not tighten.

4. Loosen all of the SHCS on the bearing sleeve approximately 1/4 turn, then torque to 15 ft-lbs. DO NOT SKIP THIS STEP. It ensures the lead screw is installed and runs parallel and flat to the linear guides and the saddle.

5. The following sequence is important to ensure proper installation of the lead screw:

- Tighten the clamp nut, hand tight, against the bearing sleeve.
- Install the shaft lock onto the bearing support end of the leadscrew. This will keep the lead screw from turning while torquing the clamp nut.
- Place a spanner wrench on the clamp nut at the motor end of the assembly.
- Torque the clamp nut against the bearing sleeve to 15 FT-LBS.
- Remove the shaft lock.
- With a T-handle wrench hand tighten the clamp nut screw and mark with yellow paint.
- Screw the clamp nut against the bearing at the bearing support end, hand tight. Tighten the clamp nut another 1/8. (If you have a torque screwdriver, torque the clamp nut to 4 IN-LBS.)
- With a T-handle wrench hand tighten the clamp nut screw and mark with yellow paint.

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

7. Replace the lower Y-axis way cover and attach it to the head casting with seven SHCS.

8. **CAUTION!** Remove the shipping lockbolts from the column and spindle head. Failure to remove these will cause severe damage to the machine.

9. Check for backlash in the lead screw (Troubleshooting section), or noisy operation.

10. Replace the rear enclosure panel with seven SHCS.

Z-Axis Bearing Sleeve

REMOVAL-

1. POWER ON the machine. Zero return all axes and put the machine in HANDLE JOG mode.

2. Jog the Y-axis to the bottom of it's travel. Jog the Z-axis all the way towards the back of the machine.

3. Remove the thirteen SHCS that attach the Z-axis way cover to the table, and collapse it towards the saddle.

4. Remove the rear enclosure panel (seven SHCS).

5. POWER OFF the machine.

6. Remove the Z-axis motor in accordance with "Z-Axis Motor - Removal".

NOTE: The motor's electrical connections do not need to be removed for this operation. After removing the motor from the mount, set it to one side.

7. Loosen the SHCS on the clamp nut at the motor end of the lead screw, and remove the clamp nut.

8. Pry open the sheet metal bracket, and remove the hard stop from the lead screw support bearing end of the lead screw.

9. Loosen the SHCS on the clamp nut at the bearing support end, and remove the clamp nut.

10. Loosen the six SHCS and remove the bearing sleeve from the motor mount (Fig. 10-1). Push on the opposite end of the lead screw to loosen.

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

INSTALLATION-

1. Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing, and ball nut are free of dirt, burrs, grease, or other contaminants.

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.

2. Place the bearing sleeve in the motor mount. It may be necessary to align the bearings in the sleeve to facilitate mounting on the lead screw.

3. Install and tighten the six SHCS on the bearing sleeve. (Place a drop of blue Loctite on each of the SHCS before inserting.) Torque to 15 ft-lbs.

4. Screw the clamp nut on the bearing support end of the lead screw two or three turns, but do not tighten, and temporarily place the hard stop over the bearing support.

5. Loosen all of the SHCS on the bearing sleeve approximately 1/4 turn, then torque to 15 ft-lbs. DO NOT SKIP THIS STEP. It ensures the lead screw is installed and runs parallel and flat to the linear guides and the saddle.

6. The following sequence is important to ensure proper installation of the lead screw:

- Tighten the clamp nut, hand tight, against the bearing sleeve.
- Install the shaft lock onto the bearing support end of the leadscrew. This will keep the lead screw from turning while torquing the clamp nut.
- Place a spanner wrench on the clamp nut at the motor end of the assembly.
- Torque the clamp nut against the bearing sleeve to 15 FT-LBS.
- Remove the shaft lock.
- With a T-handle wrench hand tighten the clamp nut screw and mark with yellow paint.
- Screw the clamp nut against the bearing at the bearing support end, hand tight. Tighten the clamp nut another 1/8. (If you have a torque screwdriver, torque the clamp nut to 4 IN-LBS.)
- With a T-handle wrench hand tighten the clamp nut screw and mark with yellow paint.

7. Reinstall and tighten the hard stop.

8. Reinstall the Z-axis motor as described in "Z-Axis Motor - Installation".

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

10. Replace the rear panel enclosure with seven SHCS.

11. Replace the Z-axis way cover, and attach it to the table with thirteen SHCS.

3.11 LEAD SCREW

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

TOOLS REQUIRED:

- ✓ **Torque wrench**
- ✓ **Spanner nut**

X-Axis Lead Screw

REMOVAL-

1. Turn the machine ON. Zero return all axes and put the machine in HANDLE JOG mode.

2. Remove the rear enclosure panel.

3. Jog the Y-axis to the bottom of it's travel. Jog the X-axis all the way towards the control.

4. POWER OFF the machine.

5. Remove the hardstop and locknut from the bearing support.

6. Remove the five SHCS that secure the nut housing to the lead screw nut.

7. Remove the oil line from the lead screw nut.

8. Rotate the nut on the lead screw, in order to move the nut near the bearing support end of the leadscrew.

9. Temporarily replace the hardstop bearing support and push the column all the way away from the control box.

10. Remove the X-axis motor and bearing sleeve in accordance with appropriate sections.

11. Push column towards the control box.

CAUTION! Do not move the column too far over since the hardstops are removed!

12. Pull the lead screw toward control box side, out of the bearing in the bearing support.

13. Lift the lead screw up, forward, and to the side of the machine until the motor end of the lead screw is free. Carefully remove the lead screw.

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. Hold the lead screw vertically with the motor end down and the nut near the support end (top).

3. Hold the lead screw at the left side of the machine near the front of the saddle and lower into place, rotating the leadscrew into position.

CAUTION! Be careful not to bump or scratch lead screw against column, saddle or bellows support.

4. Once in position, gently push the bearing support end of the lead screw into the bearing in the bearing support.

5. Replace the bearing pack.

6. Rotate the nut.

7. Rotate the leadscrew nut so it goes into the nut housing and start the five SHCS that secure the leadscrew nut to the nut housing. Do not tighten.

8. Reattach the oil line to the lead screw nut.

9. Replace the X-axis motor in accordance with the appropriate section.

10. With the lead screw secured in place, torque the five SHCS from the nut to the nut housing to 15 ft-lbs.

11. The following sequence is important to ensure proper installation of the lead screw:

- Tighten the clamp nut, hand tight, on the motor end.
- Install and tighten clamp nut on bearing support. Ensure the nut **does not** touch the support bearing.
- Install the shaft lock onto the bearing support end of the leadscrew. This will keep the lead screw from turning while torquing the clamp nut.
- Place a spanner wrench on the clamp nut at the motor end of the assembly.
- Torque the clamp nut against the bearing sleeve to 15 FT-LBS.

NOTE: The 40/50 mm leadscrew clamp nut should be torqued to 50 FT-LBS.

- With a T-handle wrench hand tighten the clamp nut screw and mark with yellow paint.
- Remove the shaft lock.
- Loosen the clamp nut screw and clamp nut at the bearing support end and tighten to 4 IN-LBS. against the bearing. Retighten the clamp screw.

12. Replace the bearing support end hard stop.

13. POWER ON the machine.

14. Rotate the leadscrew by hand to assure free movement.

15. Jog the X-axis to the left end of travel and check for free movement.

NOTE: During assembly, the leadscrew is tested for a maximum rotational torque of 12 in-lbs.

20. Replace the rear enclosure panel (seven SHCS).

Y-Axis Lead Screw

REMOVAL-

1. POWER ON the machine. Zero return all axes and put machine in HANDLE JOG mode.

2. Remove the seven SHCS attaching the upper Y-axis way cover to the head casting, collapse it upward, and tie-wrap it in place.
3. Jog the Y-axis all the way down, resting on the hard stop. Jog the X-axis to the center of travel so the lead screw can be easily accessed from the rear.

4. POWER OFF the machine.

5. Remove the rear enclosure panel (seven SHCS).

6. Remove the axis motor in accordance with "Y-Axis Motor - Removal".

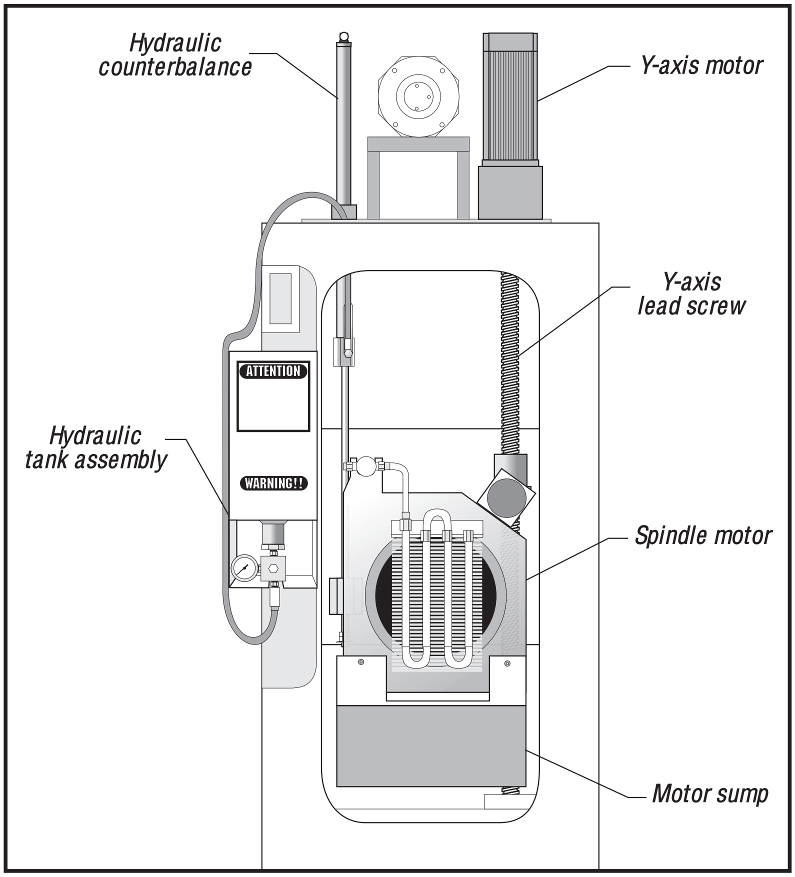


Figure 3-35. Y-axis lead screw and motor assembly (from rear).

7. Remove the SHCS securing the hood to the machine. Unplug the service light and gently move the hood forward approximately one foot.

NOTE: It is not necessary to fully remove the hood from the machine.

8. Remove the seven SHCS attaching the lower Y-axis way cover to the head casting, and collapse it downward.

9. Loosen the SHCS and remove the clamp nut on the lead screw bearing plate end.

10. Loosen the SHCS and remove the clamp nut on the motor end of the lead screw.

11. Disconnect the oil line from the ball nut.

12. Loosen the six SHCS and remove the bearing sleeve from the top of the column.

13. Remove the five SHCS on the ball nut flange. Remove the ball nut from the ball nut housing by manually screwing the nut up the lead screw.

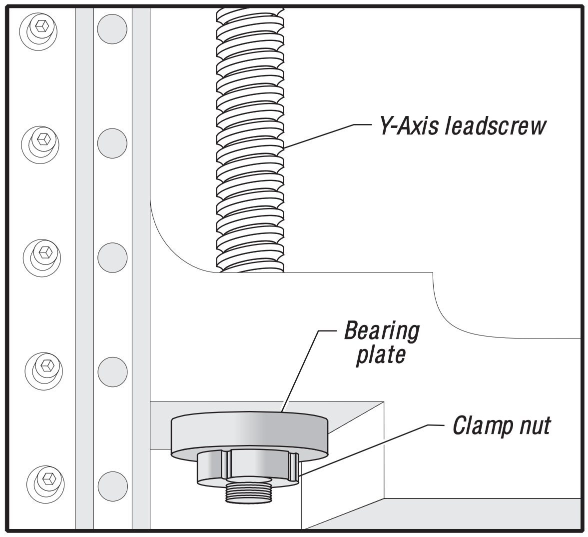


Figure 3-36. Y-axis lead screw bearing support end clamp nut.

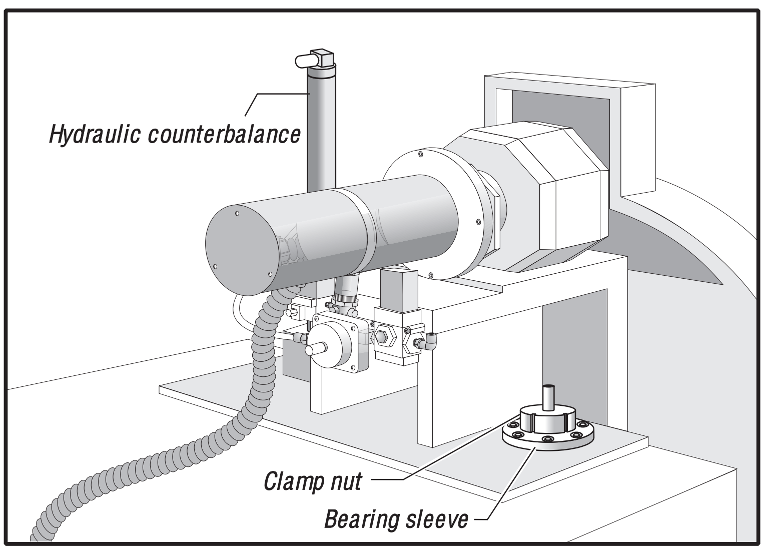


Figure 3-37. Y-axis lead screw motor end clamp nut and bearing sleeve.

14. Remove the lead screw from the column by lifting it out of the bearing support, pulling the lower end of the lead screw out the front of the column (over the top of the spindle head), and lowering the motor end out of the top of the column.

15. Remove the hard stop from the old lead screw for use on the new lead screw.

INSTALLATION-

1. Place the hard stop on the new lead screw, so the hard stop is at the top of the column and the flange of the lead screw is mounted on the upper side of the nut housing.

2. Manually turn the ball nut up the lead screw until it will be possible to install the nut into the nut housing (about halfway).

3. Insert the motor end of the lead screw through the upper bearing support hole. Lift the bottom of the lead screw over the spindle head, then lower the lead 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.

4. Place the bearing sleeve onto the lead screw and attach it to the top of the column with the six SHCS. Torque the SHCS to 15 ft-lbs.

5. Loosely screw the clamp nut on the bearing plate end of the lead screw.

6. Orient the ball nut so the oil line can be connected, then turn the lead screw by hand to pull the ball nut flange down until it contacts the nut housing.

7. Insert the five SHCS that hold the ball nut to the ball nut housing, but do not tighten completely.

8. Loosely install the clamp nut on the motor end of the lead screw.

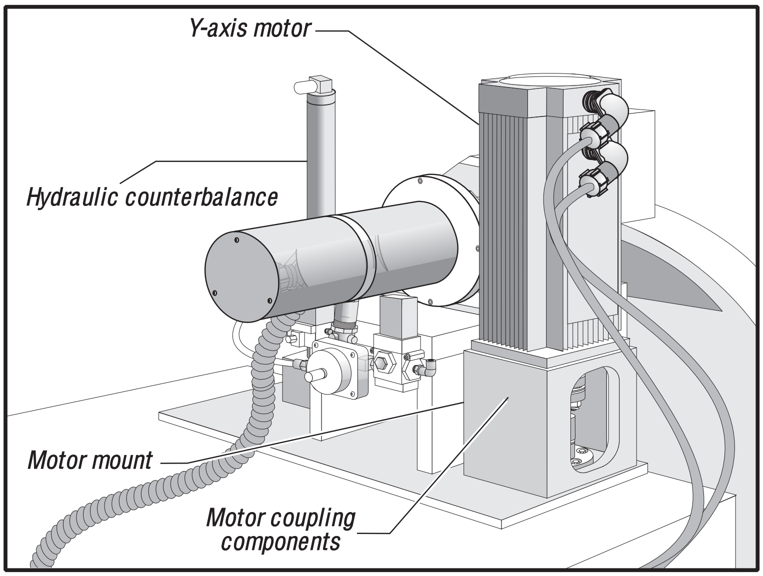


Figure 3-38. Y-axis lead screw motor.

9. Hand-turn the lead screw to move the spindle motor up and down, to assure free movement of the lead screw.

10. Torque the five SHCS that hold the ball nut to the nut housing to 15 ft-lbs.

11. The following sequence is important to ensure proper installation of the lead screw:

- Tighten the clamp nut, hand tight, on the motor end.
- Install and tighten clamp nut on bearing support. Ensure the nut **does not** touch the support bearing.
- Install the shaft lock onto the bearing support end of the leadscrew. This will keep the lead screw from turning while torquing the clamp nut.
- Place a spanner wrench on the clamp nut at the motor end of the assembly.
- Torque the clamp nut against the bearing sleeve to 15 FT-LBS.

Note: The 40/50 mm leadscrew clamp nut should be torqued to 50 FT-LBS.

- With a T-handle wrench hand tighten the clamp nut screw and mark with yellow paint.
- Remove the shaft lock.
- Loosen the clamp nut screw and clamp nut at the bearing support end and tighten to 4 IN-LBS. against the bearing. Retighten the clamp screw.

12. Reinstall the axis motor in accordance with "Y-Axis Motor - Installation".

13. Reconnect the oil line to the ball nut.

14. Check for backlash in the lead screw ("Troubleshooting" section), or noisy operation.

15. Check the grid offset and tool changer height.

16. Replace both Y-axis way covers and attach them to the head casting with seven SHCS each.

17. Replace the hood and plug in the service light.

18. Replace the rear enclosure panel with seven SHCS.

Z-Axis Lead 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 it's travel.

3. Remove the thirteen SHCS that attach the Z-axis way cover to the table, and collapse it towards the saddle.

4. Remove the rear enclosure panel (seven SHCS).

5. Remove the axis motor in accordance with "Z-Axis Motor - Removal".

> **NOTE:** The motor's electrical connections do not need to be removed for this operation. After removing the motor from the mount, set it to one side.

6. Remove the hard stop from the lead screw support bearing end of the lead screw, at the rear of the machine.

7. Loosen the SHCS on the clamp nut at the bearing support end, and remove the clamp nut. For safety, replace the hardstop.

8. Loosen the SHCS on the clamp nut at the motor end, and remove the clamp nut.

9. Disconnect the oil line at the ball nut.

10. Loosen the six SHCS and remove the bearing sleeve from the motor mount. Push on the column or the opposite end of the lead screw to loosen.

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

11. Loosen and remove the five SHCS attaching the ball nut to the nut housing.

12. Hand-turn the lead screw toward the front of the machine until the rear end of the lead screw clears the bearing by approximately six inches (6").

13. Carefully push the lead screw back, to the right of the support bearing, and under the saddle until the front of the lead screw clears the nut housing. Move the lead screw to the right of the nut housing, and remove from the front of the machine.

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. Slide the bearing support end of the lead screw under the saddle, taking care not to damage the screw threads. Position the lead screw to the right side of the nut housing and slide toward the front of the machine.

3. Place the motor end of the lead screw through the nut housing, and pull it toward the front 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 lead screw.

5. Screw the clamp nut on the bearing support end of the lead screw two or three turns, but do not tighten.

6. Pull the lead screw through the motor mount and loosely install the clamp nut as on the opposite end.

IMPORTANT! DO NOT SKIP STEPS 7-10. These steps ensure the lead screw is installed and runs parallel and flat to the linear guides and the saddle.

7. Install and tighten the six SHCS on the bearing sleeve. (Place a drop of blue Loctite on each of the SHCS before inserting). Torque to 15 ft-lbs.

8. Hand-turn the lead screw until the saddle is as far forward as possible while still allowing room to install the SHCS on the ball nut.

9. Install the two outer SHCS of the five 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-lbs.

10. Loosen all of the SHCS on the bearing sleeve approximately 1/4 turn, but do not remove.

11. Hand-turn the lead screw until it is at the rear of its travel. Retighten all six of the SHCS on the bearing sleeve, torquing them to 15 ft-lbs.

12. Install and torque down the three 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-lbs.

13. Reinstall and tighten the hard stop on the lead screw support bearing.

14. Reconnect the oil line to the ball nut.

15. Tighten the lead screw against the clamp nuts as follows:

16. The following sequence is important to ensure proper installation of the lead screw:

- Tighten the clamp nut, hand tight, on the motor end.
- Install and tighten clamp nut on bearing support. Ensure the nut **does not** touch the support bearing.
- Install the shaft lock onto the bearing support end of the leadscrew. This will keep the lead screw from turning while torquing the clamp nut.
- Place a spanner wrench on the clamp nut at the motor end of the assembly.
- Torque the clamp nut against the bearing sleeve to 15 FT-LBS.

Note: The 40/50 mm leadscrew clamp nut should be torqued to 50 FT-LBS.

- With a T-handle wrench hand tighten the clamp nut screw and mark with yellow paint.
- Remove the shaft lock.
- Loosen the clamp nut screw and clamp nut at the bearing support end and tighten to 4 IN-LBS. against the bearing. Retighten the clamp screw.

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

18. Check for backlash in the Z-axis lead screw (Troubleshooting section), or noisy operation, and the grid offset

19. Clean and seal (Permatex) surfaces, then reattach the Z-axis way cover to the saddle cover.

20. Replace the rear enclosure panel with seven SHCS.

3.12 PALLET CHANGER

Stabilizer Replacement

REMOVAL-

1. Loosen the six BHCS and one SHCS that attach the left front splash shield (on side opposite operator) and remove.

2. Loosen the hex bolts (2) that mount the stabilizers to the mounting bracket at each end and remove the stabilizers and metal bushings.

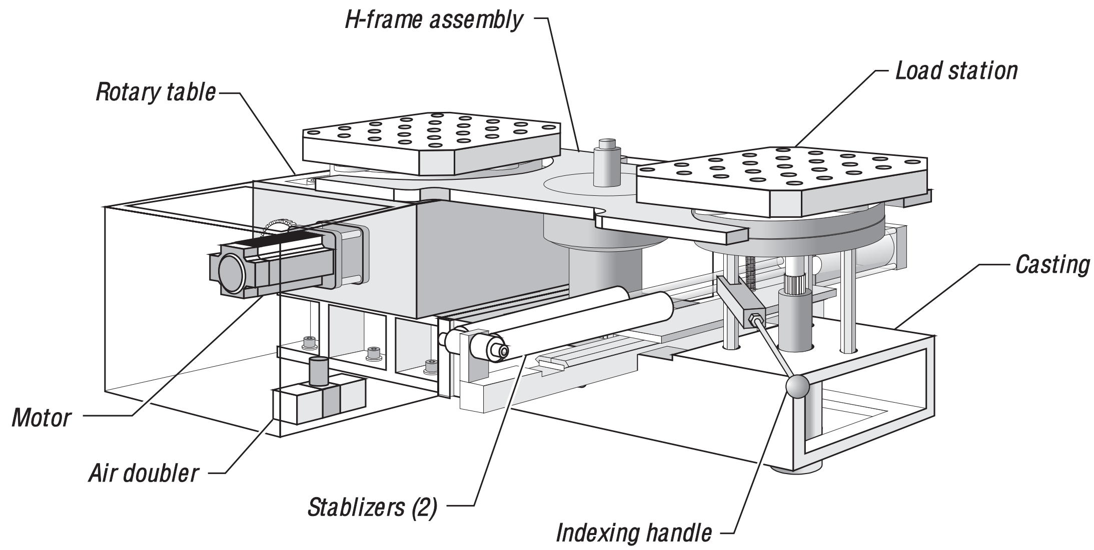


Figure 3-39. Pallet changer.

INSTALLATION-

3. Ensure that the metal bushings have been reinstalled at each end.

4. Replace the stabilizers, with the rod extending toward the rotating cylinder, and replace and tighten the two mounting hex bolts.

5. Replace the left front splash shield and tighten the six BHCS and one SHCS.

Rotary Table Drawbar Up and Down Limit Switches

REMOVAL-

1. Remove the thirteen SHCS that attach the Z-axis way cover to the rotary table bottom cover.

2. Collapse the Z-axis way cover so the linear guides are exposed. The Drawbar Up and Down Limit Switches, beneath the rotary table, can be accessed from the side of the linear guides.

3. Remove the two SHCS that mount the affected limit switch.

4. Disconnect the switch from the solenoid mounting bracket. This bracket is located at the rear of the machine on the control box side, behind an access panel.

INSTALLATION-

5. Replace the switch and mount it with two SHCS.

6. Reconnect the switch at the solenoid mounting bracket.

7. Go to the “Diagnostics” page on the control, in order to monitor the limit switch’s performance.

8. Execute an M50 cycle start, and ensure that the drawbar data is correct.

Note: The switches are designated as “RPDBUP” and “RPDBDN” on the “Diagnostics” page. When the drawbar is in the up position, both switches should read “0"; when in the down position, both should read “1”. If this data is incorrect, install a new limit switch. Refer to the "Discrete Inputs/Outputs" in "Technical Reference" for more information.

9. Tie-wrap the switch cable to the cable group beneath the rotary table and in the base.

10. Apply sealant and install a gasket where the Z-axis way cover meets the rotary table bottom cover.

11. Extend the Z-axis way cover and secure it to the rotary table bottom cover with thirteen SHCS.

Rotary Table Drawbar Up and Down Limit Switch (Pull Stud Type)

REMOVAL-

1. Remove the xxxx SHCS that attach the Z-axis way cover to the rotary table bottom cover.

2. Collapse the Z-axis way cover so the linear guides are exposed. The single Drawbar Up and Down Limit Switch is beneath the rotary table and can be accessed from the side of the linear guides.

3. Remove the two SHCS that mount the limit switch.

4. Disconnect the switch from the solenoid mounting bracket. This bracket is located at the rear of the machine on the control box side, behind an access panel.

INSTALLATION-

1. Replace the switch and mount it with two SHCS.

2. Reconnect the switch at the solenoid mounting bracket.

3. Go to the “Diagnostics” page on the control, in order to monitor the limit switch’s performance.

4. Execute an M50 cycle start, and ensure that the drawbar data is correct.

Note: The switch is designated as “RPDBUP” and “RPDBDN” on the “Diagnostics” page. When the drawbar is in the up position, the switch should read “0"; when in the down position, it should read “1”. If this data is incorrect, install a new limit switch. Refer to the "Discrete Inputs/Outputs" in "Technical Reference" for more information.

5. Tie-wrap the switch cable to the cable group beneath the rotary table and in the base.

6. Apply sealant and install a gasket where the Z-axis way cover meets the rotary table bottom cover.

7. Extend the Z-axis way cover and secure it to the rotary table bottom cover with thirteen SHCS.

Rotary Table Drawbar Clutch Inspection

Clutch Slip Test

1. Loosen the sixteen BHCS that attach the right side access panel (closest to operator) to the rotary table top cover, and remove.

2. Visually inspect the drawbar motor assembly to verify that the belt is at the desired tension. Tighten the four mounting SHCS if needed.

Note: Proper belt tension should place the motor mounting bracket all the way to the left on machines after serial #50148, and all the way to the right on machines up to serial #50148 (except machines #50132 and #50139).

3. Execute an M50 CYCLE START (pallet change), ensuring that the drive belt does not slip on the pulley, and that the clutch assembly in the drive pulley does slip (1/2 to 1-1/2 turns) as the drawbar applies clamping force to the pallet.

4. To accurately measure how much the clutch is slipping, command a M50 CYCLE START to raise the H-Frame. Once the H- Frame lifts the pallets up, press the RESET button. This is will stop the pallet change sequence and allow you to access the clutch assembly. Mark the clutch pulley and spring with a marker since they will move with respect to each other as the clutch slips. Then execute another M50 CYCLE START and verify how much the clutch slips as the pallet is clamped. If it does not slip enough (1/2 - 1-1/2 turns) then line N88 in the Pallet Changer Macro #9000 needs to be adjusted. See note below.

NOTE: Line number 88 (below) in Pallet Changer Macro #9000 should be adjusted in increments of .1 seconds until the clutch slips between 1/2 to 1-1/2 turns. Refer to the complete Pallet Changer Macro example in the Technical Reference section of the service manual.

<u>LINE N88:</u>

N88 IF [[#3001 - #136 GT 1100.] AND #135] #1108= 0 (MAIN UP, STOP IT) 1.1 seconds after coming off the main drawbar up switch, turn off main drawbar

TO INCREASE THE MAIN DRAWBAR SCREW IN TIME, INCREASE THE VALUE NOW SHOWN AS 1100. (LINE N88) (Example: 1200., 1300., 1400., etc.)

5. Complete 50 consecutive pallet change cycles to check for any faults.

6. Apply sealant and install a gasket, then replace the right side access panel. Tighten the sixteen mounting BHCS.

Clutch Torque Test

TOOLS REQUIRED

✓ **Torque tester (T-1492)**

There are two types of failures for the clutch: failure to unclamp and failure to clamp or clamp adequately.

<u>CLUTCH FAILURE: WILL NOT UNCLAMP</u>

The unclamp mechanism of the clutch is a spring loaded dowel pin, captured in a spiral groove within the clutch pulley. As the pulley rotates counterclockwise (as viewed from above the clutch) the dowel pin rides up the slope of the spiral and springs back as the clutch engages, allowing the friction material to deliver the drive torque to the pulley for controlled clamping of the drawbar.

As the pulley rotates clockwise, (as viewed from above the clutch) during the pallet unclamp sequence, the spring loaded dowel pin rides down the spiral inside the pulley and slams against the machined stop at the bottom of the spiral. This action overrides the friction surfaces and delivers full motor torque directly to the pulley and therefore to the drawbar for unclamping the pallet.

Failure of the clutch to unclamp may occur if this mechanism fails due to breakage of the dowel pin or spring, or sticking of the dowel pin in the retracted position due to gumming of the grease or a burr on the hub.

These conditions will require a replacement of the clutch in service but the clutch may be rebuilt and therefore should be handled carefully and sent back to HAAS for evaluation.

CLUTCH FAILURE: WILL NOT CLAMP PROPERLY

The clamp mechanism of the clutch is a pair of Kevlar friction discs captured between the pulley and the hub and spring loaded by a series of Belleville springs. As the pulley rotates counterclockwise (as viewed from above the clutch) the friction discs are allowed to slip against the pulley once the downward force being applied by the springs has been overcome. This system allows for a smooth application of force to the drawbar and a consistent amount of torque applied to the pulley driving the drawbar.

During assembly, the clutch springs are set to allow slipping of the friction discs once the clutch achieves 55 ft-lbs. of torque applied to the drawbar. A specialized "torque meter" is used to determine and set the clamping force of the drawbar by setting the torque with which it turns as it engages the pallet nut.

Note: Torque values for machines up to serial #50148 should range from 35 ft.lbs. to 50 ft.lbs. for factory clutches and from 50 ft.lbs. to 65 ft. lbs. for service replacement clutches.

Torque values for machines after serial #50148 should range from 50 ft.lbs. to 65 ft.lbs. Any clutch that consistently tests over 70 ft. lbs. should be reset or replaced.

MEASURING THE TORQUE:

READ THIS SECTION COMPLETELY BEFORE ATTEMPTING TO MEASURE THE CLUTCH TORQUE!

1. With the machine in MDI mode, program an M50 (pallet change sequence) and interrupt the program by pressing reset or emergency stop as the pallets rotate through the door opening. This will halt the pallet changer yet safely maintain air pressure in the lift cylinder to hold up the pallets.

Note: In machines with serial number lower than 50149, the H-frame will drop after pressing RESET or E-STOP. Stay clear to avoid injury and make sure the H-frame has rotated about 90 degrees for safety reasons.

2. Remove the six 1/4-20 SHCS that secure the pallet nut to the pallet (on either pallet). Remove the V-seal from the pallet nut located on the underside of the pallet and remove the pallet nut from the pallet.

3. Place the torque tester nut loosely in the hole where the pallet nut was.

Note: Some machines have drawbars without a non threaded lead in portion at the top of the drawbar. When using the torque tester on these machines be sure to use the proper "torque nut" for the drawbar. There are four different "torque nuts" depending on the machine to be tested:

1) Standard HAAS machines with thin pallets and drawbars with a lead in non threaded portion (long).-- **nut A**
2) Standard HAAS machines with thin pallets and drawbars without a lead in portion (short).--- **nut B**

3) Standard HAAS machines with 2.5 in. thick pallets-------------------------------- **nutC**
4) MIKRON machines with metric pallets--- **nut D**

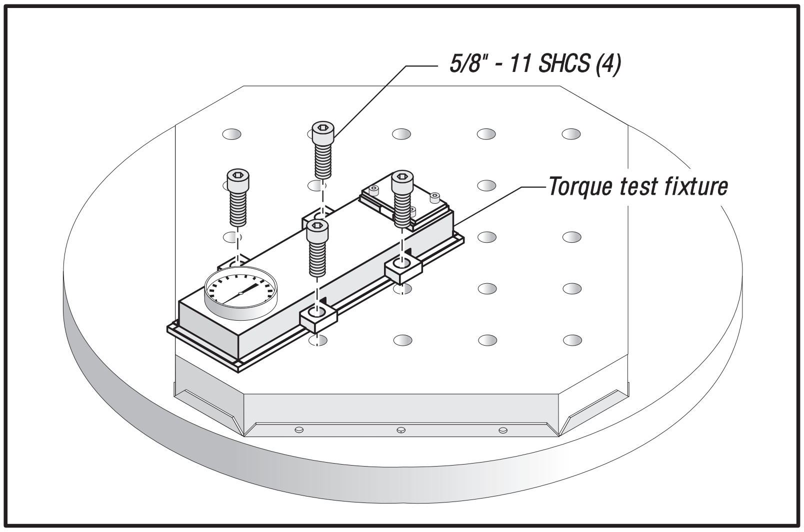


Figure 3-40. Torque tester.

4. Gently set the torque tester on the pallet so the 1/2 square drive engages the female drive in the nut. Rotate the torque tester 45 degrees on the pallet until the four mounting holes line up with four holes in the pallet. Secure the tester to the pallet using four 5/8-11 SHCS. Reach underneath the pallet and wiggle the nut to assure it moves freely with no binding or interference.

5. Let the pallet changer sequence finish by running an M50 again. This time let the pallet change sequence complete.

6. As the pallet settles down onto the four index pins the drawbar will begin to screw up into the nut, some movement of the needle will occur but no large reading should be expected yet.

7. In normal operation the drawbar shoulder contacts the bottom of the nut housing inside the rotary table and the drawbar begins to exert downward force on the pallet nut as it continues to turn, in essence "tightening" the pallet nut on the drawbar. Once the drawbar reaches 55 ft.lbs. of torque, the clutch will begin to slip and the drawbar motor will stop.

Note: The drawbar motor will not stop after the clutch begins to slip during a torque test, it is because the drawbar has not come off the "drawbar up" switch underneath the rotary table. It is not a failure, simply press reset. No harm will be done if this is done promptly.

8. If the meter on the torque tester reads beyond the recommended torque for the particular machine being tested, the clutch may need to be replaced.

Note: Torque values for machines up to serial #50148 should range from 35 ft.lbs. to 50 ft.lbs. for factory clutches and from 50 ft.lbs. to 65 ft. lbs. for service replacement clutches.

Torque values for machines after serial #50148 should range from 50 ft.lbs. to 65 ft.lbs. Any clutch that consistently tests over 70 ft. lbs. should be reset or replaced.

9. If, after repeated attempts, the clutch will not come up to the proper torque reading then it may be necessary to replace the clutch. Send the old clutch back to HAAS for inspection and evaluation.

10. When the torque test is complete, reinstall the pallet nut, six 1/4-20 SHCS and V-seal and the rotary table access cover.

ROTARY TABLE DRAWBAR CLUTCH / MOTOR SUBASSEMBLY

REMOVAL-

1. Loosen the sixteen BHCS that attach the right side access panel (closest to operator) to the rotary table top cover and remove.

2. Loosen and remove the four drawbar motor mounting SHCS, and slip the drawbar drive motor and pulley out of the drive belt.

3. Disconnect the motor power cable at the solenoid mounting bracket (on older machines). This bracket is located at the rear of the machine on the control box side, behind an access panel. On new machines the power cable may be disconnected from the plug at the motor end of the cable.

4. On older machines it may be necessary to remove the thirteen SHCS that attach the Z-axis way cover to the rotary table bottom cover, and collapse it towards the column to access the tie wraps that secure the motor power cable in place.

INSTALLATION-

5. Ensure the drive belt is wrapped around the driven pulley.

6. Slip the new drawbar motor and pulley into the drive belt, and mount it to the casting with four SHCS.

7. Move the drawbar motor assembly all the way to the left in the slots so the belt is at the desired tension. Tighten the four mounting SHCS.

Note: Proper belt tension should place the motor mounting bracket all the way to the left on machines after serial #50148, and all the way to the right on machines up to serial #50148 (except machines #50132 and #50139).

8. Execute an M50 CYCLE START (pallet change), ensuring that the drive belt does not slip on the pulley, and that the clutch assembly in the drive pulley does slip (1/2 to 1-1/2 turns) as the drawbar applies clamping force to the pallet.

9. To accurately measure how much the clutch is slipping, command a M50 CYCLE START to raise the H-Frame. Once the H- Frame lifts the pallets up, press the RESET button. This is will stop the pallet change sequence and allow you to access the clutch assembly. Mark the clutch pulley and spring with a marker. Then execute another M50 CYCLE START and verify how much the clutch slips as the pallet is clamped. If it does not slip enough (1/2 - 1-1/2 turns) then line N88 in the Pallet Changer Macro #9000 needs to be adjusted. See note below.

Note: Line number 88 (below) in Pallet Changer Macro #9000 should be adjusted in increments of .1 seconds until the clutch slips between 1/2 to 1-1/2 turns. Refer to the complete Pallet Changer Macro example in the Technical Reference section.

LINE N88:

N88 IF [[#3001 - #136 GT 1100.] AND #135] #1108= 0 (MAIN UP, STOP IT)

1.1 seconds after coming off the main drawbar up switch, turn off main drawbar

TO INCREASE THE MAIN DRAWBAR SCREW IN TIME, INCREASE THE VALUE NOW SHOWN AS 1100. (LINE N88) (Example 1200., 1300., 1400., etc.)

10. Complete 50 continuous pallet change cycles to check for any faults.

11. Apply sealant and install a gasket, then replace the right side access panel. Tighten the sixteen BHCS.

12. Apply sealant and install a gasket where the Z-axis way cover meets the rotary table bottom cover.

13. Extend the Z-axis way cover and secure to the rotary table bottom cover with thirteen SHCS.

ROTARY TABLE DRAWBAR CLUTCH / PULLEY

REMOVAL FROM MOTOR-

1. Loosen the sixteen BHCS that attach the right side access panel (closest to operator) to the rotary table top cover and remove.

2. Loosen and remove the four drawbar motor mounting SHCS, and slip the drawbar drive motor and pulley out of the drive belt.

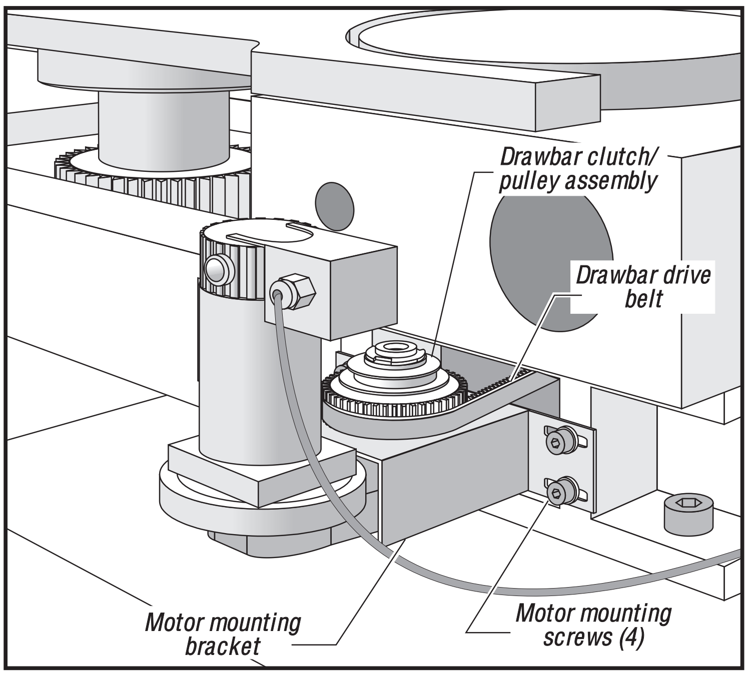


Figure 3-41. View of pallet changer rotary table (showing drawbar drive assembly)

3. Make sure the drive belt is out of the way, then replace the drive motor and pulley onto the casting. Tighten the four mounting SHCS.

4. Loosen the set screw that pushes on the key at the bottom of the clutch hub, under the pulley.

5. Using a flat tip screwdriver under each side of the pulley, exert a uniform force to lift the pulley off the motor shaft. On clutches with a large hex nut on the top, use a 1/2-13 bolt to thread through the nut and push on the top of the motor shaft, lifting the clutch off the shaft.

INSTALLATION-

6. Loosen the set screw beyond the key way to assure easy assembly of the clutch onto the motor shaft.

7. Put the two thrust washers (0.03 thick) in place on the shaft. Apply Molybdenum disulfide grease to the washer surfaces.

8. Install the key and clutch/pulley onto the shaft, pushing down until it is in contact with the thrust washers. Tighten the set screw onto the key.

9. Remove the four SHCS that mount the drive motor and pulley assembly to the casting, and slip the pulley into the drive belt.

10. Replace the four SHCS that hold the motor and pulley assembly to the casting.

11. Move the drawbar motor assembly all the way to the left so the belt is at the desired tension, and tighten the four mounting SHCS.

Note: Proper belt tension should place the motor mounting bracket all the way to the left on machines after serial #50148, and all the way to the right on machines up to serial #50148 (except machines #50132 and #50139).

12. Execute an M50 CYCLE START (pallet change), ensuring that the drive belt does not slip on the pulley, and that the clutch assembly in the drive pulley does slip (1/2 to 1-1/2 turns) as the drawbar applies clamping force to the pallet.

13. To accurately measure how much the clutch is slipping, command a M50 CYCLE START to raise the H-Frame. Once the H- Frame lifts the pallets up, press the RESET button. This is will stop the pallet change sequence and allow you to access the clutch assembly. Mark the clutch pulley and spring with a marker. Then execute another M50 CYCLE START and verify how much the clutch slips as the pallet is clamped. If it does not slip enough (1/2 - 1-1/2 turns) then line N88 in the Pallet Changer Macro #9000 needs to be adjusted. See note below.

NOTE: Line number 88 (below) in Pallet Changer Macro #9000 should be adjusted in increments of .1 seconds until the clutch slips between 1/2 to 1-1/2 turns. Refer to the complete Pallet Changer Macro example in the Technical Reference section.

LINE N88:

N88 IF [[#3001 - #136 GT 1100.] AND #135] #1108= 0 (MAIN UP, STOP IT)

1.1 seconds after coming off the main drawbar up switch, turn off main drawbar

TO INCREASE THE MAIN DRAWBAR SCREW IN TIME, INCREASE THE VALUE NOW SHOWN AS 1100. (LINE N88) (Example 1200., 1300., 1400., etc.)

14. Complete 50 continuous pallet change cycles to check for any faults.

15. Apply sealant and install a gasket, then replace the right side access panel. Tighten the sixteen BHCS.

Rotary Table Drawbar Drive Belt

REMOVAL-

1. Loosen the sixteen BHCS that attach the right side access panel (closest to operator) to the rotary table top cover and remove.

2. Remove the thirteen SHCS that attach the Z-axis way cover to the rotary table bottom cover. Collapse the Z-axis way cover so the linear guides are exposed. The driven pulley and drive belt can be accessed from the side of the linear guides.

3. Manually unscrew both the main drawbar and the load station drawbar. Manually activate the pallet lift cylinder solenoid to lift the pallets. Rotate the pallets and H-frame past the rotary table.

4. Remove the four SHCS that attach the air blast manifold and remove the manifold. Remove the six SHCS that secure the main drawbar and nut housing to the rotary table and remove the drawbar.

5. Remove the four drawbar motor mounting SHCS. Slip the rotary table drawbar drive motor and pulley out of the drive belt.

6. Slide the drive belt between the driven pulley and the air blast adapter (beneath the rotary table), and remove.

INSTALLATION-

7. Slide the new drive belt between the driven pulley and the air blast adapter, and wrap it around the driven pulley.

8. Slip the drawbar drive motor and pulley into the drive belt.

9. Mount the motor and pulley to the casting with four SHCS. Move the drawbar motor assembly until the belt is at the desired tension, and tighten the screws.

Note: The proper belt tension should place the motor mounting bracket all the way to the left.

10. Replace the drawbar and air blast manifold.

11. Active the pallet lift cylinder solenoid to lift the pallets, then rotate the pallets into position over the rotary table. Allow the pallets to settle down into place.

12. Execute an M50 CYCLE START (pallet change), ensuring that the new drive belt does not slip on the pulley, and that the clutch assembly in the drive pulley does slip as the drawbar applies clamping force to the pallet.

13. Complete 50 continuous pallet change cycles to check for any faults.

14. Apply sealant and install a gasket, then replace the right side access panel. Tighten the sixteen mounting BHCS.

15. Apply sealant and install a gasket where the Z-axis way cover meets the rotary table cover.

16. Extend the Z-axis way cover and secure to the rotary table bottom cover with thirteen SHCS.

ROTARY TABLE MOTOR AND BELT SUBASSEMBLY

REMOVAL-

1. Loosen the sixteen BHCS that attach the left side access panel (opposite the operator) to the rotary table top cover and remove.

2. Loosen the adjustment socket set screw and remove the motor adjustor plate (beside the rotary table motor mounting plate).

3. Disconnect the two air lines and two electrical connections to the motor assembly.

4. Loosen the two motor mounting HHB, but do not remove.

5. Move the motor assembly until the drive belt is loose, and remove the belt from the driven pulley.

6. Remove the two mounting HHB and the motor assembly.

7. The drive belt may be removed from the motor assembly by loosening the four SHCS and removing the mounting plate from the motor.

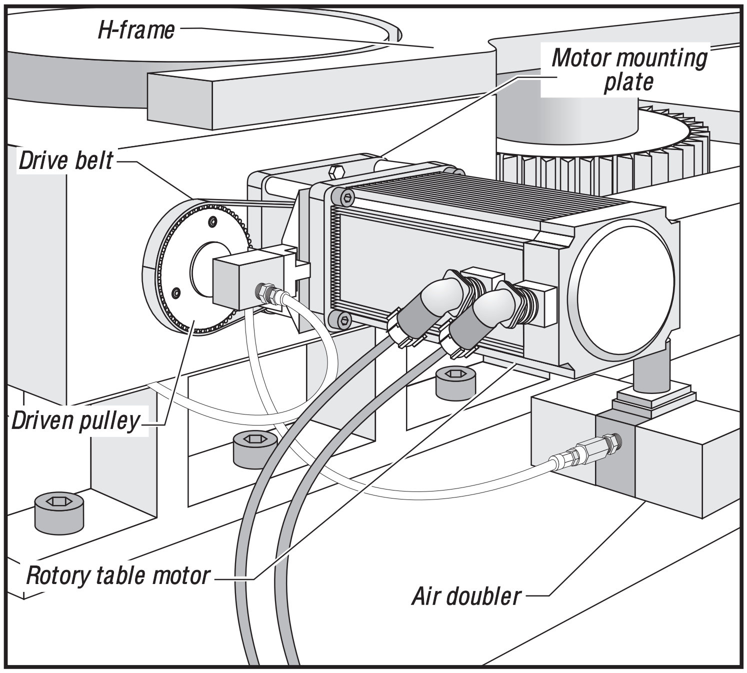


Figure 3-42. Rotary table motor and belt assembly

INSTALLATION-

8. Replace the drive belt on the motor pulley, then replace the four SHCS into the mounting plate and tighten.

9. Mount the motor assembly onto the side of the rotary table with the two mounting HHB, but do not tighten.

10. Place the other end of the drive belt on the driven pulley.

11. Replace the motor adjustor plate onto the two pins and tighten the adjustment socket set screw until the belt is at the desired tension.

12. Tighten the two motor mounting HHB.

13. Reconnect the two air lines and two electrical connections to the motor assembly.

14. Apply sealant, install a gasket, then replace the left side access panel. Tighten the sixteen mounting BHCS.

15. Perform the necessary adjustments in accordance with "H-frame alignment" and "Pallet Rotation Hardstop Adjustment" sections.

ROTARY TABLE DRAWBAR

REMOVAL-

1. Remove the pallet, in accordance with the "Pallet Replacement" section.

2. Loosen the four mounting SHCS and remove the air blast manifold from the rotary table top.

3. Loosen the eight mounting SHCS and remove a pallet nut from one of the pallets. Screw the pallet nut onto the drawbar. This will provide a way of removing the drawbar assembly.

4. Loosen the six SHCS that mount the nut housing to the rotary table.

5. Pull the pallet nut and drawbar up and remove them from the center of the rotary table.

6. Unscrew the drawbar from the nut housing and pallet nut.

INSTALLATION -

7. Lubricate (using Molybdenum disulfide grease) the threads of the new drawbar, and it's two thrust washers and the splines.

8. Screw the drawbar into the nut housing. Lower the drawbar (and nut housing) into the splines of the drive shaft in the center of the rotary table.

9. Secure the nut housing to the rotary table top with six SHCS.

10. Replace the pallet nut into the pallet and tighten the six SHCS.

11. Replace the air blast manifold onto the rotary table top and tighten the four mounting SHCS.

12. Replace the pallet according to the appropriate section.

13. Execute continuous pallet change cycles to check for any faults.

ROTARY TABLE DRAWBAR (PULL STUD TYPE)

REMOVAL-

1. Remove the pallet, in accordance with the "Pallet Replacement" section. Check for proper operation of drawbar collet balls. Make note of any wear or damage to drawbar collet and balls.

2. Loosen the four mounting SHCS and remove the air blast manifold from the rotary table top.

3. Once the air blast manifold is removed, remove the 12 rubber plugs that cover the upper draw bar mounting hardware and remove the 10 mounting SHCS that retain the upper draw bar assembly.

> **CAUTION!** Do not remove yellow marked SHCS fasteners. Marked SHCS are used to retain drawbar assembly.

4. On the mounting surface of the upper draw bar assembly, gently pry the unit upwards (the housing return spring will cause the assembly to lift, once the retaining screws are removed) until there is enough surface area to grab and lift entire assembly out. Check for any wear or damages to assembly.

INSTALLATION -

1. Lubricate (using Red-i grease) the splines of the new drawbar.

2. Apply grease to the contact surfaces to ease the installation of the assembly.

3. Carefully place drawbar assembly into mounting location. Apply a drop of blue Loctite to assembly mounting SHCS. Depress the unit against the housing spring and screw the 10 SHCS into the assembly. Torque assembly mounting SHCS to **15 FT-LBS**.

4. Replace the O-Ring for the air blast manifold and re-install. Apply a drop of blue Loctite to the air blast manifold SHCS and screw them into the manifold. Torque air blast manifold SHCS to **15 FT-LBS**.

5. Replace the pallet according to the "Pallet Replacement" section.

6. Execute continuous pallet change cycles to check for any faults.

Drawbar Insert (Pull Stud Type)

REMOVAL-

1. Remove the pallet, in accordance with the "Pallet Replacement" section.

2. Command the drawbar into its clamp position. E-Stop the machine.

3. Loosen the three mounting BHCS that retain the insert into the drawbar assembly.

4. Insert a socket extension tool into the pull-stud area of the drawbar assembly. (For steps 4 through 9, refer to *Figure 3.43)*

5. Place a standard flat head screwdriver into the annular groove at the top of the drawbar insert and position it to rest against the protruding socket extension tool.

6. Using the screwdriver as a lever arm, pivot it on the socket tool and gently pry out the insert. Alternate the position of screwdriver to evenly remove the insert.

7. Inspect the inside surface of the insert for galling marks and excessive wear.

8. Using a machinist *Hook and Pick* tool, carefully remove the v-seal that resides directly beneath the insert. Check for wear and damage. Replace if necessary.

9. Carefully clean out any debris or residue left in the insert and v-seal area. Remove the 10 mounting SHCS and two yellow marked SHCS on the upper drawbar assembly. Remove upper ball collet housing and check for proper oil level. Replace upper ball collet housing. Torque SHCS to **15 FT-LBS.**

INSTALLATION-

1. Install a new o-ring on to the drawbar insert and v-seal in the drawbar assembly.

2. Place the new insert into drawbar assembly and gently press into place. Be careful not damage insert.

3. Apply a drop of blue Loctite to the insert 3 BHCS and secure them to the drawbar assembly.

4. Power up machine. Execute clamp and unclamp cycles and check for proper operation of drawbar. Observe and check for proper movement of the collet balls.

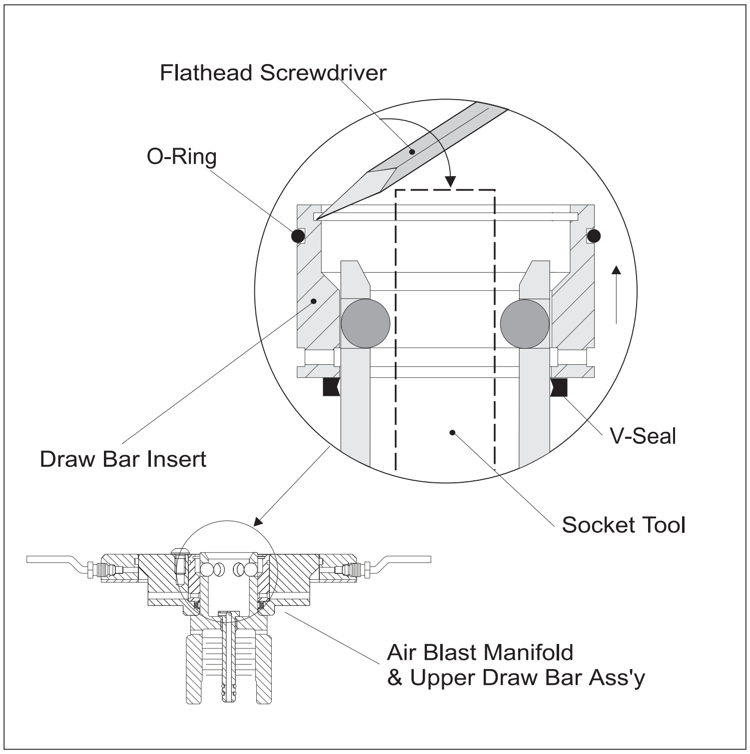


Figure 3-43

LOAD STATION DRAWBAR

REMOVAL-

1. Remove the pallet according to the appropriate section.

2. Loosen the hex nut that tightens the indexing handle onto the load station and remove the handle.

3. Loosen the four BHCS that attach the load station bottom cover to the load station and remove.

4. Disconnect the load station motor power supply cord (beneath the load station).

5. Loosen the four mounting SHCS and remove the load station motor from the bottom of the load station. Remove the drive shaft and woodruff key with the motor.

6. Remove the drawbar from the center of the load station by unscrewing it and pulling it out below the pallet turntable.

INSTALLATION-

7. Lubricate (using Molybdenum disulfide grease) the splines of the drawbar and screw it into the center of the load station.

8. Put the woodruff key and drive shaft back into place in the motor splines.

9. Mount the load station motor on the bottom of the load station with four SHCS.

10. Reconnect the load station motor power supply cord.

11. Replace the load station bottom cover onto the load station and tighten the six BHCS.

12. Replace the indexing handle into the actuator yoke, and tighten the hex nut.

13. Replace the pallet in accordance with the appropriate section.

14. Execute 50 continuous pallet change cycles to check for any faults.

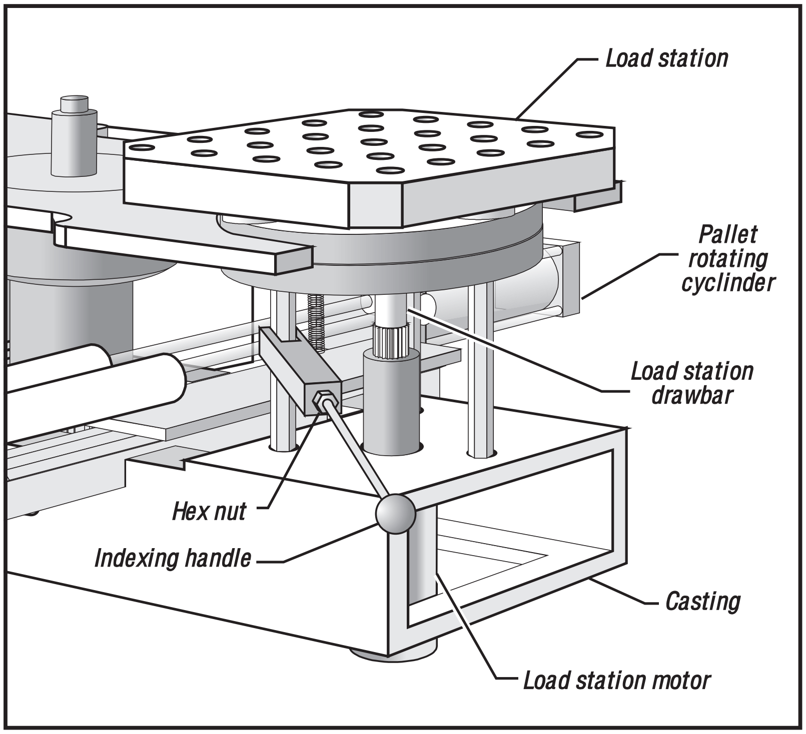


Figure 3-44 Pallet changer load station.

PALLET REPLACEMENT

REMOVAL-

The normal sequence of the pallet changer is:

1) unclamp the pallets
2) raise the pallets
3) rotate the pallets
4) lower the pallets
5) clamp the pallets

1. Execute a single M50 command from MDI, then interrupt the sequence by pressing RESET as the pallets are being lowered. Do not wait until the pallets are fully down on the stations.

2. Mark the front of the pallet to clarify orientation for when it is to be placed back on the machine.

3. Remove the pallet from the load station using some type of overhead lift, such as a hoist or crane.

CAUTION! Do not attempt to remove the pallet from inside the machine.

4. Check that the pads under the pallet are clean, and the V-ring seal is intact around the pallet nut.

5. After removing, set the pallet down on a clean surface, preferably wood, cardboard, or masonite for storage (even for temporary storage).

6. To remove the second pallet from the pallet changer, simply repeat the above procedure.

Note: It is not necessary for the pallet change sequence to begin from a "PALLETS CLAMPED" condition.

INSTALLATION-

1. Execute a single M50 command from MDI, then interrupt the sequence by pressing RESET as the lift mechanism is being lowered. Do not wait until the lifting mechanism is fully down on the stations.

2. Check that the pads under the pallet are clean, and the V-ring seal is intact around the pallet nut.

3. Ensure the load station is at the correct index position for proper pallet change operation before loading the pallet onto the load station. The correct position is defined as the position where the load station indexing handle is able to come to the fully up position.

4. **IMPORTANT!** When aligning the pallet and the load station locating pins, ensure that the three holes in the bottom of the pallet that mate to the lifting mechanism are properly oriented (the front of the pallet is facing the right direction).

5. Place the pallet onto the load station using some type of overhead lift, such as a hoist or crane.

CAUTION! Do not attempt to install the pallets from inside the machine.

AIR BLAST ADAPTER

REMOVAL-

1. Remove one pallet in accordance with the previous section.

2. Execute one more M50 in MDI, to put the empty pallet position inside the machine.

3. Remove the thirteen SHCS that attach the Z-axis way cover to the rotary table bottom cover.

4. Collapse the Z-axis way cover so the linear guides are exposed. The air blast adapter, beneath the rotary table, can be accessed from the side of the linear guides.

5. Disconnect the main air line to the machine.

6. Disconnect the air and oil lines from the air blast adapter.

7. Remove the rotary table drawbar in accordance with the appropriate section.

8. Remove the two shoulder bolts that secure the air blast adapter to the mounting bracket, and remove the air blast adapter.

INSTALLATION-

9. Attach the new air blast adapter (with O-rings installed) to the mounting bracket.

10. Replace the rotary table drawbar in accordance with "Rotary Table Drawbar" section.

11. Reconnect the oil and air lines to the air blast adaptor.

12. Reconnect the main air line to the machine.

13. Replace the pallet in accordance with the previous section.

14. Apply sealant and install a gasket where the Z-axis way cover meets the rotary table bottom cover.

15. Extend the Z-axis way cover and secure it to the rotary table bottom cover with the nine SHCS.

AIR BLAST MANIFOLD

REMOVAL-

1. Remove one pallet in accordance with the previous section.

2. Execute one more M50 in MDI, to put the empty pallet position inside the machine.

3. Loosen the four SHCS that mount the air blast manifold to the rotary table top and remove.

INSTALLATION-

4. Place the new air blast manifold, ensuring the O-ring is installed, onto the rotary table top and mount with the four SHCS.

5. Replace the pallet in accordance with the previous section.

PALLET ROTATION HARDSTOP ADJUSTMENT

1. Loosen the six BHCS and one SHCS that attach each of the front splash shields and remove the shields.

2. Slightly loosen the two SHCS that hold each of the hardstops (2) in place.

3. In MDI, execute an M50 (pallet change). Interrupt it by pressing RESET just as the pallets are lifted off the rotary table.

4. Execute an M12 to lower the pallets onto the rotary table without the drawbar clamping the pallets.

5. Rotate the cam screw inside the appropriate hardstop until the hardstop contacts the end of the roller mounting plate. Align the H-frame lifting pins with the holes in the bottom of the pallet, either by rotating the cam screw further in or backing it off.

6. Secure the hardstop by tightening the two SHCS.

Note: Clockwise rotation of the pallet changer is adjusted at the left hardstop (opposite side from the control panel), while counterclockwise rotation of the pallet changer is adjusted at the right hardstop (closest to control panel).

7. Replace the splash shields, and tighten the six BHCS and one SHCS on each shield.

PALLET ROTATION HARDSTOP ADJUSTMENT (DAMPER/SPRING & RETAINER PIN STYLE)

1. Remove any possible load(s) or fixtures from the pallets.

2. Loosen the fourteen BHCS that attach each of the front access panels and remove. (The access panels should correspond to the rotation direction of the H-frame.)

3. In MDI, execute an M13 (H-Frame up).

4. Loosen the two SHCS that hold each of the hardstops (2) in place and remove hardstop(s). Manually rotate H-frame to its full rotational swing and perform an M12 (H-frame down).

5. Remove the pallet (from the load station side) in accordance with the "Pallet Replacement" section.

6. Apply H-frame alignment tool to H-frame and pallet fixtures. (Refer to "A-axis Alignment to H-Frame" section). Using this as a reference, re-install the hardstops with the SHCS. Adjust the hardstop to mount flush against the surface of the H-frame strike. Tighten the SHCS and torque to **50 FT-LBS**.

7. Run pallet change commands and observe operation. (H-Frame full rotation shown in *Figure 3-45.*)

8. Replace pallet(s) in accordance to "Pallet Replacement" section. Replace the access panels.

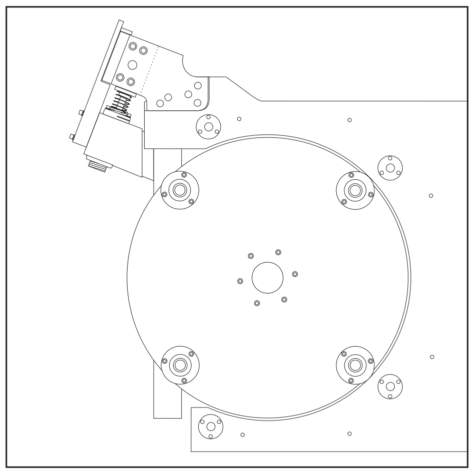


Figure 3-45.

A-AXIS ALIGNMENT TO H-FRAME

TOOLS REQUIRED

✓ **H-frame alignment tool (T-1516)**

Note: This adjustment must also be done if machine parameters are lost, or the A-axis rotary table is replaced.

1. Remove the pallet (from the load station side) in accordance with the "Pallet Replacement" section.

2. Execute a pallet change to bring the empty side of the H-frame into the machine. Press RESET as the H-frame is lowering, before the drawbar screws in.

3. Remove the pads from the rotary table (three SHCS each). Clean the pads and platter, and check for any scratches or high spots. Stone smooth if necessary.

4. Press the ALARM/MESGS key, type "Debug", then press the WRITE key.

5. Go to Parameter 224, write down the current value in Parameter 224 for reference, then enter zero (0) in it's place.

6. Press the ZERO RET key, the A key, then the ZERO SINGL AXIS key. This will zero return the A-axis only.

7. Handle jog the A-axis counterclockwise until the rotary table pins are aligned with the center pin on the H-frame.

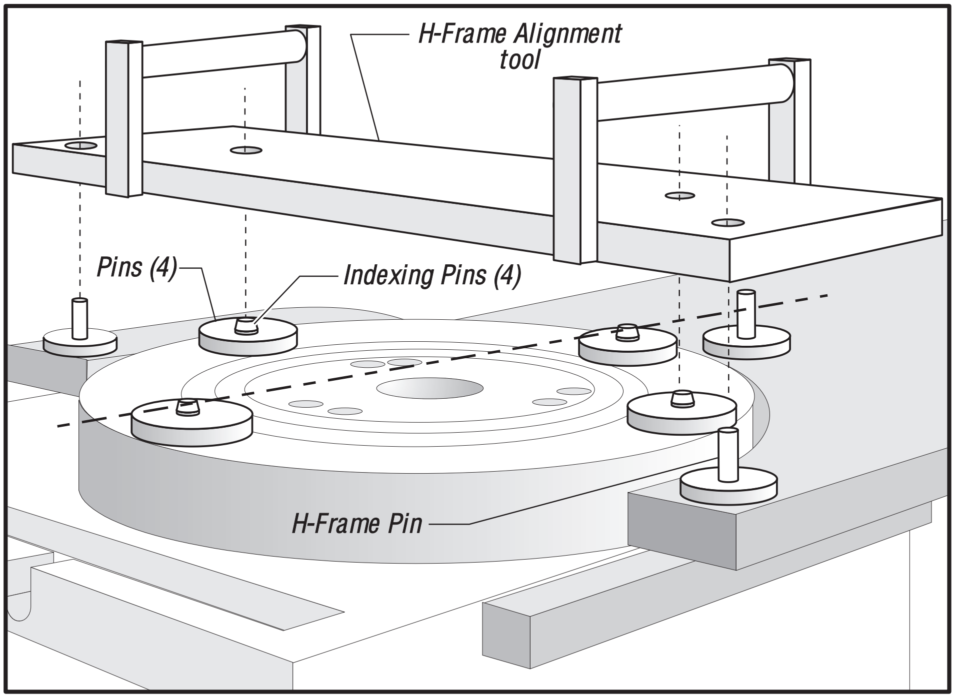


Figure 3-47. Use of the H-frame alignment tool.

8. Set the H-frame alignment tool in place on the pins. Using the jog handle, rotate the table until the alignment tool seats flat on the rotary table.

9. Press the POSIT key, then PAGE UP once. Take the actual number of encoder counts for the A-axis, disregard the decimal point and negative sign, and enter that number in Parameter 224. For example, the number -6.9347 would be entered as 69347.

10. Remove the alignment tool, zero return the A-axis (only), and check the value by replacing the alignment tool on the pins. Repeat the procedure if necessary.

11. Replace the pads on the rotary table platter with three SHCS each.

12. Replace the pallet in accordance with the "Pallet Replacement" section.

3.13 HYDRAULIC COUNTERBALANCE

TOOLS REQUIRED

✓ **Hydraulic Counter Balance Service Kit consists of :**

- **Pressure tank with manifold assembly, prefilled with (2) Quarts DTE-25 Hydraulic Oil**
- **Hydraulic cylinder with hose not attached (if necessary)**

HYDRAULIC TANK REPLACEMENT

REMOVAL -

1. Remove the rear enclosure panel (seven SHCS).

2. Jog the X-axis until the hydraulic tank can be easily accessed from the rear.

3. Jog the Y-axis until the upper two holes in the column and the corresponding holes in the spindle head are aligned. Place two of the original shipping lockbolts (5/8-11 x 4" SHCS) through the two holes and tighten. **CAUTION!** This step must be followed to keep the spindle head from crashing down during service. If this is not done, serious injury could occur.

4. EMERGENCY STOP the machine. POWER OFF the machine.

5. Disconnect the two-pin end of the pressure sensor cable from the pressure sensor located on the tank manifold.

6. Remove cap to Schrader filler valve, attach discharging hose (finger tight only), and release any remaining pressure from the tank.

> **Note:** Oil may drain out with releasing gas, so it is necessary to **slowly** discharge the system into a container.

7. Disconnect hydraulic hose from the tank assembly.

8. Remove tank assembly from the column by removing the four SHCS from tank box cover.

INSTALLATION -

1. Connect the hose to the tank, before inverting the tank for mounting. This prevents hydraulic oil from spilling.

2. Place the tank assembly in the tank mounting box. Secure the box lid with four SHCS. Ensure the hydraulic hose is not twisted.

3. Connect the two-pin end of the pressure sensor cable to the pressure sensor.

4. Connect the charging system to the Schrader filling valve. **Slowly** pressurize system with dry nitrogen gas (welding grade acceptable).

> **Note:** Do not use compressed air, oxygen or flammable gas. Verify the end of the cylinder rod is seated in the counterbore in the back of the spindle head.

5. **IMPORTANT!** Remove the two shipping lockbolts from the column and spindle head.

> **CAUTION!** Serious machine damage will occur if the axes are moved with the lockbolts in place.

6. POWER ON the machine and zero return (ZERO RET) the **Y-axis only**. Check for any leaks or abnormal noises. Verify tank pressure (600 psi) at top of travel. Remove charging system and replace valve cap. Zero return all axes.

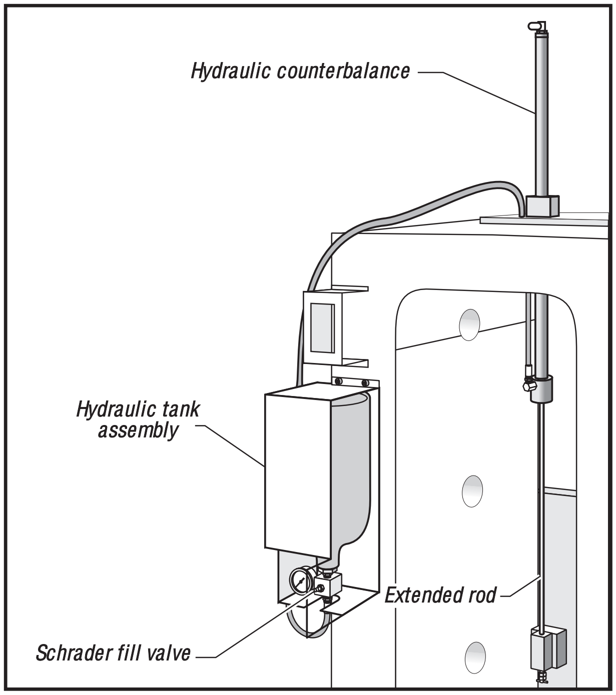


Figure 3-48. View of hydraulic counterbalance.

Note: If there is an Emergency Stop alarm that will not reset, check for correct system pressure, loose electrical connections, or the correct tank assembly.

HYDRAULIC CYLINDER REPLACEMENT

REMOVAL -

1. Remove the hydraulic tank as described in previous section.

2. To gain access to the cylinder rod, remove the rear enclosure panel (seven SHCS).

3. Insert the two shipping lockbolts into the column and spindle head, as in the previous section. **CAUTION!** This step must be followed to keep the spindle head from crashing down during service. If this is not done, serious injury could occur.

4. EMERGENCY STOP the machine. POWER OFF the machine.

5. Remove the cotter pin and lock nuts from the threaded end of the cylinder rod. These are located on the back of the spindle head, towards the control panel side of the machine.

6. Loosen the two SHCS holding the cylinder clamp to the top of the column.

7. Remove the hydraulic cylinder from the top of the column.

8. Disconnect the hose from the cylinder body.

9. Return the hose and cylinder to HAAS Automation.

INSTALLATION-

1. Install cylinder (with cylinder rod extended) through the large hole (closest to front) on top of the column. The cylinder rod should pass through spindle head mounting hole.

2. Orient cylinder body with hydraulic hose fitting facing toward the back of the machine. Secure cylinder to column using two shoulder bolts through the block on the cylinder.

3. Install washer and lock nuts (wrench tight) at threaded end of cylinder rod. Install safety cotter pin through cylinder rod.

4. Install the hydraulic tank as described in the previous section, but **DO NOT POWER UP the machine**.

5. Install the new hose through the smaller of the two holes on the top of the column, and attach to the cylinder body.

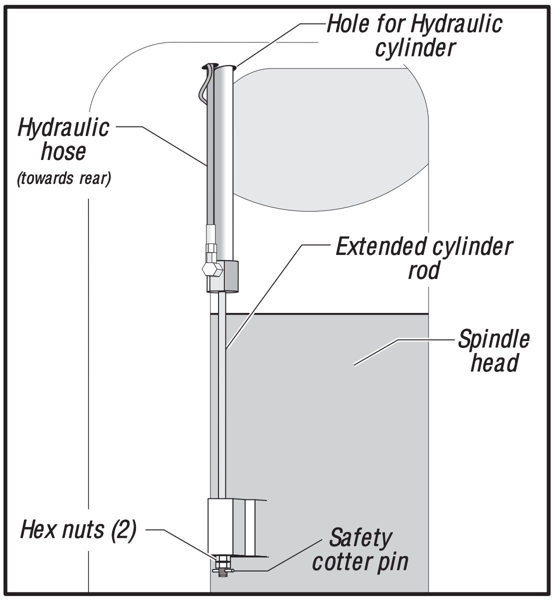


Figure 3-49. Hydraulic cylinder rod installation.

6. **IMPORTANT!** Remove the two shipping lockbolts from the column and spindle head.

CAUTION! Serious machine damage will occur if the axes are moved with the lockbolts in place.

---

7. POWER ON the machine and zero return (ZERO RET) **Y-axis only**. Observe the cylinder body for motion or abnormal noises. Check for fluid at manifold, cylinder hose connection and cylinder rod. Verify tank pressure at top of travel (600 psi). Remove charging system and replace valve cap.

8. Zero return (ZERO RET) the machine. HANDLE JOG the Y-axis in 0.1 increments. Verify full Y travel.

9. Cycle the Y-axis, using the following program, for five minutes and check for oil leaking at top of cylinder and cylinder rod:

G28, G54, Y-14.
M99
50% Rapid

10. If a Y-axis overcurrent alarm occurs during travel, verify and correct system pressure.

Note: At top of machine travel (HS-1/R/RP/HCE-400/400P), the correct pressure for the hydraulic counterbalance is 600 psi.

Note: If Y-axis overcurrent alarm is received at top or bottom of travel, call HAAS Automation Service Department immediately for assistance. If fluid leaks from hydraulic fittings, check that fittings are tight. If leaking continues, call HAAS Automation Service Department for assistance.

11. Replace the rear enclosure panel with seven SHCS.

3.14 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:**

- **0-15 PSI gauge**
- **0-600 PSI coolant gauge**
- **Ball valve**

The old TSC system must be serviced with TSC gauge kit 93-9010. The fittings on the 0-150 psi coolant gauge and on the ball valve fit the old system. The precharge gauge is the same as the new system.

PRECHARGE REGULATOR ADJUSTMENT

1. **CAUTION!** Extreme care must be taken in making this delicate adjustment. Insert a short piece of 1/4" plastic tubing into the 0-15 psi pressure gauge. Insert the short tube into the precharge pressure regulator (located on top of the transmission) and connect the plastic precharge tube (leading to the TRP) to the pressure gauge.

2. Manually turn on the precharge air by pushing the plunger on the precharge solenoid valve.

3. Hold down the precharge solenoid valve for at least 20 seconds to allow the pressure reading to stabilize, then set the precharge pressure to 4.0 psi (±0.4 psi). Release the solenoid and hold it down again for 20 seconds and re-check the precharge pressure. Repeat this a few times to ensure the pressure setting remains stable. Be sure the regulator adjustment knob is securely locked in place.

4. Remove the pressure gauge and short 1/4" hose. Reattach the precharge tube to the regulator.

PRIMING THE TSC SYSTEM

Note: When machine is ready to operate, with coolant in the coolant tank, prime the Through the Spindle Coolant (TSC) system according to the following procedure.

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.

Note: On old TSC system, If the drawbar was replaced, check that the ID of the drawbar is 0.156 dia, and not 0.190 dia. Replace it with the correct one if it is 0.190 dia.

CHECKING PUMP PRESSURE

Note: If the coolant pressure with no tool in the spindle is 60 psi or less, replace the pump assembly (30-3281A). Old TSC system uses pump head (93-3280B).

1. Insert the 0-600 psi coolant pressure gauge into the coolant line between the 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 described above.

3. Insert a standard (no through hole in pull stud) tool holder into the spindle.

4. Turn on TSC.

5. Check for leaks while TSC is still running. Shut off TSC.

6. Remove pressure gauge and reconnect the pump to the machine.

If the pump relief valve has been changed, adjust the relief valve in the following manner:

1. Remove the sealing cap from the pump relief valve. Loosen the lock nut.

2. Start with the pressure below 300 psi. Adjust the pressure relief valve until the pressure on the gauge rises to 300 psi. Tighten the lock nut, and replace the sealing cap. Setting range is 280-300psi.

3. Mark across the pump and sealing cap with a paint marker. This will indicate 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).

3.15 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).

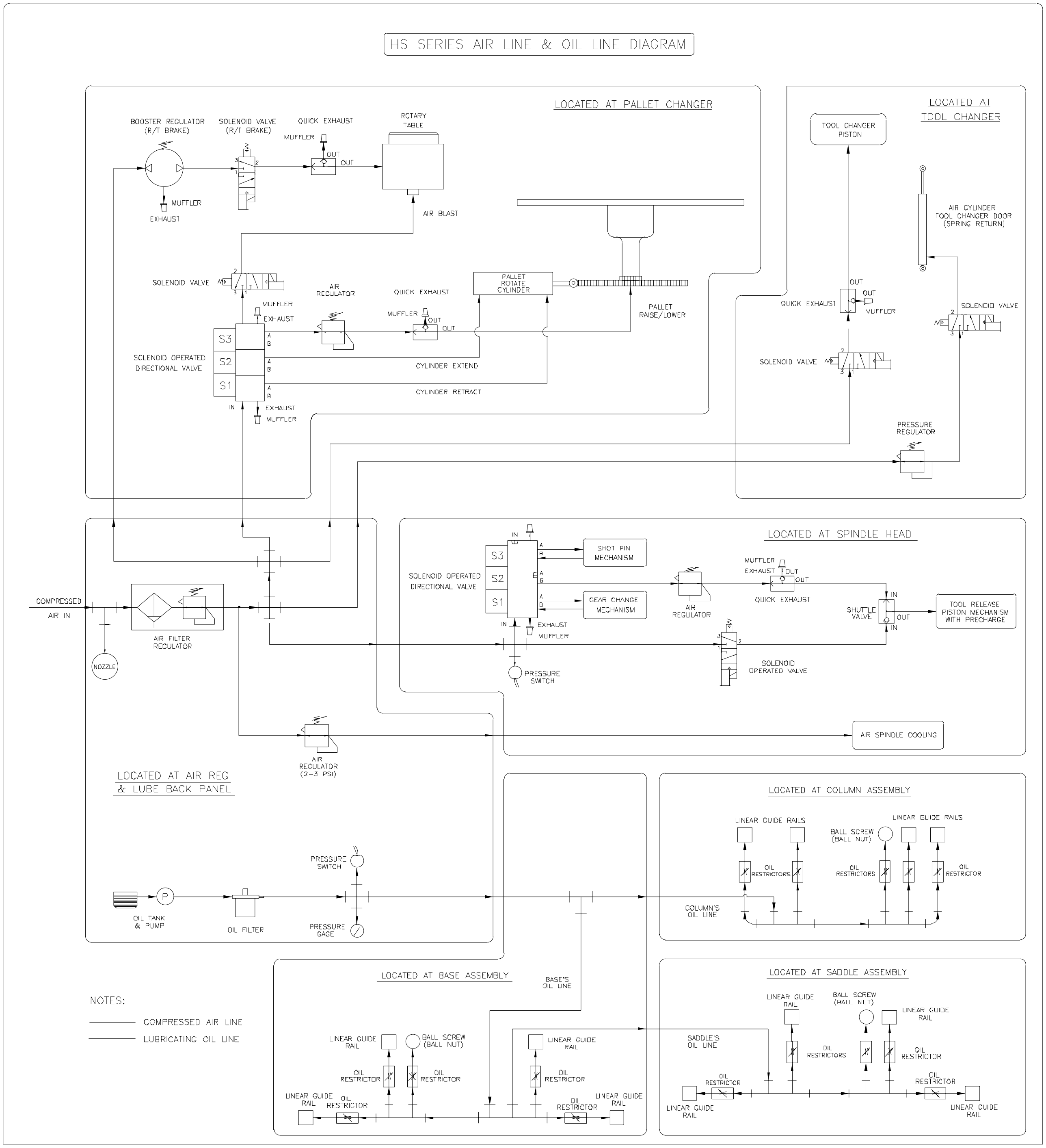
(DISTANCE TO GO - .118) x Ratio = Grid Offset

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.

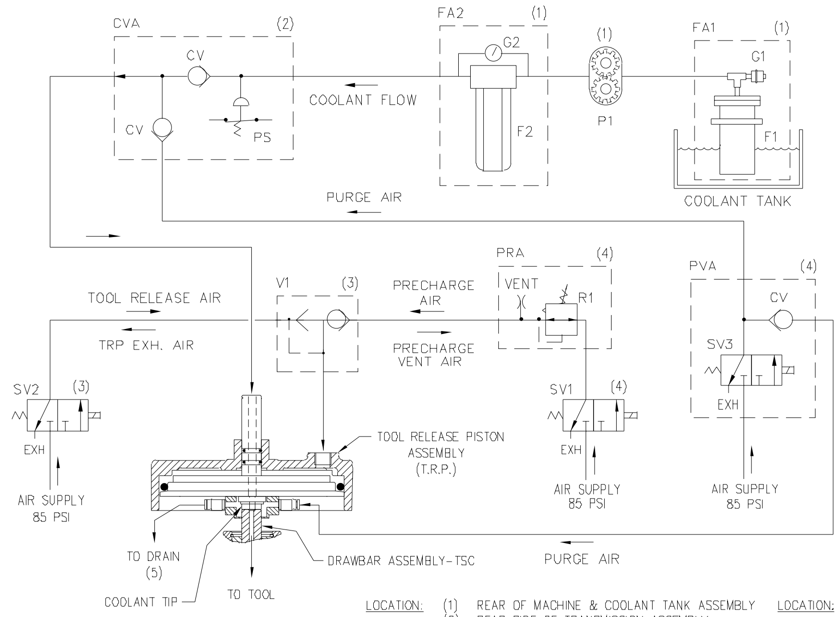
4. ZERO RET the axis again to use this offset.

NOTE: If Z-axis grid offset is reset, Parameter 64 should be checked and adjusted accordingly.

3.16 AIR / OIL LINE DIAGRAM



THROUGH THE SPINDLE COOLANT SYSTEM FLOW DIAGRAM



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

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

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

THROUGH SPINDLE COOLANT SYSTEM FLOW DIAGRAM

THROUGH SPINDLE COOLANT (TSC) WARNINGS!!

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

THROUGH SPINDLE COOLANT ALARMS

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

THROUGH SPINDLE COOLANT (TSC) MAINTENANCE SCHEDULE

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

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

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

WARNING!

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

WHEN MACHINING CASTINGS, SAND FROM THE CASTING PROCESS AND THE ABRASIVE PROPERTIES OF CAST ALUMINUM AND CAST IRON WILL SHORTEN PUMP LIFE UNLESS A SPECIAL FILTER IS USED IN ADDITION TO THE 100 MESH SUCTION FILTER. CONTACT HAAS FOR RECOMMENDATIONS.

MACHINING OF CERAMICS AND THE LIKE VOIDS ALL WARRANTY CLAIMS FOR WEAR AND IS DONE ENTIRELY AT CUTOMER'S RISK. INCREASED MAINTENANCE SCHEDULES ARE ABSOLUTELY REQUIRED WITH ABRASIVE SWARF. THE COOLANT MUST BE CHANGED MORE OFTEN AND THE TANK THOROUGHLY CLEANED OF SEDIMENT ON THE BOTTOM. A LARGER COOLANT TANK IS RECOMMENDED. SHORTENED PUMP LIFE, REDUCTION OF PRESSURE AND INCREASED MAINTENANCE ARE NORMAL AND TO BE EXPECTED IN ABRASIVE ENVIRONMENTS AND IS NOT COVERED BY WARRANTY.

4. ELECTRICAL SERVICE

4.1 SOLENOIDS

Please read this section in its entirety before attempting to replace any solenoid assemblies.

AIR SOLENOID ASSEMBLY

REMOVAL -

1. Turn machine power ON and lower spindle head to the lowest position. Turn power OFF.

2. Remove the rear enclosure panel (seven SHCS).

3. Remove air supply from machine.

4. Disconnect all air lines going to and from the air solenoid assembly on the top front of the solenoid bracket. Do not remove the fittings --- remove the lines from the fittings.
5. Disconnect the two leads to the low air pressure sensor.

6. Unplug the wiring leading to the plug marked on the solenoid bracket as "880 FROM I/O PCB TO SOLENOID VALVES" and the plug marked "SPARE".

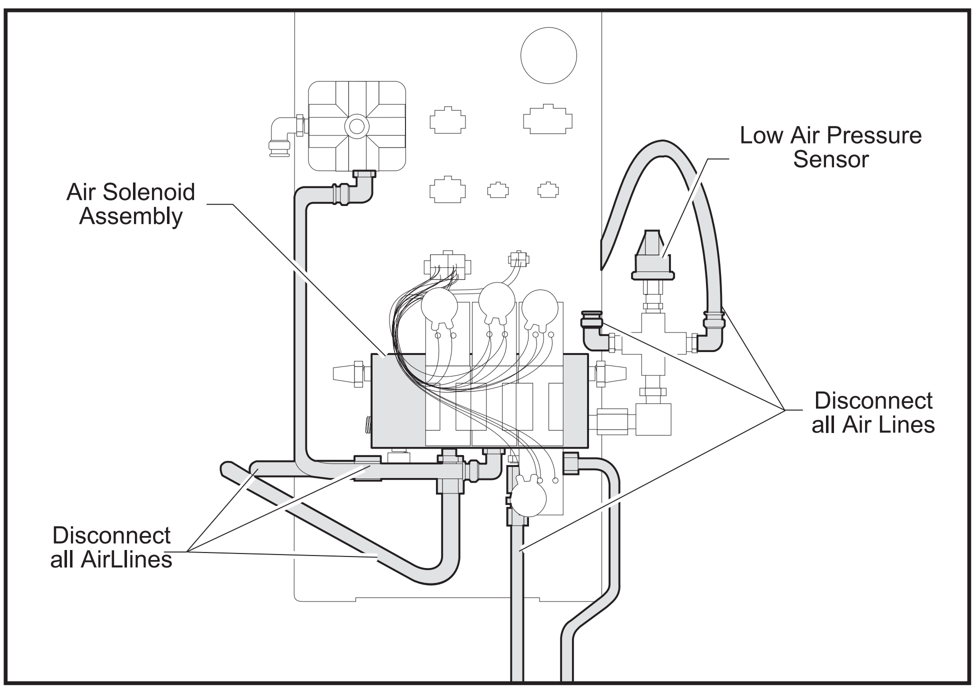


Figure 4-1. Air solenoid assembly.

7. Remove the SHCS holding the assembly to the bracket and remove the assembly.

INSTALLATION -

8. Replace the air solenoid assembly and attach to the bracket with the SHCS previously removed. Tighten securely.

9. Reconnect all air lines at this time, ensuring that all connections are tight and do not leak.

10. Reconnect the two leads to the low air pressure sensor.

11. Reconnect the wiring to the plugs on the solenoid bracket (See step 6).

12. Reconnect air supply to the machine.

13. Replace the rear enclosure panel (seven SHCS).

Tool Release Piston Assembly Air Solenoid

1. Turn machine power ON and raise spindle head to uppermost position. Turn power OFF.

2. Remove air supply from machine.

3. Remove the tool release piston assembly (Mechanical Service).

4. Unscrew the air solenoid assembly from the tool release piston assembly, taking care to not disturb the position of the clamp/unclamp switches.

5. Unscrew the air solenoid from the air solenoid assembly.

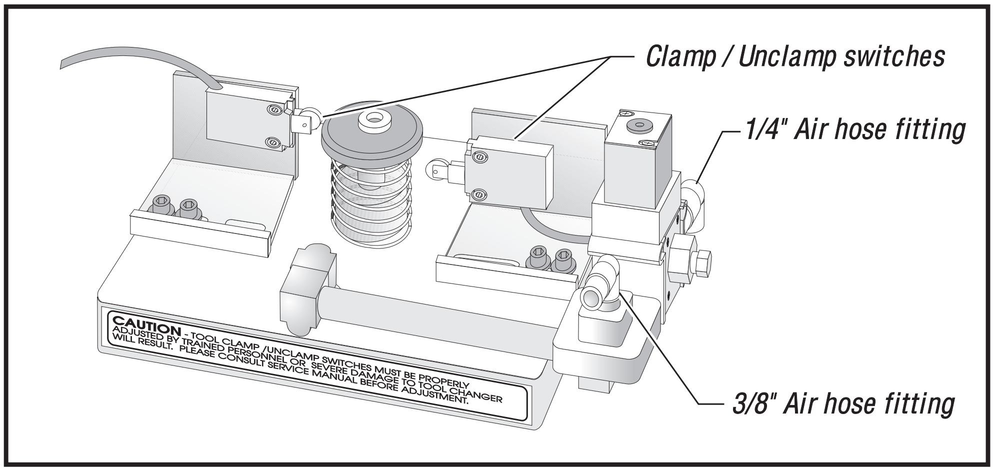


Figure 4-2. Tool release piston assembly with air solenoid assembly.

6. Install the new air solenoid on the air solenoid assembly. Reinstall the air solenoid assembly onto the tool release piston assembly. Take care to not disturb the position of the clamp/unclamp switches.

7. Reinstall the tool release piston assembly (Mechanical Service).

IMPORTANT! Ensure all air lines are reconnected to their proper fitting!

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 an interlock will prevent it from powering up.

CAUTION! Working with the electrical services required for the Horizontal can be extremely hazardous. The electrical power must be off and steps must be taken to ensure that it will not be turned on while you are working with it. In most cases this means turning off a circuit breaker in a panel and then locking the panel door. However, if your connection is different or you are not sure how to do this, check with the appropriate personnel in your organization or otherwise obtain the necessary help BEFORE you continue.

WARNING! The electrical panel should be closed and the three screws on the door should be secured at all times except during installation and service. At those times, only qualified electricians should have access to the panel. When the main circuit breaker is on, there is high voltage throughout the electrical panel (including the circuit boards and logic circuits) and some components operate at high temperatures. Therefore extreme caution is required.

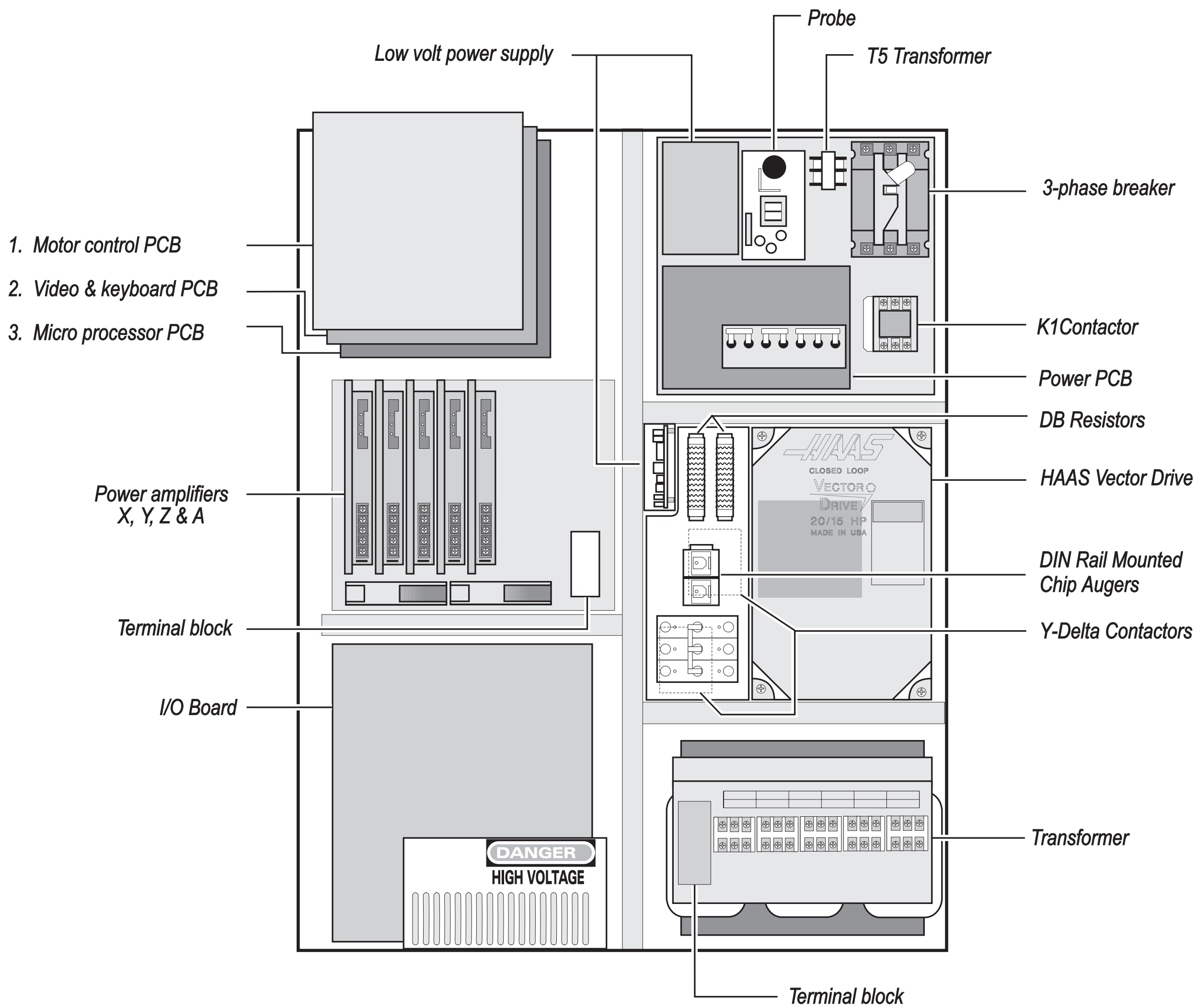


Figure 4-3. Control panel general overview.

1. Hook up the three power lines to the terminal 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.

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.

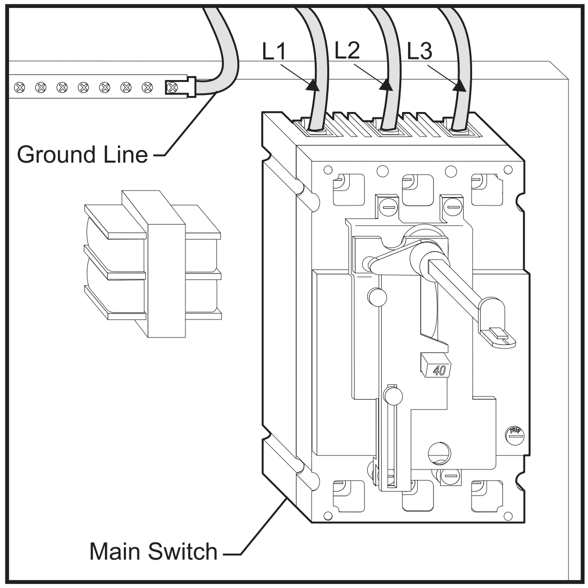


Figure 4-4. Power lines; hookup location.

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.

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.

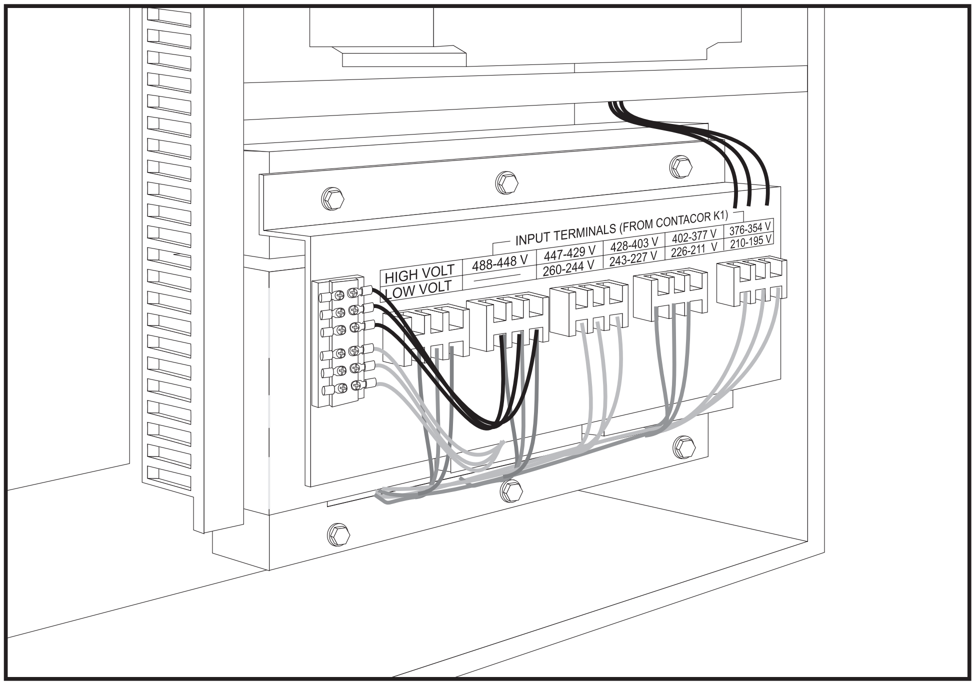


Figure 4-5. Transformer connections.

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 to this transformer. The input voltage range for each terminal block is as follows:

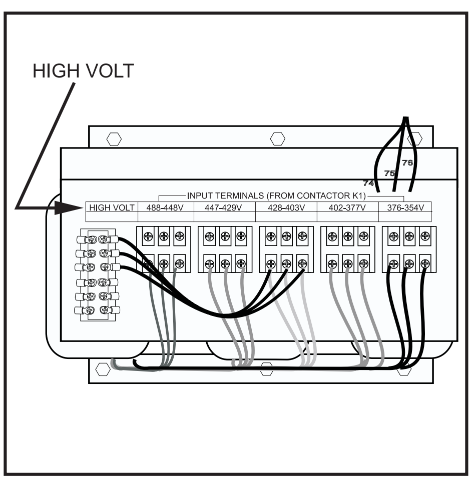


Figure 4-6a Transformer with 354-488V range

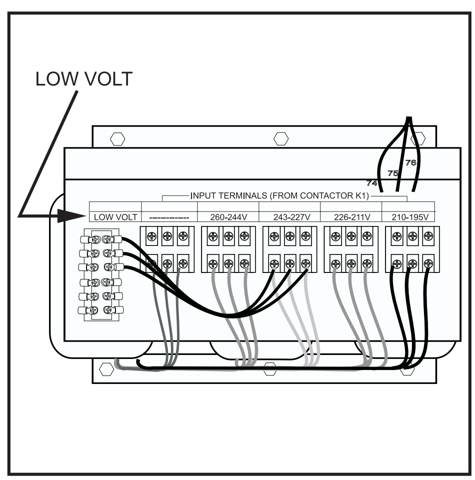


Figure 4-6b Transformer with 195-260 range.

4. 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.

5. 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.

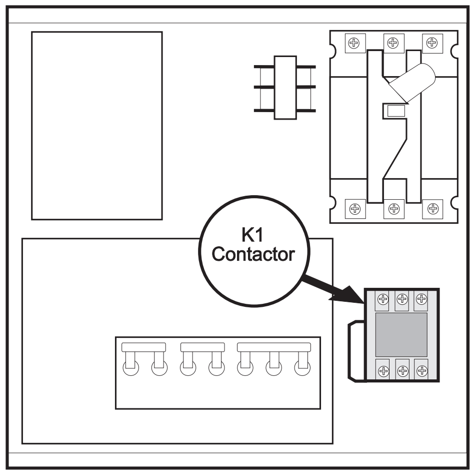


Figure 4-7. Measure voltage here. problems, call the factory.

6. Check the DC voltage displayed in the second page of Diagnostic data on the CRT. It is labeled DC BUS. This voltage must be between 150 and 175 volts. If the voltage is outside these limits, turn off the power and recheck the incoming power and the transformer wiring (repeat steps 2 and 3). If the voltage is still incorrect, turn off the power and call the factory.

7. 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, screw the screws into place, and turn the power back on.

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.

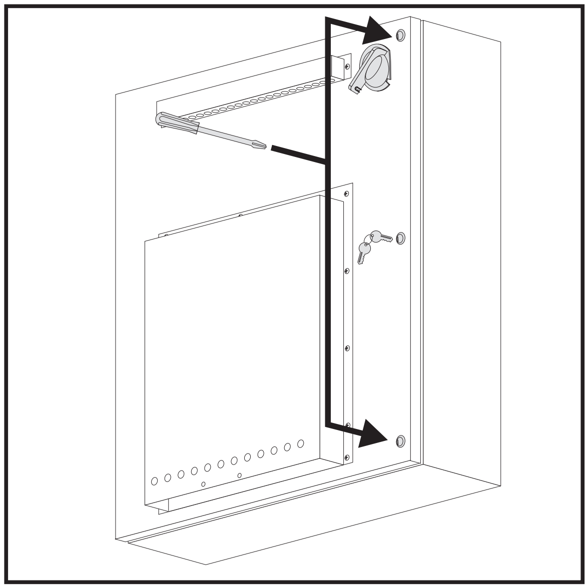


Figure 4-8. Unscrew the three screws to open the cabinet door. (Newer control cabinets may require a key)

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).

5. Using a flat tip screwdriver, turn the fuse(s) counterclockwise to remove and replace the blown fuse(s) with ones having the same type and rating (½ amp, type AGC, 250V).

CAUTION! When the left fuse is blown, it is still possible to operate the machine, thereby making an overvoltage situation possible. VERIFY absolute voltage to the machine does not exceed 260 volts.

Operator's Lamp Fuse

1. Turn the main switch (upper right of electrical cabinet) to the OFF position.

2. 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.

3. The Operator's Lamp Fuses (2) are connected to the 115 volt terminal of the main transformer, and are located approximately halfway up the electrical panel. An orange light will be on to indicate the blown fuse.

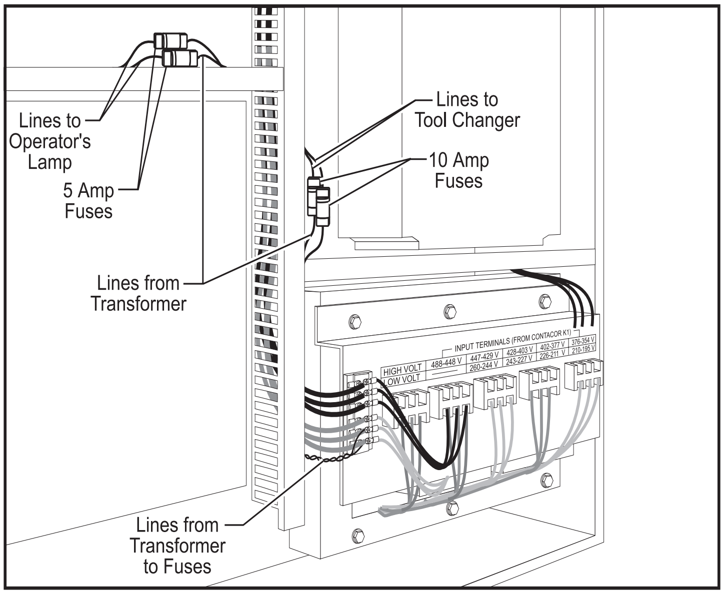


Figure 4-9. Location of operator's lamp fuses.

4. Unscrew the fuse casing to remove and replace the blown fuse with one having the same type and rating (operator's lamp: 5 amp, type AGC, 250V).

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 need replacing, please skip the next step.

11. Replace the Video / Keyboard, attaching it to the PROCESSOR board (beneath the Video / Keyboard) with the standoffs.

12. Reconnect all leads (previously removed) to their proper connections.

PROCESSOR BOARD -

Note: Refer to "Cable Locations" for a diagram of this board.

13. Remove the MOCON 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 & Low Voltage Supply

POWER BOARD -

Note: Refer to "Cable Locations" for a diagram of this board.

1. Follow all precautions noted previously before working in the electrical cabinet

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. Don't forget to use the lower left screw for a ground connection.

7. Reconnect all cables to the POWER board at their proper location.

LOW VOLTAGE POWER SUPPLY -

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

Note: Refer to "Cable Locations" for a diagram of this board.

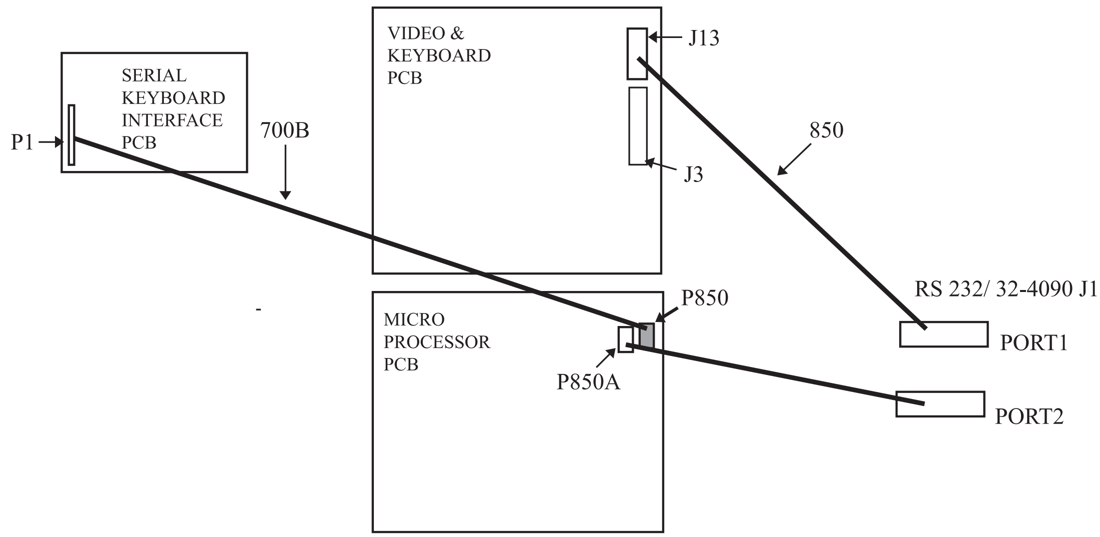
1. Follow all precautions noted previously before working in the electrical cabinet (See warning at beginning of "Servo Driver & SDIST" section).

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 4-10. 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.

4.5 FRONT PANEL

Please read this section in its entirety before attempting to replace any component of the control panel.

CRT Assembly Replacement

1. Turn the power off and disconnect power to the machine.

2. Remove the screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Unplug the white cable from the black cable at the connection in the control panel. It may be necessary to cut straps off the black cable's connector to unplug.

4. Unscrew the four hex nuts on the bottom row of the CRT bracket and remove, along with the washers. Set aside in a safe place.

5. While holding up the CRT assembly, remove the four hex nuts on the top row of the CRT bracket, along with the washers.

CAUTION! Take extreme care to not drop or damage the CRT assembly when removing from the control panel.

6. CAREFULLY pull the CRT assembly out toward the rear until it is clear of the control panel and all wiring. Set CRT assembly down in a safe place so as not to damage.

7. Replace by sliding the new assembly onto the eight bolts (four each on top and bottom). Starting with the bottom right, place the washers and hex nuts on the bolts to hold in place. Refer to Fig. 4-11 for the order of replacement.Once all washers have been attached and nuts have been hand-tightened, tighten down completely with the socket.

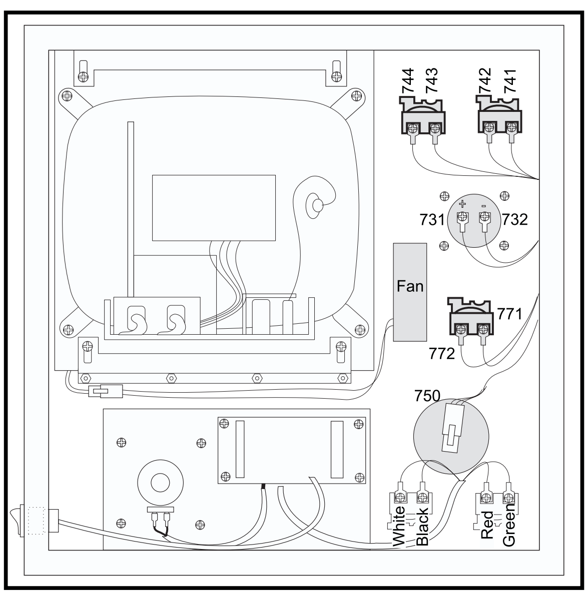


Figure 4-11. Interior of control panel (rear).

8. Plug the black cable and white cable into the matching cables. Feed the white cable through the opening in the top of the control panel.

9. Replace the back cover panel and attach with the four screws previously removed.

JOG HANDLE REPLACEMENT

The JOG handle is actually a 100-line-per-revolution encoder. We use 100 steps per revolution to move one of the servo axes. If no axis is selected for jogging, turning of the crank has no effect. When the axis being moved reaches its travel limits, the handle inputs will be ignored in the direction that would exceed the travel limits.

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. 4-12 when reconnecting; otherwise, damage may occur to the machine.

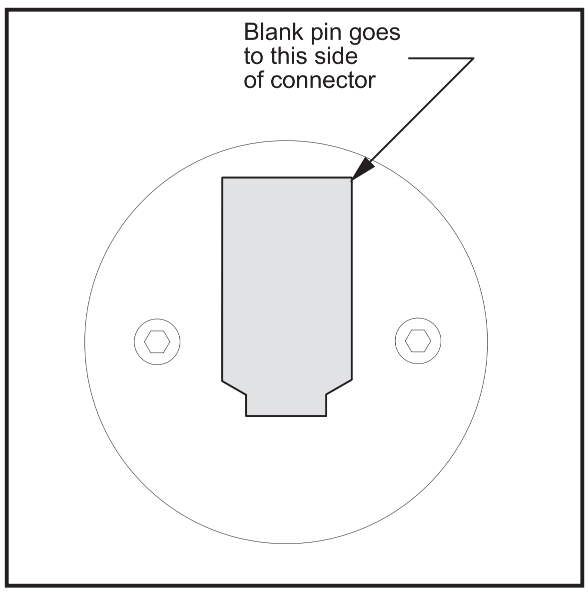


Figure 4-12. Jog handle encoder.

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

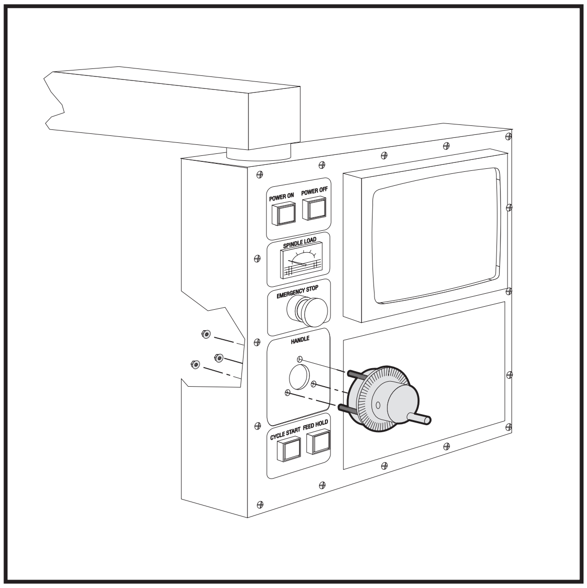


Figure 4-13. Jog Handle removal.

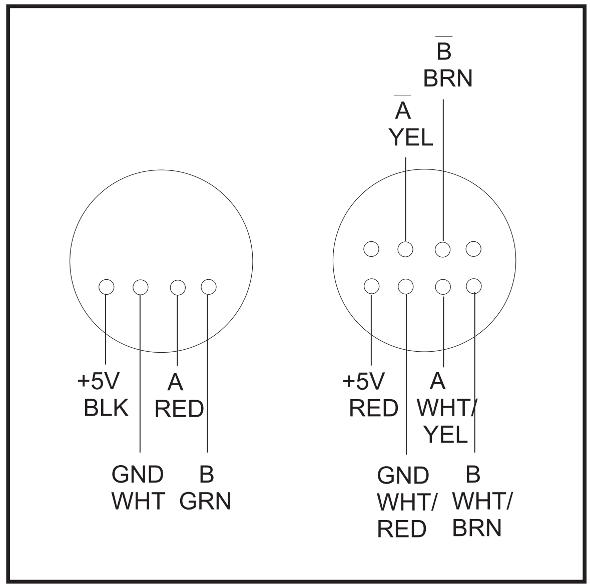


Figure 4-14. Jog Handle wiring diagram

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. 4-11 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. Remove all switches, spindle load meter, and the jog handle as described in the previous sections.

4. Unplug the keypad's 24-pin ribbon cable from the Keyboard Interface board.

5. Remove the screws from the front of the control panel. Take care to hold the front cover panel and bezel spacer in place until all screws have been removed. Remove the two pieces and set aside in a safe place.

6. 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.

7. To replace, first put the bezel spacer in place and fasten temporarily with screws in the top corners.

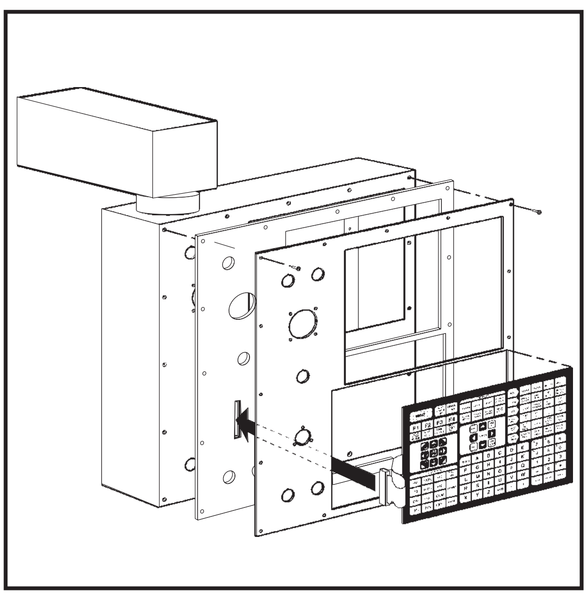


Figure 4-15. Keypad installation.

8. Insert the ribbon cable through the opening in the control panel and place the keypad in the upper right corner of the lower opening and 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.

9. While holding the bezel spacer in place, remove the two screws holding the spacer, put the front cover panel in place, and fasten with all screws previously removed.

10. Reinstall all switches, spindle load meter, and the jog handle as described in the previous sections.

11. Replace the rear cover panel 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 encoder. Turn machine off.

2. Disconnect the encoder cable at the top of the encoder.

3. Unscrew and remove the four screws holding the encoder to the standoffs . Remove the encoder, leaving the belt on the pulley at the orient ring.

INSTALLATION -

Note: If you wish to install an encoder on a machine start at Step 5; if this is just a replacement, skip to Step 13.

4. Place some blue Loctite on the threads of the four set screws and screw approximately halfway into the standoffs. Screw the hex end of the set screws into the standoffs.

5. Screw the standoffs into the four holes located at the rear of the transmission's top plate.

6. Place the 18- tooth pulley onto the pulley bushing and tighten down. Place the SHCS through the center axis of the pulley.

7. Screw this assembly into the spindle orientation ring.

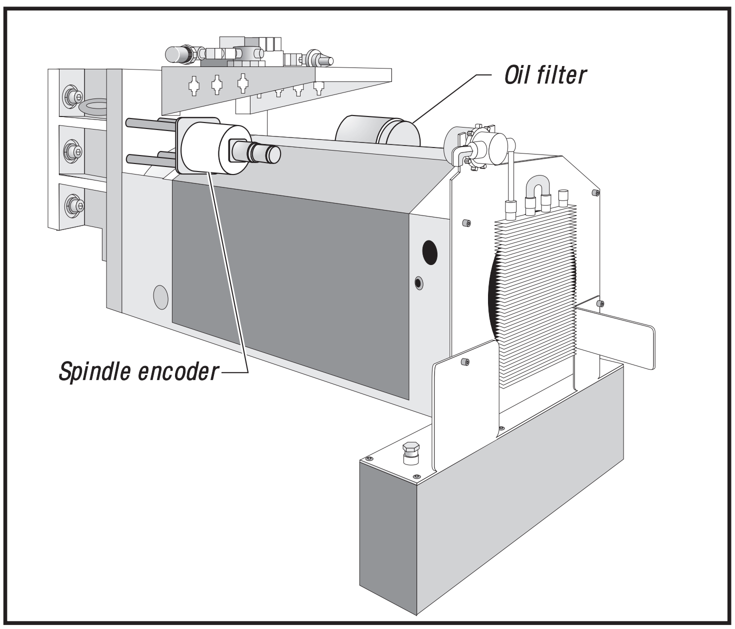


Figure 4-16. Spindle encoder installation.

8. Place the 36-tooth pulley onto the encoder, making the top of the pulley flush with the end of the shaft. Tighten down with the hex wrench.

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

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

11. Place the 18 tooth belt on the pulley, then loop the 36 tooth pulley over the 18-tooth pulley. Place the encoder assembly on the four standoffs and attach with the four 10-32 SHCS, placing the #10 lock washers between the socket head and the encoder base.

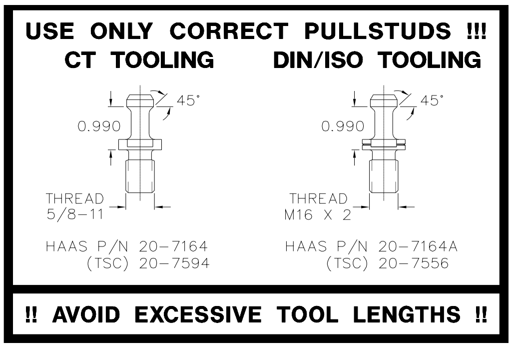
12. Connect the encoder cable to the encoder assembly.

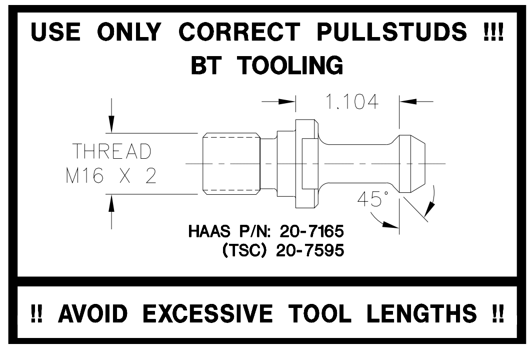
5. TECHNICAL REFERENCE

5.1 TOOL CHANGER

Tools are always loaded through the spindle and should never be installed directly in the carousel in order to avoid crashes. The pocket open to the spindle must always be empty in the retracted position. All wiring to the tool changer goes through connector P8 on the side of the control cabinet.

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.





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.

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.

If the tool changer should crash, the control will automatically come to an alarm state. To correct this, press the TOOL CHANGER RESTORE key. The control will then ask questions and provide instruction to help restore the tool changer.

CAUTION! Never put your hands near the tool changer when powered unless the EMERGENCY STOP button is pressed.

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 CB4.

The tool changer is controlled with a single axis control mounted inside the control.

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

1) Z axis moves to machine zero,
2) If the spindle is turning, it is commanded to stop,

3) Y moves to machine zero as spindle is oriented,
4) TSC pump turns off, (optional)
5) Y moves up to deposit the tool in the carousel,
6) Tool unclamps,
7) Carousel shuttles out,
8) Carousel rotates,
9) Carousel shuttles in,
10) Tool clamps,
11) Y moves to machine zero,
12) TSC pump turns on (optional)

Carousel Rotation Motor

A DC brush motor is used to rotate the carousel between tool changes. The motor has an encoder and is driven by the single axis control mounted inside the control.

Note: This motor should never be disassembled.

Tool Changer Position Switches

TOOL CHANGER IN/OUT SWITCHES

Two switches are used to sense the position of the tool changer carousel. One switch is activated when the carousel is moved full travel inward and one is activated when it is full travel outward. These switches are normally closed so that both will be closed between in and out. The diagnostic display will show this status of this input switch. A “1” indicates the associated switch is activated or open.

5.2 TOOL CLAMP/UNCLAMP

The tool holder draw bar is held clamped by spring pressure. Air pressure is used to release the tool clamp. When the tool is unclamped, air is directed down the center of the spindle to clear the taper of water, oil, or chips. Tool unclamp can be commanded from a program (but this is quite dangerous), 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 and one will activate at the end of travel during unclamping and the other during clamping. When both switches are closed, it indicates that the draw bar is between positions.

A tool change operation will wait until the unclamped switch is sensed before the Z-axis pulls back from the tool. This prevents any possibility of breaking the tool changer or its support mounts.
The diagnostic display can be used to display the status of the relay outputs and the switch inputs.

The Precharge and Through the Spindle Coolant system applies low air pressure and releases the clamped switch.

5.3 SPINDLE OPERATION

Spindle speed functions are controlled primarily by the **S** address code. The **S** address specifies RPM in integer values from 1 to maximum spindle speed (Parameter 131). NOT TO BE CHANGED BY USER! When using the Through the Spindle Coolant option, the maximum spindle speed is 7500 RPM for all spindles.

Speeds from S1 to the Parameter 142 value (usually 1200) will automatically select low gear and speeds above Parameter 142 will select high gear. Two **M** codes, M41 and M42 can be used to override the gear selection. M41 for low gear and M42 for high gear. Low gear operation above S1250 is not recommended. High gear operation below S100 may lack torque or speed accuracy. Spindle speed accuracy is best at the higher speeds and in low gear.

The spindle is hardened and ground to the precise tool holder dimensions providing an excellent fit to the holder.

SPINDLE ORIENTATION

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

SPINDLE ORIENT SWITCH
[Top rear of transmission]

Note: This switch does not exist on machines with a Vector Drive.

A normally-closed switch is used to sense when the pin drops in to lock the spindle. When the pin drops the switch opens, indicating orientation is complete.

The normally-closed side of the same switch is wired to the spindle drive and commands it into a "Coast Stop" condition. This is done to ensure the spindle motor is not powered when the pin is locking the spindle.

On machines equipped with a **Haas vector drive**, orientation is performed electrically and no shot pin or solenoid is required for locking the motor in place. Orientation of the spindle is automatically performed for tool changes and can be programmed with M19 commands. Orientation is performed by turning the spindle until the encoder reference is reached , the spindle motor holds the spindle locked in position. If the spindle is orientated and locked, commanding spindle forward or reverse will release the lock.

SPINDLE ORIENTATION LUBRICATION

The spindle orientation mechanism does not require regular lubrication.

SPINDLE ORIENTATION AIR SOLENOID

A solenoid controls the air valve supplying pressure to the orientation lock pin. The diagnostic display can be used to display the status of the relay output and the switch inputs. Circuit breaker CB4 will interrupt power to this solenoid.

Spindle Orientation Sequence

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

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

5.4 CONTROL CABINET

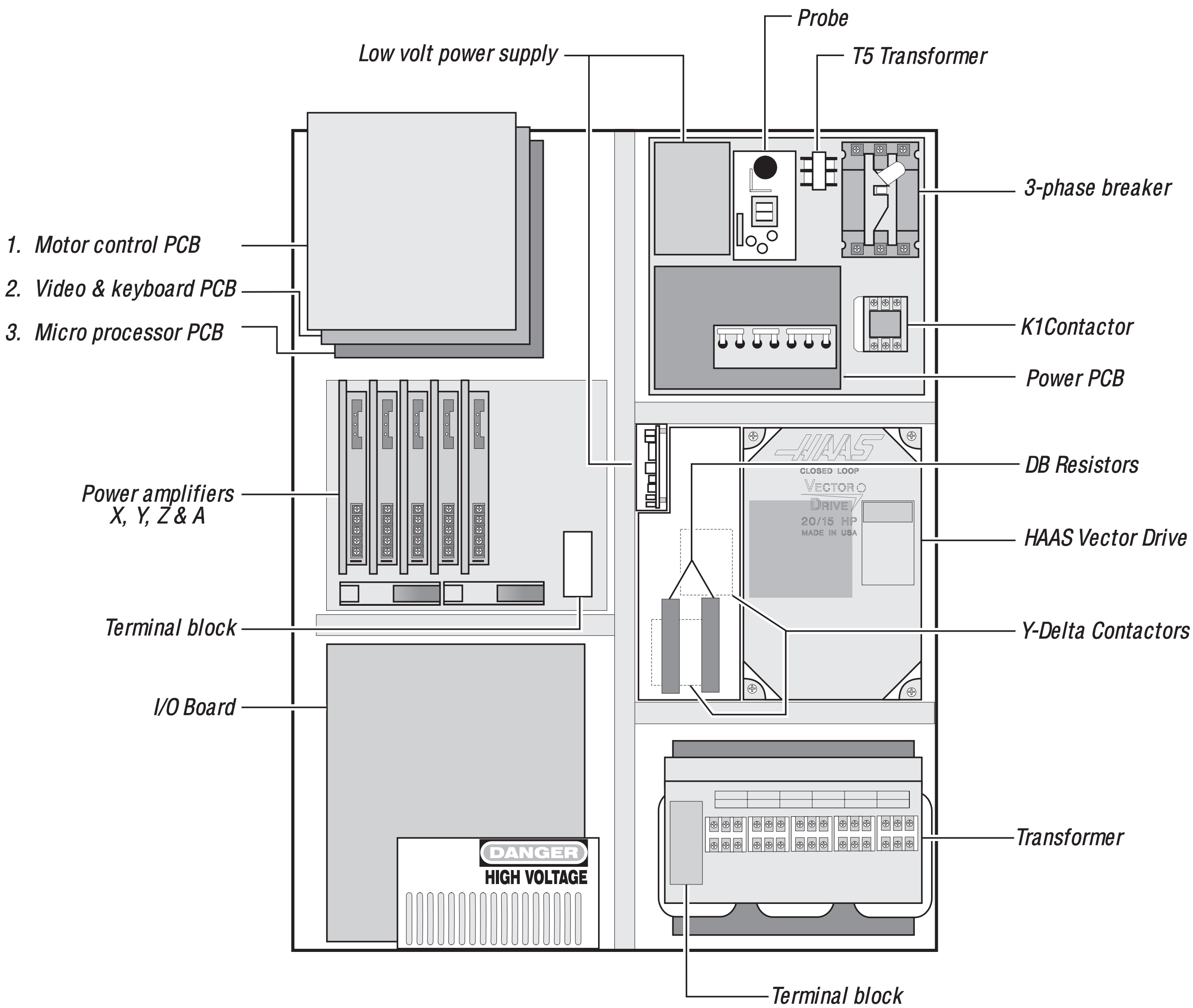


Figure 5-1. Control cabinet general overview.

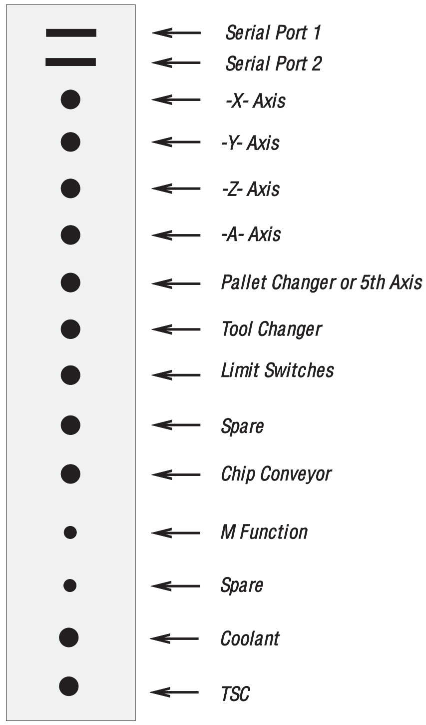


Figure 5-2. Connectors on side of control cabinet.

5.5 SERVOS (BRUSHLESS)

SERVO ENCODERS (BRUSHLESS)

Haas machines are equipped with brushless motors, which provide for better performance, and no maintenance. In addition to the performance differences, these machines differ from brush type machines, in the following areas:

The brushless motors have 8192 line encoders built in, which result in differences in acceleration parameters 7, 21,35,49 and 157. The exponential accel/decel time is set by parameters 115, 116 and 168. "In Position" parameters 101, 102, 103, 104 and 165 also affect brushless motors.

The motor controller board has a dedicated processor which does all the servo control algorithm.

There is no servo distribution board, therefore there is no CHARGE light present. Care should still be taken however, since there are high voltages present on the amplifiers, even when power is shut off. The high voltage comes from the spindle drive, which does have a CHARGE light.

The servo drive cards are replaced by Brushless Servo Amplifiers, and are controlled differently.

A low voltage power supply card is added to the servo drive assembly to supply the low voltage requirement to the amplifiers.

The CNC software is version 9.xx.

The user interface and motion profiling have not changed, however, and the user should not see any functional differences between a brush type machine and a brushless machine.

SERVO CHARACTERISTICS (BRUSHLESS)

This machine is not capable of instantly changing speed. That is, it takes some non-zero time to accelerate and decelerate. Acceleration and deceleration in this machine have both a constant accel/decel mode and an exponential mode. Constant acceleration is used at the beginning of a rapid move and at the end of any move whose speed exceeds the exponential accel/decel time constant.

Constant acceleration is a type of motion when the amount of speed change over time is constant. This constant is set by Parameters 7, 21, 35, and 49. It has units of encoder increments per second per second.

Exponential acceleration and deceleration is a type of motion where the speed is proportional to the distance remaining in a programmed travel. The exponential accel/decel time constant is set by Parameters 113, 114, 115, 116 and 168. It has units of 0.0001 seconds. The speed limit at which exponential accel/decel is not available is defined by the relationship between Parameters 7 and 113 (for the X-axis). Thus if Parameter 7 is 8000000 steps/sec/sec and Parameter 113 is 375 (0.0375 seconds); the maximum velocity for accurate interpolation should be:

8000000 x 0.0375 = 300000 steps/second

For an 8192 line encoder and 6 mm screw, this would be:

60 x 300000 / 138718 = 130 inches/minute

In the normal feed cutting mode, with G64 active, giving continuous cutter motion, deceleration of the axes in motion begins at some distance away from the end point. If look-ahead has provided another motion, the acceleration for that motion will begin at the same instant. This means that two motions, at right angles to each other, will not produce a perfectly square corner. The corner will be rounded. It also means that if the two motions are parallel or nearly parallel, there will be a smooth transition from one stroke to the next.

Rapid moves have a slightly different operation when continuous cutter mode is active. Acceleration for the next motion is started when the axes being moved all fall within the “In Position Limit” Parameters 101, 102, 103, and 104. These parameters have units of encoder steps. Rapid moves will also decelerate at the constant accel/decel limit until the speed drops below that for exponential accel/decel (see example above giving 130 inches per minute). Parameter 57 can be used to override this.

To prevent the rounding of corners, you can specify exact stop either with G09 (non-modal) or with G61 (modal). When either of these is active in a motion, all of the axes are brought to an exact stop, at zero speed, before the next motion is started.

The tool path in a circular move (G02 or G03) is not changed by the exponential acceleration/deceleration so there is no error introduced in the radius of the cut unless the speed exceeds that for exponential accel/decel (see example above giving 130 inches per minute).

SERVO AMPLIFIERS (BRUSHLESS)

Note: Refer to "Cable Locations" section 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 16 KHz. The amplifiers are currently limited to 30 amps peak. 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 and over-temperature and overheat protection.

There is a 10 amp supply fuse for failure protection. This fuse is relatively slow, therefore it can handle the 30 amp peak. Actual continuous current limit to the motor is controlled by software.

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 9and 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 printer circuit board called the IOPCB.

The connectors on the IOPCB Rev. M are:
*Indicates HS- 1RP machines.

P1	16-pin relay drivers from MOCON 1 to 8 (510)
P2	16-pin relay drivers from MOCON 9 to 16 (520)
P3	16-pin relay drivers from MOCON 25 to 32 (M21-M24) (540)
P4	34-pin inputs to MOCON (550)
P5	Servo power on relay 1-1 (110)
P6	230V AC from CB3 (930)
P7	230V AC to coolant pump (940)
P8	Auto-off relay 1-7 (170)
P9	Spindle drive commands (710)
P10	Spindle fan and oil pump 115V AC (300)
P11	Spin Lock I/F
P12	115V AC to spindle head solenoids (880A)
P13	Tool changer status inputs / DB Down *(820)
P14	LO CLNT (TSC) 950
P15	Spindle head status inputs (890)
P16	Emergency stop input (770)
P17	Spare(960)
P18	Over Voltage Input (970)
P19	Low air / Low Input (950)

P20 Overheat input (830)
P21 Spindle drive status inputs (780)
P22 M-FIN input (100)
P23 Load station locked* (190)
P24 Pal CW / CCW* (790)
P25 Pal Up / Down* (200)
P26 Spare terminals for M21 to M24
P27 CE Door Interlock* (1040)
P28 115V AC from CB4 (910)
P29 A-axis brake solenoid output (390)
P30 Main Drawbar Motor Output* (810A)
P31 230 VAC for Chip Conveyor (160)
P32 160 VDC Spare (80)
P33 115V AC three-phase input from power supply assembly (90)
P34 115V AC to CRT (90A)
P35 115V AC to heat exchanger (90B)
P36 115V AC to CB4 (90C)
P37 115V AC Servo Fan
P38 Door open (1050)
P39 Operator Drawbar motor Output * (810)
P40 2nd E-Stop (770A) A / B
P42 Lube Oil Pump (300)
P43 Ground fault sense signal input (1060) Axis Brake
P44 Air blast* / 5th Brake
P45 HTC Shuttle
P46 Chip Conveyor (140)
P47 Skip input signal (1070), Probe Option
P48 Purge Switch (270)
P49 Pallet Ready Light* (260)
P50 Spigot Motor (Spare)
P51 16 PIN Relay drivers 17-24 (530)
P52 Spare
P53 Spigot Sense (180)
P54 Servo Brake (350) Spare
P55 Red / Green Lights (280)
P56 Thru Spindle Cool (940A)
P57 115V Pallet Alarm*
P58 115V VAC Purge
P60 TSC 230 In (930A)
P61 E-Stop C (770B)

M Code Relay Board

The M Code relay board contains 8 relay outputs (M21- M28) and 2 terminal strips P4 and P5. Each terminal strip has 12 positions which are NORMALLY OPEN, NORMALLY CLOSED and COMMON.

TERMINALS NORMALLY CLOSED: 1, 4, 7, 10
TERMINALS NORMALLY OPEN: 3 , 6, 9, 12
COMMON TERMINALS: 2, 5, 8, 11

M CODE RELAY BOARD CONNECTORS:

P4 CONTAINS:
M21 M FUNCTION
M22 PROBE OPTION
M23 SPARE
M24 PALLET ALARM *

P5 CONTAINS:

M25 PALLET CW*
M26 PALLET CCW*
M27 AIR BLAST*
M28 SPARE

P1 16-PIN RELAY DRIVERS FROM MOCON (M21- M28) (540) (INPUT)
P3 16-PIN RELAY OUTPUT TO IOPCB (540)
P2 12 VDC FROM POWER SUPPLY BOARD (860A)

*** INDICATES HS-1RP MACHINES**

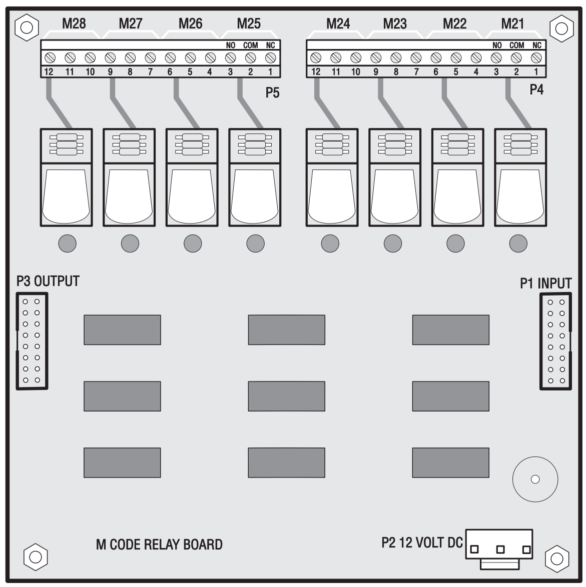


Figure 5-3 M-Code relay board.

5.7 TWO-SPEED GEAR TRANSMISSION

The spindle head contains a two-speed gear transmission. The spindle motor is directly coupled to the transmission and the transmission is cog belt-coupled to the spindle.

Gear Box Lubrication

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 spindle is grease-packed. 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. See Mechanical Service for spindle motor and transmission removal.

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 PANEL

Jog Handle

The JOG handle is actually a 100-line-per-revolution encoder. We use 100 steps per revolution to move one of the servo axes. If no axis is selected for jogging, turning of the crank has no effect. When the axis being moved reaches its travel limits, the handle inputs will be ignored in the direction that would exceed the travel limits.

Parameter 57 can be used to reverse the direction of operation of the handle.

Power On/Off Switches

The POWER ON switch engages the main contactor. The on switch applies power to the contactor coil and the contactor thereafter maintains power to its coil. The POWER OFF switch interrupts power to the contactor coil and will always turn power off. POWER ON is a normally open switch and POWER OFF is normally closed. The maximum voltage on the POWER ON and POWER OFF switches is 24V AC and this voltage is present any time the main circuit breaker is on.

Spindle Load Meter

The load meter measures the load on the spindle motor as a percentage of the rated continuous power of the motor. There is a slight delay between a load and the actual reflection of the meter. The eighth A-to-D input also provides a measure of the spindle load for cutter wear detection. The second page of diagnostic data will display % of spindle load. The meter should agree with this display within 5%. The spindle drive display #7 should also agree with the load meter within 5%.

There are different types of spindle drive that are used in the control. They are all equivalent in performance but are adjusted differently.

Emergency Stop Switch

The EMERGENCY STOP switch is normally closed. If the switch opens or is broken, power to the servos will be removed instantly. This will also shut off the tool changer, spindle drive, and coolant pump. The EMERGENCY STOP switch will shut down motion even if the switch opens for as little 0.005 seconds.

Be careful of the fact that Parameter 57 contains a status switch that, if set, will cause the control to be powered down when EMERGENCY STOP is pressed.

You should not normally stop a tool change with EMERGENCY STOP as this will leave the tool changer in an abnormal position that takes special action to correct.

Note that tool changer alarms can be easily corrected by first correcting any mechanical problem, pressing RESET until the alarms are clear, selecting ZERO RETURN mode, and selecting “AUTO ALL AXES”.

If the tool changer should crash, the control will automatically come to an alarm state. To correct this, push the EMERGENCY STOP button. Push the RESET key to clear any alarms. Push the ZERO RETURN and the AUTO ALL AXES keys to reset the Z-axis and tool changer. Never put your hands near the tool changer when powered unless the EMERGENCY STOP button is pressed.

Keyboard Beeper

There is a speaker inside the control panel that is used as an audible response to pressing keyboard buttons and as a warning beeper. The beeper is a one 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 speaker. Check that the problem occurs with more than one button and check that the speaker volume is not turned down.

5.9 MICROPROCESSOR ASSEMBLY

The microprocessor assembly is in the rear cabinet at the top left position. It contains three large boards. They are: microprocessor, the keyboard and the MOCON. All three boards of the processor assembly receive power from the low voltage power supply. The three PCB’s are interconnected by a local buss on dual 50-pin connectors. At power-on of the control, some diagnostic tests are performed on the processor assembly and any problems found will generate alarms 157 or 158. In addition, while the control is operating, it continually tests itself and a self test failure will generate Alarm 152.

Microprocessor PCB (68ECO30)

The Microprocessor PCB contains the 68ECO30 processor running at 40 MHz, one 128K EPROM; between 256K and 8MB of CMOS RAM and betwen 512K and 1MB of FAST STATIC RAM. It also contains a dual serial port, a five year battery to backup RAM, buffering to the system buss, and eight system status LED’s.

Two ports on this board are used to set the point at which an NMI* is generated during power down and the point at which RESET* is generated during power down.

The eight LED's are used to diagnose internal processor problems. As the system completes power up testing, the lights are turned on sequentially to indicate the completion of a step. The lights and meanings are:

+5V **+5V logic power supply is present. (Normally On)**
If this light does not come on, check the low voltage power supply and check that all three phases of 230V input power are present.

HALT **Processor halted in catastrophic fault. (Normally Off)**
If this light comes on, there is a serious problem with the processor PCB. Check that the EPROM is plugged in. Test the card with the buss connectors off.

POR **Power-on-reset complete. (Normally On)**
If this light does not come on, there is a serious problem with the processor PCB. Check that the EPROM is plugged in. Test the card with the buss connectors off.

SIO **Serial I/O initialization complete. (Normally On)**
If this light does not come on, there is a problem with the serial ports. Disconnect anything on the external RS-232 and test again.

MSG **Power-on serial I/O message output complete. (Normally On)**
If this light does not come on, there is a problem with serial I/O or interrupts. Disconnect anything on the external RS-232 and test again.

CRT **CRT/VIDEO initialization complete. (Normally On)**
If this light does not come on, there is a problem communicating with the VIDEO PCB. Check the buss connectors and ensure the VIDEO PCB is getting power.

PGM **Program signature found in memory. (Normally On)**
If this light does not come on, it means that the main CNC program package was not found in memory or that the auto-start switch was not set. Check that switch S1-1 is on and the EPROM is plugged in.

RUN **Program running without fault exception. (Normally On)**
If this light does not come on or goes out after coming on, there is a problem with the microprocessor or the software running in it. Check all of the buss connectors to the other two PCB's and ensure all three cards are getting power.

There 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) Brushless

The brushless machining centers are equipped with a microprocessor based brushless motor controller board (MOCON)that replaces the motor interface in the brush type controls. It runs in parallel with the main processor, receiving servo commands and closing the servo loop around the servo motors.

In addition to controlling the servos and detecting servo faults, the motor controller board (MOCON) is also in charge of processing discrete inputs, driving the I/O board relays, commanding the spindle and processing the jog handle input. Another significant feature is that it controls 6 axes, so there is no need for an additional board for a 5 axis machine.

P1	Data Bus
P2	X amplifier control and fault sensing (610)
P3	Y amplifier control and fault sensing (620)
P4	Z amplifier control and fault sensing (630)
P5	A amplifier control and fault sensing (640)
P32	B amplifier control and fault sensing (640B)
P33	C amplifier control and fault sensing (640C)
P6	X encoder input (660)
P7	Y encoder input (670)
P8	Z encoder input (680)
P9	A encoder input (690)
P30	B encoder input (690B)
P31	C encoder input (690C)
P18	Jog encoder input (750)
P20	Spindle encoder input (1000)
P10	Inputs from I/O board (550)
P11	I/O relays K1-8 (510)
P12	I/O relays K9-16 (520)

P13	I/O relays K17-24 (530)
P14	I/O relays K25-32 (540)
P15	Low Voltage Power (860)
P16	Spindle command output (720)
P19	Address bus
P24	Axis home switches (990)

5.10 SPINDLE DRIVE ASSEMBLY

The spindle drive is located in the main cabinet on the right side and halfway down. It operates from three-phase 200 to 240V AC. It has a 7.5 (or 10) H.P. continuous rating, and a 11.25 (or 15) H.P. one-minute rating. The spindle drive is protected by CB1 at 40 amps (20 for High Voltage option). Never work on the spindle drive until the small red CHARGE light goes out. Until this light goes out, there are dangerous voltages inside the drive, even when power is shut off.

For all other data on the spindle drive, refer to the documentation with your drive.

Haas Vector Drive

The Haas vector drive is a current amplifier controlled by the MOCON software, using the C axis output. The vector drive parameters are a part of the machine parameters and are accessible through the Haas front panel. The spindle encoder is used for the closed loop control and spindle orientation, as well as rigid tapping if the option is available. Spindle speed is very accurate, since this is a closed loop control, and the torque output at low speeds is to non vector drive spindles.

5.11 RESISTOR ASSEMBLY

The Resistor Assembly is located on top of the control cabinet. It contains the servo and spindle drive regen load resistors.

Spindle Drive Regen Resistor

A resistor bank is used by the spindle drive to dissipate excess power caused by the regenerative effects of decelerating the spindle motor. If the spindle motor is accelerated and decelerated again in rapid succession repeatedly, this resistor will get hot. In addition, if the line voltage into the control is above 255V, this resistor will begin to heat. This resistor is overtemp protected at 100^0 C. At that temperature, an alarm is generated and the control will begin an automatic shutdown. If the resistor is removed from the circuit, an alarm may subsequently occur because of an overvoltage condition inside the spindle drive.

Servo Drive Regen Resistor

A 25-ohm, 300-watt resistor bank is used by the servo drives to dissipate excess power caused by the regenerative effects of decelerating the servo motors. If the servo motors are accelerated and decelerated again in rapid succession repeatedly, this resistor will get hot. In addition, if the line voltage into the control is above 255V, this resistor will begin to heat. This resistor is overtemp protected at 100^0 C. At that temperature, an automatic control shutdown is begun. If that resistor is removed from the circuit, an alarm may subsequently occur because of an overvoltage condition for the servo buss.

Overheat Sense Switch

There is an overtemperature sense switch mounted near the above-mentioned regen resistors. This sensor is a normally-closed switch that opens at about 100^0 C. It will generate an alarm and all motion will stop. After four minutes of an overheat condition, an automatic shutdown will occur in the control.

5.12 POWER SUPPLY ASSEMBLY

All power to the control passes through the power supply assembly. It is located on the upper right corner of the control cabinet.

Main Circuit Breaker CB1

Circuit breaker CB1 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.

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 (POWER)

The low voltage power distribution and high voltage fuses and circuit breakers are mounted on a circuit board called the POWER PCB. The following connectors are on it:

P1 Five-pin brings 230V AC three ph from main breaker
P2 On/Off connections to front panel (740)
P3 Coil and aux connections to contactor K1
P4 Auto-off connection to IOPCB (170)
P5 Low voltage control transformer to power K1
P6 230V AC from CB3 to coolant pump and TSC (930)
P7 115V AC from CB4 to IOPCB for solenoids and to pallet changer (910)
P8 115V AC /T1 (90)
P9 +5 / +12 / Gnd from low volt supply to logic board (860)
P10 +5/+12/Gnd form low volt supply to logic boards (860)

P11 +5/+12/Gnd form low volt supply to logic boards (860)
P12 +5/+12/Gnd form low volt supply to logic boards (860)
P13 +5/+12/Gnd form low volt supply to logic boards (860)
P14 12V AC to pallet ready lamp switch (800A)
P15 230V AC from main transformer for coolant pump (70)
P16 N/ A
P17 +12V DC to IOPCB (860A)
P18 Not used
P19 Connector to pallet ready lamp transformer T4 (290)
P20 115V AC to low voltage supply
P21 -12V DC to processor PCB
P22 -12V DC to MOTIF PCB

P26 +12V DC option connector
P27 +5/+12/Gnd form low volt supply to logic boards (860)

P30 12V AC pallet ready lamp (800)
P31 +12V (860A)

For older internal transformer with 208/230 taps:
TB1 115VAC from main transformer
TB2 115VAC to IOPCB & servo drive module

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

Three more circuit breakers are 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.

CB4 controls the 115V AC to the air solenoids, 4th axis brake, and the oiler. It can be tripped by a short circuit in the wiring on the I/O assembly or the wiring to the solenoids on the spindle head.

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 190/260V to three-phase 115V and is primarily used by the servo drives. The video monitor, solenoids, fans, and oiler also use 115V AC. This transformer's maximum input voltage is 260V @ 60 Hertz, and 240V @ 50 Hertz. It is located in the main cabinet in the lower right corner. It is rated at 12KVA and its primary is protected to 40 amps.

This transformer has four voltage connections that allow for a range of inputs from 195V to 260V. The transformer has an autotransformer primary to supply 240V , three- phase to the spindle drives other 240V applications.

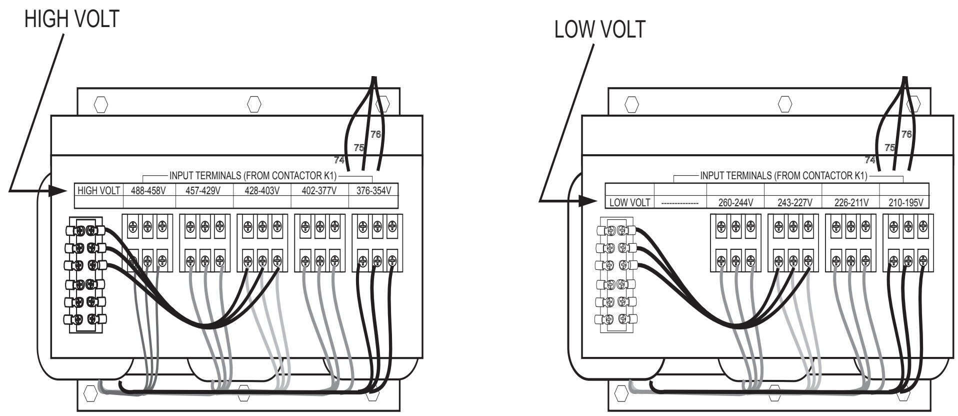


Fig. 5-4 Polyphase bank transformer.

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 480 Transformer

Voltage Selection Taps for the 480 Transformer:

Right to left:

353 to 376
377 to 400
401 to 425
426 to 451
452 to 480*

* 480 V transformer has additional terminal block

5.14 FUSES

The servo drive (DRIVER) cards have three fuses on each of the X, Y, Z, and A PCB's (F1, F2, F3). If these fuses are ever blown, the associated motor will stop. This will only happen if there is a failure of the drive card, and the user should never attempt to replace these fuses.

The POWER PCB contains three ½-amp fuses located at the top right (FU1, FU2, FU3). If the machine is subject to a severe overvoltage or a lightning strike, these fuses will blow and turn off all of the power. Replace these fuses only with the same type and ratings. The other two fuses protect the tool changer (FU5) and the operator's lamp (FU6).

On the servo drive assembly, there is a printed circuit board (SDIST) containing three one-amp fuses (FU1, FU2, FU3). Two of these fuses protect the contactor and small transformers. The third fuse protects the regen load circuit load from shorts.

FUSE NAME	TYPE	RATING	VOLTAGE (amps)	LOCATION	
FU1	AGC	½	250V	POWER pcb,	upper right
FU2	AGC	½	250V	" "	
FU3	AGC	½	250V	" "	
LAMP	AGC	½	250V	"	lower left
FU1	AGC	½	250V	SDIST pcb,	right center
FU2	AGC	½	250V	" "	
FU3	AGC	5	250V	"	top center
F1	ABC	20	250V	SDRIVER pcb's (X, Y, Z, A)	
F2	ABC	20	250V	"	
F3	ABC	10	250V	"	
FU1	ABC	5	250V	I/O PCB	
FU2	ABC	5	250V	I/O PCB	
FU3	ABC	5	250V	I/O PCB	
FU4	ABC	5	250V	I/O PCB	

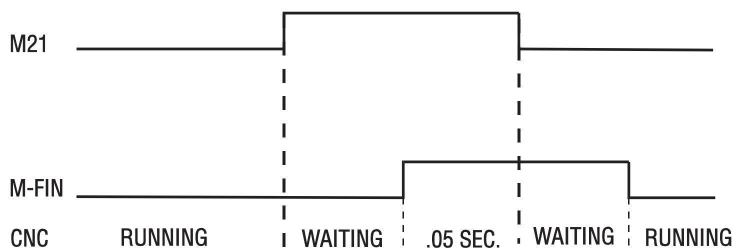
5.15 SPARE USER M CODE INTERFACE

The M code interface uses outputs M21-23, M28 and one discrete input circuit. M codes M21 through M23, and M28 will activate relays labeled M21-23, and M28. 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.

Note: If the optional M code relay board is installed, relays M21-28 become available on the secondary board. These relays will be controlled by outputs M21-28.

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 eight 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:

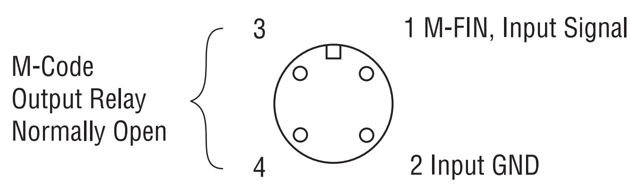


The Diagnostic Data display page may be used to observe the state of these signals.

M Function Relays

The M code relay board has four relays (M21-23 and M28) 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.



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 #10 and is wired from input #10 on the Inputs PCB on the Input/Output Assembly. The return line for grounding the circuit should also be picked up from that PCB. For reliability, these two wires should be routed in a shielded cable where the shield is grounded at one end only. The diagnostic display will show this signal a "1" when the circuit is open and a "0" when this circuit is grounded.

Turning M Functions On And Off

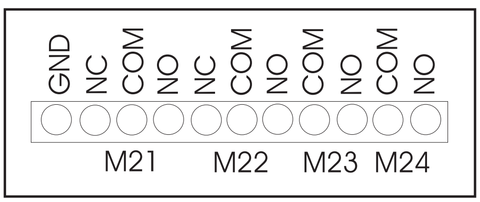
The M code relays can also be separately turned on and off using M codes M51-M53, M58 and M61-M63, M68. M51 to M53, and M58 will turn on one of the eight relays and M61 to M63, and M68 will turn the relays off. M51 and M61 correspond to M21, etc.

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

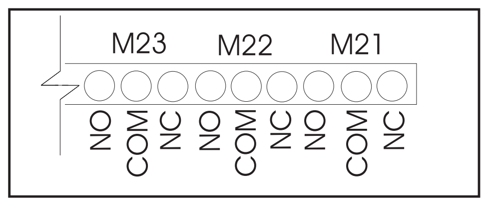
Wiring the Relays

The relays are marked on both the IOPCB and the M code relay board, with their respective terminals forward of them. If the optional M code relay board is installed then the connections on the IOPCB are to be left unused as they are replaced by the relays on the optional board. Refer to the figures below, and the Probe Option figurrre in the Electrical Diagrams section for the terminal labeling. Maximum voltage for the relays is 125 VAC with a maximum amperage of 3 amps.

WARNING! Power circuits and inductive loads must have snubber protection.



IOPCB Relays



M Code Relay Board

CAUTION! If a screw terminal is already in use **DO NOT** connect anything else to it. Call you dealer.

Note: Relay M24 on the IOPCB is reserved for Through the Sindle Coolant (AUXCLT).

5.16 LUBRICATION SYSTEM

The lubrication system is a resistance type system which forces oil through metering units at each of the 16 lubricating points within the machine. The system uses one metering unit at each of the lubricating points: one for each linear guide pad, one for each lead screw and one for spindle lubrication. A single oil pump is used to lubricate the system. The pump is powered only when the spindle and/or an axis moves. Once powered the pump cycles approximately 3.0 cc of oil every 30 minutes throughout the oil lines to the lube points. Every lube point receives approximately 1/16 of oil. The control monitors this system through an internal level switch in the reservoir and 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 an lube pressure switch that senses the lube pressure. Parameter 117 controls the lube pressure check. If Parameter 117 is not zero, the lube pressure is checked for cycling high within that period. Parameter 117 has units of 1/50 seconds; so 30 minutes gives a value of 90000. Parameter 57, bit "Oiler on/off", indicates the lube pump is only powered when the spindle fan is powered. The lube pressure is only checked when the pump is on.

5.17 SWITCHES

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

Note: There are many limit switches located on the Horizontal mill, and some are difficult to reach. There are also seven (7) limit switches associated with the pallet changer. Ensure the problem is the switch *before* beginning removal procedures. The following is a list of all switches, their general location, and a functional description:

X, Y, Z TRAVEL LIMIT SWITCHES

X - Left side of saddle by X-axis motor
Y - Top of column by Y-axis motor

Z - Rear of 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 HYDRAULIC COUNTERBALANCE

The spindle head weight is balanced by the upward pull of a hydraulic cylinder. The hydraulic oil forces the piston to retract into the cylinder body. The oil is then pressurized by a nitrogen resevoir. The system is self contained and passive (no pump is required to maintain the lift). Normal Y-axis of the gas/oil counter balance has the initial pressure to balance the weight at full system volume, plus an additional 50-75 psi overcharge for longevity.

The CNC controls senses a normally closed status from the hydraulic counterbalance at all times. If this switch opens for any reason the control will alarm as an E-Stop.

5.19 PALLET CHANGER FOR THE HS-1RP

ROTARY TABLE (HRT310HRPA)

The rotary table is a standard HAAS 310 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.

MAIN DRAWBAR ASSEMBLY

The main drawbar's primary function is to hold the pallet tightly to the rotary table. The main drawbar is rotated by the drawbar drive assembly so that it screws into the pallet nut of the pallet, securing it to the table. It also provides a path for lubrication to the threads of the main drawbar and pallet nut, and a flowpath for the air blast from beneath the rotary table to the working area of the machine. The main drawbar assembly consists of five components: the main drawbar, air blast tube, air blast plug, lubrication tube, and a retaining clip. The main drawbar, air blast tube, and air blast plug are pressed together, and the lubrication tube is inserted through the drawbar and held in place by the retaining clip.

Mounted beneath the rotary table is a bracket that mounts the lube tube adaptor. The lubrication for the drawbar and the supply for the air blast both enter the drawbar assembly through the lube tube adaptor. Oil from the lube oil system fills the lower part of the air blast plug, which is attached to the bottom of the drawbar assembly. The lubrication tube extends into the air blast plug, below the level of the oil. When a pallet change is performed, the air blast system is activated, and oil is forced up the lubrication tube as a mist. The main volume of the air blast, however, is directed up the air blast tube around the outside of the lubrication tube, to the drawbar. The air is then directed from the interior of the drawbar, through the nut housing, and into the air blast manifold.

MAIN DRAWBAR DRIVE ASSEMBLY

The drawbar drive assembly provides the torque required to clamp and unclamp the pallet to the rotary table platter. The system includes a gearmotor, a drive pulley, a drive belt, and a drive shaft/driven pulley. The gearmotor turns a drive pulley, which drives the belt. This belt drives the pulley on the drive shaft of the main drawbar. The torque is transferred to the main drawbar from the drive shaft by means of a splined interface. The drawbar is then either raised or lowered through the floating nut, which is in the nut housing assembly. A one-way slip clutch pulley prevents the drawbar from overtightening into the pallet nut. This clutch allows a preset torque to be acheived when tightening the drawbar, and assures the ability of the system to free itself on command of a pallet change. If the drawbar were to be overtightened, no damage to either component would occur; unless it was left in this condition for too long, where it may become so tightly engaged that the system may not be able to free itself.

Note: Refer to the Diagnostic section in the manual for specific switch status and other machine Inputs and Outputs.

AIR BLAST SYSTEM

The main components of the air blast system are the lube tube adaptor and air blast manifold. The air blast system, along with the chip shroud, keeps metal chips from accumulating at the rotary table pallet locating pins and the H-frame locating pins, ensuring the pallets will be able to rest squarely on these pins.

The air blast moves up the center of the drawbar assembly, and into the nut housing. The air then moves into the air blast manifold, where it is directed to the rotary table pallet locating pins.

Lifting Assembly

The pallet lifting assembly consists of a large guided pneumatic cylinder and an H-frame. Pins are mounted in the H-frame to engage the pallets from below and to give aid in stabilizing the load during rotation of the pallets. The H-frame itself is attached to the top of the lifting cylinder in order to lift and lower the load. The rotation pinion is mounted on the lifting cylinder (near the bottom), and interlock pins are attached to the bottom of the pinion. These pins are intended as a protective feature, as well as a means to trip the two switches that sense the lift cylinder up or down position.

Note: Refer to the Diagnostic section in the manual for specific switch status and other machine Inputs and Outputs.

Rotation / Rack Assembly

The rotation/rack assembly provides the motive force to rotate the pallets clockwise and counter clockwise during the pallet change sequence. A rack is attached to two pneumatic cylinders, and engages the pinion of the lifting cylinder assembly. The pneumatic cylinders are mounted to a support plate, so when their rods extend, the rack exerts a force on the pinion and causes rotation of the lifting cylinder. The rack moves along a V-guide assembly, consisting of rollers on V-guides, to ensure there are no variations in the end points of the rotation. A switch is mounted at each end of the V-guide support bar, to sense the rotational position of the pallet changer during a pallet change sequence. A stabilizer is attached to the rack assembly, to limit the amount of erratic motion that typically occurs when accelerating loads with a pneumatic actuator.

Note: Refer to the Diagnostic section in the manual for specific switch status and other machine Inputs and Outputs.

Load Station

The load station is a 90 degree manual indexing station that can clamp a pallet securely into place while maintaining the ability to index freely. The load station clamps the pallet by means of a gearmotor that has a direct drive train to a threaded drawbar. The gearmotor rotates the drawbar, which screws into or out of the pallet to clamp or unclamp the pallet, in the same manner as the rotary table drawbar. 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.

Note: Refer to the Diagnostic section in the manual for specific switch status and other machine Inputs and Outputs.

Pallet Changer Switches

The pallet changer uses seven (7) switches to provide feedback for the pallet change sequence.

Note: Refer to the Diagnostic section in the manual for specific switch status and other machine Inputs and Outputs.

MAIN DRAWBAR UP/DOWN SWITCHES

[Switch bracket beneath rotary table (2)]

The main drawbar has two switches that sense drawbar up or down position. Both switches are tripped when the drawbar is in the down position, and both are not tripped when the drawbar is in the up position. The switches are actuated directly by the drawbar.

PALLET UP/DOWN SWITCHES

[Switch bracket on lifting assembly mounting plate (2)]

The lift cylinder has two switches that sense the cylinder lifted position (pallet up) or cylinder lowered position (pallet down). Both switches are tripped when the cylinder is in the lowered position, and both switches are not tripped when the cylinder is in the lifted position. The switches are directly actuated by the two interlock pins on the rotation pinion.

CW/CCW SWITCHES

[V-guide support bar (2)]

The rack has two switches, one to sense full clockwise rotation, and one to sense full counterclockwise rotation. The switches are mounted on the V-guide support bar, and are actuated by two trip brackets mounted at each end of the rack.

LOAD STATION LOCKED LIMIT SWITCH

[Base of indexing handle (1)]

The load station has a switch to sense proper orientation of the load station, which is required before a pallet change will be permitted to occur.

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 counterclock-wise 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 PALLET CHANGER MACRO EXPLANATION

MACRO VARIABLES THAT CORRELATE DIRECTLY TO DIAGNOSTICS:

IMPORTANT!!

THE MACRO PROGRAM LISTED IN THIS SECTION SHOULD NOT BE MODIFIED IN ANY WAY AND IS FOR REFERENCE ONLY.

CHANGING THE MACRO PROGRAM WILL CAUSE THE PALLET CHANGER TO MALFUNCTION.

THE PALLET CHANGER MACRO IS A PROGRAM THAT LOOKS FOR INPUTS FROM THE SWITCHES MOUNTED ON THE PALLET CHANGER TO MAKE DECISIONS. THESE INPUTS ARE DISPLAYED ON THE DIAGNOSTICS PAGE(S). WHEN THE DECISION IS MADE, THE MACRO PROGRAM INSTRUCTS CERTAIN OUTPUTS TO CAUSE SOMETHING TO HAPPEN. THESE OUTPUTS ARE ALSO DISPLAYED ON THE DIAGNOSTICS PAGE(S). THERE ARE SEVEN DIRECT SWITCH INPUTS THAT ARE CONSIDERED AND ELEVEN DIRECT OUTPUTS TO PERFORM THE PALLET CHANGE FUNCTION. REFER TO THE DIAGNOSTICS PAGES IN THE SERVICE MANUAL TO SHOW HOW TO LOCATE THE PROPER INPUT OR OUTPUT THAT RELATES TO THE MACRO.

The following macro variables are used and altered by the pallet changer macro: #5, #11, #133, #134, #135, #136, #160, #161, and #191.

INPUTS:

1) LOAD STATION INDEX HANDLE SWITCH (IS THE STATION PROPERLY ORIENTED?).
   INPUT: #1024=1 (NOT ORIENTED); #1024 = 0 (HANDLE UP, STATION ORIENTED)
2) MAIN DRAWBAR UP SWITCH (IS THE MAIN DRAWBAR OFF OR ON THE TOP SWITCH?).
   INPUT: #1004=1 (TOP SWITCH TRIPPED); #1004=0 (TOP SWITCH NOT TRIPPED)
3) MAIN DRAWBAR DOWN SWITCH (IS THE MAIN DRAWBAR OFF OR ON THE BOTTOM SWITCH?). INPUT: #1002=1 (BOTTOM SWITCH TRIPPED); #1002=0 (BOTTOM SWITCH NOT TRIPPED)
4) CW ROTATION SWITCH (IS THE PALLET CHANGER CURRENTLY ROTATED FULLY CLOCKWISE?). INPUT: #1022=1 (ROTATED FULLY CW); #1022=0 (NOT ROTATED CW)
5) CCW ROTATION SWITCH (IS THE PALLET CHANGER CURRENTLY ROTATED FULLY COUNTERCLOCKWISE?). INPUT: #1023=1 (ROTATED FULLY CCW); #1023=0 (NOT ROTATED CCW)
6) PALLET UP SWITCH (IS THE TOP LIFT SWITCH TRIPPED OR NOT?).
   INPUT: #1026=1 (TOP SWITCH IS TRIPPED); #1026=0 (TOP SWITCH NOT TRIPPED)
7) PALLET DOWN SWITCH (IS THE BOTTOM LIFT SWITCH TRIPPED OR NOT?).
   INPUT: #1027=1 (BOTTOM SWITCH IS TRIPPED); #1027=0 (BOTTOM SWITCH NOT TRIPPED)

OUTPUTS:

1) AIR BLAST SOLENOID (TURN ON/OFF AIR BLAST).
   OUTPUT: #1138=1 (AIR BLAST ON); 1138=0 (AIR BLAST OFF)
2) CW ROTATION SOLENOID (ROTATE PALLET CHANGER CW).
   OUTPUT: #1136=1 (TURN ON CW AIR); #1136=0 (TURN OFF CW AIR)
3) CCW ROTATION SOLENOID (ROTATE PALLET CHANGER CCW).
   OUTPUT: #1137=1 (TURN ON CCW AIR); #1137=0 (TURN OFF CCW AIR)
4) LIFT CYLINDER SOLENOID (LIFT/LOWER PALLETS).
   OUTPUT: #1122=1 (LIFT THE PALLETS); #1122=0 (LOWER THE PALLETS)
5) AUDIBLE ALARM (BEEPER).
   OUTPUT: #1135=1 (BEEPER ON); #1135=0 (BEEPER OFF)
6) MAIN DRAWBAR POWER ENABLE (SUPPLY POWER TO CIRCUIT).

OUTPUT: #1124=1 (SUPPLY POWER TO MAIN); #1124=0 (CUT OFF POWER TO MAIN)
7) MAIN DRAWBAR CLOCKWISE RELAY (SCREW IN DRAWBAR).
OUTPUT: #1108=1 (TURN MOTOR CW); #1108=0 (TURN OFF CW MAIN)
8) MAIN DRAWBAR COUNTERCLOCKWISE RELAY (SCREW OUT DRAWBAR).
OUTPUT: #1109=1 (TURN MOTOR CCW); #1109=0 (TURN OFF CCW MAIN)
9) FRONT DRAWBAR POWER ENABLE (SUPPLY POWER TO CIRCUIT).
OUTPUT: #1125=1 (SUPPLY POWER TO FRONT); #1125=0 (CUT OFF POWER TO FRONT)
10) FRONT DRAWBAR CLOCKWISE RELAY (SCREW IN DRAWBAR).
OUTPUT: #1110=1 (TURN MOTOR CW); #1110=0 (TURN OFF CW FRONT)
11) FRONT DRAWBAR COUNTERCLOCKWISE RELAY(SCREW OUT DRAWBAR).
OUTPUT: #1111=1 (TURN MOTOR CCW), #1111=0 (TURN OFF CCW FRONT)

OUTPUTS FROM THE MACRO THAT ARE NOT PART OF THE PALLET CHANGER MECHANISM:

THE PALLET CHANGE FUNCTION IS MORE COMPREHENSIVE THAN SIMPLY OPERATING THE MECHANICAL PALLET CHANGER DEVICE. PROTECTING THE MACHINE AND THE OPERATOR ARE ALSO NECESSARY. IT IS NOT DESIRABLE, FOR EXAMPLE, TO HAVE TSC, OR THE SPINDLE, RUNNING WHILE CHANGING PALLETS. SOME OUTPUTS HAVE A COMPLETELY INTERNAL USE TO THE PALLET CHANGE MACRO, SUCH AS USING THE MILLISECOND TIMER.

1) SPINDLE ROTATION CLOCKWISE (TURN OFF ROTATION CW)
OUTPUT: #1101=0 (TURN OFF SPINDLE ROTATION)
2) SPINDLE ROTATION COUNTERCLOCKWISE (TURN OFF ROTATION CCW)
OUTPUT: #1102=0 (TURN OFF SPINDLE ROTATION)
3) TURN OFF STANDARD COOLANT
OUTPUT: M09
4) TURN OFF THROUGH THE SPINDLE COOLANT
OUTPUT: M89
5) RESET THE MILLISECOND TIMER
OUTPUT: #3001=0 (ZERO THE MILLISECOND TIMER)
6) FEED HOLD
OUTPUT: #3004=1 (DISABLE FEED HOLD); #3004=0 (ENABLE FEED HOLD)
7) ALARM MESSAGES
#3000= SOME NUMBER
WILL SHOW THE ALARM AS A 1000 SERIES ALARM AND WRITE THE MESSAGE TO THE SCREEN.

SPECIAL PARAMETERS THAT ARE REQUIRED FOR THE PALLET CHANGE SEQUENCE:

THERE WERE (3) PARAMETERS ADDED TO <u>8.25 AND 8.26 SOFTWARE</u> TO DIFFERENTIATE BETWEEN HS-1 AND HS-1R, AND HS-1RP. THE SPINDLE "LOCKOUT" FUNCTION IS DESIRABLE ONLY WITH HS-1RP SINCE IT IS THE ONLY ONE WITH A PALLET CHANGER.

PARAMETER 226: VALUE SHOULD BE SET TO "21"
FUNCTION OF 226?: SPECIFIES THE MAIN DRAWBAR "UP" SWITCH
PARAMETER 209: "CK PALLET IN": VALUE SHOULD BE "1" <u>(HS-1RP ONLY)</u>
FUNCTION OF "CK PALLET IN"?: TELLS SOFTWARE TO CHECK STATUS OF SWITCH SPECIFIED BY PARAMETER 226.
PARAMETER 209: "CK HIDDN VAR": VALUE SHOULD BE "1" <u>(HS-1RP ONLY)</u>
FUNCTION OF "CK HIDDN VAR"?: TELLS SOFTWARE TO CHECK THE VALUE OF THE VARIABLE SET BY THE PALLET CHANGER MACRO.

THERE WERE (3) PARAMETERS ADDED TO <u>9.08 AND LATER SOFTWARE</u> TO DIFFERENTIATE BETWEEN HS-1 AND HS-1R, AND HS-1RP. THE SPINDLE "LOCKOUT" FUNCTION IS DESIRABLE ONLY WITH HS-1RP SINCE

IT IS THE ONLY ONE WITH A PALLET CHANGER.

PARAMETER 256: VALUE SHOULD BE SET TO "4"
FUNCTION OF 256?: SPECIFIES THE MAIN DRAWBAR "UP" SWITCH
PARAMETER 278: "CK PALLET IN": VALUE SHOULD BE "1" (HS-1RP ONLY)
FUNCTION OF "CK PALLET IN"?: TELLS SOFTWARE TO CHECK STATUS OF SWITCH SPECIFIED BY PARAMETER 256.
PARAMETER 278: "CK HIDDN VAR": VALUE SHOULD BE "1" (HS-1RP)
FUNCTION OF "CK HIDDN VAR"?: TELLS SOFTWARE TO CHECK THE VALUE OF THE VARIABLE SET BY THE PALLET CHANGER MACRO.

DESCRIPTION OF THE PALLET CHANGER SEQUENCE OF OPERATION:

THE MACRO PROGRAM OPERATES THE PALLET CHANGER MUCH THE SAME WAY THAT YOU WOULD THINK THE SEQUENCE THROUGH. IF YOU KEEP THIS IN MIND IT MAKES IT EASIER TO UNDERSTAND THE STRUCTURE OF THE MACRO. LISTED BELOW ARE SOME TYPICAL SITUATIONS, AND THE RELATED SEQUENCE OF MACRO EVENTS, THAT CAN OCCUR. BE ADVISED THAT THESE SITUATIONS ARE FAIRLY TYPICAL AND DO NOT REFLECT ALL OF THE POSSIBLE SITUATIONS THE MACRO PROGRAM NEEDS TO DEAL WITH.

SITUATION 1:

THE NORMAL PALLET CHANGE SEQUENCE WOULD BEGIN WITH THE PALLETS CLAMPED. LOOKING AT IT FROM THAT POINT OF VIEW, THE SEQUENCE WOULD BE:

1) TURN OFF COOLANT
2) TURN OFF THE SPINDLE IF NOT ALREADY OFF
3) SEND Z-AXIS TO HOME
4) SEND A-AXIS TO HOME
5) SET THE PALLET CHANGER MACRO INCOMPLETE BIT
6) CHECK THE LOAD STATION ORIENTATION/PART READY BUTTON
7) TURN ON THE BEEPER
8) TURN ON THE AIR BLAST
9) UNLOCK THE PALLETS BY UNSCREWING THE DRAWBARS
10) LIFT THE PALLETS
11) ROTATE THE PALLETS
12) LOWER THE PALLETS
13) CLAMP THE PALLETS BY SCREWING IN THE DRAWBARS
14) CLEAR THE PALLET CHANGER MACRO INCOMPLETE BIT

THESE LISTED STEPS DO NOT TAKE INTO ACCOUNT THE INDIRECT ROUTINES THAT PERFORM SWITCH CHECKS (LOOKING FOR BROKEN SWITCHES), RETRY SEQUENCES, TIMING LOOPS, ALARM CONDITIONS, ETC.... IGNORING THESE ITEMS FOR THE TIME BEING, LET US CONSIDER ANOTHER POSSIBILITY:

SITUATION 2:

THE PALLET CHANGER WAS LIFTED, OR LIFTED AND ROTATED, WHEN THE RESET BUTTON, OR THE E-STOP BUTTON, WAS PUSHED. WHEN THE ALARM IS CLEARED (IF E-STOP WAS USED) AND M50 IS EXECUTED AGAIN FROM MDI, THE SEQUENCE IS SIMILAR, BUT NOT IDENTICAL TO, THE NORMAL PALLET CHANGE SEQUENCE:

1) TURN OFF COOLANT
2) TURN OFF THE SPINDLE IF NOT ALREADY OFF
3) SEND Z-AXIS TO HOME
4) SEND A-AXIS TO HOME
5) SET THE PALLET CHANGER MACRO INCOMPLETE BIT
6) CHECK THE LOAD STATION ORIENTATION/PART READY BUTTON

7) TURN ON THE BEEPER
8) TURN ON THE AIR BLAST
9) ROTATE THE PALLETS CLOCKWISE TO <u>RECOVER</u> THE PALLET CHANGER
10) LOWER THE PALLETS
11) CLAMP THE PALLETS BY SCREWING IN THE DRAWBARS
12) CLEAR THE PALLET CHANGER MACRO INCOMPLETE BIT

SITUATION 3:

NOW LET US ASSUME THAT AN M50 HAS BEEN COMMANDED IN THE NORMAL CLAMPED CIRCUMSTANCE, BUT THE LOAD STATION HAS NOT BEEN PROPERLY ORIENTED FOR THE PERFORMANCE OF A PALLET CHANGE. THE SEQUENCE WOULD BE NORMAL IF THE LOAD STATION WERE ORIENTED, BUT NOW IT WILL BECOME A BROKEN SEQUENCE THAT REQUIRES THE OPERATOR TO FILL IN THE MISSING LINK:

1) TURN OFF COOLANT
2) TURN OFF THE SPINDLE IF NOT ALREADY OFF
3) SEND Z-AXIS TO HOME
4) SEND A-AXIS TO HOME
5) SET THE PALLET CHANGER MACRO INCOMPLETE BIT
6) CHECK THE LOAD STATION ORIENTATION/PART READY BUTTON
** THE PART READY LIGHT ON THE FRONT SWITCH BOX IS FLASHING. **
** THE OPERATOR MUST ORIENT THE LOAD STATION SO THE HANDLE **
** COMES ALL THE WAY UP. THEN THE OPERATOR MUST PRESS THE **
** FLASHING PART READY BUTTON TO CONTINUE THE EXECUTION OF **
** THE PALLET CHANGE MACRO. **
7) TURN ON THE BEEPER
8) TURN ON THE AIR BLAST
9) UNLOCK THE PALLETS BY UNSCREWING THE DRAWBARS
10) LIFT THE PALLETS
11) ROTATE THE PALLETS
12) LOWER THE PALLETS
13) CLAMP THE PALLETS BY SCREWING IN THE DRAWBARS
14) CLEAR THE PALLET CHANGER MACRO INCOMPLETE BIT

SITUATION 4:

NOW LET US ASSUME THAT AN M50 HAS BEEN COMMANDED IN THE NORMAL CLAMPED CIRCUMSTANCE, BUT INSTEAD OF RUNNING THE M50 FROM THE MAIN PROGRAM IT IS BEING RUN FROM MDI. IT WOULD BE ATYPICAL OF OPERATORS TO HIT THE RESET BUTTON AS SOON AS THE PALLETS HAVE BEEN PLACED ON THE PALLET STATIONS. THE RESULT WILL BE A 180 ALARM (PALLETS NOT CLAMPED). LOOKING AT THE PALLET CHANGER SEQUENCE THIS IS EASIER TO UNDERSTAND:

1) TURN OFF COOLANT
2) TURN OFF THE SPINDLE IF NOT ALREADY OFF
3) SEND Z-AXIS TO HOME
4) SEND A-AXIS TO HOME
5) SET THE PALLET CHANGER MACRO INCOMPLETE BIT
6) CHECK THE LOAD STATION ORIENTATION/PART READY BUTTON
7) TURN ON THE BEEPER
8) TURN ON THE AIR BLAST
9) UNLOCK THE PALLETS BY UNSCREWING THE DRAWBARS
10) LIFT THE PALLETS
11) ROTATE THE PALLETS
12) LOWER THE PALLETS
** INTERRUPTION OF THE PALLET CHANGER SEQUENCE MAY HAVE HAPPENED BEFORE THE

PALLETS GOT ALL THE WAY DOWN. THE PALLETS ARE NOT EVEN PARTIALLY CLAMPED **
13) CLAMP THE PALLETS BY SCREWING IN THE DRAWBARS
** INTERRUPTION OF THE PALLET CHANGER SEQUENCE MAY HAVE HAPPENED BEFORE THE DRAWBARS FULLY CLAMPED THE PALLETS **
14) CLEAR THE PALLET CHANGER MACRO INCOMPLETE BIT

REGARDLESS OF WHERE THE PALLET CHANGE SEQUENCE WAS INTERRUPTED, IT IS EASY TO RECOGNIZE THAT THE PALLET CHANGER MACRO INCOMPLETE BIT WAS NOT CLEARED. THE RESULT IS ALARM 180, AND RIGHTLY SO, BECAUSE THE PALLETS ARE NOT KNOWN TO BE IN THE CLAMPED CONDITION. THE OPERATOR MAY HAVE INTERVENED, AS DESCRIBED ABOVE. AN ALARM GENERATED BY THE PALLET CHANGER MACRO OR BY THE CONTROL MAY HAVE INTERVENED.

HEED NO CLAIM TO THE CONTRARY, ALARM 180 CAN HAPPEN IN ONLY ONE WAY: INTERRUPTION OF THE PALLET CHANGE SEQUENCE HAS NOT PERMITTED THE MACRO INCOMPLETE BIT TO BE CLEARED.

PALLET CHANGER ALARMS AND WHERE THEY COME FROM IN THE MACRO

1001 (INDEX STATION UNLOCKED, VERIFY LEVER UP) (CE FRONT DOORS OPEN)

AFTER THE PALLET CHANGE SEQUENCE PASSES THE INITIAL LOAD STATION ORIENTATION CHECK, EITHER THE HANDLE WAS DEPRESSED OR THE FRONT DOORS WERE OPENED. THE STATUS OF THE LOAD STATION ORIENTATION IS CONTINUOUSLY CHECKED UNTIL BOTH PALLETS ARE UNCLAMPED, AND THEN IT IS IGNORED FOR THE REMAINDER OF THE PALLET CHANGE SEQUENCE (THE EXCEPTION TO THIS IS THE CE VERSION WHERE THE STATUS OF THE FRONT DOORS IS RUN IN SERIES WITH THE LOAD STATION ORIENTATION. THIS STATUS IS CONTINUOUSLY CHECKED THOUGHOUT THE PALLET CHANGE SEQUENCE FOR CE MACHINES).

REFER TO TROUBLESHOOTING THE PALLET CHANGER FOR MORE INFORMATION.

1002 (PALLET LOCKED DOWN, VERIFY DRAWBAR DOWN)

THIS ALARM FLAG IS SET AS THE LIFTING SEQUENCE IS ENTERED. THE SWITCHES HAVE VERIFIED THAT THE MAIN DRAWBAR UNSCREWED ALL THE WAY, BUT DOES NOT HAVE FEEDBACK TO VERIFY THE LOAD STATION DRAWBAR IN THE DOWN POSITION.
THE STRUCTURE OF THE PALLET CHANGER MACRO PROGRAM FORCES THIS CONCLUSION: FOR SOME REASON THE LOAD STATION DRAWBAR DID NOT UNSCREW, OR FULLY UNSCREW, FROM THE PALLET.

REFER TO TROUBLESHOOTING THE PALLET CHANGER FOR MORE INFORMATION.

1003 (PALLETS JAMMED, CHECK FOR OBSTRUCTION)

THIS ALARM FLAG IS SET AS THE ROTATE SEQUENCE IS ENTERED. IF THE PALLET CHANGER FAILS TO (A) BEGIN ROTATION WITHIN 3 SECONDS OF ROTATE COMMAND OR (B) COMPLETE ROTATION WITHIN 20 SECONDS OF ROTATE COMMAND THIS ALARM IS GENERATED. THE GENERAL CONCLUSION MUST BE THAT SOMETHING IS PREVENTING THE PALLET CHANGER FROM ROTATING.

REFER TO TROUBLESHOOTING THE PALLET CHANGER FOR MORE INFORMATION.

1004 (CW/CCW SWITCH ILLEGAL CONDITION)

THE ILLEGAL CONDITION IS DEFINED BY THE PALLET CHANGER MACRO AS:
THE PALLET CHANGER IS FULLY ROTATED CLOCKWISE AND COUNTERCLOCKWISE AT THE SAME TIME BECAUSE THE SWITCH INPUTS SAY THAT IT IS (THE CW AND CCW SWITCHES ARE BOTH TRIPPED). THE

ALARM FLAG IS SET DURING THE SWITCH CHECK AND DURING THE ROTATION SEQUENCES.

REFER TO TROUBLESHOOTING THE PALLET CHANGER FOR MORE INFORMATION.

1007 (UP/DOWN SWITCH ILLEGAL POSITION - LIFT CYLINDER)

THE ILLEGAL CONDITION IS DEFINED BY THE PALLET CHANGER MACRO AS:
THE H-FRAME IS BOTH LIFTED AND LOWERED AT THE SAME TIME BECAUSE THE SWITCH INPUTS SAY THAT IT IS (THE TOP SWITCH IS NOT TRIPPED, BUT THE BOTTOM SWITCH IS TRIPPED). THE ALARM FLAG IS SET DURING THE SWITCH CHECK AND DURING THE LIFT AND LOWER SEQUENCES.

REFER TO TROUBLESHOOTING THE PALLET CHANGER FOR MORE INFORMATION.

1008 (MAIN DRAWBAR LOCKED IN UP POSITION)

THIS ALARM FLAG IS SET WHEN THE MACRO GOES INTO A RETRY SEQUENCE TO UNSCREW THE MAIN DRAWBAR. IF THE INITIAL ATTEMPT TO UNCLAMP FAILS (AFTER 3.5 SECONDS) TO UNSCREW THE MAIN DRAWBAR, AN AGGRESSIVE ATTEMPT TO FREE THE MAIN DRAWBAR IS BEGUN. THE ATTEMPT OF THE RETRY SEQUENCE IS TO TRY TO SCREW IN AGAIN (EVEN THOUGH WE THINK IT IS ALREADY WE WANT TO TRY TO BREAK IT FREE) AND THEN OUT AGAIN UNTIL IT TRIPS THE DRAWBAR UP SWITCH. IF IT DOES TRIP THE SWITCH, NO ALARM IS GENERATED. IF, AFTER 20 TRIES, IT DOES NOT TRIP THE SWITCH, THIS ALARM IS GENERATED.

REFER TO TROUBLESHOOTING THE PALLET CHANGER FOR MORE INFORMATION.

1009 (MAIN DRAWBAR LOCKED IN DOWN POSITION)

THIS ALARM FLAG IS SET WHEN THE MACRO GOES INTO A RETRY SEQUENCE TO SCREW IN THE MAIN DRAWBAR. IF THE INITIAL ATTEMPT TO CLAMP FAILS (AFTER 8.5 SECONDS) TO SCREW IN THE MAIN DRAWBAR, AN AGGRESSIVE ATTEMPT TO FREE THE MAIN DRAWBAR IS BEGUN. THE ATTEMPT OF THE RETRY SEQUENCE IS TO TRY TO SCREW IN AGAIN AND AGAIN UNTIL IT COMES OFF THE DRAWBAR DOWN SWITCH. IF IT DOES COME OFF THE SWITCH, NO ALARM IS GENERATED. IF, AFTER 20 TRIES, IT DOES NOT COME OFF THE SWITCH, THIS ALARM IS GENERATED.

REFER TO TROUBLESHOOTING THE PALLET CHANGER FOR MORE INFORMATION.

1010 (MAIN DRAWBAR SWITCH ILLEGAL CONDITION)

THE ILLEGAL CONDITION IS DEFINED BY THE PALLET CHANGER MACRO AS:
THE MAIN DRAWBAR HAS TRIPPED THE DOWN SWITCH BUT NOT TRIPPED THE TOP SWITCH. OF COURSE, THIS IS NOT PHYSICALLY POSSIBLE BUT THE SWITCH INPUTS SAY THAT IT IS. THE ALARM FLAG IS SET DURING THE SWITCH TEST AND DURING CLAMP AND UNCLAMP SEQUENCES.

REFER TO TROUBLESHOOTING THE PALLET CHANGER FOR MORE INFORMATION.

1011 (MAIN DRAWBAR UNCLAMP TIMEOUT)

THE ALARM FLAG IS SET FOR THIS WHEN THE MACRO ENTERS THE DRAWBAR UNCLAMP ROUTINE. THE DRAWBAR HAS SUCCESSFULLY TRIPPED THE DRAWBAR UP SWITCH WHILE ON THE WAY DOWN, BUT IT JUST CAN'T SEEM TO GET TO THE DRAWBAR DOWN SWITCH EVEN AFTER 10 SECONDS OF RUNNING THE GEARMOTOR.

REFER TO TROUBLESHOOTING THE PALLET CHANGER FOR MORE INFORMATION.

1012 (MAIN DRAWBAR CLAMP TIMEOUT)

THE ALARM FLAG IS SET FOR THIS WHEN THE MACRO ENTERS THE DRAWBAR CLAMPING ROUTINE. THE DRAWBAR HAS SUCCESSFULLY COME OFF THE DRAWBAR DOWN SWITCH WHILE ON THE WAY UP, BUT IT JUST CAN'T SEEM TO GET OFF THE DRAWBAR UP SWITCH EVEN AFTER 15 SECONDS OF RUNNING THE GEARMOTOR.

REFER TO TROUBLESHOOTING THE PALLET CHANGER FOR MORE INFORMATION.

1119 (UNKNOWN ALARM)

IF THIS ALARM HAS BEEN GENERATED IT IS BECAUSE SOMETHING HAS HAPPENED TO THE MACRO TO CORRUPT IT OR IT HAS BEEN ALTERED.... THE ONLY WAY TO GET THIS ALARM IS TO SET THE ALARM FLAG INSIDE THE MACRO TO A VALUE THAT IS NOT LATER SPECIFIED AS A PARTICULAR ALARM IN THE ALARM SUBROUTINE OF THE MACRO.

REFER TO TROUBLESHOOTING THE PALLET CHANGER FOR MORE INFORMATION.

VERSION V O9000 PALLET CHANGER MACRO AS AN EXAMPLE:

THE MACRO PROGRAM LISTED BELOW IS THE COMPLETE VERSION V MACRO. IT IS PROVIDED AS AN EXAMPLE TO EXTEND UNDERSTANDING OF THE PALLET CHANGER SEQUENCE OF OPERATION FOR PURPOSES OF TROUBLESHOOTING AND SHOULD PROVIDE AN ADEQUATE UNDERSTANDING SHOULD SOME MODIFICATION BE REQUIRED FOR SPECIAL OPERATION OF THE PALLET CHANGER. DO NOT MODIFY THE MACRO PROGRAM IN ANY PALLET CHANGER WITHOUT FIRST CONSULTING HAAS AUTOMATION FOR CLARIFICATION... THE MACRO IS COMPLEX ENOUGH THAT AN INADVERTANT ERROR COULD OCCUR DUE TO A MISUNDERSTANDING.

THE BODY OF THE PROGRAM IS IN CAPITAL LETTERS.
the explanations of the line above are in small case letters.
SPECIAL NOTES ARE IN BOLD CAPTIAL LETTERS.

```
%
O9000 (* MACRO PALLETS/V 14-MAY-96 *)
defined this program as the o9000 program
(* 16-MAY-96 ACI UPDATED PER AHMAD L.)
(* REQUIRES 9.08 SOFTWARE 14-MAY-96*)
(* SET PARAMETER: 278 CHK PALLET IN=1 14-MAY-96*)
(* SET PARAMETER: 278 CHK HIDDN PAR=1 14-MAY-96*)
(* SET PARAMETER: 256 PALLET INPUT=4 14-MAY-96*)
(* ADD SELF RECOVERY, RENAME ALARMS 14-MAY-96*)
(* 709=MACRO NOT COMPLETED BIT ADDED 14-MAY-96*)
(* BRUSHLESS MACHINES, IOPCB REV L, 9.3 M-RELAY BOARD*)
(* CHANGE ADDR IN/OUT: DB DWN;DB UP/WARN;PAL CW;PAL CCW;AIR;PAL UP*)
(* ADD CE OVERRIDE BEFORE PAL ALARM & CE SW ENABLE COMMAND *)
(* WORKS ONLY IN MACHINES WITH AIR TC DOOR SHIPPED AFTER 1-JUL-95 *)
(* ADDED PRECHARGE TO SMOOTH CW,CC ROTATION 8-NOV-95 *)
(* CHANGE TO SLOWER GEAR MTR 12-DEC-95)
(* INCREASE DWELL BEFORE PALLET SETTLES 8-NOV-95 *)
(* ADDED Z MOVE AFTER #3004=1 AND ROTATE DELAY TO 20 SEC 26-AUG-95 *)
(* ADDED COOLANT OFF 4-AUG-95 *)
(* AIR BLAST 1127 TO 1138 5TH BRAKE *)
(* THIS ALLOWS 1127/M24 TC AIR DOOR *)
```

(* ELSE SAME AS RPLMAC OF 29JUN95 *)
(MODIFICATIONS 4/24/96)
(#3001 GT 3500 WAS 2000 N7)
(#3001 - #134 GE 1300 WAS 350 N8)
(CLAMP TIMEOUT IS 8500 WAS 7500 N80)
(* MODIFIED 8JUN 95 *)
(.3SEC RATCHET MAIN 1/3 FOR N94 LOCK)
(THIS CODE HAS ALARMS 1 TO 12)
(N88 SLIP CLUTCH 1.100 SEC DELAY)
(N8 SCREW OUT TIME IS .35 SEC)
(4MAY95 32OO FT DOWN, 2000 PALLET DOWN)
(the above are remarks and comments that do not affect the function of the pallet changer macro)
G103 P1
change lookahead to 3 lines
M09
turn off standard coolant
M89
turn off thru the spindle coolant
#1101= 0 (SP CW OFF)
turn off spindle clockwise
#1102= 0 (SP CCW OFF)
turn off spindle counter clockwise
G53 G00 G90 Z0.
move z-axis to home for safety and clearance
G53 G00 G90 A0.
move a-axis to home to align to pallet changer
#709= 1 (SET MACRO INCOMPLETE BIT)
software interface - does not allow spindle rotation if pallet change not complete
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97
(* SCREW OUT AND PALLETS UP *)
#160= 0 (GOT UP OK)
variable: lift attempts: reset to zero
N5 #161= 0 (CONTINUE, SET RETURN FLAG)
reset variable to zero. if it was set to 1 it happened because it couldn't lift pallets. returned here after screwing in the drawbars again. will attempt the whole pallet changer sequence again.
M97 P97 (SYNC)
synchronizes lookahead
IF [#1024 EQ 0] GOTO6 (IF OPER LOCKED DOWN, PROCEED)
check index station switch-position. index station orientation. if not oriented, then turn on part ready light. will keep checking until load station is properly oriented to execute a pallet change.
M97 P97 (SYNC)
synchronizes lookahead
M36 (WAIT FOR OPER PART READY BUTTON)
index station not at zero: flash part ready light
M97 P97 (SYNC)
synchronizes lookahead
GOTO5
part ready light pushed - loop back to check orientation again
N6 M97 P97 (SYNC)
got here because load station is oriented.synchronizes lookahead.
#1139= 1 (CE DISABLE FRNT SWITCHES)
M97 P97 (SYNC)
synchronizes lookahead

#1135= 1 (AUDIBLE ALARM ON/CE DISABLE FRNT SWITCHES)
turns on beeper
M97 P97 (SYNC)
synchronizes lookahead

(* START SWITCH STATUS CHECK HERE ***)**
checks for broken switches on lift cylinder, main drawbar, and cw/ccw positions
[#1027 EQ 0] GOTO18 (PALLET NOT DOWN)
sequence was stopped with pallets lift - go to recovery
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead. must check the position of the load station before the pallets are lifted. after pallets are lifted doesn't check load station position anymore because depressing the handle would stop the sequence from completing. it is a natural tendency for the operator to depress the load station index handle as soon as the pallets are lowered to rotate the pallet; not checking the load station will permit the operator to do this without interrupting the clamping sequence.
IF [[#1026 EQ 0] AND [#1027]] #191= 7 GOTO91
check pallet up/down switches for illegal condition
(UP/DOWN SWITCH ILLEGAL CONDITION)
defined above as 1026 down switch tripped and 1027 up switch not tripped; an impossible situation
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
IF [#1022 AND #1023] #191= 4 GOTO91 (CW/CCW SWITCH ILLEGAL CONDITION)
check rotation switches for illegal condition: defined as 1022 cw switch tripped and 1023 ccw switch tripped at the same time; an impossible situation
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
IF [#1002 AND [#1004 EQ 0]] #191= 10 GOTO91 (MAIN DB SW ILLEGAL CONDITION)
check main drawbar switches for illegal condition: defined as 1002 drawbar down switch tripped and 1004 drawbar up switch not tripped; an impossible situation
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
(*** END SWITCH STATUS CHECK HERE ***)

(* START HERE TO REMOVE BOTH LOCKDOWNS ***)**
#3001= 0 (RESET MSEC TIMER)
millisecond timer is used and reset often in the macro. the use is: when certain flags are set, we want a time delay to occur before proceeding with the pallet change sequence of events. conditional statements are used for this purpose.
#1138= 1 (AIR BLAST ON)
air blast is turned on before unlocking the drawbars to clear chips away from the locating pins
N7 #3004= 1 (DISABLE FEED HOLD)
to protect drawbars/gearmotor from jamming/breaking when feed hold is used. if this were not there, but feed hold or reset were pressed, the drawbar motors would continue to run since they are controlled by the macro instead of the main control.
G53 G00 G90 Z0.
send z-axis to home - redundant statement since it was already commanded. better safe than sorry.
#191= 11 (SET ALARM FLAG)
present alarm variable to main drawbar clamp timeout. will generate alarm 1011.
#133= 0 (RESET .25 MAIN DELAY FLAG)
when #133=1 will signal drawbar down switch is tripped and 0.25 second time delay for shutting off the main drawbar will begin
IF [#1002 EQ 0] #1124= 1 (MAIN ENABLE IF NOT DOWN)
checks the drawbar down switch. if the drawbar down switch is not tripped will supply power to main drawbar

circuit. if the switch is tripped, then the drawbar must be down already and power is not required.
IF [#1002 EQ 0] #1109= 1 (BACK OUT MAIN IF NOT DOWN)
check the drawbar down switch. if the drawbar down switch is not tripped will supply power to unscrew the drawbar. if the switch is tripped, then the drawbar must be down already, and there is no need to unscrew.
IF [[#3001 GT 3500.] AND [#1004 EQ 0]] GOTO94
after 3.5 seconds if top switch not tripped go to unscrew retry subroutine
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
IF [#1004 EQ 0] GOTO7 (WAIT FOR NOT LOCKED)
unscrew until drawbar top switch is tripped, then continue, if not tripped, loop back until it is.
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
G04 P0.25 (WAIT)
0.25 second time delay, top switch hit, delay, start front drawbar down. for circuit protection on i/o board. the main drawbar may draw a little over ten amps when it has to unscrew , so to give the load station the chance to draw its' maximum current, the delay was put in. overheating of the circuit could occur otherwise
#3001= 0 (RESET MSEC TIMER FOR FT DRAWBAR)
now that the main drawbar has passed the test (waiting for the top switch to be be tripped) the timer may be used for other time delay requirements and conditional tests.
IF [#1002 EQ 0] #1125= 1 (FRONT ENABLE)
supply power to front drawbar motor circuit
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
IF [#1002 EQ 0] #1111= 1 (BACK OUT FRONT)
set unscrew direction of front drawbar, unscrew
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
N10 #191= 11 (SET ALARM FLAG)
preset alarm variable to drawbar clamp time (if the drawbar unscrew retry subroutine was used this could have been changed while unscrewing main drawbar) (will generate alarm 1011)
WHILE [[#1002] AND [#1004 EQ 0]] DO3
check for broken drawbar switches; illegal condition as above in switch status check. since this is a while loop, it does not affect the alarm condition previously set if the while condition is not met.
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
#191= 10 (SET ALARM FLAG)
alarm variable set to main drawbar switch illegal condition (will generate alarm 1010)
GOTO91 (SWITCH ALARM)
go to alarm sequence if down switch tripped but top switch not
END3 (BROKEN SWITCH CHECK)
IF [#3001 GT 10000.] GOTO91 (MAIN DB UP TO DWN TIMEOUT)
if it takes longer than 10 seconds to trip the down switch after tripping the top switch, alarm
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
IF [#3001 GE 3200.] #1111= 0 (FRONT DOWN, STOP IT)
after 3.2 seconds of running, stop front drawbar
TO INCREASE THE FRONT DRAWBAR UNSCREW TIME, INCREASE THE VALUE NOW SHOWN AS 3200.
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
IF [#1002 EQ 0] GOTO10 (NOT DONE)
if main drawbar down switch not tripped, loop to continue unscrewing. if it is, continue past this condition
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
IF [#133] GOTO8

routine passes this one time, but sees it second time
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
#133= 1 (SET FLAG FOR MAIN SHUTDOWN DELAY)
now set to 1. next loop bypasses this line, goes to n8
#134= #3001 (SET MSEC TIMER FOR .25 SEC DELAY)
should say (set msec timer for 1.3 sec delay). next loop bypasses this line because #133=1. set time datum for comparison; how long the main drawbar will run after the main drawbar down switch is tripped.
N8 IF [[#3001 - #134 GE 1300.] AND #133 EQ 1] #1109= 0 (MAIN DOWN, STOP IT)
1.3 seconds after drawbar down switch tripped, turn off main drawbar motor
TO INCREASE THE MAIN DRAWBAR UNSCREW TIME (LINE N8), INCREASE THE VALUE NOW SHOWN AS 1300.
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
IF [#1109] GOTO10 (NOT DONE)
loops back once (#133 variable) (motor still on, so loop)
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
IF [#1111] GOTO10 (NOT DONE)
loops back until front drawbar motor off. the motor is turned off by the time condition above.
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
#1124= 0 (DISABLE MAIN)
turn off power to main drawbar motor circuit
#1125= 0 (DISABLE FRONT)
turn off power to front drawbar motor circuit
#160= #160 + 1 (INCREMENT DOWN ATTEMPTS)
increment h-frame lift attempts; preparation for the next sequence which is lifting the pallets. this is here instead of below because unclamping the drawbars may be required as part of the lifting retry sequence.... it all depends where the operator hits reset or estop, etc...
IF [#160 GT 3] #191= 2 GOTO91
set alarm variable to pallet locked down after failing to lift 4 times. usually front drawbar problem. will generate alarm 1002.
(* END OF UNLOCKING ***)**

(* BEGIN LIFTING ***)**
N18 #191= 2 (SET ALARM FLAG)
recovery sequence starts. could have been sent here by meeting the conditional test at the top of the switch status check routine (pallet changer stopped with pallets lifted), so we have to duplicate setting alarm variable.
#1138= 1 (AIR BLAST ON)
have to turn on air blast again. recovery sequence bypasses first instruction to turn on air blast
#1122= 1 (PALLETS UP ON)
activate lift cylinder solenoid
#3001= 0 (RESET MSEC TIMER)
to time how long it takes to lift
N20 IF [[#3001 GT 2000] AND [#1027]] GOTO96 (STILL LOCKED)
if it takes longer than 2 seconds to lift - assume front drawbar locked, go to subroutine at n96. checks pallet down switch as condition.
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
IF [#1026 AND [#3001 LT 6000]] GOTO20 (WAIT FOR PALLETS UP)
check pallet up switch. loop for maximum 6 seconds, checking down switch at n20 for 2 of those seconds.

if it doesn't come off the top switch in 6 seconds then it will fall thru the next conditional test.
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
G04 P0.5 (WAIT FOR PALLET UP)
if not sent to retry subroutine, checks status every 1/2 second
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
IF [#1026 EQ 0] GOTO25 (GOT UP OK)
if the lift cylinder is off the top switch then jump to next step in sequence
#161= 1 (RETURN TO UNCLAMP ROUTINE)
got off down switch okay but not off up switch after 6 seconds
GOTO60 (RETRY CLAMP, UNCLAMP)
starts a big loop, goes to the clamp routine, then to the top of the macro & starts everything over
M97 P90 (CHECK OPER LOCK SW / SYNC)
check index station orientation and synchronize lookahead.
N25 #160= 0 (GOT UP OK)
got here because it lifted, reset lift attempts to zero for next time that sequence is used.
#3004= 0 (ENABLE FEED HOLD)
no need to protect gearmotors/drawbars while rotating clockwise or counterclockwise.
(* FINISHED LIFTING ***)**

(* BRANCH CW/CCW ***)**
IF [#1022 EQ 1] GOTO40 (IF CW NOW, DO CCW)
decides which way to rotate. if 1022 if 1 then it is now rotated all the way clockwise, so it would jump to the counterclockwise routine. if 1022 is 0, then it falls thru this condition
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97. not checking load station orientation now because the operator is not allowed to stop the pallet changer sequence that way anymore. he will have to hit reset or estop to do that now.

(* BEGIN CW ***)**
#191= 3 (SET ALARM FLAG)
set variable to incomplete motion (rotation). will generate alarm 1003.
#1137= 1 (PRECHARGE AIR CYL)
to reduce "jerk" as rotation starts clockwise the "wrong" side of the cylinder is charged before the "right" side is pressurized
G04 P1000
1 second pause to charge cylinder
#1137= 0
turn off rotation cylinder precharge
#1136= 1 (CW ON)
turn on cw rotation solenoid
#3001= 0 (RESET MSEC TIMER)
N30 IF [#1023 AND [#3001 GT 3000]] GOTO91
if it didn't start to rotate after 3 seconds generate pallet jammed alarm
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97.
IF [[#1022 EQ 0] AND [#3001 GT 20000]] GOTO91
if it didn't complete cw rotation after 20 second then alarm subroutine
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97.
IF [#1023 AND #1022] #191= 4 GOTO91

checks switches while rotating for illegal condition
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97.
IF [#1022 EQ 0] GOTO30 (WAIT FOR CW)
if it hasn't finished cw rotation, loop until cw switch is tripped or an alarm occurs
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97.
G04 P1500 (DWELL FOR PALLETS TO SETTLE CW)
rotation is complete, but hold it there to prevent bouncing back with heavy loads
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97.
#1136= 0 (CW OFF)
turn off cw rotation solenoid
GOTO60 (NOW DOWN)
jump over ccw rotation to lower pallets routine
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97.
(* FINISHED CW MOVEMENT ***)**

(* BEGIN CCW ***)**
N40 #1136= 1 (PRECHARGE AIR CYL)
to reduce "jerk" as rotation starts clockwise the "wrong" side of the cylinder is charged before the "right" side is pressurized
G04 P1000
1 second pause to charge cylinder
#1136= 0
disable precharge of air cylinder
#1137= 1 (CCW ON)
turn on ccw rotation solenoid
#191= 3 (SET ALARM FLAG)
preset alarm variable to pallets jammed
#3001= 0 (RESET MSEC TIMER)
N50 IF [#1022 AND [#3001 GT 3000]] GOTO91
if it didn't start to rotate after 3 seconds - alarm: pallets jammed
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97.
IF [[#1023 EQ 0] AND [#3001 GT 20000]] GOTO91
if it didn't finish ccw rotation after 20 seconds - alarm: pallets jammed
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97.
IF [#1023 AND #1022] #191= 4 GOTO91
broken switch, illegal condition check while rotating
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97.
[#1023 EQ 0] GOTO50 (WAIT FOR CCW)
if it hasn't tripped ccw switch, loop until it does
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97.
G04 P1000 (DWELL FOR PALLET TO SETTLE)
got here because ccw switch is tripped, hold rotation air on for 1 second longer to prevent bounce back

```
M97 P97 (SYNC)
synchronize lookahead by executing 3 blank lines at n97.
#1137= 0 (CCW OFF)
disable ccw rotation solenoid
```
(* END CCW MOVEMENT ***)**

(* BEGIN PALLETS DOWN ***)**
```
N60 (* PALLETS DOWN *)
#191= 3
preset alarm variable to pallets jammed
#1122= 0 (PALLETS UP OFF)
turn off lift cylinder solenoid
#3001= 0 (RESET MSEC TIMER)
N70 IF [ [ #1027 EQ 0 ] AND [ #3001 GT 20000 ] ] #1122= 1 GOTO91 (TIMEOUT)
if it doesn't set down within 20 seconds, lift again and alarm pallets jammed
M97 P97 (SYNC)
[ #1027 EQ 0 ] GOTO70 (WAIT FOR PALLETS DOWN)
loop until pallet down switch is tripped
M97 P97 (SYNC)
#1138= 0 (AIR BLAST OFF)
G04 P0.1
0.1 second pause
M97 P97 (SYNC)
```
(* END OF PALLETS DOWN ***)**

(* START HERE TO LOCKDOWN BOTH ***)**
```
#135= 0 (MAIN UP DELAY FLAG)
reset main drawbar time delay flag
#191= 12 (SET ALARM STATUS)
preset alarm to main drawbar clamp timeout
#3004= 1 (DISABLE FEED HOLD)
to protect drawbars and gearmotors
G53 G00 G90 Z0.
redundant z-axis home move
#3001= 0 (ZERO TIMER FOR FRONT DB LOCKDOWN)
M97 P97 (SYNC)
#1124= 1 (MAIN ENABLE)
turn on main drawbar power
#1108= 1 (SCREW IN MAIN)
turn on main drawbar direction to screw in (clamp)
G04 P0.3 (WAIT)
pause to protect i/o board circuit
#1125= 1 (FRONT ENABLE)
turn on front drawbar power
#1110= 1 (SCREW IN FRONT)
turn on front drawbar to screw in (clamp)
N80 #191= 12 (SET ALARM STATUS)
preset alarm to main drawbar clamp timeout
IF [ #3001 GT 15000 ] GOTO91
if not off drawbar up switch, alarm timeout
M97 P97 (SYNC)
(* TIMEOUT MUST BE GT CLAMP TIME *)
IF [ [ #3001 GT 8500 ] AND [ #1002 ] ] GOTO92
if not off the main drawbar down switch after 8.5 seconds, go to retry clamping routine
```

M97 P97 (SYNC)
IF [#1002 AND [#1004 EQ 0]] #191= 10 GOTO91
if main drawbar up switch is off, but the down switch is on, alarm: illegal condition
M97 P97 (SYNC)
(* CLAMP TIME, FRONT MOTOR *)
IF [#3001 GT 7500.] #1110= 0 (FRONT UP, STOP IT)
after 7.5 seconds of screwing in the front drawbar, stop it (power off direction)
TO INCREASE THE FRONT DRAWBAR SCREW IN TIME, INCREASE THE VALUE NOW SHOWN AS 7500. WHEN INCREASING FRONT DRAWBAR SCREW IN TIME YOU MUST INCREASE THE ALARM TIMEOUT FOR THE MAIN DRAWBAR SHOWN ABOVE AS 8500. UNDER THE LINE "(* TIMEOUT MUST BE GT CLAMP TIME *)".
M97 P97 (SYNC)
IF [#1004] GOTO80 (NOT DONE)
if not off the main drawbar up switch, keep looping until it is
M97 P97 (SYNC)
IF [#135] GOTO88 (SWITCH & TIMER)
if main drawbar time delay flag is set, go to timing
#135= 1
set main drawbar time delay flag, got here because drawbar off the up switch
#136= #3001
set time differential flag at this instant
N88 IF [[#3001 - #136 GT 1100.] AND #135] #1108= 0 (MAIN UP, STOP IT)
1.1 seconds after coming off the main drawbar up switch, turn off main drawbar
TO INCREASE THE MAIN DRAWBAR SCREW IN TIME, INCREASE THE VALUE NOW SHOWN AS 1100. (LINE N88).
M97 P97 (SYNC)
IF [#1108] GOTO80 (NOT DONE)
n88 condition did not turn off main drawbar, so loop back until it does
M97 P97 (SYNC)
IF [#1110] GOTO80 (NOT DONE)
front drawbar motor still running, so loop back until 7.5 second run time condition is met
M97 P97 (SYNC)
got here because conditions were met
#1124= 0 (DISABLE MAIN)
#1125= 0 (DISABLE FRONT)
power supply off for front and main drawbar gearmotors
(* END OF LOCKDOWN ***)**

(* RETURN TO CALLING PROGRAM ***)**
#3004= 0 (ENABLE FEED HOLD)
no need to protect drawbars and gearmotors
[#161] GOTO5 (BACK TO UNCLAMP)
was set because it couldn't lift pallets. it lowered pallets, screwed in both drawbars, and now it will start from the very beginning of the pallet change sequence
M97 P97 (SYNC)
#1135= 0 (AUDIBLE ALARM OFF)
#709= 0 (CLEAR MACRO INCOMPLETE BIT)
pallet change macro complete. clear flag so spindle can run because pallets are clamped
M97 P97 (SYNC)
G103
reset lookahead to normal
M99 (RETURN FROM PALLET CHANGE)

end pallet change macro, m50 complete

(* BEGIN TEST OPER LOCK SUB *)
N90 (TEST OPER LOCK SUB)
IF [#1024] #191= 1 GOTO91
check index station orientation. if not oriented alarm: index station unlocked
M99
(* END TEST OPER LOCK SUB *)

(* BEGIN ALARM SUBROUTINE*)
N91 (ALARM SUB)
got here because an alarm condition was met
G103
set lookahead to normal
#1135= 0 (AUDIBLE ALARM OFF)
#1138= 0 (AIR BLAST OFF)
#1108= 0 (MAIN MOTOR UP DISABLE)
#1109= 0 (MAIN MOTOR DOWN DISABLE)
#1110= 0 (FRONT MOTOR UP DISABLE)
#1111= 0 (FRONT MOTOR DOWN DISABLE)
#1136= 0 (CW SOLENOID DISABLE)
#1137= 0 (CCW SOLENOID DISABLE)
#1124= 0 (MAIN MOTOR DISABLE)
#1125= 0 (FRONT MOTOR DISABLE)
IF [#191 EQ 2] #1122= 0 (PALLET DOWN)
if pallets couldn't lift after trying, let them down
IF [#191 EQ 6] #1122= 1 (PALLET UP)
if alarm happened with pallets lifted, keep them lifted
[#191 EQ 1] #3000= 1 (INDEX ST UNLOCKED,VERFY LVR UP,M50)
set alarm to 1001. (message displayed)
[#191 EQ 2] #3000= 2 (PALLET LCKD DWN,VRFY DB IS DWN,M50)
set alarm to 1002. (message displayed)
(PALLET UNABLE TO LIFT)
[#191 EQ 3] #3000= 3 (PALLETS JAMD,CHK FOR OBSTRUCTN,M50)
set alarm to 1003. (message displayed)
[#191 EQ 4] #3000= 4 (CW/CCW SW ILGL CND,CHK BRKN SW,M50)
(CONFLICTING CW&CCW TOGETHER)
set alarm to 1004. (message displayed)
[#191 EQ 7] #3000= 7 (UP/DN SW ILGL COND,CHK BRKN SW,M50)
(CONFLICTING DOWN BUT NOT UP)
set alarm to 1007. (message displayed)
[#191 EQ 8] #3000= 8 (MAIN DB LCKD IN UP POS,M50)
(MAIN MOTOR TIMEOUT, LOCKED STATUS)
set alarm to 1008. (message displayed)
[#191 EQ 9] #3000= 9 (MAIN DB LCKD IN DWN POS, M50)
(MAIN MOTOR TIMEOUT, DB DOWN STATUS)
set alarm to 1009. (message displayed)
[#191 EQ 10] #3000= 10 (MN DB SW ILGL CND,CHK BRKN SW,M50)
(CONFLICTING DOWN BUT NOT UP)
set alarm to 1010 (message displayed)
[#191 EQ 11] #3000= 11 (MN DB UNCL TIMEOUT,CHK MTR/SW,M50)
(GOT OFF THE LOCKED SWITCH BUT NOT DOWN)
set alarm to 1011 (message displayed)

[#191 EQ 12] #3000= 12 (MN DB CL TIMEOUT,CHK MTR/SW,M50)
(GOT OFF THE DOWN SWITCH BUT NOT LOCKED)
set alarm to 1012 (message displayed)
#3000= 119 (UNKNOWN ALARM,M50)
set alarm to 1119 (message displayed) got here because something weird happened like an undefined alarm.
works as a macro troubleshooting tool for programming
(* END ALARM SUBROUTNE *)

N92 **(*DRAWBAR MOTOR TIME OUT SUB*)**
got here because the main drawbar didn't get off the down switch in 8.5 seconds
#11= 0 (LOCAL DOWN ATTEMPTS)
#191= 9 (SET ALARM FLAG)
alarm variable set for drawbar locked down
#1108= 0 (MAIN MOTOR UP DISABLE)
#1109= 0 (MAIN MOTOR DOWN DISABLE)
#1110= 0 (FRONT MOTOR UP DISABLE)
#1111= 0 (FRONT MOTOR DOWN DISABLE)
#1124= 0 (MAIN MOTOR DISABLE)
#1125= 0 (FRONT MOTOR DISABLE)
G04 P0.2 (RELAY DELAY)
keeps arcing from happening with main drawbar circuit relays
M97 P97 (SYNC)
WHILE [[#1002] AND [#1004 EQ 0]] DO3
check for main drawbar switch illegal condition
M97 P97 (SYNC)
#191= 10 (SET ALARM FLAG)
GOTO91 (SWITCH ALARM)
END3 (BROKEN SWITCH CHECK)
M97 P97 (SYNC)
#1124= 1 (MAIN ENABLE)
power on main drawbar. getting ready to try to break free
#11= 0 (ZERO UP COUNTER)
zero counter. will try 20 times to screw in
G04 P0.2 (SEC RELAY DELAY)
protect relays in circuit
M97 P97 (SYNC)
WHILE [#11 LT 20] DO2
while less than 20, tries to screw in main drawbar, loop
#11= #11 + 1
count up for next try
#1108= 1 (SCREW IN MAIN)
power on direction to screw in
G04 P0.6
run main drawbar motor for 0.6 seconds. not longer, we don't want to fry the i/o board
M97 P97 (SYNC)
#1108= 0 (HALT MAIN)
turn off power for direction to screw in
G04 P0.2 (RELAY DELAY)
M97 P97 (SYNC)
IF [#1002 EQ 0] GOTO93
if the main drawbar got off the down switch, jump to continue
M97 P97 (SYNC)

END2 (SCREW UP 20 TRIES)
M97 P97 (SYNC)
got here because after 20 attempts, could not get off down switch
#1124= 0 (MAIN MOTOR DISABLE)
turn off power supply to main drawbar gearmotor
GOTO91 (MAX LIMIT RETRYS)
go to alarm: drawbar locked down
M97 P97 (SYNC)
N93 #3001= 0 (RESET MSEC COUNTER)
got here because drawbar got off the down switch
#1108= 1 (MAIN MOTOR UP)
turn on motor again to finish clamp sequence
GOTO80 (OFF UNLOCKED SWITCH)
return to clamp sequence
(*END OF N92 DRAWBAR ATTEMPTS SUB*)

N94 (*DRAWBAR MOTOR TIME OUT SUB*)

got here because the drawbar could not unclamp and trip the top switch in 3.5 seconds
#11= 0 (LOCAL DOWN ATTEMPTS)
#191= 8 (SET ALARM FLAG)
set alarm variable to main drawbar locked up
#1108= 0 (MAIN MOTOR UP DISABLE)
#1109= 0 (MAIN MOTOR DOWN DISABLE)
#1110= 0 (FRONT MOTOR UP DISABLE)
#1111= 0 (FRONT MOTOR DOWN DISABLE)
#1124= 0 (MAIN MOTOR DISABLE)
#1125= 0 (FRONT MOTOR DISABLE)
G04 P0.2 (RELAY DELAY)
protect relays in main drawbar power circuit
M97 P90 (CHECK OPER LOCK SW / SYNC)
WHILE [[#1002] AND [#1004 EQ 0]] DO3
check for main drawbar illegal condition
M97 P90 (CHECK OPER LOCK SW / SYNC)
#191= 10 (SET ALARM FLAG)
set alarm flag
GOTO91 (SWITCH)
go to alarm subroutine
END3 (BROKEN SWITCH CHECK)
M97 P90 (CHECK OPER LOCK SW / SYNC)
#1124= 1 (MAIN ENABLE)
turn on power supply to main drawbar gearmotor
#11= 0 (ZERO DOWN COUNTER)
set attempts counter to zero
G04 P0.2 (RELAY DELAY)
protect relays
M97 P90 (CHECK OPER LOCK SW / SYNC)
WHILE [#11 LT 20] DO2
while less than 20 tries to unscrew main drawbar, loop 2 out of 3 times in the loop, go to n98
#11= #11 + 1
increment counter
IF [#11 MOD 3.] GOTO98
two out of three times go to n98
M97 P90 (CHECK OPER LOCK SW / SYNC)

```
#1108= 1.
turn on power to screw in
(RATCHET TIME)
G04 P1. (UP TIME)
screw in for 1 second
M97 P90 (CHECK OPER LOCK SW / SYNC)
#1108= 0
turn off power to screw in
G04 P3.
wait 3 seconds for i/o board circuit to cool down
M97 P90 (CHECK OPER LOCK SW / SYNC)
N98 #1109= 1 (SCREW OUT MAIN)
turn power on to screw out
G04 P0.6
screw out for 0.6 seconds
M97 P90 (CHECK OPER LOCK SW / SYNC)
#1109= 0 (HALT MAIN)
turn off power to screw out
G04 P0.2 (RELAY DELAY)
protect relays
M97 P90 (CHECK OPER LOCK SW / SYNC)
IF [ #1004 ] GOTO95 (UNLOCKED)
if the top switch is tripped go to n95
M97 P90 (CHECK OPER LOCK SW / SYNC)
END2 (BACKED OUT 20 TRIES)
end of loop
M97 P90 (CHECK OPER LOCK SW / SYNC)
got here because it failed to unclamp
#1124= 0 (MAIN MOTOR DISABLE)
power supply off to main drawbar gearmotor
GOTO91 (MAX LIMIT RETRYS)
go to alarm subroutine:  main drawbar locked up
N95 #3001= 0 (RESET MSEC COUNTER)
got here because drawbar up switch tripped - reset timer
#1109= 1 (MAIN MOTOR DOWN)
turn on direction to unscrew main drawbar
GOTO7 (OFF LOCKED SWITCH)
return to unclamp subroutine
```

(*END OF N94 DRAWBAR ATTEMPTS SUB*)

(*N96 PALLET LIFT ATTEMPTS*)

```
N96 (PALLET LIFT ATTEMPTS ALARM)
got here because it couldn't lift, front drawbar locked
#5= 0
set lift attempt counter to zero
#191= 2
set alarm variable to pallet locked down
#1108= 0 (MAIN MOTOR UP DISABLE)
#1109= 0 (MAIN MOTOR DOWN DISABLE)
#1110= 0 (FRONT MOTOR UP DISABLE)
#1111= 0 (FRONT MOTOR DOWN DISABLE)
#1124= 0 (FRONT MOTOR DISABLE)
#1125= 0 (MAIN MOTOR DISABLE)
```

```
WHILE [ #5 LT 3 ] DO1
for 3 tries, do this loop
#5= #5 + 1
increment counter for next try
#1125= 1 (FRONT ENABLE)
power on front drawbar
G04 P0.2 (RELAY DELAY)
protect relays
M97 P97 (SYNC)
#1111= 1 (BACK OUT FRONT)
turn on direction of front drawbar to unscrew
G04 P1. (UNSCREW TIME)
unscrew front drawbar for 1 second
M97 P97 (SYNC)
#1111= 0 (BACK OUT OFF)
turn off direction of front drawbar
G04 P0.2 (RELAY DELAY)
protect relays
M97 P97 (SYNC)
#1125= 0 (FRONT MOTOR DISABLE)
turn off power to front drawbar circuit
#1122= 1 (PALLETS UP ON)
turn on lift cylinder solenoid to lift pallets
#1138= 1 (AIR BLAST ON)
#3001= 0 (RESET MSEC TIMER)
G04 P2. (PALLET DOWN STATUS DELAY)
wait 2 seconds before checking switches
M97 P97 (SYNC)
IF [ #1023 ] GOTO20 (OFF DOWN SWITCH)
if off the pallets down switch, return to pallet lift subroutine
M97 P97 (SYNC)
#1122= 0 (PALLETS UP OFF)
didn’t get off the pallets down switch, lower pallets
#1138= 0 (AIR BLAST OFF)
END1
(ALARM IF IT GETS HERE)
got here because it couldn’t lift after 3 tries
#160= 0 (RESET UP ATTEMPTS COUNTER)
#191= 2 (PALLET NOT LIFTING)
set alarm variable to pallets locked down
GOTO91 (TRIED TO LIFT)
go to alarm subroutine
```

(* END OF PALLET LIFT ALARM N96*)

```
N97 (SYNC)
“synchronization” subroutine for lookahead
(BLANK LINE)
M99
(* END OF MACRO PALLET *)
%
```

5.21 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 "Troubleshooting" 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.

DISCRETE INPUTS / OUTPUTS

When the machine is operating normally, a second push of the **PARAM/DGNOS** key will select the diagnostics display page. The PAGE UP and PAGE DOWN keys are then used to select one of two different displays. These are for diagnostic purposes only and the user will not normally need them. The diagnostic data consists of 32 discrete input signals, 32 discrete output relays and several internal control signals. Each can have the value of 0 or 1. In addition, there are up to three analog data displays and an optional spindle RPM display. Their number and functions are listed below.

Note: Use the IOPCB Chart on the following pages to cross-reference specific machine models and options with their corresponding Inputs and Outputs.

The following discrete inputs and outputs and their descriptions are for current production machines operating with Software Revision 9.14 or later.

Note: Inputs/Outputs that are **BOLD** pertain only to the pallet changer.

The inputs/outputs that are followed by an asterick (*) are active when equal to zero (0).

DISCRETE INPUT

#	Name	Description	#	Name	Description
1000	TC IN	TC Carousel Extended	1016	spare	spare
1001	TC OUT	TC Carousel Parked	1017	spare	spare
1002	**RPDBDN**	**Main Drawbar Down**	1018	spare	spare
1003	LO CNT	Low Coolant	1019	spare	spare
1004	**RPDBUP**	**Main Drawbar Up**	1020	LO OIL	Low Sp.Coolant Pres.
1005	SP HIG	Spindle in High	1021	TCDRO	Tool Changer Door Open
1006	SP LOW	Spindle in Low	**1022**	**RP CW**	**Pallet Rotate CW**
1007	EM STP	Emergency Stop	**1023**	**RP CCW**	**Pallet Rotate CCW**
1008	DOOR S	Door Open Switch	**1024**	**RPOPLK**	**Load Station Orient.**
1009	M-FIN*	Not M Func Finish	1025	LOPHSE	Low Phase Voltage
1010	OVERVT	Not Over Voltage	**1026**	**RP UP**	**Pallets Lifted**
1011	LO AIR	Low Air Pressure	**1027**	**RP DN**	**Pallets Lowered**
1012	LO LUB	Low Lube Oil	1028	GR FLT	Ground Fault
1013	OVERHT	Not Over Heat	1029	SKIP	Skip Input Signal
1014	DB OPN	Tool Unclamped	1030	TCDRO	Carousel Door Open
1015	DB CLS	Tool Clamped	1031	CNVEYR	Conveyor Overload

DISCRETE OUTPUTS

#	Name	Description	#	Name	Description
1100	SRV PO	Servo Power On	1116	SPG CW	Spigot Clockwise
1101	spare	spare	1117	SPG CCW	Spigot Counterclockwise
1102	spare	spare	**1118**	**RPRDYL**	**Pallet Ready Light**
1103	spare	spare	1119	PURGE	Purge TSC
1104	4TH BK	4th Axis Brk Rel	1120	PRE-CH	Unclamp Pre-charge
1105	COOLNT	Coolant Pump	1121	HTC SH	Shuttle (TC Carousel Out)
1106	AUT OF	Auto Turn Off	**1122**	**RP UP**	**Lift Pallets**
1107	SP FAN	Spindle Motor Fan	1123	DOOR L	Door Lock
1108	**RPMCLA**	**DB Motor Clamp**	**1124**	**RPMEN**	**Main DB Motor Enable**
1109	**RPMUNC**	**DB Motor Unclamp**	**1125**	**RPOEN**	**Load Station DB Motor Enable**
1110	**RPOCLA**	**L. St. DB Motor Clamp**	1126	AIR DR	Air Door
1111	**RPOUNC**	**L.S.DB Motor Unclamp**	1127	AUXCLT	Aux Coolant
1112	SP HIG	Spindle High Gear	1128	GRNBCN	Green Beacon
1113	SP LOW	Spindle Low Gear	1129	REDBCN	Red Beacon
1114	T UNCL	Tool Unclamped	1130	CNVENA	Chip conveyor enable
1115	SP D:Y	Spindle Delta-Wye	1131	CNVREV	Chip conveyor reverse
1110	**RPOCLA**	***SHUTTLE IN**	1121	HTC SH	***NOT USED**
1111	**RPOUNC**	***SHUTTLE OUT**			

* Specified **DISCRETE OUTPUTS** for **HS-2RP** Machine
The inputs are numbered the same as the connections on the inputs printed circuit board.

The following eight discrete outputs are present on the HS-1RP only, which is equipped with the M-Code relay board, and are displayed on page 3 of the Diagnostics display.

Name	Description	Name	Description
M21	spare	**RP CW**	**Pallet Rotate CW**
M22	spare	**RP CCW**	**Pallet Rotate CCW**
M23	spare	RPAIRB	Air blast
RPWARN	**Audible alarm**	M28	spare

The second page of diagnostic data is displayed using the PAGE UP and PAGE DOWN keys. It contains:

INPUTS 2

Name	Description	Name	Description	Name	Description
X Z CH	X-axis Z Channel	**X OVRH**	X Motor Overheat	**X CABL**	Broken cable to X encoder
Y Z CH	Y-axis Z Channel	**Y OVRH**	Y Motor Overheat	**Y CABL**	Broken cable to Y encoder
Z Z CH	Z-axis Z Channel	**Z OVRH**	Z Motor Overheat	**Z CABL**	Broken cable to Z encoder
A Z CH	A-axis Z Channel	**A OVRH**	A Motor Overheat	**A CABL**	Broken cable to A encoder
B Z CH	B-axis Z Channel	**B OVRH**	B Motor Overheat	**B CABL**	Broken cable to B encoder
X HOME	X-axis Home/Lim Switch	**X DRVF**	X-axis drive fault	**SZ CH**	Spindle Z Channel
Y HOME	Y-axis Home	**Y DRVF**	Y-axis drive fault		
Z HOME	Z-axis Home	**Z DRVF**	Z-axis drive fault		
A HOME	A-axis Home	**A DRVF**	A-axis drive fault		
B HOME	B-axis Home	**B DRVF**	B-axis drive fault		

The following inputs and outputs pertain to the Haas Vector Drive. If it is not enabled, these will display a value of *. Otherwise, it will display a 1 or 0.

HAAS VECT	Haas Vector Drive Enabled
SP FWD	Spindle Forward
SP REV	Spindle Reverse
SP LOK	Spindle Lock Commanded
AT SPD*	Spindle at Speed
SP STP*	Spindle Stopped
SP FLT	Spindle Fault
SP LKD	Spindle is Locked
SP OHT	Spindle Overheat
S CABL	Spindle Cable

ANALOG DATA

Name	Description
DC BUSS	Voltage from Haas Vector Drive (if equipped)
uP TEMP	Microprocessor enclosure temperature (dis played only when Parameter 278 bit "uP ENCL TEMP" is set to 1)
SP LOAD	Spindle load in %
SP SPEED	Spindle RPM CW or CCW
RUN TIME	Machine total run time
TOOL CHANGES	Number of tool changes
VER X.XXX	Software version number
MOCON	MOCON software version
YY/MM/DD	Today's date
MDL HS__	Machine model

I Num	Circuit #	IOPCB	MACHINES BEFORE #50149 (EXCEPT #50132 AND #50139)						MACHINE W/HAAS VECTOR DRIVE	
			HS-1 NO Air Door NO Tsc	HS-1 W/Air Door NO Tsc	HS-1 W/Air Door W/Tsc	HS-1RP NO Air Door NO Tsc	HS-1RP W/Air Door NO Tsc	HS-1RP W/Air Door W/Tsc	HS-1/R	HS-1RP
1000	820	P13	TC In	TC In	TC In	TC In	TC In	TC In	TC In	TC In
1001	820	P13	TC Out	TC Out	TC Out	TC Out	TC Out	TC Out	TC Out	TC Out
1002	820	P13	spare *	spare *	spare *	spare *	spare *	1 DB Down	spare *	1 DB Down
1003	900	P14	spare *	spare *	2 Lo Clnt	1 DB Down	1 DB Down	2 Lo Clnt	2 Lo Clnt	2 Lo Clnt
1004	820	P13	spare *	spare *	spare *	spare *	spare *	spare *	spare *	1 DB up
1005	890	P15	spare *	spare *	spare *	spare *	spare *	spare *	4 High Gear	4 High Gear
1006	890	P15	spare *	spare *	spare *	spare *	spare *	spare *	4 Low Gear	4 Low Gear
1007	770	P16	E-Stop	E-Stop	E-Stop	E-Stop	E-Stop	E-Stop	E-Stop	E-Stop
1008	1050	P38	Side Door Open	Side Door Open	Side Door Open	Side Door Open	Side Door Open	Side Door Open	Door Open	Door Open
1009	100	P22	M-Fin	M-Fin	M-Fin	M-Fin	M-Fin	M-Fin	M-Fin	M-Fin
1010	970	P18	Over Volt	Over Volt	Over Volt	Over Volt	Over Volt	Over Volt	Over Volt	Over Volt
1011	950	P19	Low Air	Low Air	Low Air	Low Air	Low Air	Low Air	Low Air	Low Air
1012	950	P19	Low Lube	Low Lube	Low Lube	Low Lube	Low Lube	Low Lube	Low Lube	Low Lube
1013	830	P20	Overheat	Overheat	Overheat	Overheat	Overheat	Overheat	Overheat	Overheat
1014	890	P15	SP DB Open	SP DB Open	SP DB Open	SP DB Open	SP DB Open	SP DB Open	Spare	Spare
1015	890	P15	SP DB Closed	SP DB Closed	SP DB Closed	SP DB Closed	SP DB Closed	SP DB Closed	Spare	Spare
1016	890	P15	SP Locked	SP Locked	SP Locked	Spare	Spare	Spare	Spare	Spare
1017	780	P21	SP Drive Fault	SP Drive Fault	SP Drive Fault	Spare	Spare	Spare	Spare	Spare
1018	780	P21	SP Stopped	SP Stopped	SP Stopped	Spare	Spare	Spare	SP Stopped	SP Door Open
1019	780	P21	SP At Speed	SP At Speed	SP At Speed	Spare	Spare	Spare	SP At Speed	SP DB CLS
1020	960	P17	spare *	spare *	spare *	Spare	Low Oil	Low Oil	4 Low Oil	4 Low Oil
1021	410	P52	Front Door Open	Front Door Open	Front Door Open	TC Door Open	TC Door Open	TC Door Open	TC Door Open	TC Door Open
1022	790	P24	spare *	spare *	spare *	1 Pallet CW	1 Pallet CW	1 Pallet CW	spare *	1 Pallet CW
1023	790	P24	spare *	spare *	spare *	1 Pallet CCW	1 Pallet CCW	1 Pallet CCW	spare *	1 Pallet CCW
1024	190	P23	spare *	spare *	spare *	1 Operator station locked	1 Operator station locked	1 Operator station locked	spare *	1 Operator station locked
1025			Lo Phase	Lo Phase	Lo Phase	Lo Phase	Lo Phase	Lo Phase	Lo Phase	Lo Phase
1026	240	P25	spare *	spare *	spare *	1 Pallet Up	1 Pallet Up	1 Pallet Up	spare *	1 Pallet Up
1027	240	P25	spare *	spare *	spare *	1 Pallet Down	1 Pallet Down	1 Pallet Down	spare *	1 Pallet Down
1028	1060	P43	Grnd Fault	Grnd Fault	Grnd Fault	Grnd Fault	Grnd Fault	Grnd Fault	Grnd Fault	Grnd Fault
1029	1070	P47	Skip	Skip	Skip	Skip	Skip	Skip	Skip	Skip
1030	180	P53	spare *	spare *	spare *	spare *	spare *	spare *	3 Spigot	3 Spigot
1031	140		Chip Conveyor	Chip Conveyor	Chip Conveyor	Chip Conveyor	Chip Conveyor	Chip Conveyor	Chip Conveyor	6 Chip Conveyor

			MACHINES BEFORE #50149 (EXCEPT #50132 AND #50139)					MACHINE W/HAAS VECTOR DRIVE		
Num	**Circuit #**	**IOPCB**	**HS-1 NO Air Door NO Tsc**	**HS-1 W/Air Door NO Tsc**	**HS-1 W/Air Door W/Tsc**	**HS-1RP NO Air Door NO Tsc**	**HS-1RP W/Air Door NO Tsc**	**HS-1RP W/Air Door W/Tsc**	**HS-1/R**	**HS-1RP**
1100	110	P5	Servo Power	Servo Power	Servo Power	Servo Power	Servo Power	Servo Power	Servo Power	Servo Power
1101	710	P9	Spindle Forward	Spindle Forward	Spindle Forward	Spindle Forward	Spindle Forward			
1102	710	P9	Spindle Reverse	Spindle Reverse	Spindle Reverse	Spindle Reverse	Spindle Reverse			
1103	710	P9	Spindle Reset	Spindle Reset	Spindle Reset	Spindle Reset	Spindle Reset			
1104	390	P29	4'th axis brake	4'th axis brake	4'th axis brake	4'th axis brake	4'th axis brake	4'th axis brake	4'th axis brake	4'th axis brake
1105	940	P7	Coolant	Coolant	Coolant	Coolant	Coolant	Coolant	Coolant	Coolant
1106	170	P8	Auto Off	Auto Off	Auto Off	Auto Off	Auto Off	Auto Off	Auto Off	Auto Off
1107	300	P10	Sp Fan/Oil pump/luber	Sp Fan/Oil pump/luber	Sp Fan/Oil pump/luber	Sp Fan/Oil pump/luber	Sp Fan/Oil pump/luber	Sp Fan/Oil pump/luber	Sp Fan/Oil pump/luber	Sp Fan/Oil pump/luber
1108	810A	P30	spare *	spare *	spare *	1 Main DB forward	1 Main DB forward	1 Main DB forward	spare *	1 Main DB forward
1109	810A	P30	spare *	spare *	spare *	1 Main DB reverse	1 Main DB reverse	1 Main DB reverse	spare	1 Main DB reverse
1110	810	P39	spare *	spare *	spare *	1 Operator DB forward	1 Operator DB forward	1 Operator DB forward	spare *	1 Operator DB forward
1111	810	P39	spare *	spare *	spare *	1 Operator DB reverse	1 Operator DB reverse	1 Operator DB reverse	spare *	1 Operator DB reverse
1112	880A	P12	spare *	spare *	spare *	spare *	spare *	1 Pallets up	4 High Gear	4 High Gear
1113	880A	P12	spare *	spare *	spare *	spare *	spare *	spare *	4 Low Gear	4 Low Gear
1114	880A	P12	Tool Unclamp	Tool Unclamp	Tool Unclamp	Tool Unclamp	Tool Unclamp	Tool Unclamp	Tool Unclamp	Tool Unclamp
1115	880A	P12	Spindle Lock	Spindle Lock	Spindle Lock	Spindle Lock	Spindle Lock	Spindle Lock	Wye-Delta Cntcrs	Wye-Delta Cntcrs
1116	200	P50	spare *	spare *	spare *	1 Warning sounder	1 Warning sounder	1 Warning sounder	3 Spigot CW	3 Spigot CW
1117	200	P50	spare *	spare *	spare *	1 Warning sounder	1 Warning sounder	1 Warning sounder	3 Spigot CCW	3 Spigot CCW
1118	270	P49	spare *	spare *	spare *	1 Pallets CW	1 Pallets CW	1 Pallets CW	Pallet Ready light	Pallet Ready light
1119	260	P48	spare *	spare *	spare *	1 Pallets CCW	1 Pallets CCW	1 Pallets CCW	2 Purge	2 Purge
1120	880A	P12	Pre-charge	Pre-charge	Pre-charge	Pre-charge	Pre-charge	Pre-charge	Pre-charge	Pre-charge
1121	250	P45	HTC Shuttle	HTC Shuttle	HTC Shuttle	HTC Shuttle	HTC Shuttle	HTC Shuttle	HTC Shuttle	HTC Shuttle
1122	230	P44	5'th axis brake	5'th axis brake	5'th axis brake	5'th axis brake	1 Air blast	1 Air blast	5'th axis brake	1 Pallet Up
1123		P27	Pallet Ready light	Pallet Ready light	Pallet Ready light	Pallet Ready light	Pallet Ready light	Pallet Ready light	5 Door Interlock	5 Door Interlock
1124		P26	M21 spare *	M21 spare *	spare *	1 Main DB enable	1 Main DB enable	1 Main DB enable	spare *	1 Main DB enable
1125		P26	M22 spare *	M22 spare *	spare *	1 Operator DB enable	1 Operator DB enable	1 Operator DB enable	M22 Probe Option	1 Operator DB enable
1126		P26	M23 spare *	M23 spare *	M23 Air door	M23 1 Pallet up	M23 1 Pallet up	M23 Air door	M23 Air door	Air door
1127	/940A	P26/P6	M24 spare *	M24 Air door	xtra contacts * + 2 Aux Clnt	M24 Air blast	M24 Air door	xtra contacts * + 2 Aux Clnt	xtra contacts * + 2 Aux Clnt	xtra contacts * + + 2 Aux Clnt
1128	280	P55	Green beacon	Green beacon	Green beacon	Green beacon	Green beacon	Green beacon	Green beacon	Green beacon
1129	280	P55	Red beacon	Red beacon	Red beacon	Red beacon	Red beacon	Red beacon	Red beacon	Red beacon
1130	140	P46	Chip Conv Power	Chip Conv Power	Chip Conv Power	Chip Conv Power	Chip Conv Power	Chip Conv Power	Chip Conv Power	6 Chip Conv Power
1131	140	P46 P58	Chip Conv Rev.	Chip Conv Rev.	Chip Conv Rev.	Chip Conv Rev.	Chip Conv Rev.	Chip Conv Rev. Wye-Delta Cntcrs	Chip Conv Rev. Wye-Delta Cntcrs	6 Chip Conv Rev. Wye-Delta Cntcrs

NOTES: **1 Pallet Changer** **2 Through Spindle Coolant** **3 Programmable Coolant Spigot** **4 Transmission** **5 CE Safety Interlocks** **6 Chip Conveyor**

Num	Circuit #	RLYBRD	HS-1 NO Air Door NO Tsc	HS-1 W/Air Door NO Tsc	HS-1 W/Air Door W/Tsc	HS-1RP NO Air Door NO Tsc	HS-1RP W/Air Door NO Tsc	HS-1RP W/Air Door W/Tsc	MACHINE W/HAAS VECTOR DRIVE HS-1	HS-1RP
1132	M21	P4 -1,2,3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	M21 M-Function
1133	M22	P4 -4,5,6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	M22 Probe Option
1134	M23	P4 -7,8,9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	M23 spare *
1135	M24	P4 -10,11,12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	M24 1 Warning Sounder
1136	M25	P5 -1,2,3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	M25 1 Pallet CW
1137	M26	P5 -4,5,6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	M26 1 Pallet CCW
1138	M27	P5 -7,8,9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	M27 1 Air Blast
1139	M27	P5 -10,11,12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	M28 spare *

NOTES: 1 Pallet Changer 2 Through Spindle Coolant 3 Programmable Coolant Spigot 4 Transmission 5 CE Safety Interlocks 6 Chip Conveyor

6. PARAMETERS

Parameters are seldom-modified values that change the operation of the machine. These include servo motor types, gear ratios, speeds, stored stroke limits, lead screw compensations, motor control delays and macro call selections. These are all rarely changed by the user and should be protected from being changed by the parameter lock setting. If you need to change parameters, contact HAAS or your dealer. Parameters are protected from being changed by Setting 7.

The Settings page lists some parameters that the user may need to change during normal operation and these are simply called "Settings". Under normal conditions, the parameter displays should not be modified. A complete list of the parameters is provided here.

The PAGE UP, PAGE DOWN, up and down cursor keys , and the jog handle can be used to scroll through the parameter display screens in the control. The left and right cursor keys are used to scroll through the bits in a single parameter.

PARAMETER LIST

Parameter 1 X SWITCHES

Parameter 1 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

REV ENCODER	Used to reverse the direction of encoder data.
REV POWER	Used to reverse direction of power to motor.
REV PHASING	Used to reverse motor phasing.
DISABLED	Used to disable any axis.
Z CH ONLY	With **A** only, indicates that no home switch.
AIR BRAKE	With **A** only, indicates that air brake is used.
DISABLE Z T	Disables encoder **Z** test (for testing only).
SERVO HIST	Graph of servo error (for diagnostics only).
INV HOME SW	Inverted home switch (N.C. switch).
INV Z CH	Inverted **Z** channel (normally high).
CIRC. WRAP.	(***Future Option - Not Yet Implemented)*** With **A** only, causes 360 wrap to return to 0.
NO I IN BRAK	With **A** only, removes **I** feedback when brake is active.
LOW PASS +1X	Adds 1 term to low pass filter.
LOW PASS +2X	Adds two terms to low pass filter.
OVER TEMP NC	Selects a normally closed overheat sensor in motor.
CABLE TEST	Enables test of encoder signals and cabling.
Z TEST HIST	History plot of Z channel test data.
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/X HI.
INVIS AXIS	Used to create an invisible axis.
ROT ALM LMSW	Rotary alarms at the limit switch.
ROT TRVL LIM	Rotary travel limits are used.
UNDEFINED	
UNDEFINED	
UNDEFINED	
TORQUE ONLY	For HAAS only.
3 EREV/MREV	For HAAS only.
2 EREV/MREV	For HAAS only.
NON MUX PHAS	Not currently used.
BRUSH MOTOR	Enables the brushless motor option.

LINEAR DISPL	This bit changes the display from degrees to inches (or millimeters) on the A and B axes.
SCALE/X LO	With SCALE/X HI bit, determines the scale factor used in bit SCALE FACT/X,
SCALE/X HI	With SCALE/X LO bit, determines the scale factor used in bit SCALE FACT/X. See below:

HI	LO	
0	0	3
0	1	5
1	0	7
1	1	9

Parameter 2 X P GAIN
Proportional gain in servo loop.

Parameter 3 X D GAIN
Derivative gain in servo loop.

Parameter 4 X I GAIN
Integral gain in servo loop.

Parameter 5 X RATIO (STEPS/UNIT)
The number of steps of the encoder per unit of travel. Encoder steps supply four (4) times their line count per revolution. Thus, an 8192 line encoder and 6mm pitch screw give:
8192 x 4 x 25.4 / 6 = 138718

Parameter 6 X MAX TRAVEL (STEPS)
Max negative direction of travel from machine zero in encoder steps. Does not apply to A-axis. Thus, a 20 inch travel, 8192 line encoder, and 6 mm pitch screw give:
20.0 x 138718 = 2774360

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

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

Parameter 9 X MAX ERROR
Max error allowed in servo loop before alarm is generated. Units are encoder steps.

Parameter 10 X FUSE LEVEL
Fuse level in % of max power to motor. Applies only when motor in motion.

Parameter 11 X BACK EMF
Back EMF of motor in volts per 1000 RPM times 10. Thus a 63 volt/KRPM motor gives 630.

Parameter 12 X STEPS/REVOLUTION
Encoder steps per revolution of motor. Thus, an 8192 line encoder gives:
8192 x 4 = 32768

Parameter	13	X	BACKLASH Backlash correction in encoder steps.
Parameter	14	X	DEAD ZONE Dead zone correction for driver electronics. Units are 0.0000001 seconds.
Parameter	15	Y	SWITCHES See Parameter 1 for description.
Parameter	16	Y	P GAIN See Parameter 2 for description.
Parameter	17	Y	D GAIN See Parameter 3 for description.
Parameter	18	Y	I GAIN See Parameter 4 for description.
Parameter	19	Y	RATIO (STEPS/UNIT) See Parameter 5 for description.
Parameter	20	Y	MAX TRAVEL (STEPS) See Parameter 6 for description.
Parameter	21	Y	ACCELERATION See Parameter 7 for description.
Parameter	22	Y	MAX SPEED See Parameter 8 for description.
Parameter	23	Y	MAX ERROR See Parameter 9 for description.
Parameter	24	Y	FUSE LEVEL See Parameter 10 for description.
Parameter	25	Y	BACK EMF See Parameter 11 for description.
Parameter	26	Y	STEPS/REVOLUTION See Parameter 12 for description.
Parameter	27	Y	BACKLASH See Parameter 13 for description.
Parameter	28	Y	DEAD ZONE See Parameter 14 for description.
Parameter	29	Z	SWITCHES See Parameter 1 for description.
Parameter	30	Z	P GAIN See Parameter 2 for description.

Parameter	31	Z	D GAIN See Parameter 3 for description.
Parameter	32	Z	I GAIN See Parameter 4 for description.
Parameter	33	Z	RATIO (STEPS/UNIT) See Parameter 5 for description.
Parameter	34	Z	MAX TRAVEL (STEPS) See Parameter 6 for description.
Parameter	35	Z	ACCELERATION See Parameter 7 for description.
Parameter	36	Z	MAX SPEED See Parameter 8 for description.
Parameter	37	Z	MAX ERROR See Parameter 9 for description.
Parameter	38	Z	FUSE LEVEL See Parameter 10 for description.
Parameter	39	Z	BACK EMF See Parameter 11 for description.
Parameter	40	Z	STEPS/REVOLUTION See Parameter 12 for description.
Parameter	41	Z	BACKLASH See Parameter 13 for description.
Parameter	42	Z	DEAD ZONE See Parameter 14 for description.
Parameter	43	A	SWITCHES See Parameter 1 for description AND make sure that this parameter is set to enable the fourth axis before you try to enable the fourth axis from settings.
Parameter	44	A	P GAIN See Parameter 2 for description.
Parameter	45	A	D GAIN See Parameter 3 for description.
Parameter	46	A	I GAIN See Parameter 4 for description.
Parameter	47	A	RATIO (STEPS/UNIT) See Parameter 5 for description.
Parameter	48	A	MAX TRAVEL (STEPS) See Parameter 6 for description.

Parameter	49	A	ACCELERATION See Parameter 7 for description.
Parameter	50	A	MAX SPEED See Parameter 8 for description.
Parameter	51	A	MAX ERROR See Parameter 9 for description.
Parameter	52	A	FUSE LEVEL See Parameter 10 for description.
Parameter	53	A	BACK EMF See Parameter 11 for description.
Parameter	54	A	STEPS/REVOLUTION See Parameter 12 for description
Parameter	55	A	BACKLASH See Parameter 13 for description.
Parameter	56	A	DEAD ZONE See Parameter 14 for description.

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

Parameter 57 COMMON SWITCH 1

Parameter 57 is a collection of general purpose single bit flags used to turn some functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

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

INVERT SKIP	Invert sense of skip to active low=closed.
HANDLE CURSR	Enable use of jog handle to move cursor.
NEG WORK OFS	Selects use of work offsets in negative direction.
SPIN COOLANT	Enables spindle low oil pressure detection.
ENA QUIKCODE	Enables conversational programming.
OILER ON/OFF	Enables oiler power when servos or spindle is in motion.
NC OVER VOLT	Inverts sense of over voltage signal.
TL DR SWITCH	Enables tool carousel door configuration.
DOOR STOP SP	Enables functions to stop spindle and manual ops at door switch.

Parameter 58 LEAD COMPENS SHIFT
Shift factor when applying lead screw compensation. Lead screw compensation is based on a table of 256 offsets; each +\-127 encoder steps. A single entry in the table applies over a distance equal to two raised to this parameter power encoder steps.

Parameter 59 MAX FEED RATE (INCH)
Maximum feed rate in inches per minute.

Parameter 60 TURRET START DELAY
Maximum delay allowed in start of tool turret. Units are milliseconds. After this time, an alarm is generated.

Parameter 61 TURRET STOP DELAY
Maximum delay allowed in motion of tool turret. Units are milliseconds. After this time, an alarm is generated.

Parameter 62 SHUTTLE START DELAY
Vertical mills only. Maximum delay allowed in start of tool shuttle. Units are milliseconds. After this time, an alarm is generated.

Parameter 63 SHUTTLE STOP DELAY
Vertical mills only. Maximum delay allowed in motion of tool shuttle. Units are milliseconds. After this time, an alarm is generated.

Parameter 64 Z TOOL CHANGE OFFSET
On Horizontal mills, this parameter is not used. It should be set to zero.

Parameter 65 NUMBER OF TOOLS
Number of tool positions in tool changer. This number must be 24 for the present Horizontal mill configuration.

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

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

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

Parameter	69	A AIR BRAKE DELAY Delay provided for air to release from brake on A-axis prior to moving. Units are milliseconds.
Parameter	70	MIN SPIN DELAY TIME Minimum delay time in program after commanding new spindle speed and before proceeding. Units are milliseconds.
Parameter	71	DRAW BAR OFFSET In Vertical mills, the offset provided in motion of Z-axis which accomodates the distance the spindle head travels during a tool change to initially open the carousel door. Units are encoder steps.
Parameter	72	DRAW BAR Z VEL UNCL In Vertical mills, the speed of motion in Z-axis to accomodate spindle head entry and exit from tool change door. Units are encoder steps per second.
Parameter	73	SP HIGH G/MIN SPEED Command speed used to rotate spindle motor when orienting spindle in high gear. Units are maximum spindle RPM divided by 4096.
Parameter	74	SP LOW G/MIN SPEED Command speed used to rotate spindle motor when orienting spindle in low gear. Units are maximum spindle RPM divided by 4096.
Parameter	75	GEAR CHANGE SPEED Command speed used to rotate spindle motor when changing gears. Units are maximum spindle RPM divided by 4096.
Parameter	76	LOW AIR DELAY Delay allowed after sensing low air pressure before alarm is generated. Alarm skipped if air pressure returns before delay. Units are 1/50 seconds.
Parameter	77	SP LOCK SETTLE TIME Required time in milliseconds that the spindle lock must be in place and stable before spindle orientation is considered complete.
Parameter	78	GEAR CH REV TIME Time in milliseconds before motor direction is reversed while in a gear change.
Parameter	79	SPINDLE STEPS/REV Sets the number of encoder steps per revolution of the spindle. Applies only to rigid tapping option.
Parameter	80	MAX SPIN DELAY TIME The maximum delay time control will wait for spindle to get to commanded speed or to get to zero speed. Units are milliseconds.
Parameter	81	M MACRO CALL O9000 **M** code that will call O9000. Zero causes no call.
Parameter	82	M MACRO CALL O9001 same as 81
Parameter	83	M MACRO CALL O9002 same as 81
Parameter	84	M MACRO CALL O9003 same as 81

Parameter	85	M MACRO CALL O9004 same as 81
Parameter	86	M MACRO CALL O9005 same as 81
Parameter	87	M MACRO CALL O9006 same as 81
Parameter	88	M MACRO CALL O9007 same as 81
Parameter	89	M MACRO CALL O9008 same as 81
Parameter	90	M MACRO CALL O9009 same as 81
Parameter	91	G MACRO CALL O9010 **G** code that will call O9010. Zero causes no call.
Parameter	92	G MACRO CALL O9011 same as 91
Parameter	93	G MACRO CALL O9012 same as 91
Parameter	94	G MACRO CALL O9013 same as 91
Parameter	95	G MACRO CALL O9014 same as 91
Parameter	96	G MACRO CALL O9015 same as 91
Parameter	97	G MACRO CALL O9016 same as 91
Parameter	98	G MACRO CALL O9017 same as 91
Parameter	99	G MACRO CALL O9018 same as 91
Parameter	100	G MACRO CALL O9019 same as 91
Parameter	101	IN POSITION LIMIT X How close motor must be to endpoint before any move is considered complete when not in exact stop (G09 or G61). Units are encoder steps.
Parameter	102	IN POSITION LIMIT Y Same definition as Parameter 101.
Parameter	103	IN POSITION LIMIT Z Same definition as Parameter 101.
Parameter	104	IN POSITION LIMIT A Same definition as Parameter 101.
Parameter	105	X MAX CURRENT Fuse level in % of max power to motor. Applies only when motor is stopped.
Parameter	106	Y MAX CURRENT Same definition as Parameter 105.
Parameter	107	Z MAX CURRENT Same definition as Parameter 105.
Parameter	108	A MAX CURRENT Same definition as Parameter 105.
Parameter	109	D*D GAIN FOR X Second derivative gain in servo loop.
Parameter	110	D*D GAIN FOR Y Second derivative gain in servo loop.
Parameter	111	D*D GAIN FOR Z Second derivative gain in servo loop.

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

Parameter 113 X ACC/DEC T CONST
Exponential acceleration time constant. Units are 1/10000 seconds. This parameter provides for a constant ratio between profiling lag and servo velocity. It is also the ratio between velocity and acceleration.

Parameter 114 Y ACC/DEC T CONST
Same definition as Parameter 113

Parameter 115 Z ACC/DEC T CONST
Same definition as Parameter 113

Parameter 116 A ACC/DEC T CONST
Same definition as Parameter 113

Parameter 117 LUB CYCLE TIME
If this is set nonzero, it is the cycle time for the lube pump and the lube pressure switch option is checked for cycling in this time. It is in units of 1/50 seconds.

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

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

Parameter 120 SPINDLE ACC/DECEL
Accel/decel time constant in steps/ms/ms for spindle motor.

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

Parameter 122 Y PHASE OFFSET
See Parameter 121 for description.

Parameter 123 Z PHASE OFFSET
See Parameter 121 for description.

Parameter 124 A PHASE OFFSET
See Parameter 121 for description.

Parameter 125 X GRID OFFSET
This parameter shifts the effective position of the encoder **Z** pulse. It can correct for a positioning error of the motor or home switch.

Parameter 126 Y GRID OFFSET
See Parameter 125 for description.

Parameter 127 Z GRID OFFSET
See Parameter 125 for description.

Parameter 128 A GRID OFFSET
See Parameter 125 for description.

Parameter 129 GEAR CH SETTLE TIME
Gear change settle time. This is the number of one millisecond samples that the gear status must be stable before considered in gear.

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

Parameter 131 MAX SPINDLE RPM
This is the maximum RPM available to the spindle. When this speed is programmed, the D-to-A output will be +10V and the spindle drive must be calibrated to provide this.

Parameter 132 SPIN. Y TEMP. COEF.
This parameter controls the amount of correction to the Y-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 133 SPIN. Z TEMP. COEF.
This parameter controls the amount of correction to the Z-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 134 X EXACT STOP DIST.
Parameter 135 Y EXACT STOP DIST.
Parameter 136 Z EXACT STOP DIST.
Parameter 137 A EXACT STOP DIST.
These parameters control how close each axis must be to its end point when exact stop is programmed. They apply only in G09 and G64. They are in units of encoder steps. A value of 34 would give 34/138718 = 0.00025 inch.

Note: To change the values of parameters 134-137 permanently the machine must be rebooted.

Parameter 138 X FRICTION COMPENSAT
Parameter 139 Y FRICTION FACTOR
Parameter 140 Z FRICTION FACTOR
Parameter 141 A FRICTION FACTOR
These parameters compensate for friction on each of the four axes. The units are in 0.004V.

Parameter 142 HIGH/LOW GEAR CHANG
This parameter sets the spindle speed at which an automatic gear change is performed. Below this parameter, low gear is the default; above this, high gear is the default.

Parameter 143 DRAW BAR Z VEL CLMP
This parameter sets the speed of the Z-axis motion that compensates for tool motion during tool clamping. Units are in encoder steps per second.

Parameter 144 RIG TAP FINISH DIST
This parameter sets the finish tolerance for determining the end point of a rigid tapping operation. Units are encoder counts.

Parameter 145 X ACCEL FEED FORWARD
This parameter sets the feed forward gain for the X-axis servo. It has no units.

Parameter	146	Y ACCEL FEED FORWARD Same as Parameter 145.
Parameter	147	Z ACCEL FEED FORWARD Same as Parameter 145.
Parameter	148	A ACCEL FEED FORWARD Same as Parameter 145.
Parameter	149	PRE-CHARGE DELAY This parameter sets the delay time from pre-charge to tool release. Units are milliseconds.
Parameter	150	MAX SP RPM LOW GEAR Max spindle RPM in low gear.
Parameter	151	B SWITCHES See Parameter 1 for description.
Parameter	152	B P GAIN See Parameter 2 for description.
Parameter	153	B D GAIN See Parameter 3 for description.
Parameter	154	B I GAIN See Parameter 4 for description.
Parameter	155	B RATIO (STEPS/UNIT) See Parameter 5 for description.
Parameter	156	B MAX TRAVEL (STEPS) See Parameter 6 for description.
Parameter	157	B ACCELERATION See Parameter 7 for description.
Parameter	158	B MAX SPEED See Parameter 8 for description.
Parameter	159	B MAX ERROR See Parameter 9 for description.
Parameter	160	B FUSE LEVEL See Parameter 10 for description.
Parameter	161	B BACK EMF See Parameter 11 for description.
Parameter	162	B STEPS/REVOLUTION See Parameter 12 for description.
Parameter	163	B BACKLASH See Parameter 13 for description.

Parameter 164 B DEAD ZONE
See Parameter 14 for description.

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

Parameter 166 B MAX CURRENT
Same definition as Parameter 105.

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

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

Parameter 169 B PHASE OFFSET
See Parameter 121 for description.

Parameter 170 B GRID OFFSET
See Parameter 125 for description.

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

Parameter 172 B FRICTION FACTOR
See Parameter 138 for description.

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

Parameter 174 SPINDLE B TEMP. COEF.
This parameter controls the amount of correction to the B-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 175 B AIR BRAKE DELAY
Delay provided for air to release from brake on B-axis prior to moving. Units are milliseconds.

The C-axis parameters (176-200) are used to control the Haas Vector Drive. Parameter 278 bit HAAS VECT DR must be set to 1 for these parameters to be available.

Parameter 176 C SWITCHES
See Parameter 1 for description.

Parameter 177 C P GAIN
See Parameter 2 for description.

Parameter 178 C D GAIN
See Parameter 3 for description.

Parameter 179 C I GAIN
See Parameter 4 for description.

Parameter 180 C SLIP GAIN
The value that the slip rate would assume at maximum speed and maximum current.

Parameter 181 C MIN SLIP
The minimum value allowed for the slip rate.

Parameter 182 C ACCELERATION
See Parameter 7 for description.

Parameter 183 C MAX FREQ
The frequency at which the motor will be run when maximum spindle RPM is commanded.

Parameter 184 C MAX ERROR
The maximum allowable error (in Hz) between commanded spindle speed and actual speed. If set to zero, it will default to 1/4 of Parameter 183.

Parameter 185 C FUSE LEVEL
See Parameter 10 for description.

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

Parameter 187 C HIGH GEAR STEPS/REV
The number of encoder steps per revolution of the motor when the transmission is in high gear. If the machine does not have a transmission, this is simply the number of encoder steps per revolution of the motor.

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

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

Parameter 190 C HI SP CURR LIM
At speeds higher than the base frequency, the maximum current that is applied to the motor must be reduced.

Parameter 191 C MAX CURRENT
Same definition as Parameter 105.

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

Parameter 193 C SPIN ORIENT MARGIN
When a spindle orientation is done, if the actual position of the spindle is within this value (plus or minus), the spindle will be considered locked. Otherwise, the spindle will not be locked.

Parameter 194 SPINDLE STOP FREQ
The spindle is considered to be stopped (discrete input SP ST*=0) when the speed drops below this value. Units are encoder steps/millisecond.

Parameter 195 C START/STOP DELAY
This delay is used at the start of motion to magnetize the rotor before accelera tion starts.

Parameter 196 C ACCEL LIMIT LOAD
This is the % load limit during acceleration.

Parameter 197 C RESERVED
Parameter 198 C RESERVED
Parameter 199 C RESERVED
Parameter 200 C RESERVED

Parameter 201 X SPINDLE TEMP. COEF.
This parameter controls the amount of correction to the X-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 202 X AIR BRAKE DELAY
This parameter is not used.

Parameter 203 Y AIR BRAKE DELAY
This parameter is not used.

Parameter 204 Z AIR BRAKE DELAY
This parameter is not used.

Parameter 205 A SPINDLE TEMP. COEF.
This parameter controls the amount of correction to the A-axis in response to heating of the spindle head. It is 10 times the number of encoder steps per degree F.

Parameter 206 SPIGOT POSITIONS
For Vertical mills only.

Parameter 207 SPIGOT TIMEOUT (MS)
For Vertical mills only.

Parameter 208 SPIN. FAN OFF DELAY
Delay for turning the spindle fan off after the spindle has been turned off.

Parameter 209 COMMON SWITCH 2
Parameter 209 is a collection of general purpose single bit flags used to turn some functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

HORIZONTAL When set to (1), the control identifies the machine as a horizontal mill. The control will then make the necessary adjustments, such as enabling the horizontal tool changer.

RST STOPS T.C. Tool changer can be stopped with RESET button.
M21-28 @ 540 When enabled (1), M21-M28 is installed at cable 540.

ENA CONVEYOR	Enables chip conveyor, if machine is equipped.
50% RPD KBD	When (1) the control will support the new style keyboards with the 50% rapid traverse key. For controls without a 50% rapid keypad set this bit to (0).
FRONT DOOR	When enabled the control will look for an additional door switch and will generate an operator message.
TC Z NO HOME	This bit prevents Z-axis motion to machine zero prior to a tool change.
M36 AUTO MOT	When set to (1), an M36 rotates the A-axis after the PART READY button is pressed.
AUX AXIS TC	When enabled, means the tool changer carousel is driven by an aux. axis.
SPIGOT KEY INV	When (1) the commands to the spigot are reversed so that forward becomes reverse. If the conveyor is wired incorrectly, this bit can be set so that the conveyor runs in the proper direction.
T SUBROUTINE	Reserved for future use.
SPIN Y ENCDR	Not used in horizontal mill.
REV CONVEYOR	When (1) the commands to the conveyor motor are reversed so that forward becomes reverse. If the conveyor is wired incorrectly, this bit can be set so that the conveyor runs in the proper direction.
M27-M28 CONVYR	Usually the chip conveyor motor and direction relays are attached to the user relays M21 M22. When this bit is set, the control expects to see the conveyor hooked up to M27 and M28.
RESERVED	
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.
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.
CONVY DR OVRD	When (1) the conveyor will continue to run with the door open. When (0) the conveyor will stop when the door is open, but will resume when the door is closed. For safety it is recommended that the bit be set to (0).
DSBL CLNT IN	If set to 1 low coolant input will not be used.
DSC INP PR	Horizontal mills only. Discrete pallet rotate/part ready; inputs enabled if set to 1.
RMT TOOLS RLS	Vertical mills only.
FLOPPY ENABL	If set to 1, enables the optional floppy drive.
TCR KEYPAD	If set to 1, enables tool changer restore button on keypad.
MCD RLY BRD	If set to 1, adds 8 additional relays, for a total of 40. These additional relays (M21-M28) become available on a secondary board, and are shown on the discrete outputs page.
TSC ENABLE	When set to 1, "DSBL CLNT IN" bit is ignored, and TSC will operate. When set to zero, the control functions normally.

AUX JOG NACC	Does not allow accumulation on auxiliary axis jog.
ALISM PRGRST	Alias M codes during program restart.
DSBL JOG TST	Disables the encoder test for the jog handle.
AIR DR @ M24	On Horizontal mill, air door uses M24. When set to zero, air door output is at M23.
RESERVED	Not currently used.
P RDY @ Y160	This bit places the Part Ready Light at Y160 (output 24). When set to zero (0) and AIR DR @ M24 is set to zero (0), the Part Ready Light is at spare output 19.
SPNDL NOWAIT	When (1), the machine will not wait for the spindle to come up to speed immediately after an M03 or M04 command. Instead, it will check and/or wait for the spindle to come up to speed immediately before the next interpolated motion is initiated. This bit does not affect rigid tapping or the TSC option.

Parameter 210 X TOOL CHANGE OFFSET
This parameter is not used.

Parameter 211 Y TOOL CHANGE OFFSET
On Horizontal mills: For Y-axis; displacement from the home position to tool change position.

Parameter 212 A TOOL CHANGE OFFSET
This parameter is not used.

Parameter 213 B TOOL CHANGE OFFSET
This parameter is not used.

Parameter 214 RESERVED

Parameter 215 CAROUSEL OFFSET
Parameter used to align tool 1 of tool changing carousel precisely. Units are encoder steps.

Parameter 216 CNVYR RELAY DELAY
Delay time in 1/50 seconds required on conveyor relays before another action can be commanded. Default is 5.

Parameter 217 CNVYR IGNORE OC TIM
Amount of time in 1/50 seconds before overcurrent is checked after conveyor motor is turned on. Default is 50.

Parameter 218 CONVYR RETRY REV TIM
Amount of time that the conveyor is reversed in 1/50 seconds after overcurrent is sensed. Default is 200.

Parameter 219 CONVYR RETRY LIMIT
Number of times that the conveyor will cycle through the reverse/forward sequencing when an overcurrent is sensed before the conveyor will shut down. An overcurrent is sensed when chips jam the conveyor. By reversing and then forwarding the conveyor, the chip jam may be broken. Default is 3.

Parameter 220 CONVYR RETRY TIMEOUT
Amount of time in 1/50 seconds between consecutive overcurrents in which the overcurrents is considered another retry. If this amount of time passes between overcurrents then the retry count is set to (0). Default is 1500, 30 seconds.

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

Parameter 222 ROTARY AXIS INCRMNT
For Horizontal mills only. This parameter sets the degrees of rotation of the A-axis at an M36 or Pallet Rotate.

Parameter 223 AIR TC DOOR DELAY
For Horizontal mills only. This parameter sets the delay to open the tool changer door (in milliseconds). If the tool changer does not have a pneumatic door, this parameter is set to zero.

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

Parameter 225 MAX ROT AXIS ALLOW
For Horizontal mills with a wheel fixture only. This parameter sets the maximum rotation (in degrees) allowed before stopping at front door.

Parameter 226 EDITOR CLIPBOARD
This parameter assigns a program number (nnnn) to the contents of the clipboard.

Parameter 227 FLOPPY DIR NAME
This parameter sets the program numbers to store in the floppy directory.

Parameter 228 QUICKCODE FILE
This parameter set the program numbers to store in the Quickcode definition.

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

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

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

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

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

Parameter 235 TSC PISTON SEAT
With the TSC option, the amount of time given for the piston to seat during system start-up. The default is 500 milliseconds.

Parameter 236 — TSC LOW PR FLT
After the TSC system has stabilized following startup, Alarm 151 is generated if coolant pressure falls below 40 psi for the amount of time set in this parameter. The default is 1000 milliseconds.

Parameter 237 — TSC CLNT LINE PURGE
The amount of time given for the coolant to purge when the TSC system is shut off. This parameter may be increased by the user to a higher value to help purge coolant from small orifice tooling. The minimum (default) value is 2500 milliseconds.

Parameter 238 — MAX TSC SPINDLE RPM
When Through the Spindle Coolant (TSC) is enabled and in use, this parameter limits the maximum spindle speed. The default is 7500 RPM.

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

Parameter 240 — C AXIS MAX TRAVEL
This parameter sets the C-axis maximum travel in the positive direction.

Parameter 241 — U AXIS MAX TRAVEL
This parameter sets the U-axis maximum travel in the positive direction.

Parameter 242 — V AXIS MAX TRAVEL
This parameter sets the V-axis maximum travel in the positive direction.

Parameter 243 — W AXIS MAX TRAVEL
This parameter sets the W-axis maximum travel in the positive direction.

Parameter 244 — C AXIS MIN TRAVEL
This parameter sets the C-axis minimum travel in the negative direction.

Parameter 245 — U AXIS MIN TRAVEL
This parameter sets the U-axis minimum travel in the negative direction.

Parameter 246 — V AXIS MIN TRAVEL
This parameter sets the V-axis minimum travel in the negative direction.

Parameter 247 — W AXIS MIN TRAVEL
This parameter sets the W-axis minimum travel in the negative direction.

Parameter 255 — CONVEYOR TIMEOUT
The amount of time (in minutes) the conveyor will operate without any machine motion or keyboard action. After this time, the conveyor will automatically shut off.

Parameter 256 — PALLET LOCK INPUT
This parameter selects the discrete input (0 to 31) that is to be used to monitor the pallet locked status.

Parameter 257 — SPINDL ORIENT OFSET
If the machine is equipped with a spindle vector drive (as set in bit 7 of Parameter 278), this bit sets the spindle orientation offset. The offset is the

number of encoder steps between the Z pulse and the correct spindle orientation position.

Parameter 258 LS PER INCH
The number of steps on the linear scale per inch of travel.

Parameter 259 LS PER REV
The number of steps between Z pulses on the linear scale.

Parameter 266 X SWITCHES (Not currently used on the Horizontal mill)
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:

X LIN SCALE EN	Used to enable linear scales for the X axis.
X INVRT LN SCL	Used to invert the X-axis linear scale.
X DSBL LS ZTST	Used to disable the linear scale Z test.
X ZERO AXIS TC	Used to return axis prior to toll change.
X 2ND HOME BTN	Used to move axis to coordinates specified in Work Offset G129
X NEG COMP DIR	Used to negate the direction of thermal compensation.
X DELAY AXIS 0	Used with an APL to ensure X axis is zeroed before A axis of a APL.

Parameter 267 Y SWITCHES (Not currently used on the Horizontal mill)
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:

Y LIN SCALE EN	Used to enable linear scales for the Y axis.
Y INVRT LN SCL	Used to invert the Y-axis linear scale.
Y DSBL LS ZTST	Used to disable the linear scale Z test.
Y ZERO AXIS TC	Used to return axis prior to toll change.
Y 2ND HOME BTN	Used to move axis to coordinates specified in Work Offset G129
Y NEG COMP DIR	Used to negate the direction of thermal compensation.
Y DELAY AXIS 0	Used with an APL to ensure X axis is zeroed before A axis of a APL.

Parameter 268 Z SWITCHES (Not currently used on the Horizontal mill)
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:

Z LIN SCALE EN	Used to enable linear scales for the Z axis.
Z INVRT LN SCL	Used to invert the Z-axis linear scale.
Z DSBL LS ZTST	Used to disable the linear scale Z test.
Z ZERO AXIS TC	Used to return axis prior to toll change.
Z 2ND HOME BTN	Used to move axis to coordinates specified in Work Offset G129
Z NEG COMP DIR	Used to negate the direction of thermal compensation.
Z DELAY AXIS 0	Used with an APL to ensure X axis is zeroed before A axis of a APL.

Parameter 269 A SWITCHES (Not currently used on the Horizontal mill)
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:

A LIN SCALE EN	Used to enable linear scales for the A axis.
A INVRT LN SCL	Used to invert the A-axis linear scale.

A DSBL LS ZTST	Used to disable the linear scale Z test.
A ZERO AXIS TC	Used to return axis prior to toll change.
A 2ND HOME BTN	Used to move axis to coordinates specified in Work Offset G129
A NEG COMP DIR	Used to negate the direction of thermal compensation.
A DELAY AXIS 0	Used with an APL to ensure X axis is zeroed before A axis of a APL.

Parameter 270 B SWITCHES (Not currently used on the Horizontal mill)

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:

B LIN SCALE EN	Used to enable linear scales for the B axis.
B INVRT LN SCL	Used to invert the B-axis linear scale.
B DSBL LS ZTST	Used to disable the linear scale Z test.
B ZERO AXIS TC	Used to return axis prior to toll change.
B 2ND HOME BTN	Used to move axis to coordinates specified in Work Offset G129
B NEG COMP DIR	Used to negate the direction of thermal compensation.
B DELAY AXIS 0	Used with an APL to ensure X axis is zeroed before A axis of a APL.

Parameter 271 C SWITCHES

Parameter 271 is a collection of single-bit flags used to turn servo related functions on and off. This parameter is not used when machine is equipped with a Haas vector drive. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

C LIN SCALE EN	Used to enable linear scales for the C axis.
C INVRT LN SCL	Used to invert the C-axis linear scale.
C DSBL LS ZTST	Used to disable the linear scale Z test.
C ZERO AXIS TC	Used to return axis to zero prior to tool change.
C ZERO AXIS TC	Used to return axis prior to toll change.
C 2ND HOME BTN	Used to move axis to coordinates specified in Work Offset G129
C NEG COMP DIR	Used to negate the direction of thermal compensation.
C DELAY AXIS 0	Used with an APL to ensure X axis is zeroed before A axis of a APL.

Parameter 278 COMMON SWITCH 3

Parameter 278 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:

INVERT G.B. This bit allows an alternate gearbox configuration. It inverts the sense of the gearbox inputs.

DPR SERIAL Causes the main serial inputs/outputs to go through the floppy video board.

CK PALLET IN This bit will cause an alarm (180, "Pallet Not Clamped") if the spindle is commanded and the discrete input selected by Parameter 256 is set to 1.

CK HIDN VAR This bit will cause an alarm (180, "Pallet Not Clamped") if the spindle is commanded and macro variable 709 is not set to zero.

DISPLAY ACT When set to 1, displays the actual spindle speed on the Current Commands display page.

TSC PRG ENBL Enables purge output on TSC option.

RESERVED	Not currently used.
SPND DRV LCK	This bit must be set to 0 if machine is equipped with a Haas vector spindle drive.
RESERVED	Not currently used.
CNCR SPINDLE	(Concurrent Spindle) When set to 1, the spindle will be commanded to start concurrently with other commands in the same block. In the following example, with this bit set to 1, the spindle will start at the same time as the feed: **G1 X-1. F1. S7500 M3;**
RESERVED	Not currently used.
HAAS VECT DR	(Haas Vector Drive) This bit must be set to 1 if machine is equipped with a HAAS vector spindle drive. When set to 1, voltage to the Haas vector drive is displayed in the diagnostics display as DC BUSS.
uP ENCL TEMP	(Microprocessor Enclosure Temperature) When set to 1, the enclosure temperature will be displayed on INPUTS2 screen of the diagnostics display.
HAAS RJH	(Haas Remote Jog Handle) This bit must be set to 1 if the machine is equipped with a Haas 5-Axis Remote Jog Handle.
SPIN TEMP 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 for machines with a Haas vector drive, and 0 for machines that do not have a vector drive.
TL DR SWITCH	This bit specifies the 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 door is spring loaded closed and is driven open by a timed operation against the door open switch.
SAFETY INVERT	This bit supports the CE door interlock that locks when power is turned off. For machines that have the regular door lock that locks when power is applied, this bit must be set to 0. For machines that have the inverted door lock, this bit must be set to 1.
Parameter 279	X MAX 3rd DERIV This parameter supports S-curve. It is initialized to 250000000 and can be altered as needed. In order to ensure the desired effect, the minimum value that the control will use is: 11700* ACCELERATION / ACC / DEC T CONST If the parameter is set to a lower value, the control will instead use the value computed using the above formula.
Parameter 280	Y MAX 3rd DERIV See parameter 279 for description
Parameter 281	Z MAX 3rd DERIV See parameter 279 for description

Parameter 282 — A MAX 3rd DERIV
See parameter 279 for description

Parameter 283 — B MAX 3rd DERIV
See parameter 279 for description

Parameter 284 — C MAX 3rd DERIV
See parameter 279 for description

Parameter 294 — MIN BUSS VOLTAGE
This parameter specifies the minimum Haas Vector Drive buss voltage. When a Haas Vector Drive is installed, it should be set to 200 volts. Otherwise, it should be set to zero. Alarm 160 will be generated if the voltage falls below this value.

Parameter 296 — MAX OVER VOLT TIME
Specifies the amount of time (in 50ths of a second)that an overvoltage condition (alarm 119 OVER VOLTAGE) will be tolerated before the automatic shut down process is started.

Parameter 297 — MAX OVERHEAT TIME
Specifies the amount of time (in 50ths of a second) that an overheat condition (alarm 122 REGEN OVERHEAT) will be tolerated before the automatic shut down process is started.

Parameter 298 — MAX FEED (DEG/MIN)
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 200. For all other mills, this bit should be set to 99999.

Parameter 299 — AUTOFEED-STEP-UP
This parameter works with the AUTOFEED feature. It specifies the feed rate step-up percentage per second and should initially be set to 10.

Parameter 300 — AUTOFEED STEP-DOWN
This parameter works with the AUTOFEED feature. It specifies the feed rate step-down percentage per second and should initially be set to 20.

Parameter 301 — AUTOFEED-MIN-LIMIT
This parameter works with the AUTOFEED feature. It specifies the minimum allowable feed rate override percentage that the AUTOFEED feature can use and should initially be set to 1.

Lead Screw Compensation

Separate lead screw compensation is provided for each of the **X**, **Y**, and **Z** axes. The operator-entered compensation values are spaced at 0.5 inch intervals within the machine coordinate system. The compensation values are entered in inches with a resolution of 0.0001 inch. The operator entered values are used to interpolate into a table of 256 entries. The spacing between two entries in the table of 256 is defined by Parameter 58. The entered values are limited to +/-127 encoder steps; so the limit in inches is dependent on Parameters 5, 19, and 33.

Note that the first entry corresponds to machine position zero and subsequent entries are for increasingly negative positions in the machine coordinate system. The user should not ever need to adjust the lead screw compensation tables.

Electronic Thermal Compensation

When ballscrews rotate they generate heat. Heat causes the ballscrews to expand. In constant duty cycles as in mold making the resultant ball screw growth can lead to cutting errors on the next morning start up. Haas' new 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 growth due to the 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.

The compensation time constant is on the order of 20 to 50 minutes to lose half of the heat in the screw. 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. Thus a real time clock is required for this compensation to work if the machine is turned off for less than 2 hours.

7. MAINTENANCE SCHEDULE AND LUBRICATION CHART

The following is a list of required regular maintenance for the HAAS HS Series Horizontal Machining Centers. Listed are the frequency of service, capacities, and type of fluids required. These required specifications must be followed in order to keep your machine in good working order and protect your warranty.

MAINTENANCE SCHEDULE

INTERVAL	MAINTENANCE PERFORMED
DAILY	✓ Check coolant level every eight hour shift 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 automatic dump air line's water trap for proper operation. ✓ On machines with the TSC option, clean the chip basket on the coolant tank. Remove the tank cover and remove any sediment inside the tank. Be careful to disconnect the coolant pump from the controller and POWER OFF the control before working on the coolant tank. **Do this MONTHLY for machines without the TSC option.** ✓ Check air gauge/regulator for 85 psi. ✓ For 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 gearbox. Add oil until oil begins dripping from over flow tube at bottom of sump tank. Clean pads on bottom of pallets. ✓ Clean the locating pads on the A-axis and the load station. This requires removing the pallet. ✓ Inspect way covers for proper operation and lubricate with light oil, if necessary.
SIX MONTHS	✓ Replace coolant and thoroughly clean the coolant tank. ✓ Check all hoses and lubrication lines for cracking.
ANNUALLY	✓ Replace the gearbox oil. Drain the oil from the gearbox, and slowly refill it with 2 quarts of Mobil DTE 25 oil. ✓ Check oil filter and clean out residue at bottom of filter. ✓ **Replace air filter on control box every (2) years.**

TSC MAINTENANCE

- ✓ Top off the coolant tank every eight hour shift during heavy TSC usage.
- ✓ Refer to the next section, and check gauge (G2) on 100 micron filter with TSC system running and no tool in the spindle. Change element when the indicator reaches the red zone. Use 100 micron filter element (58-6045) or commercially available equivalent.
- ✓ Clean pump intake filter when indicator (G1) is in red zone. Reset with button.

SPECIAL INSTRUCTIONS:
After changing or cleaning filter elements, run TSC system with no tool in spindle for at least one minute to purge air.

LUBRICATION CHART

SYSTEM:	WAY LUBE AND PNEUMATICS	TRANSMISSION	COOLANT TANK
LOCATION	Under the control panel on the right side of the machine	Rear of spindle head	Side of machine
DESCRIPTION	Piston pump with 30-minute cycle time. Pump is only on when spindle is turning or when axis is moving.		
LUBRICATES	Linear guides and ball nuts	Transmission only	
QUANTITY	1-QT. Tank	2-QT. Tank	40 gal. (80 gal. HS-2)
LUBRICANT	Mobil Vactra #2	Mobil DTE 25	Water soluble, synthetic

TSC Maintenance

- ✓ Check dirt indicator on 100 micron filter (Figure 7-3) with TSC system running and no tool in the spindle. Change element when the indicator reaches the red zone.
- ✓ Clean pump intake filter when indicator is in 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.

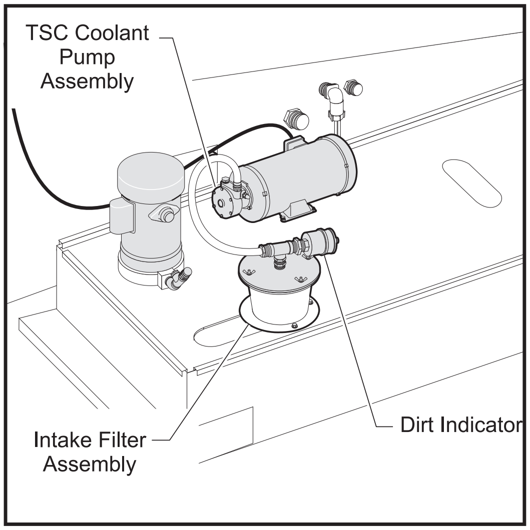


Figure 7-1. TSC coolant pump assembly.

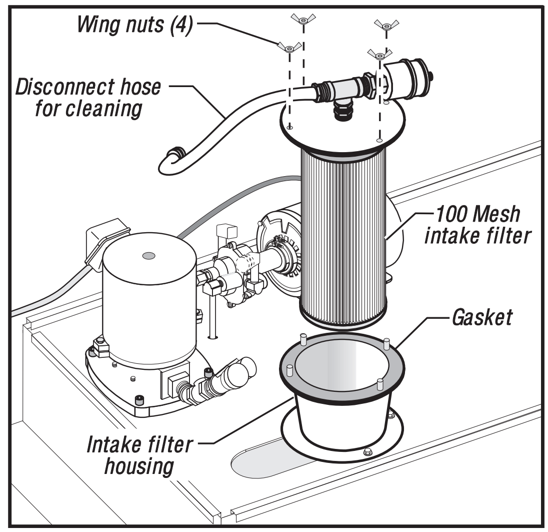


Figure 7-2. Cleaning the intake filter.

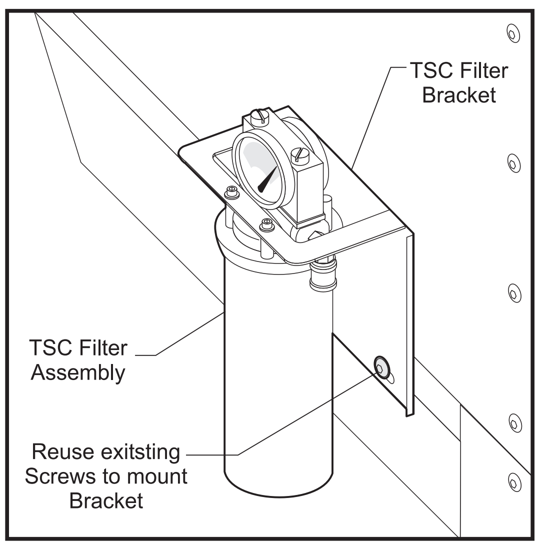


Figure 7-3. 100 Micron TSC filter.

CHECKING DRAWBAR HEIGHT

TOOLS REQUIRED

- ✓ **Right angle fixture, such as a right angle plate**
- ✓ **Machined aluminum block (2"x4"x4")**
- ✓ **Tool holder (without a tool)**

1. Secure the rigid fixture in place on the table. Place a sheet of paper on the table for protection, then place the machined block of aluminum against the rigid fixture.

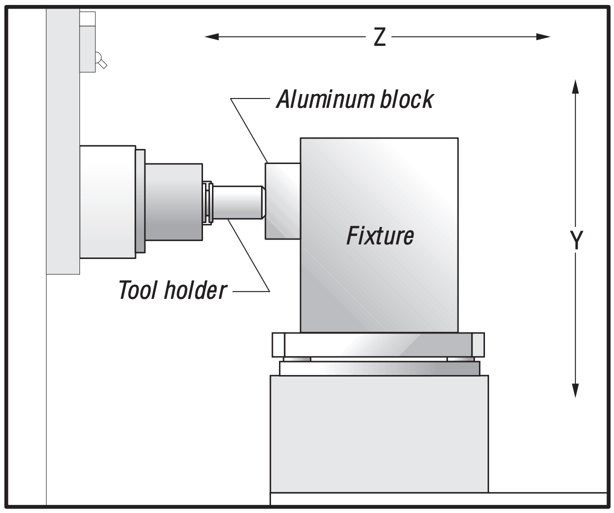


Figure 7-4. Setup for checking drawbar height.

2. POWER ON the machine. Insert an empty tool holder into the spindle taper.

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

4. 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. The tool holder will come out of the taper.

5. The clearance from the tool holder to the block should be zero (0). To accomplish this, set the jog increments to .001 and jog in the negative (-) Z direction a few increments at a time. Between these moves, push the TOOL RELEASE button and feel for movement by placing your finger between the tool holder and the spindle. ***Do this until no movement is felt.*** You are now at zero (0).

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

6. Press the MDI key and turn the jog handle to zero (0). Press HANDLE JOG. Jog the Z-axis in the positive (+) direction .100".

7. 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 block moves at .100, jog the Z-axis in the negative (-) direction one increment at a time. Press the TOOL RELEASE button and check for movement between increments until block is tight.

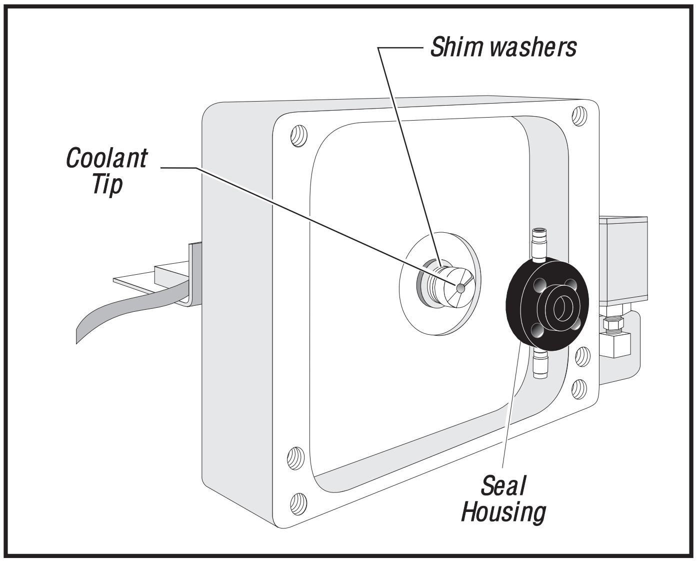
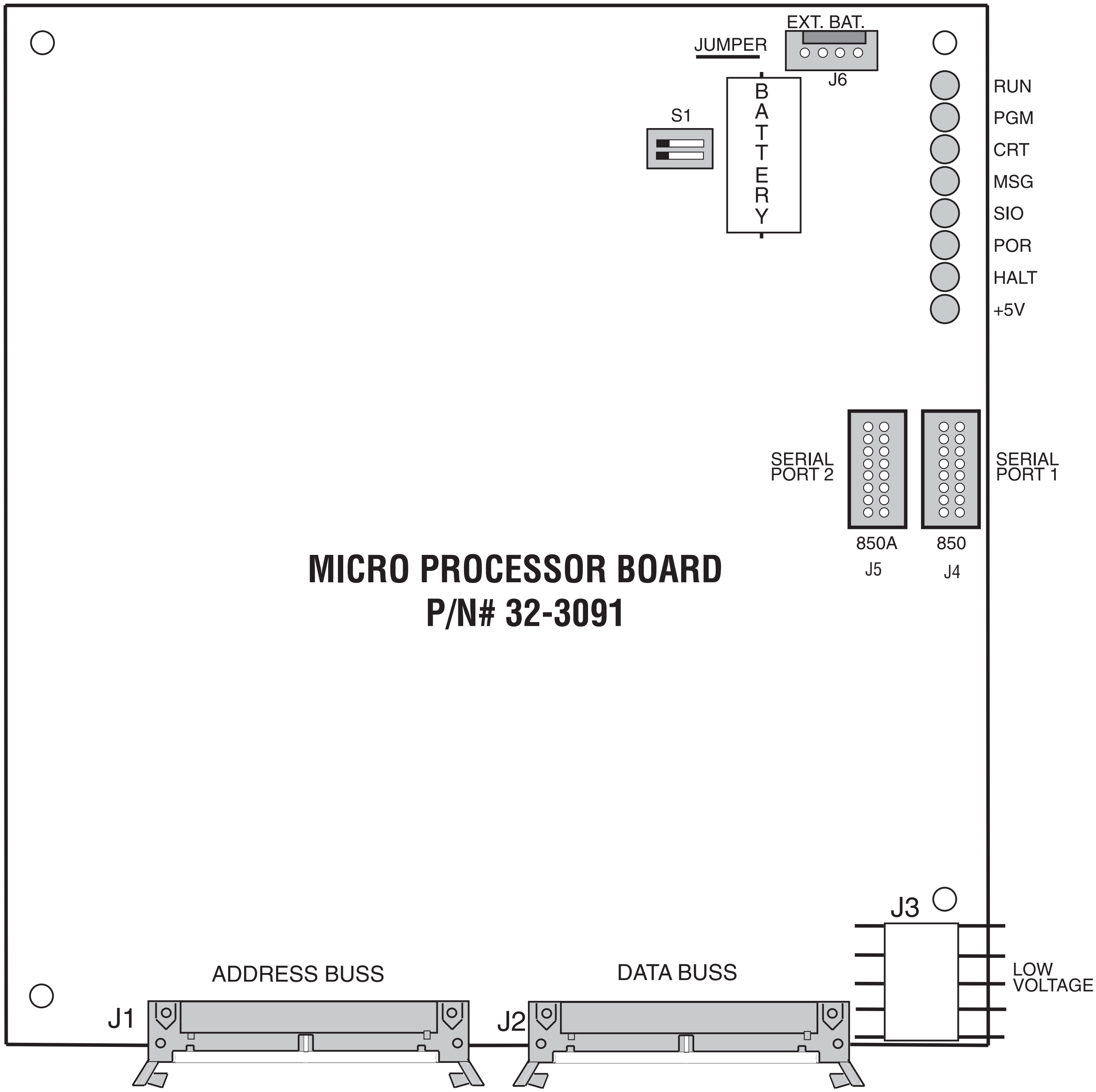


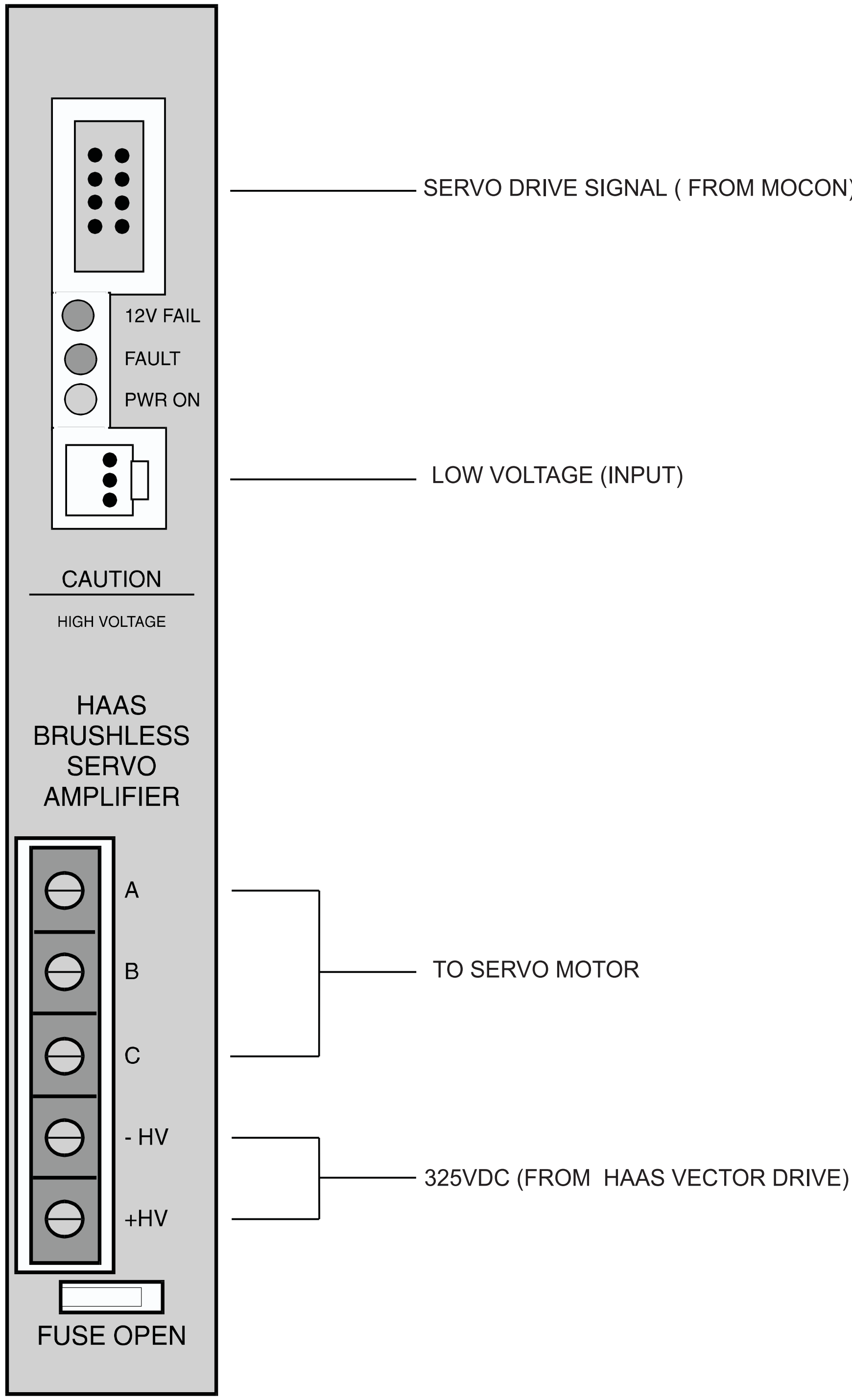
Figure 7-5. Coolant tip and seal housing (TSC machines only).

8. PCB'S, CABLE LOCATIONS AND BOARD DIAGRAMS


EXT. BAT.
JUMPER
J6
S1
BATTERY
RUN
PGM
CRT
MSG
SIO
POR
HALT
+5V
SERIAL PORT 2
SERIAL PORT 1
850A
850
J5
J4
MICRO PROCESSOR BOARD
P/N# 32-3091
J3
LOW VOLTAGE
ADDRESS BUSS
DATA BUSS
J1
J2

MICRO PROCESSOR PCB - P/N 32-3091
CABLE CONNECTIONS

PROC. PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨	LOCATION	PLUG #
ADDRESS		ADDRESS BUSS		VIDEO	——-
& DATA		DATA BUSS		MOTIF PCB	——-
P3	860	LOW VOLTAGE		POWER SUPPLY PCB	——-
P6	N/A	EXTERNAL BATTERY		(EXT. BATTERY)	——-
PORT 1	850	SERIAL PORT #1		SERIAL PORT #1	——-
PORT 2	850A	SERIAL PORT #2		SERIAL PORT #2	——-



BRUSHLESS SERVO AMPLIFIER P/N 32-5550B

BRUSHLESS SERVO AMPLIFIER - P/N 32-5550B CABLE CONNECTIONS

MOCON

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

Y AXIS AMP

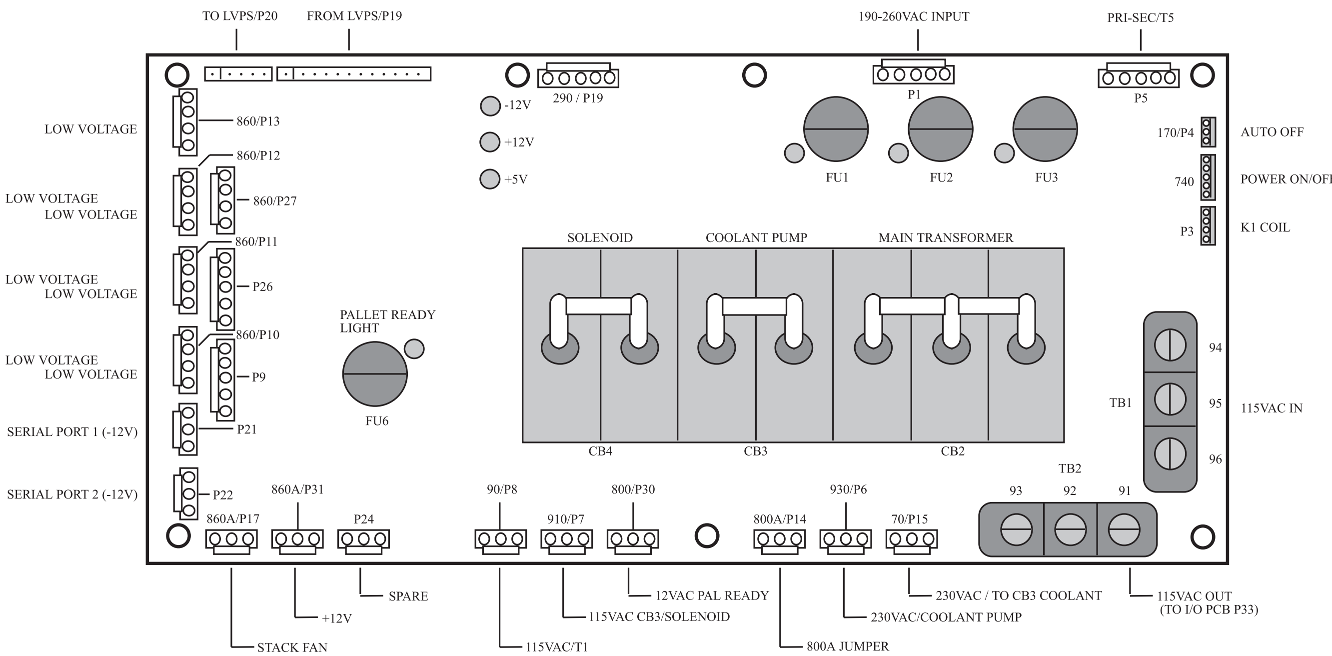
P	580	LOW VOLTAGE	L. V. POWER SUPPLY	——-
TB A, B, C	——-	MOTOR DRIVE	X SERVO MOTOR	——-
P	620	X DRIVE SIGNAL	MOCON PCB	P3
TB -HV +HV	——-	320VDC	SPINDLE DRIVE	——-

Z AXIS AMP

P	590	LOW VOLTAGE	L. V. POWER SUPPLY	——-
TB A, B, C	——-	MOTOR DRIVE	X SERVO MOTOR	——-
P	630	X DRIVE SIGNAL	MOCON PCB	P4
TB -HV +HV	——-	320VDC	SPINDLE DRIVE	——-

A AXIS AMP

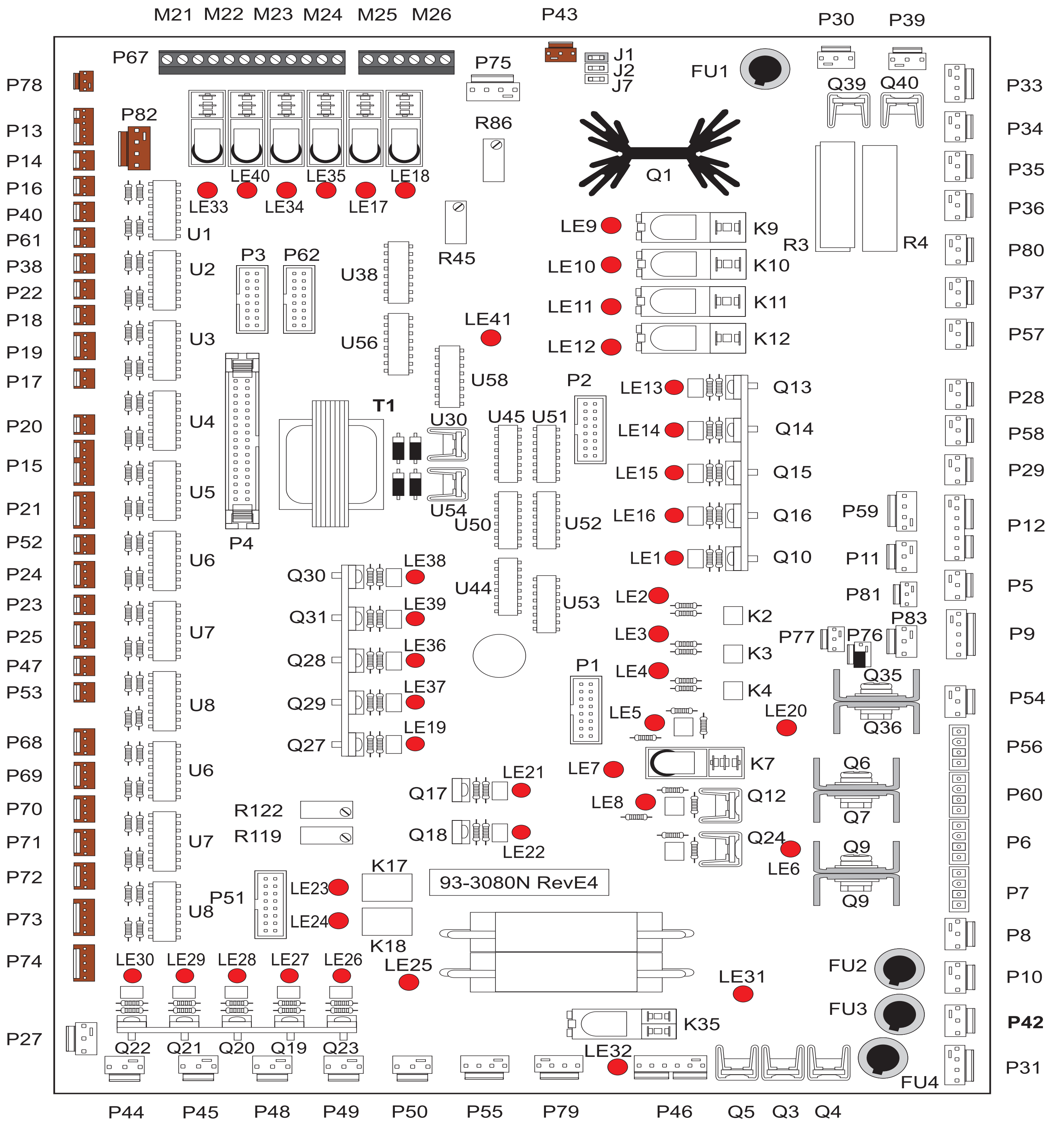
P	600	LOW VOLTAGE	L. V. POWER SUPPLY	——-
TB A, B, C	——-	MOTOR DRIVE	X SERVO MOTOR	——-
P	640	X DRIVE SIGNAL	MOCON PCB	P5
TB -HV +HV	——-	320VDC	SPINDLE DRIVE	——-



POWER PCB 32-5010

POWER PCB 32-5010
CABLE CONNECTIONS

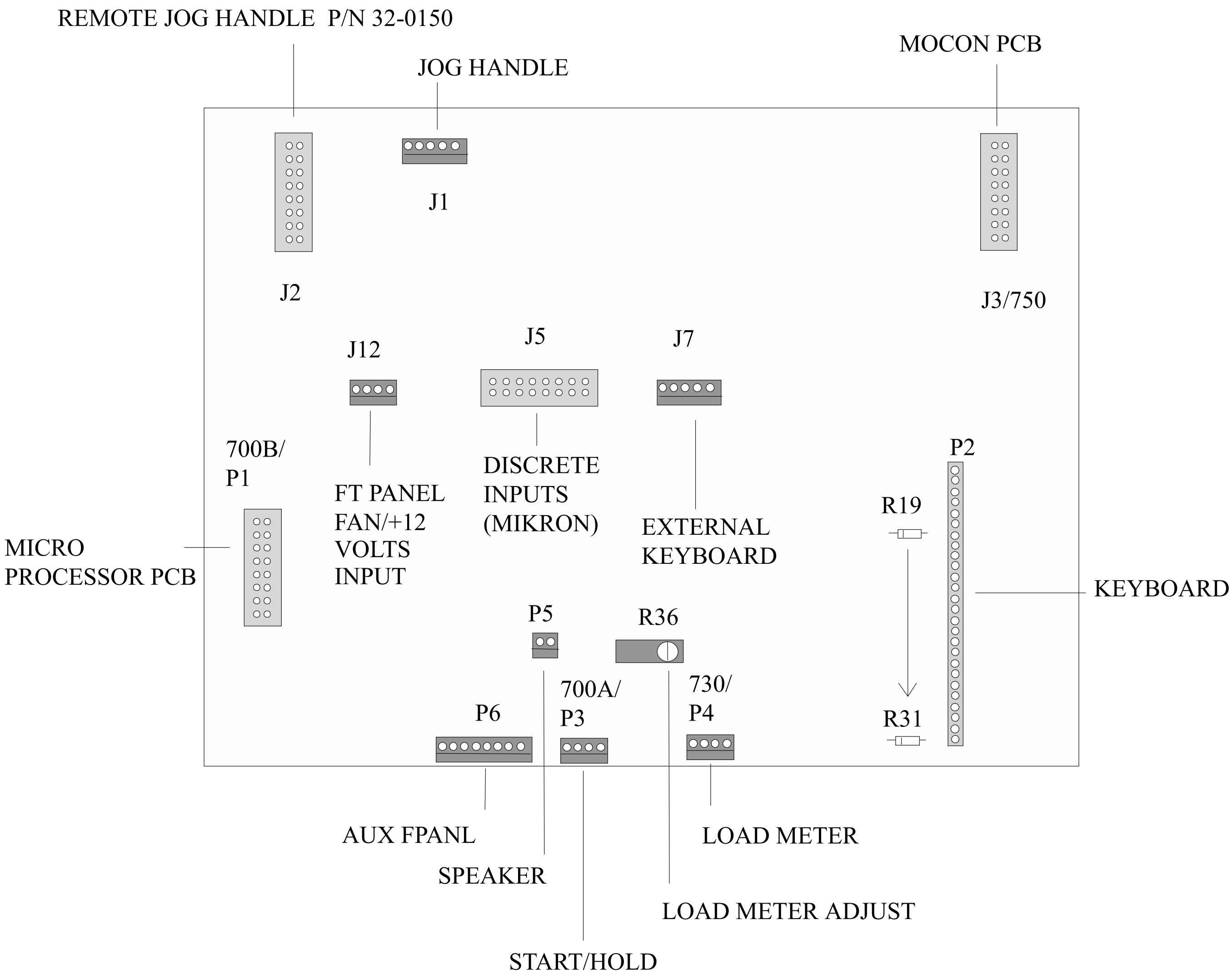
PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨	LOCATION	PLUG #
P1	——	190-260VAC INPUT		CB1	—--
P3	——	K1 COIL		K1 CONTACTOR	——
P4	170	AUTO OFF		I/O PCB	P8
P5	PRI-SEC	PRI-SEC/T5		T5	——
P6	930	230VAC/COOLANT PUMP		I/O PCB	P6
P7	910	115VAC CB3/SOLENOID		I/O PCB	P28
P8	90	115VAC/T1		I/O PCB	P36
P9	860	LOW VOLTAGE		POWER	—-
P10	860	LOW VOLTAGE		POWER	——-
P11	860	LOW VOLTAGE		POWER	——-
P12	860	LOW VOLTAGE		POWER	——-
P13	860	LOW VOLTAGE		POWER	——-
P14	800A	800A JUMPER		OP LAMP SWITCH	——-
P15	70	230VAC/TO CB3 COOLANT		CB3 COOLANT	——-
P17	860A	STACK FAN		POWER	——-
P19	290	——-		——-	——-
P21	PORT 1&2	-12VDC PORT 1 & 2		PROCESSOR PCB	P3
P22	——-	-12VDC		——-	——-
P24	SPARE	SPARE		SPARE	N/A
P26	860	LOW VOLTAGE		POWER	——-
P27	860	LOW VOLTAGE		POWER	——-
P30	800	12VAC/OP LAMP		OPERATORS LAMP	——-
P31	860A	+12VDC		POWER	——-
TB1	——-	115VAC IN		T1 - SECONDARY	——-
TB2	——-	115VAC OUT			
POWER ON/ OFF	740	POWER ON/OFF		ON/OFF SWITCH	——-



I/O PCB - P/N 32-3080 VER. MA

I/O PCB - P/N 32-3080 VER. MA CABLE CONNECTIONS

I/O PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1	510		MOCON PCB	P11
P2	520		MOCON PCB	P12
P3	540		MOCON PCB	P14
P4	550		MOCON PCB	P10
P5	110		SERVO POWER ON	——-
P6	930		POWER PCB	P6
P7	940		COOLANT PUMP	——-
P8	170		POWER PCB	P4
P9	710		SPARE	——-
P10	300		SP FAN/GEAR BOX	——-
P11			SPIN LOCK I/F	——-
P12	880A		SPINDLE HEAD	——-
P13	820		PAL C/TOOL C	——-
P14	900		LOW TSC SENSOR	——-
P15	890		SPINDLE HEAD	——-
P16	770		E-STOP SWITCH	——-
P17	960		AIR/OIL	——-
P18	970		VECTOR DR OVER V	J1
P19	950		AIR/OIL	——-
P20	830		REGEN RESISTORS	——-
P21	780		NOT USED	——-
P22	100		M-FIN	——-
P23	190		L/S LOCKED	——-
P24	790		PAL CW/CCW	N/A
P25	200		PAL UP/DWN	N/A
P26	M21-24		DB MN, L/S, T/C DR ENBL	——-
P27	1040		DOOR LOCK	——-
P28	910		POWER SOLENOIDS	P7
P29	390		(EXTERNAL)	——-
P30	810A		DB MOTOR	——-
P31	160		CHIP CONVEYOR	——-
P33	90		TB2 PSUP	——-
P34	90A		CRT	——-
P35	90B		DOOR FAN	——-
P36	90C		POWER PCB	P8
P37	870		SERVO FAN	——-
P38	1050		DOOR SWITCH	——-
P39	810		L/S MOTOR	——-
P40	770A		HYD PRESSURE TANK	——-
P42	300		LUBE OIL PUMP	——-
P43	1060		NOT USED	N/A
P44	319		5TH BRAKE	——-
P45	——-		HTC	——-
P46	140		CHIP CONVEYOR	——-
P47	1070		PROBE OPTION	——-
P48	270		PURGE	——-
P49	260		READY LAMP	——-
P50	200		SPIGOT MOTOR	——-
P51	530		MOCON PCB	P13
P52	410		TOOL CHANGER DOOR	P52
P53	180		SPIGOT SENSE	——-
P54	350		SERVO BRAKE	——-
P55	280		RED/GREEN LTS	——-
P56	940A		TSC PUMP	——-
P57	90D		PALLET ALARM	——-
P58	910C		115VAC Y-Δ CONTCTR	——-
P60	930A		TSC 230 IN	——-
P61	770B		E-STOP C	——-

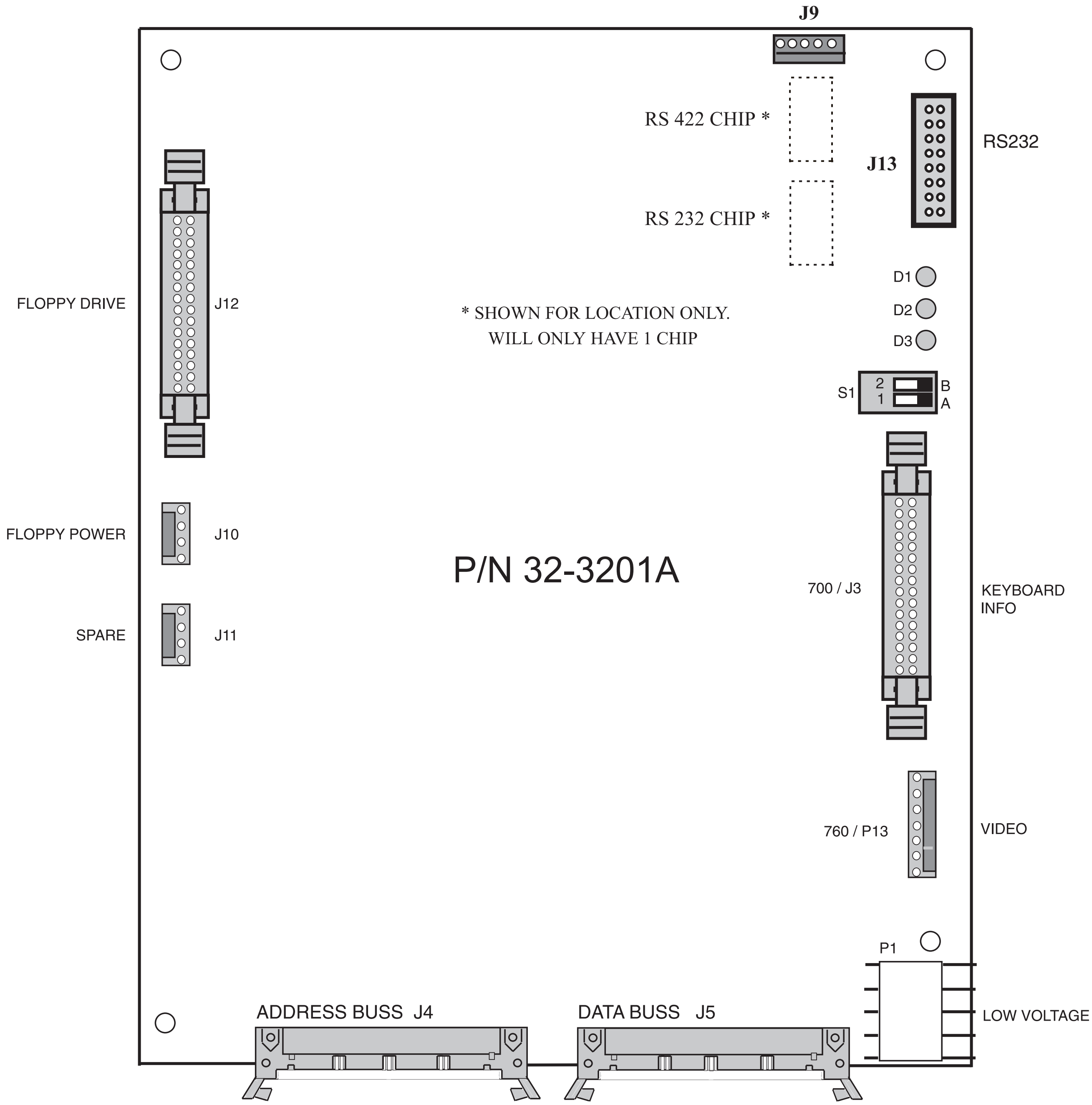


SERIAL KEYBOARD INTERFACE PCB WITH HANDLE JOG P/N 32-4030

SERIAL KEYBOARD INTERFACE PCB WITH HANDLE JOG
P/N 32-4030
CABLE CONNECTIONS

PLUG#	CABLE#	⇨ TO ⇨	LOCATION	PLUG#
P1	700B		PROCESSOR	850
P2	—		KEYPAD	—
P3	700A		CYCLE START/ HOLD SWITCHES	—
P4	730		SP LOAD METER	—
P5	—		SPEAKER	—
P6	—		AUX FPANEL	—
J1	—		JOG HANDLE	—
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.



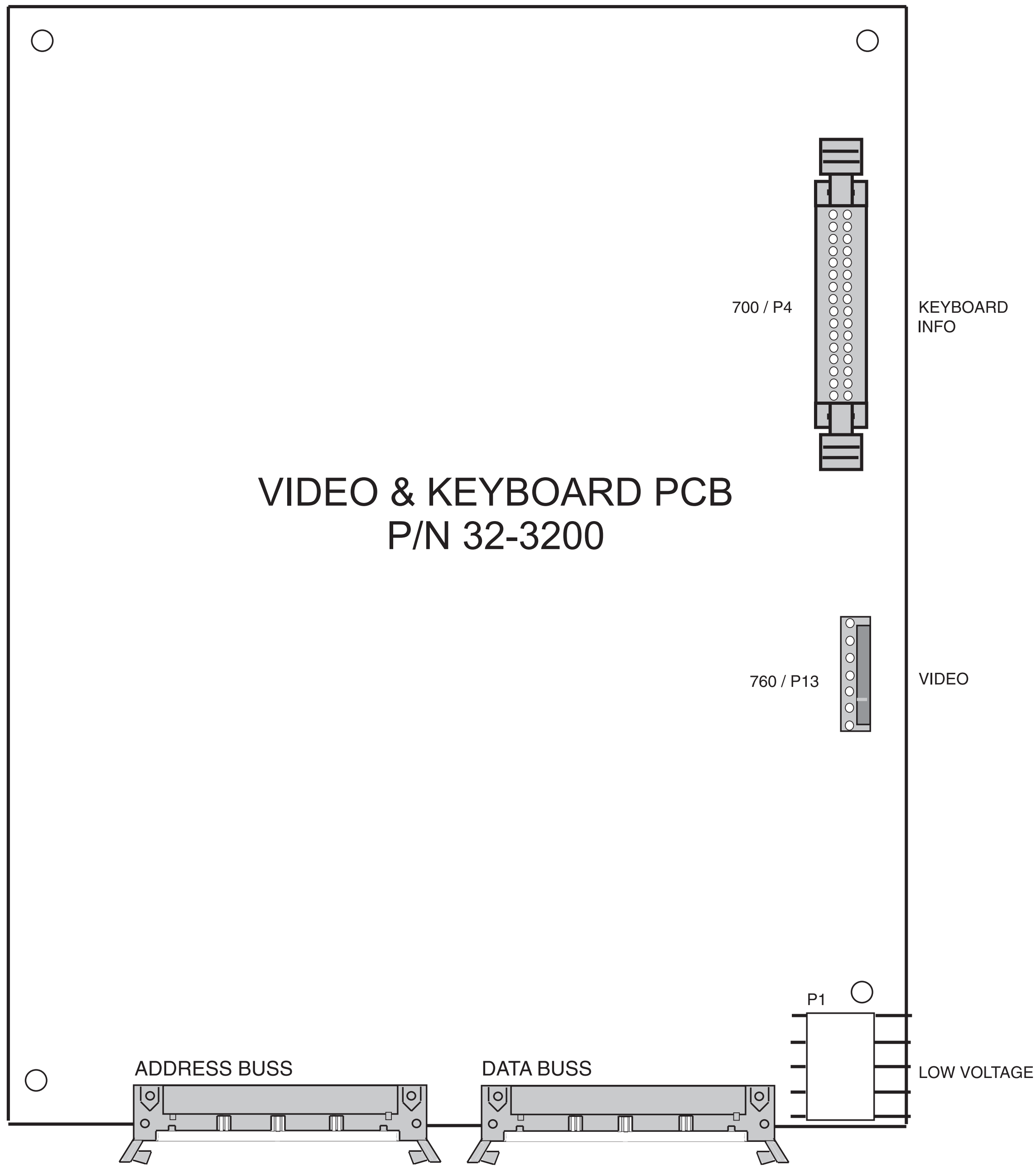
VIDEO & KEYBOARD PCB W/ FLOPPY DRIVE

VIDEO & KEYBOARD PCB W/ FLOPPY DRIVE
P/N 32-3201A
CABLE CONNECTIONS

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

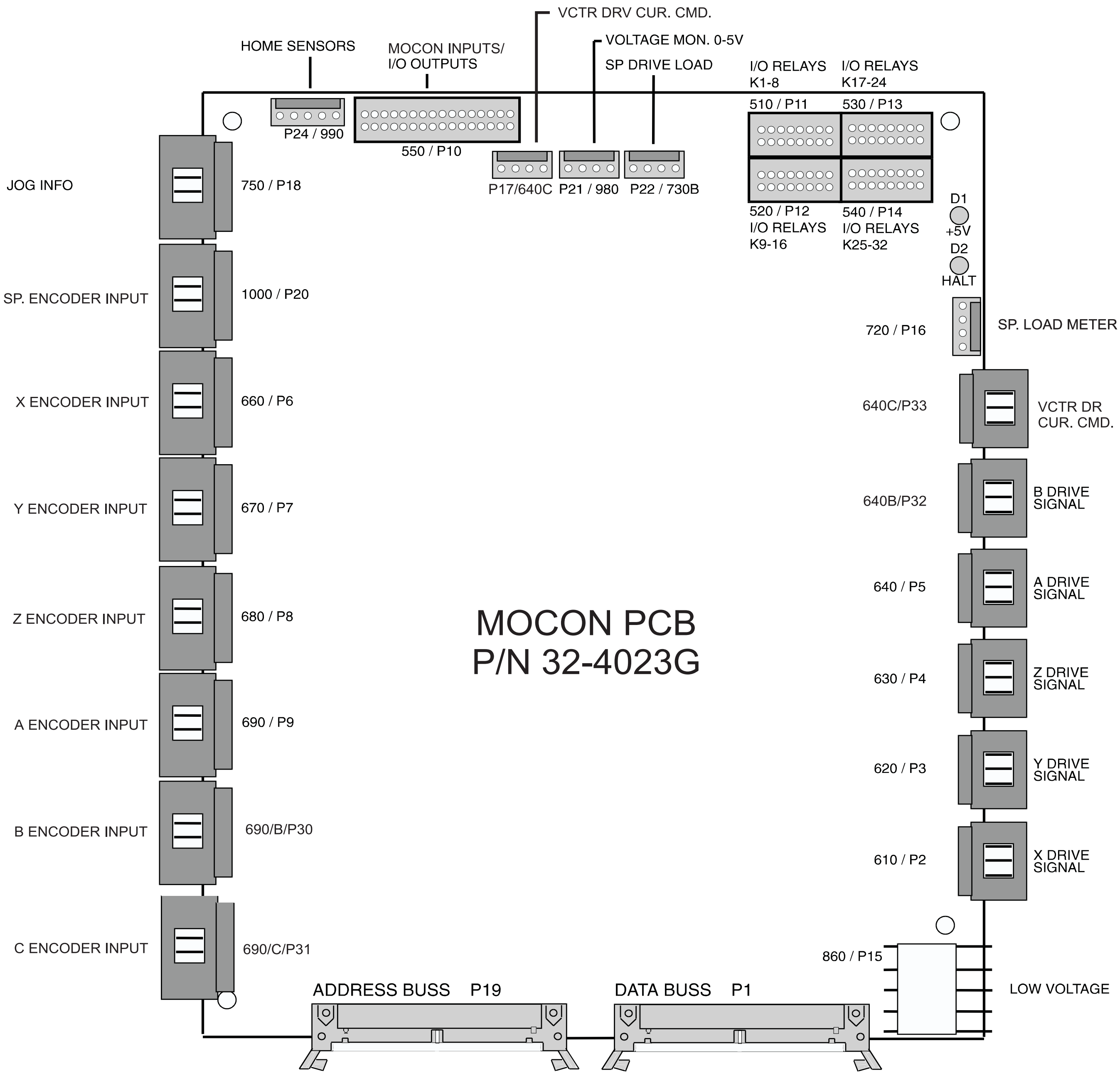
* Not used with Serial Keyboard Interface


700 / P4
KEYBOARD
INFO
VIDEO & KEYBOARD PCB
P/N 32-3200
760 / P13
VIDEO
P1
LOW VOLTAGE
ADDRESS BUSS
DATA BUSS

VIDEO & KEYBOARD PCB - P/N 32-3200
CABLE CONNECTIONS

VIDEO

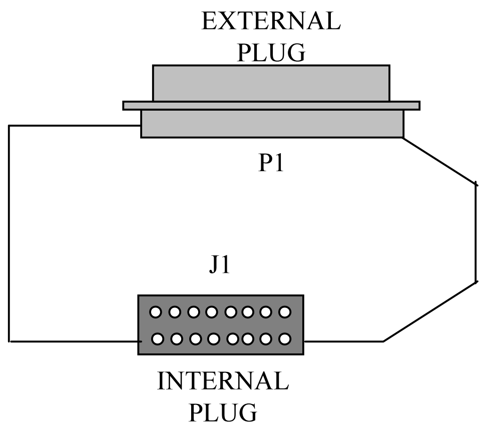
PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨	LOCATION	PLUG #
ADDRESS &	——	ADDRESS BUSS		MICRO PROC. PCB	——
DATA	——-	DATA BUSS		MOTIF PCB	——-
P1	860	LOW VOLTAGE POWER SUPPLY PCB			——-
P13	760	VIDEO SIGNAL		CRT	——
P4	700	KEYBOARD INFO.		KEYBOARD INT.	——-


VCTR DRV CUR. CMD.
VOLTAGE MON. 0-5V
SP DRIVE LOAD
HOME SENSORS
MOCON INPUTS/
I/O OUTPUTS
I/O RELAYS
K1-8
I/O RELAYS
K17-24
510 / P11
530 / P13
P24 / 990
550 / P10
P17/640C
P21 / 980
P22 / 730B
520 / P12
I/O RELAYS
K9-16
540 / P14
I/O RELAYS
K25-32
D1
+5V
D2
HALT
JOG INFO
750 / P18
SP. ENCODER INPUT
1000 / P20
720 / P16
SP. LOAD METER
X ENCODER INPUT
660 / P6
640C/P33
VCTR DR
CUR. CMD.
Y ENCODER INPUT
670 / P7
640B/P32
B DRIVE
SIGNAL
640 / P5
A DRIVE
SIGNAL
Z ENCODER INPUT
680 / P8
MOCON PCB
P/N 32-4023G
630 / P4
Z DRIVE
SIGNAL
A ENCODER INPUT
690 / P9
620 / P3
Y DRIVE
SIGNAL
B ENCODER INPUT
690/B/P30
610 / P2
X DRIVE
SIGNAL
C ENCODER INPUT
690/C/P31
860 / P15
LOW VOLTAGE
ADDRESS BUSS P19
DATA BUSS P1

MOCON PCB - P/N 32-4023G
CABLE CONNECTIONS

MOCON

PLUG #	CABLE #	SIGNAL NAME ⇨ TO ⇨	LOCATION	PLUG #
P1	——-	DATA BUSS	VIDEO PCB	——-
			MICRO PROC. PCB	——-
P2	610	X DRIVE SIGNAL	X SERVO DRIVE AMP.	P
P3	620	Y DRIVE SIGNAL	Y SERVO DRIVE AMP.	P
P4	630	Z DRIVE SIGNAL	Z SERVO DRIVE AMP.	P
P5	640	A DRIVE SIGNAL	A SERVO DRIVE AMP.	P
P32	640B	B DRIVE SIGNAL	B SERVO DRIVE AMP.	P
P6	660	X ENCODER INPUT	X ENCODER	——-
P7	670	Y ENCODER INPUT	Y ENCODER	——-
P8	680	Z ENCODER INPUT	Z ENCODER	——-
P9	690	A ENCODER INPUT	A ENCODER	——-
P30	690B	B ENCODER INPUT	B ENCODER	——-
P10	550	MOTIF INPUTS/		
		I/O OUTPUTS	I/O PCB	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	640C	VCTR DR CUR. CMD.	SPINDLE DRIVE	J3
P18	750	JOG INFO	JOG HANDLE	——-
P19		ADDRESS BUSS	VIDEO PCB	——-
			MICRO PROC. PCB	——-
P20	1000	SP. ENCODER OUTPUT	SPINDLE ENCODER	——-
P21	980	VOLTAGE MONITOR	N/A	N/A
P22	730B	SP. DRIVE LOAD	SPINDLE DRIVE	——-
P24	990	HOME SENSORS	X, Y & Z LIMIT	——-
P33	640C	VCTR DR CUR. CMD.	SPINDLE DRIVE	J3

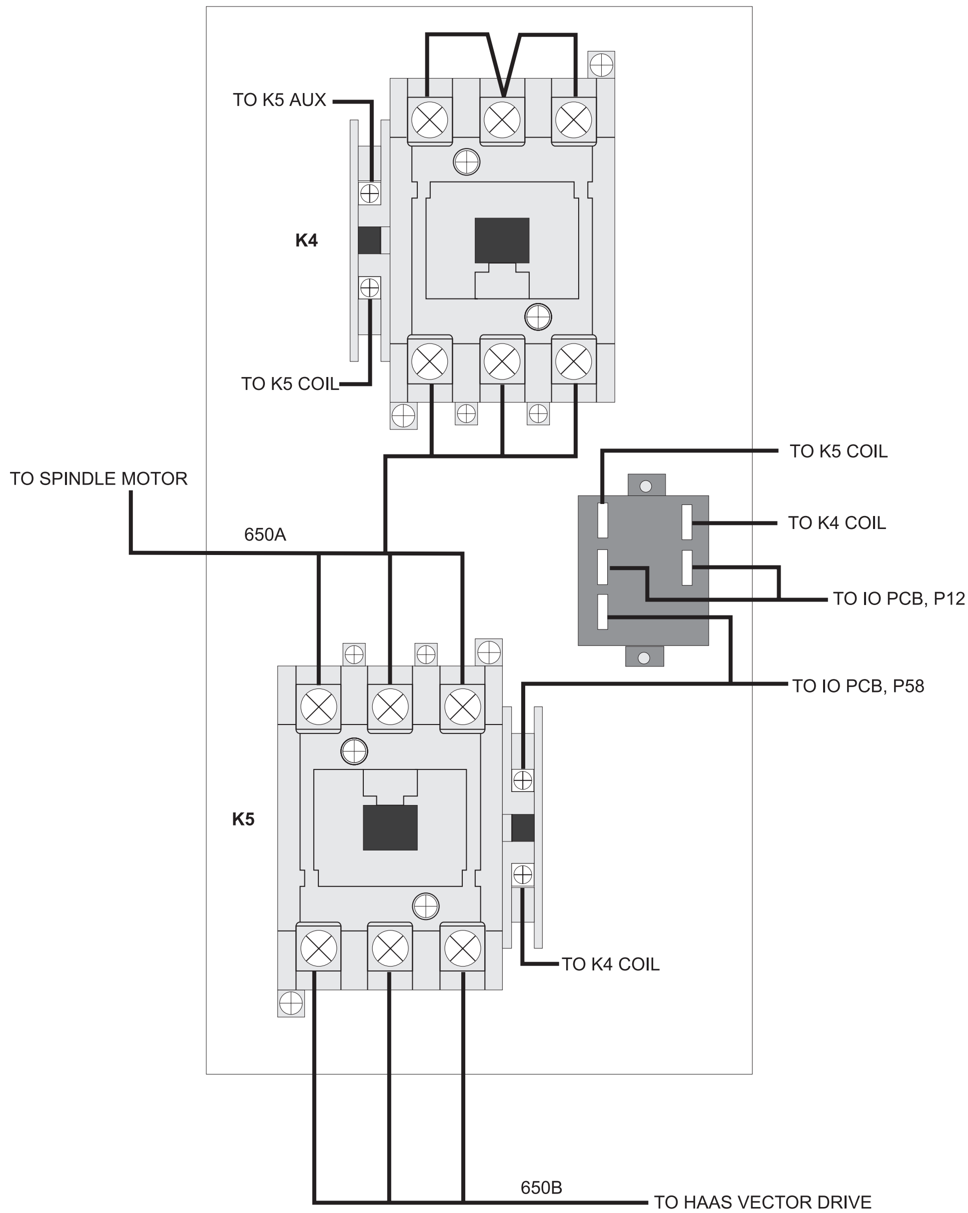


RS-232 PORT #1 PCB - P/N 32-4090

CABLE CONNECTIONS

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

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



9. CABLE LIST

JUNE 1998

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 LOAD STATION INPUT SWITCH - SHIELD +2
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 PALLETS UP AND DOWN INPUTS - SHIELD +3
241 PALLETS UP #20
242 PALLETS DOWN #20
243 COMMON #20
244 SHIELD DRAIN

250 115 VAC TO TOOL CHANGER SHUTTLE VALVE - SHIELD +2
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

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 LIMIT SWITCH TOOL CHANGER DOOR

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 SPARE
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 HANDJE 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)

850A SERIAL PORT #2 INTERFACE CABLE (16 WIRE RIBBON #24)

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

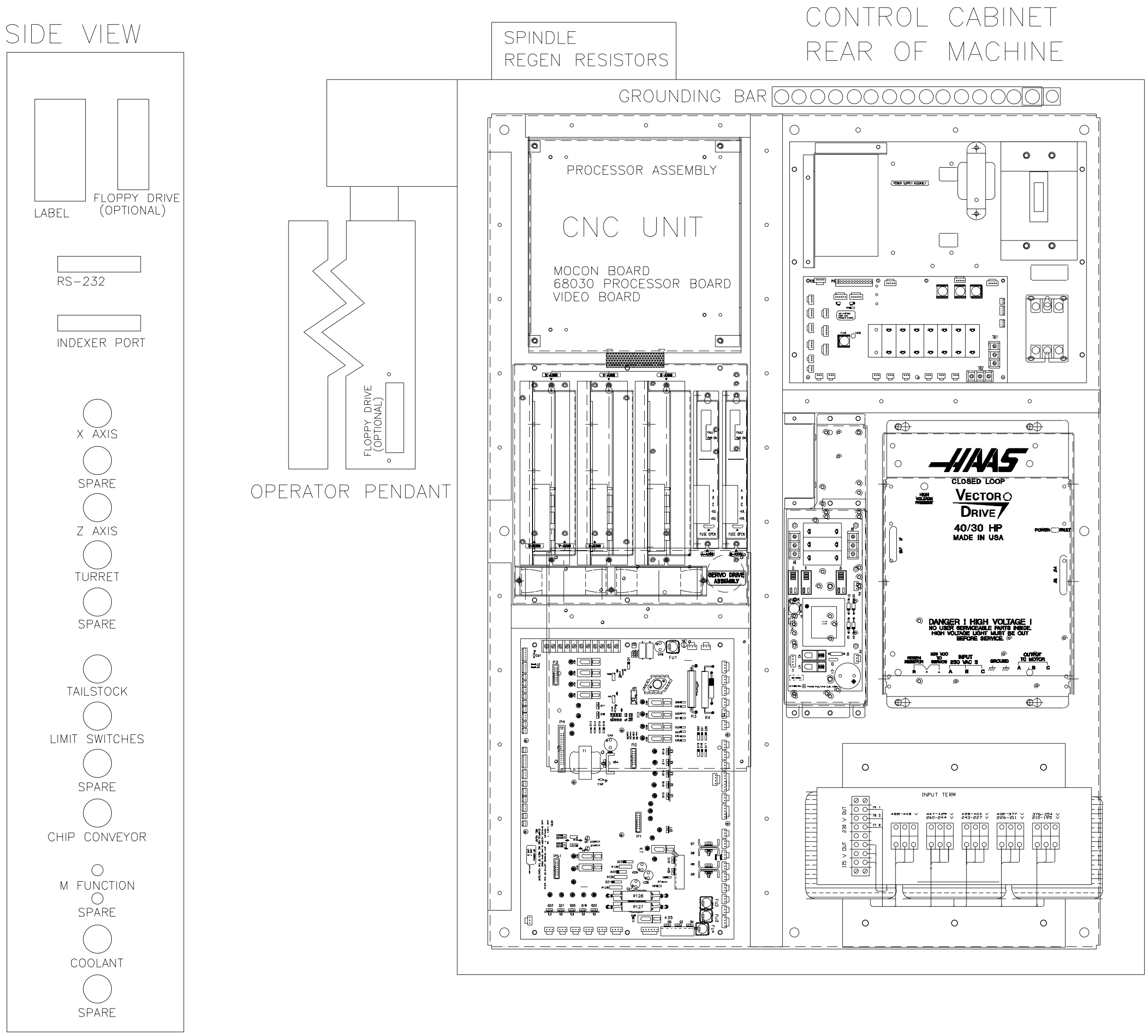
1060 SPARE (GROUND FAULT DETECTION SENSE INPUT)

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

——— END ———

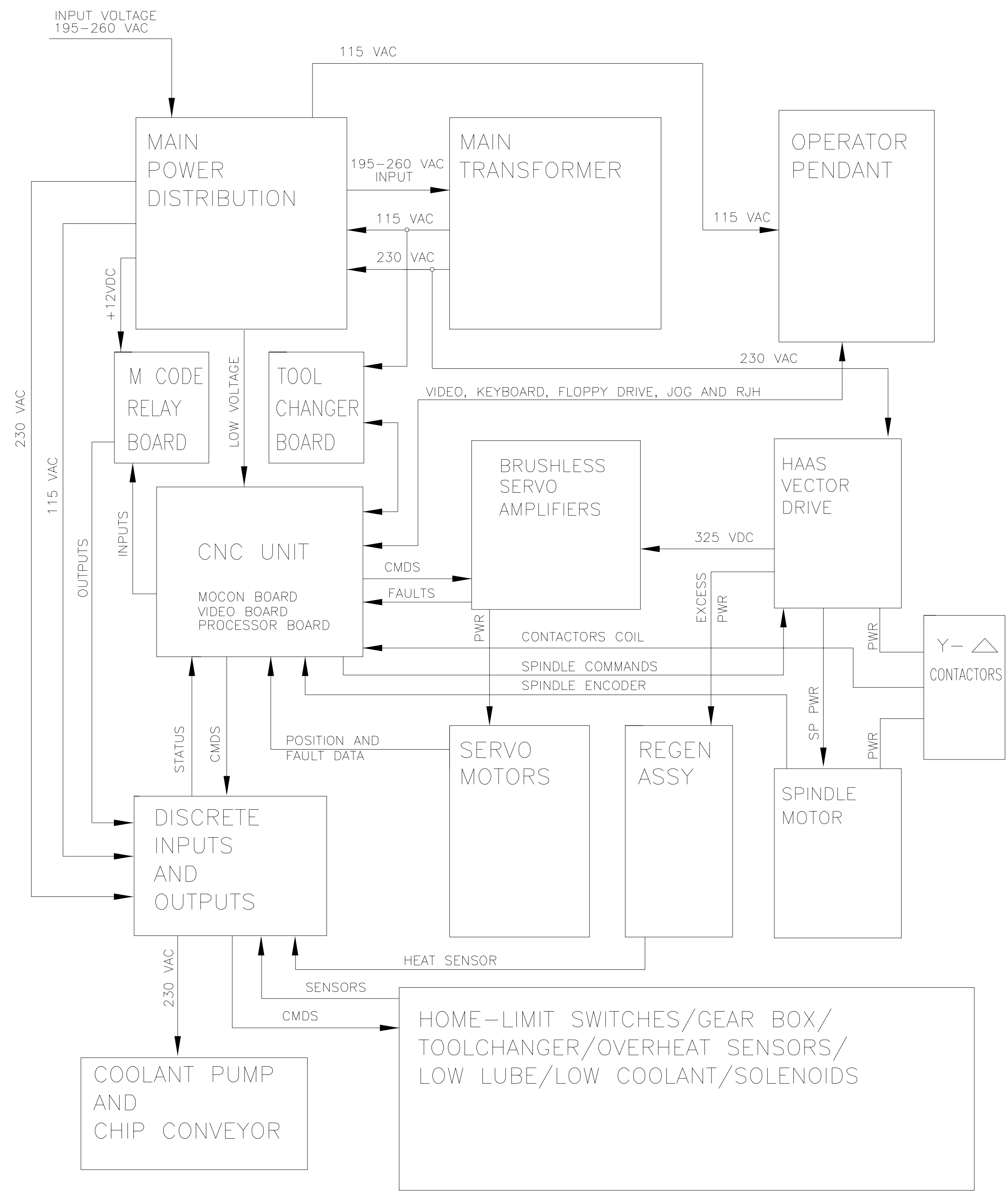
ELECTRICAL WIRING DIAGRAMS



ITEM DESCRIPTION	PAGE #	ITEM DESCRIPTION	PAGE #
CNC LAYOUT	A	RELAY COIL DRIVERS, IOPCB	8-11
SYSTEM BLOCK DIAGRAM	B,C	SPINDLE DRIVE UNIT	12
CABLE INTERCONNECT DIAGRAM	D	AXIS MOTOR & ENCODER	13,14
SERVO SYSTEM	1	CABINET CONNECTORS	15
MAIN TRANSFORMER	2,3	TOOL CHANGE MOTORS	16
CNC UNIT	4	CHIP CONVEYOR	17
115VAC CIRCUITS	5	OPERATOR PENDANT	18
INPUTS IOPCB	6,7	ELECTRICAL SYMBOLS	19

CONTROL LAYOUT DIAGRAM

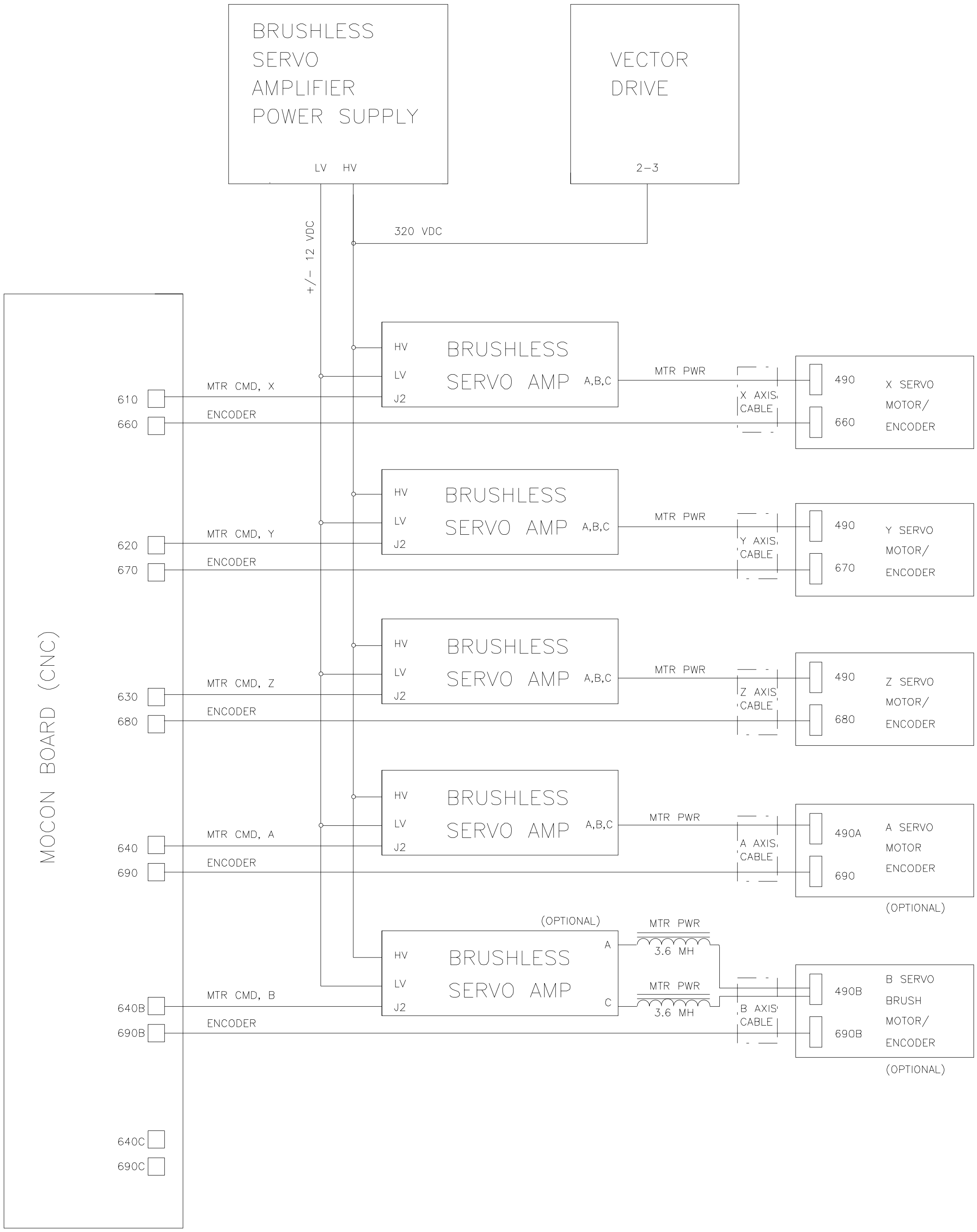
6/98 HAAS AUTOMATION HL SERIES PAGE A



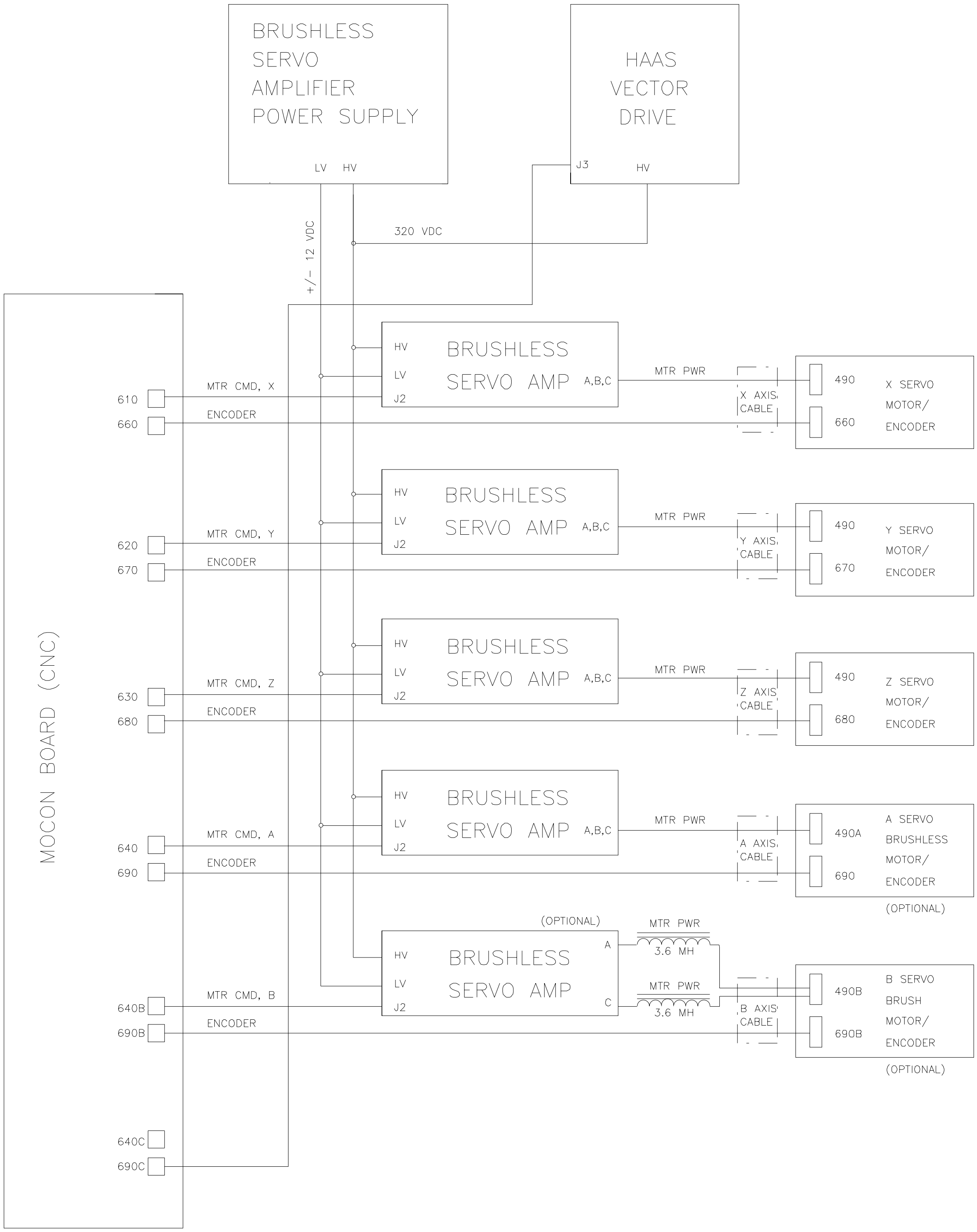
NOTE FOR HIGH VOLTAGE IN, SEE PAGE C.

SYSTEM BLOCK DIAGRAM – LOW VOLTAGE

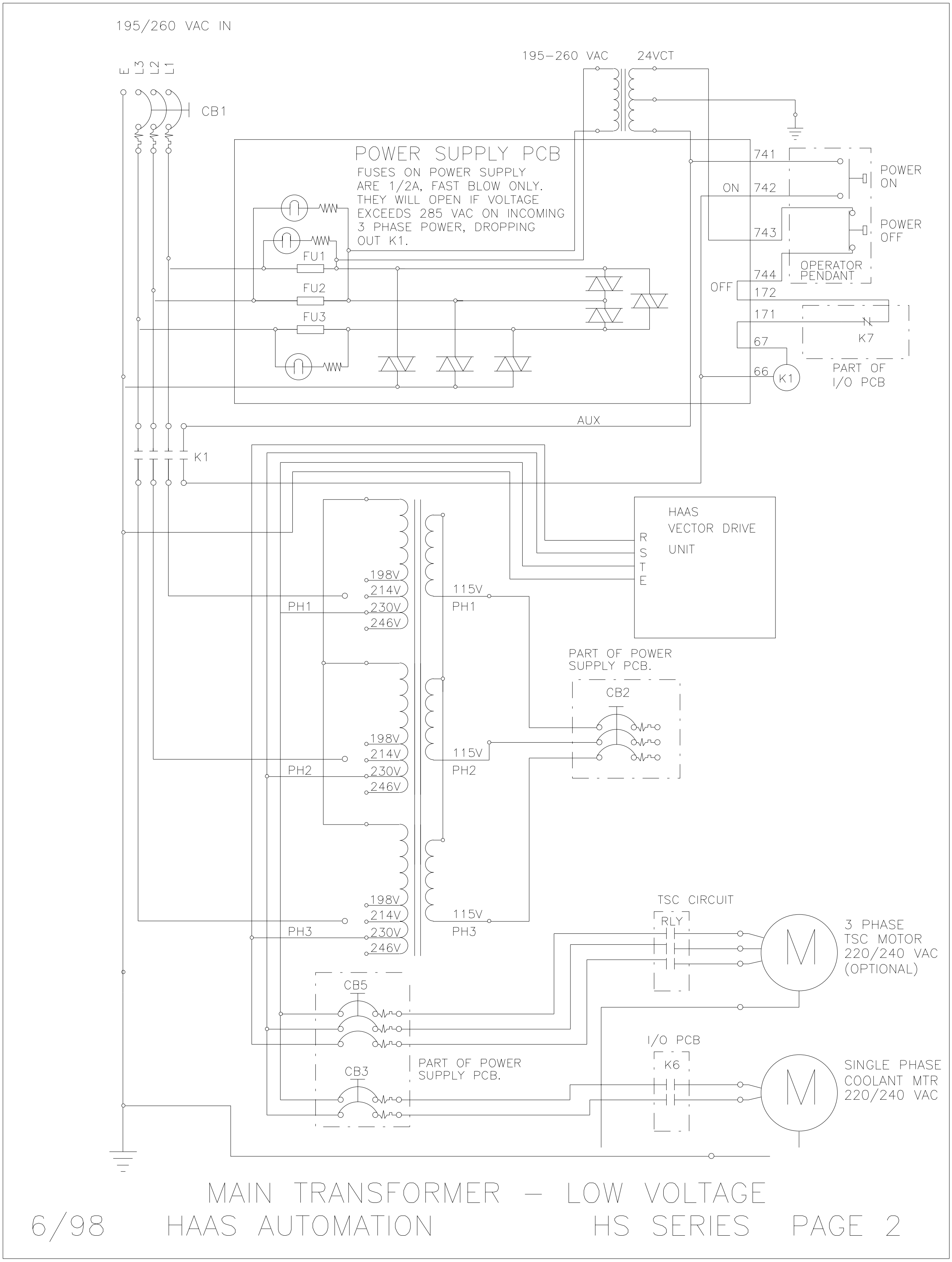
6/98 HAAS AUTOMATION HS SERIES PAGE B

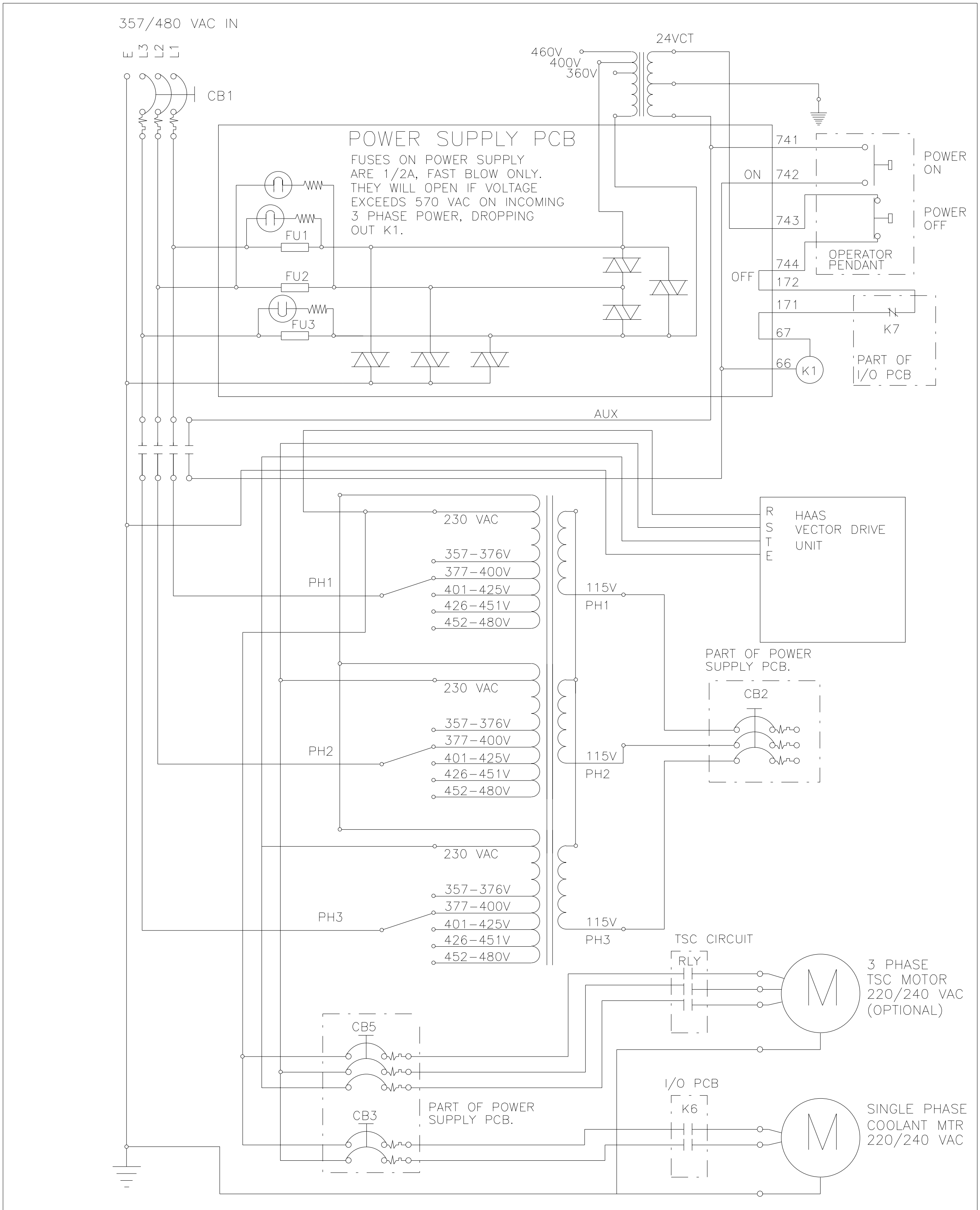


SERVO SYSTEM
HS-1 WITH BRUSH 5TH AXIS OPTION
6/98 HAAS AUTOMATION PAGE 1



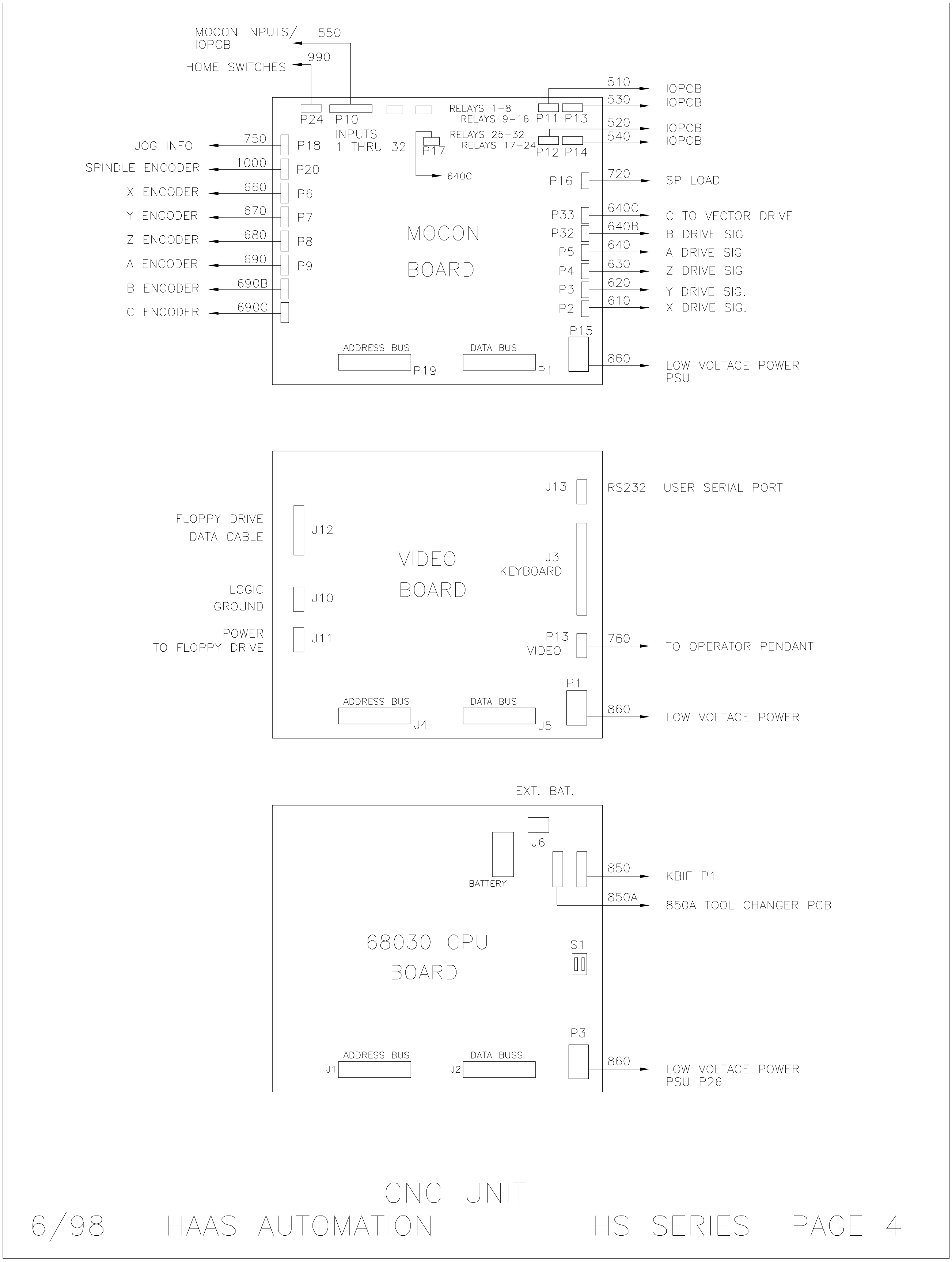
SERVO SYSTEM
HS-1 4TH AXIS BL AND 5TH AXIS OPTION (BRUSH)
6/98 HAAS AUTOMATION PAGE 1A

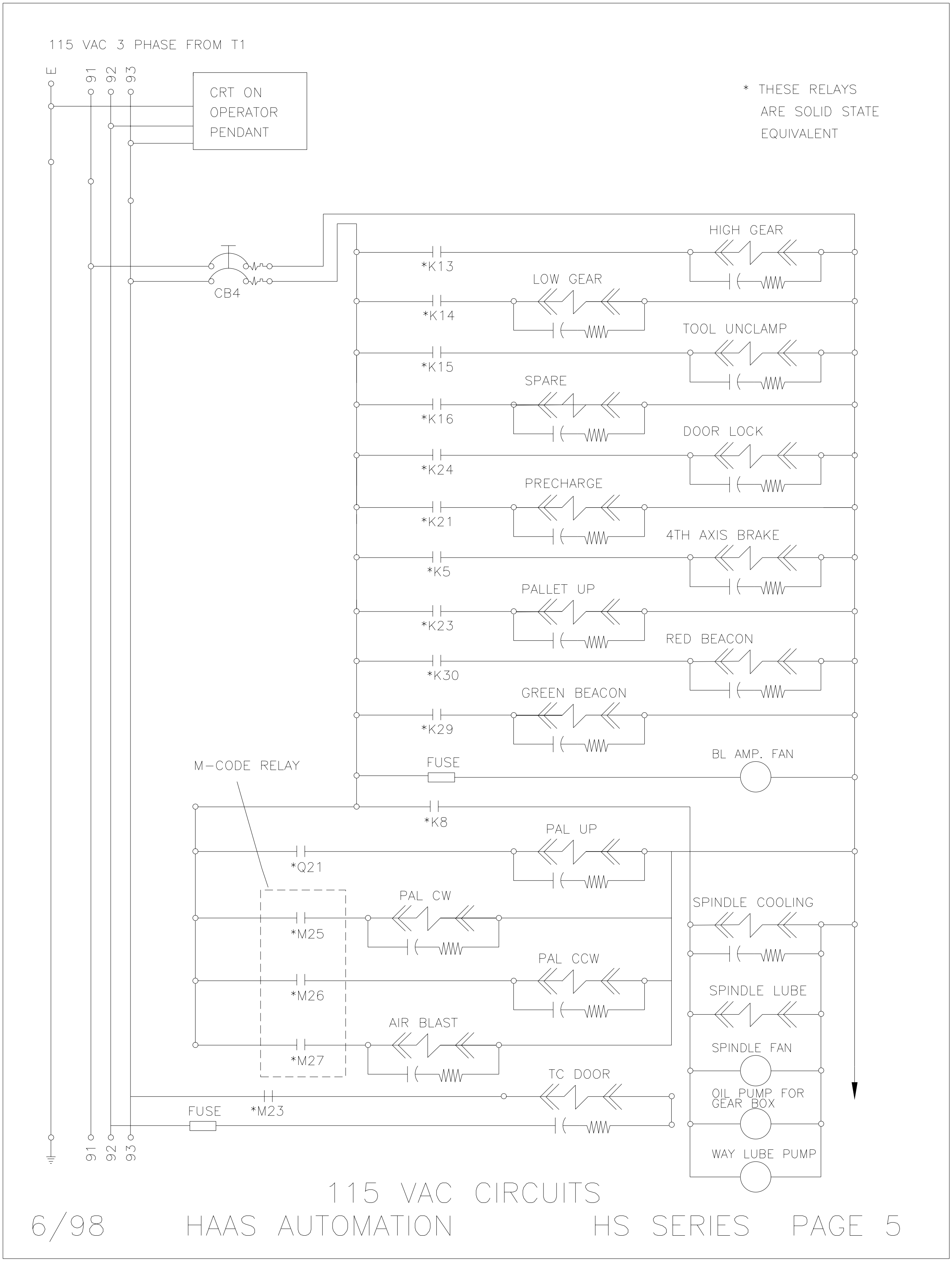

195/260 VAC IN
E L3 L2 L1
CB1
195-260 VAC
24VCT
POWER SUPPLY PCB
FUSES ON POWER SUPPLY
ARE 1/2A, FAST BLOW ONLY.
THEY WILL OPEN IF VOLTAGE
EXCEEDS 285 VAC ON INCOMING
3 PHASE POWER, DROPPING
OUT K1.
FU1
FU2
FU3
741
ON 742
743
744
OFF 172
171
67
66
POWER ON
POWER OFF
OPERATOR PENDANT
K7
K1
PART OF I/O PCB
AUX
K1
HAAS VECTOR DRIVE UNIT
R
S
T
E
198V
214V
230V
246V
PH1
115V
PH1
PART OF POWER SUPPLY PCB.
CB2
PH2
115V
PH2
PH3
115V
PH3
TSC CIRCUIT
RLY
M
3 PHASE TSC MOTOR 220/240 VAC (OPTIONAL)
CB5
CB3
PART OF POWER SUPPLY PCB.
I/O PCB
K6
M
SINGLE PHASE COOLANT MTR 220/240 VAC
MAIN TRANSFORMER - LOW VOLTAGE
6/98 HAAS AUTOMATION HS SERIES PAGE 2

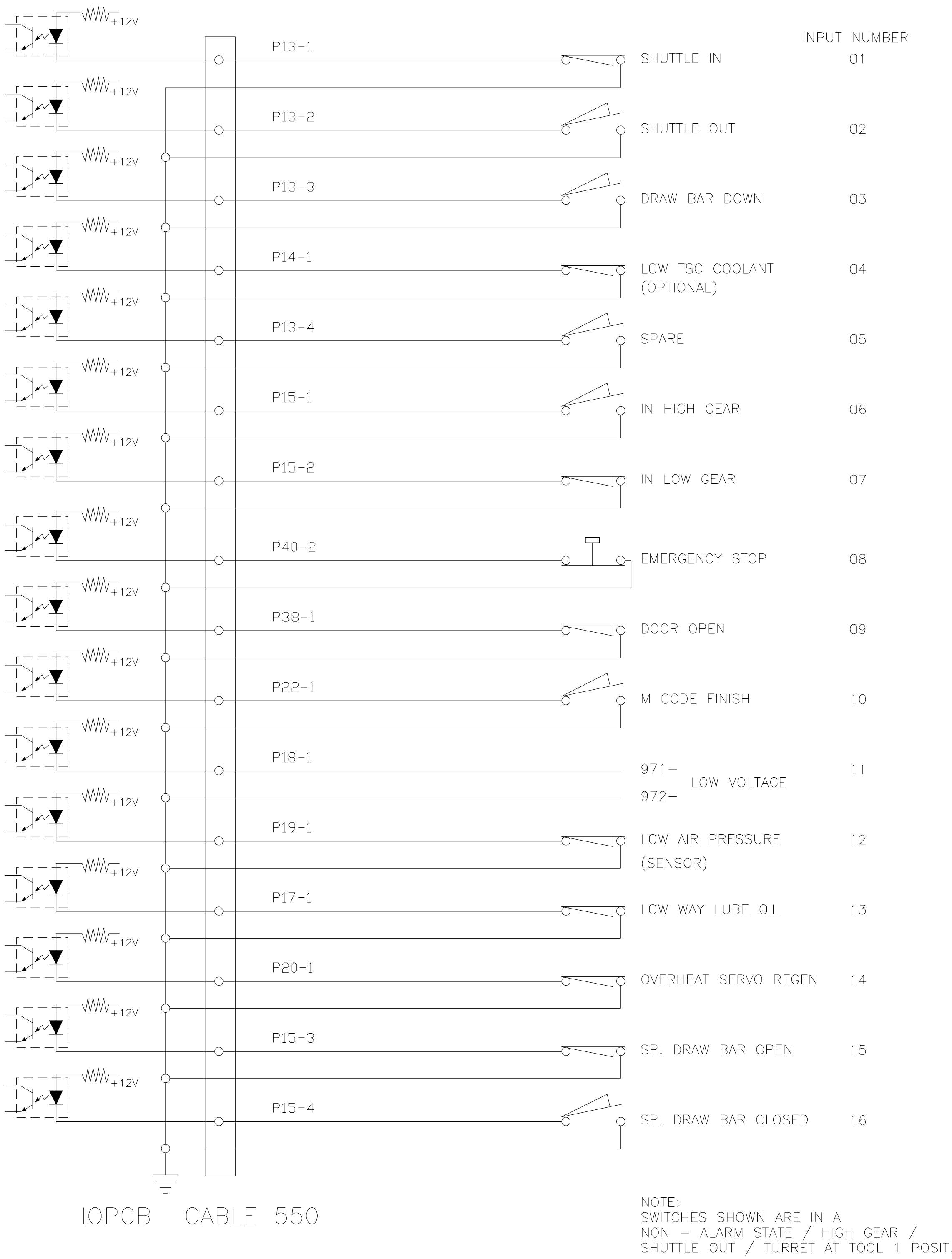


MAIN TRANSFORMER - HIGH VOLTAGE

6/98 HAAS AUTOMATION HS SERIES PAGE 3

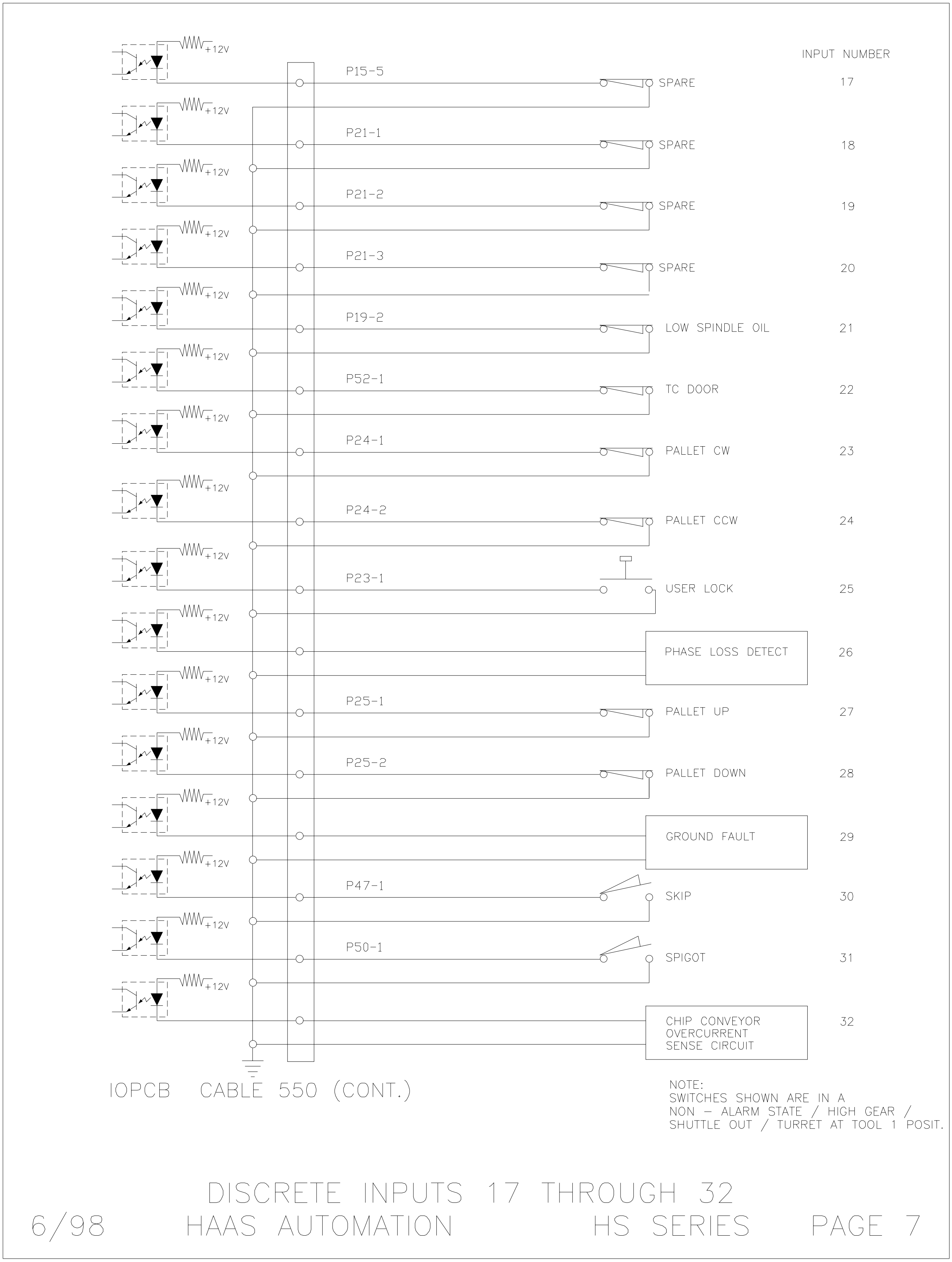

MOCON INPUTS/
IOPCB
550
990
HOME SWITCHES
510
530
520
540
IOPCB
IOPCB
IOPCB
IOPCB
P24
P10
INPUTS
1 THRU 32
RELAYS 1-8
RELAYS 9-16
RELAYS 25-32
RELAYS 17-24
P11 P13
P12 P14
P17
640C
JOG INFO
750
P18
SPINDLE ENCODER
1000
P20
X ENCODER
660
P6
Y ENCODER
670
P7
Z ENCODER
680
P8
A ENCODER
690
P9
B ENCODER
690B
C ENCODER
690C
MOCON
BOARD
P16
720
SP LOAD
P33
640C
C TO VECTOR DRIVE
P32
640B
B DRIVE SIG
P5
640
A DRIVE SIG
P4
630
Z DRIVE SIG
P3
620
Y DRIVE SIG.
P2
610
X DRIVE SIG.
P15
ADDRESS BUS
DATA BUS
P19
P1
860
LOW VOLTAGE POWER
PSU
J13
RS232 USER SERIAL PORT
FLOPPY DRIVE
DATA CABLE
J12
VIDEO
BOARD
J3
KEYBOARD
LOGIC
GROUND
J10
POWER
TO FLOPPY DRIVE
J11
P13
VIDEO
760
TO OPERATOR PENDANT
P1
ADDRESS BUS
DATA BUS
J4
J5
860
LOW VOLTAGE POWER
EXT. BAT.
J6
BATTERY
850
KBIF P1
850A
850A TOOL CHANGER PCB
68030 CPU
BOARD
S1
P3
ADDRESS BUS
DATA BUSS
J1
J2
860
LOW VOLTAGE POWER
PSU P26
CNC UNIT
6/98 HAAS AUTOMATION HS SERIES PAGE 4

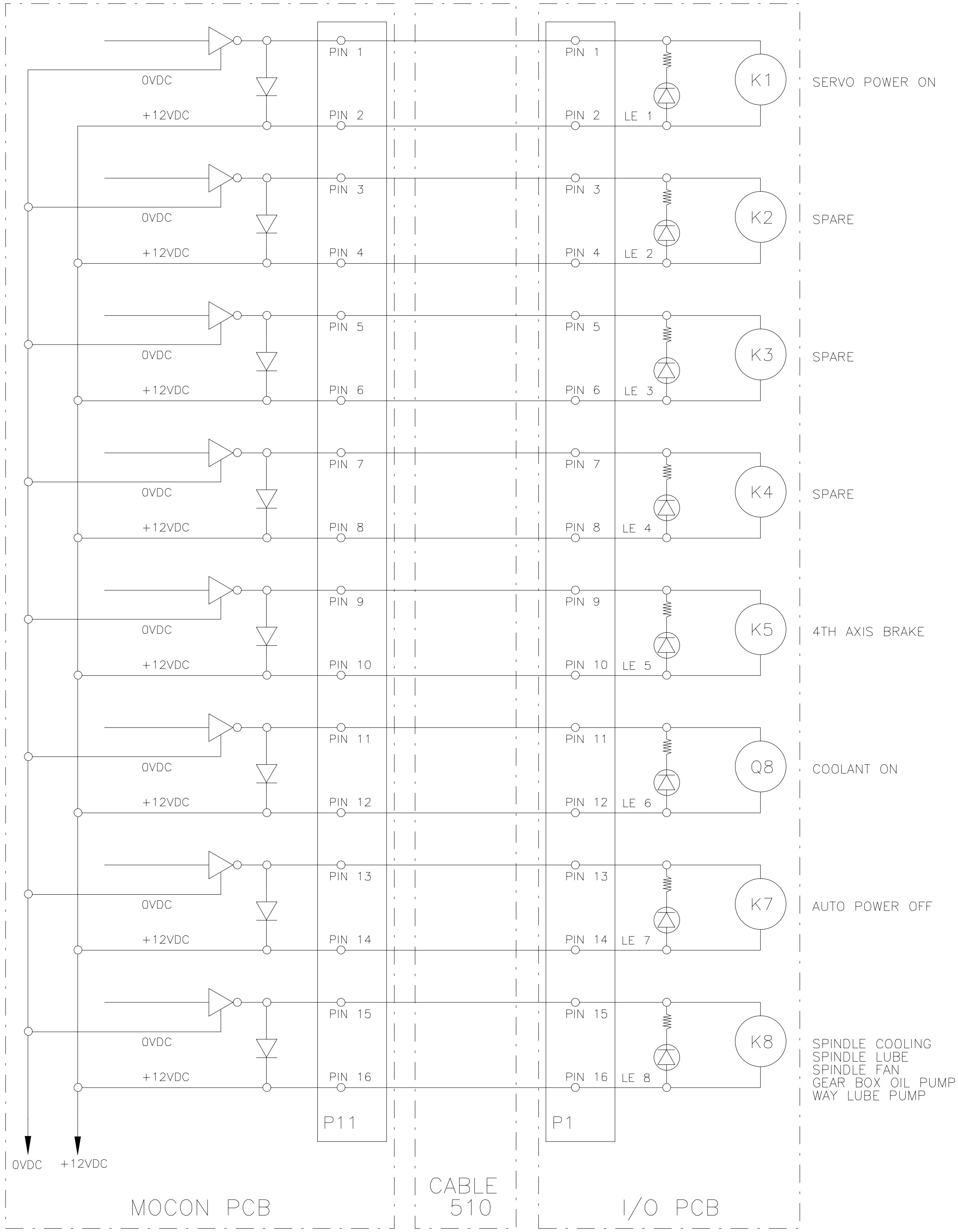

115 VAC 3 PHASE FROM T1
E
91
92
93
CRT ON
OPERATOR
PENDANT
* THESE RELAYS
ARE SOLID STATE
EQUIVALENT
CB4
HIGH GEAR
*K13
LOW GEAR
*K14
TOOL UNCLAMP
*K15
SPARE
*K16
DOOR LOCK
*K24
PRECHARGE
*K21
4TH AXIS BRAKE
*K5
PALLET UP
*K23
RED BEACON
*K30
GREEN BEACON
*K29
M-CODE RELAY
FUSE
BL AMP. FAN
*K8
PAL UP
*Q21
PAL CW
*M25
SPINDLE COOLING
PAL CCW
*M26
SPINDLE LUBE
AIR BLAST
*M27
SPINDLE FAN
TC DOOR
FUSE
*M23
OIL PUMP FOR
GEAR BOX
WAY LUBE PUMP
91
92
93
115 VAC CIRCUITS
6/98
HAAS AUTOMATION
HS SERIES
PAGE 5



DISCRETE INPUTS 1 THROUGH 16

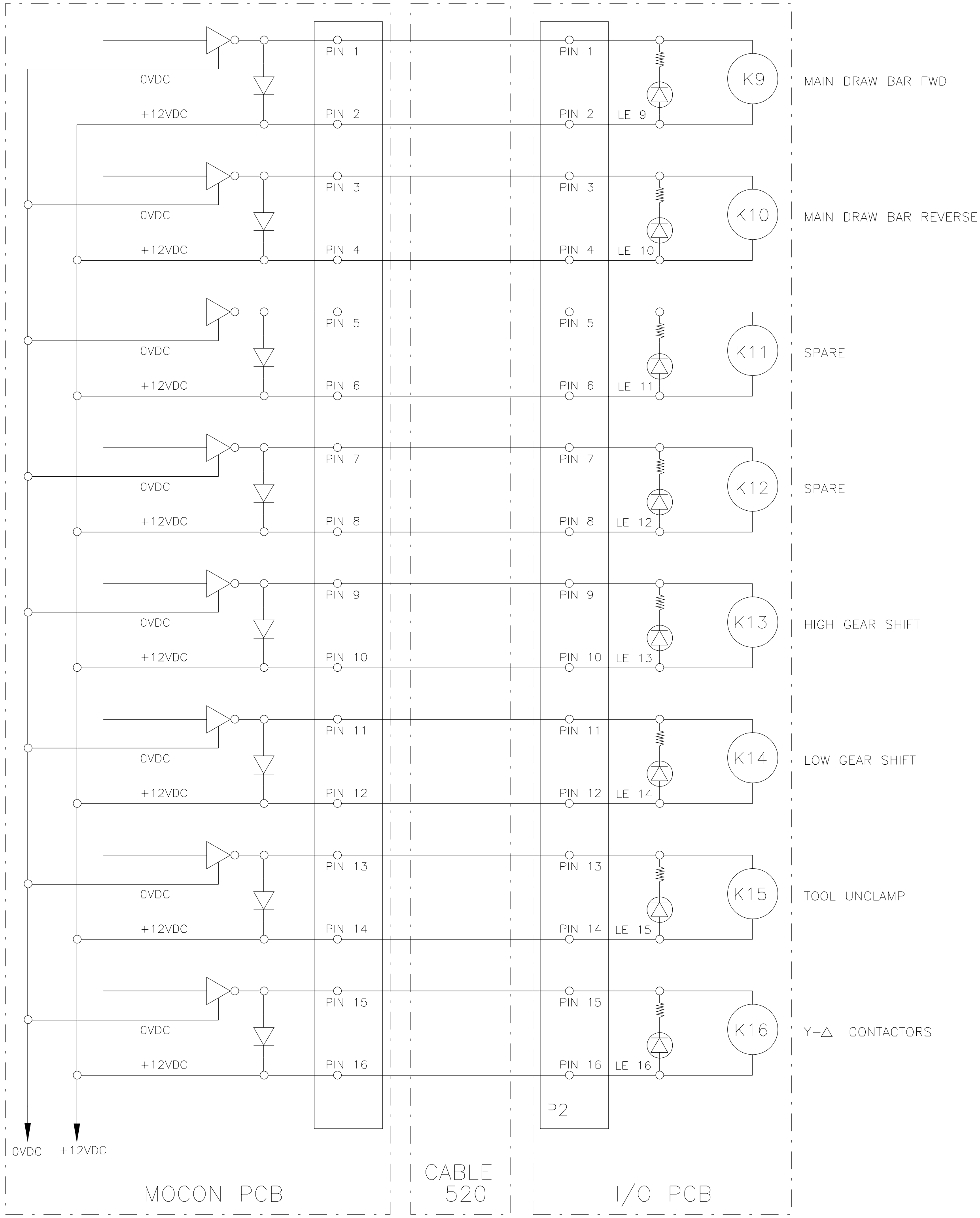
6/98 HAAS AUTOMATION HS SERIES PAGE 6


INPUT NUMBER
+12V
P15-5
SPARE
17
P21-1
SPARE
18
P21-2
SPARE
19
P21-3
SPARE
20
P19-2
LOW SPINDLE OIL
21
P52-1
TC DOOR
22
P24-1
PALLET CW
23
P24-2
PALLET CCW
24
P23-1
USER LOCK
25
PHASE LOSS DETECT
26
P25-1
PALLET UP
27
P25-2
PALLET DOWN
28
GROUND FAULT
29
P47-1
SKIP
30
P50-1
SPIGOT
31
CHIP CONVEYOR
OVERCURRENT
SENSE CIRCUIT
32
IOPCB CABLE 550 (CONT.)
NOTE:
SWITCHES SHOWN ARE IN A
NON – ALARM STATE / HIGH GEAR /
SHUTTLE OUT / TURRET AT TOOL 1 POSIT.
DISCRETE INPUTS 17 THROUGH 32
6/98 HAAS AUTOMATION HS SERIES PAGE 7



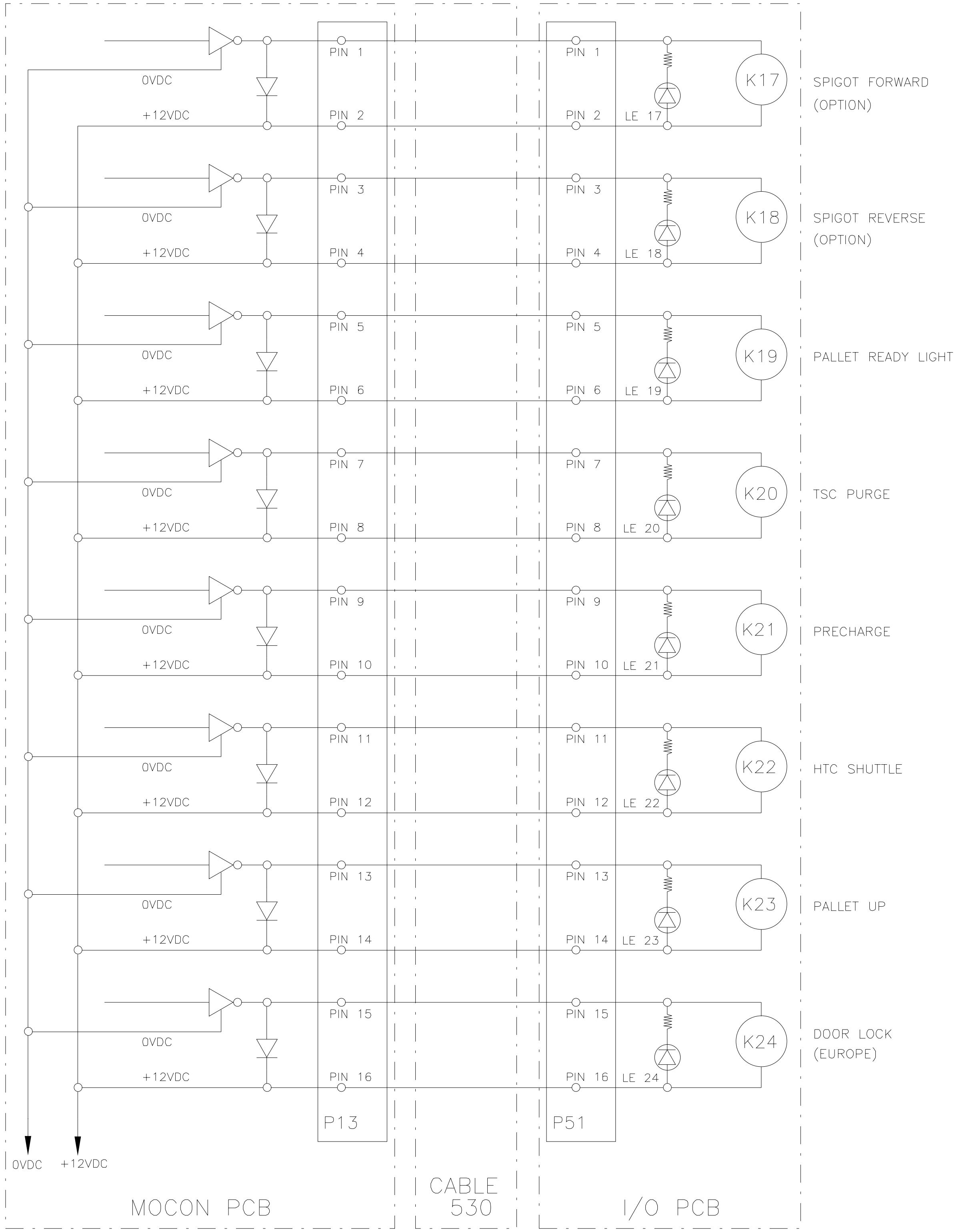
RELAY COIL DRIVERS, K1 THROUGH K8

6/98 HAAS AUTOMATION HS SERIES PAGE 8



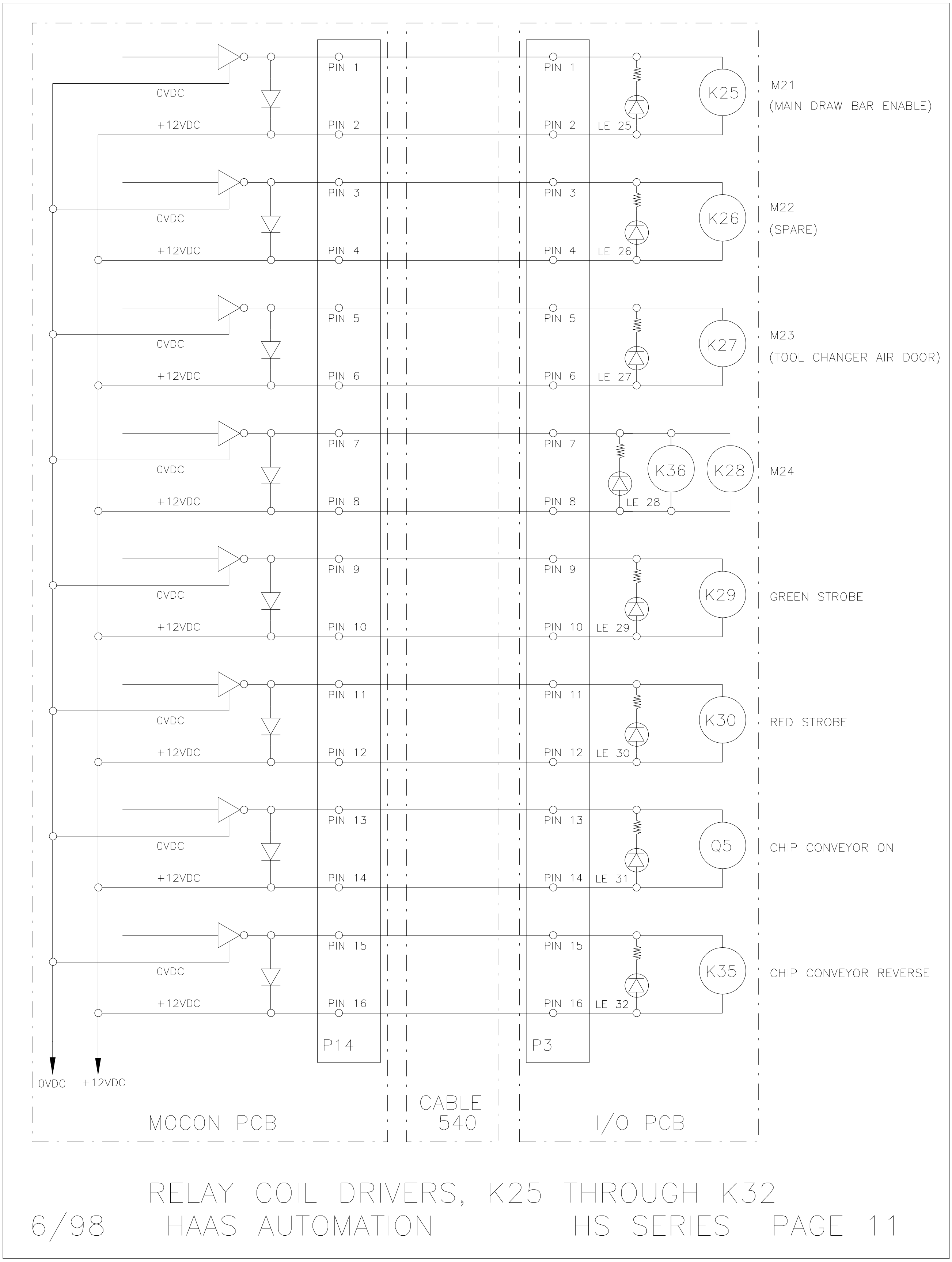
RELAY COIL DRIVERS, K9 THROUGH K16

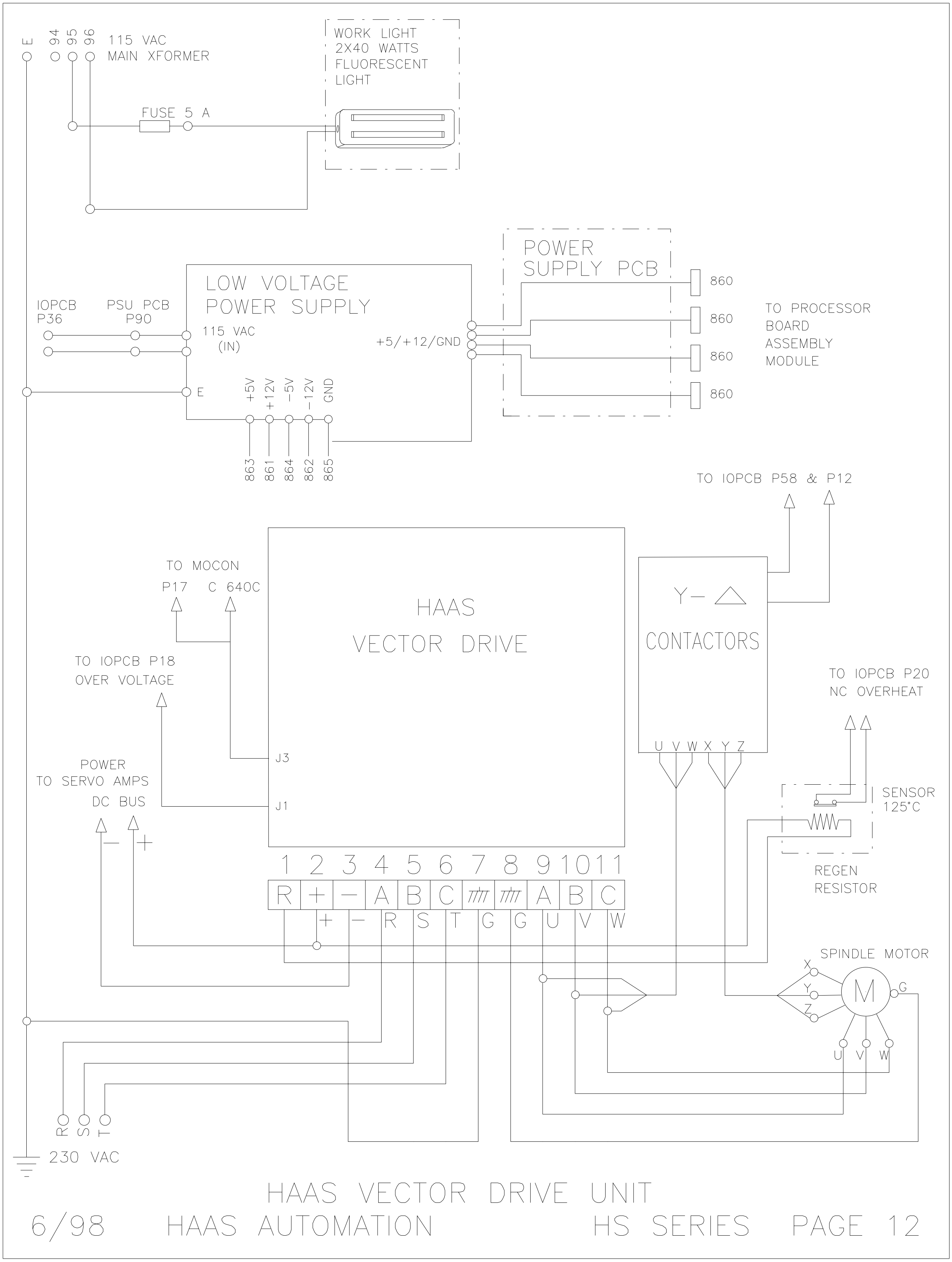
6/98 HAAS AUTOMATION HS SERIES PAGE 9



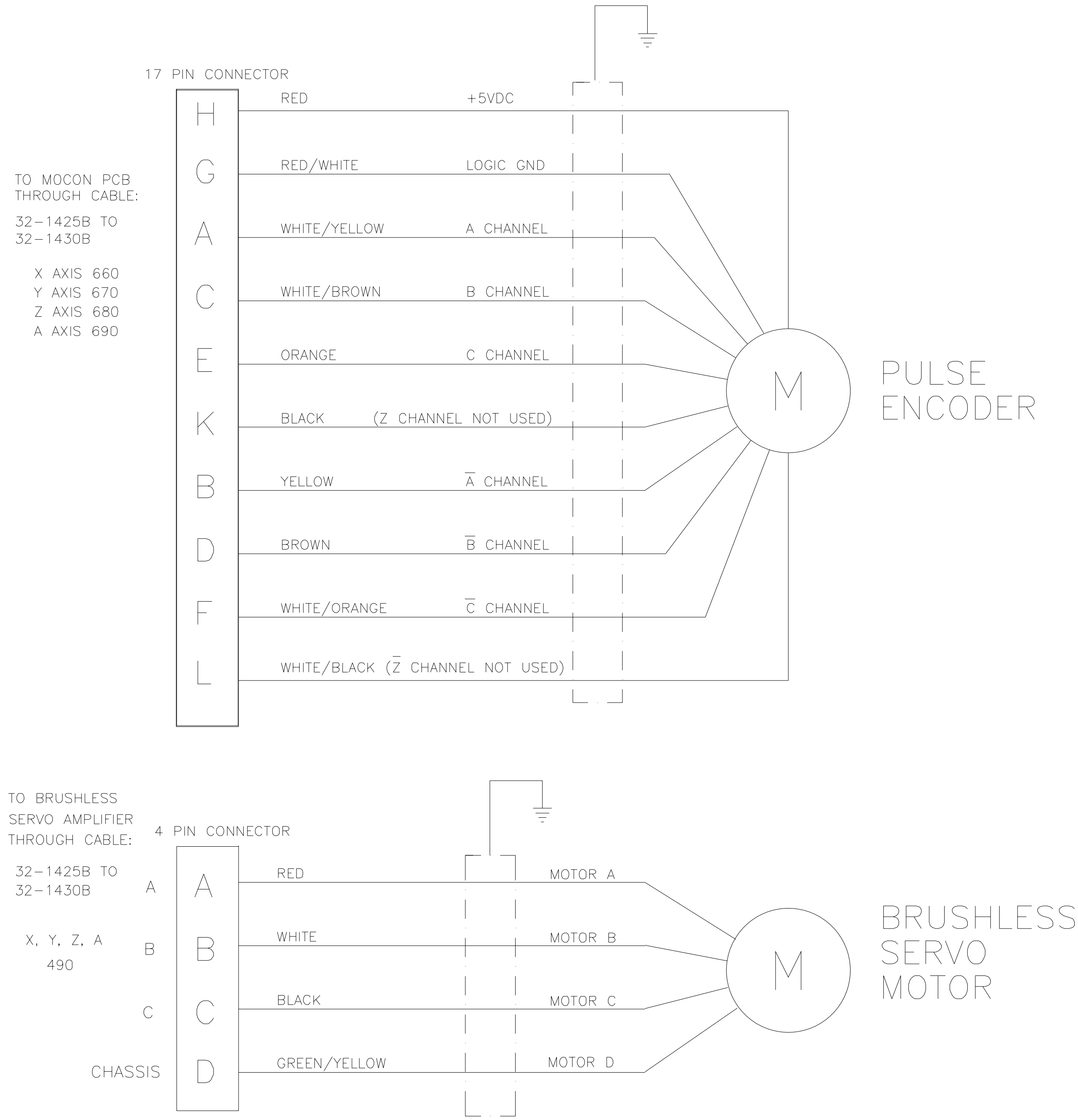
RELAY COIL DRIVERS, K17 THROUGH K24

6/98 HAAS AUTOMATION HS SERIES PAGE 10


PIN 1
PIN 2
PIN 3
PIN 4
PIN 5
PIN 6
PIN 7
PIN 8
PIN 9
PIN 10
PIN 11
PIN 12
PIN 13
PIN 14
PIN 15
PIN 16
0VDC
+12VDC
P14
P3
K25
LE 25
M21
(MAIN DRAW BAR ENABLE)
K26
LE 26
M22
(SPARE)
K27
LE 27
M23
(TOOL CHANGER AIR DOOR)
K36
K28
LE 28
M24
K29
LE 29
GREEN STROBE
K30
LE 30
RED STROBE
Q5
LE 31
CHIP CONVEYOR ON
K35
LE 32
CHIP CONVEYOR REVERSE
MOCON PCB
CABLE 540
I/O PCB
RELAY COIL DRIVERS, K25 THROUGH K32
6/98 HAAS AUTOMATION HS SERIES PAGE 11

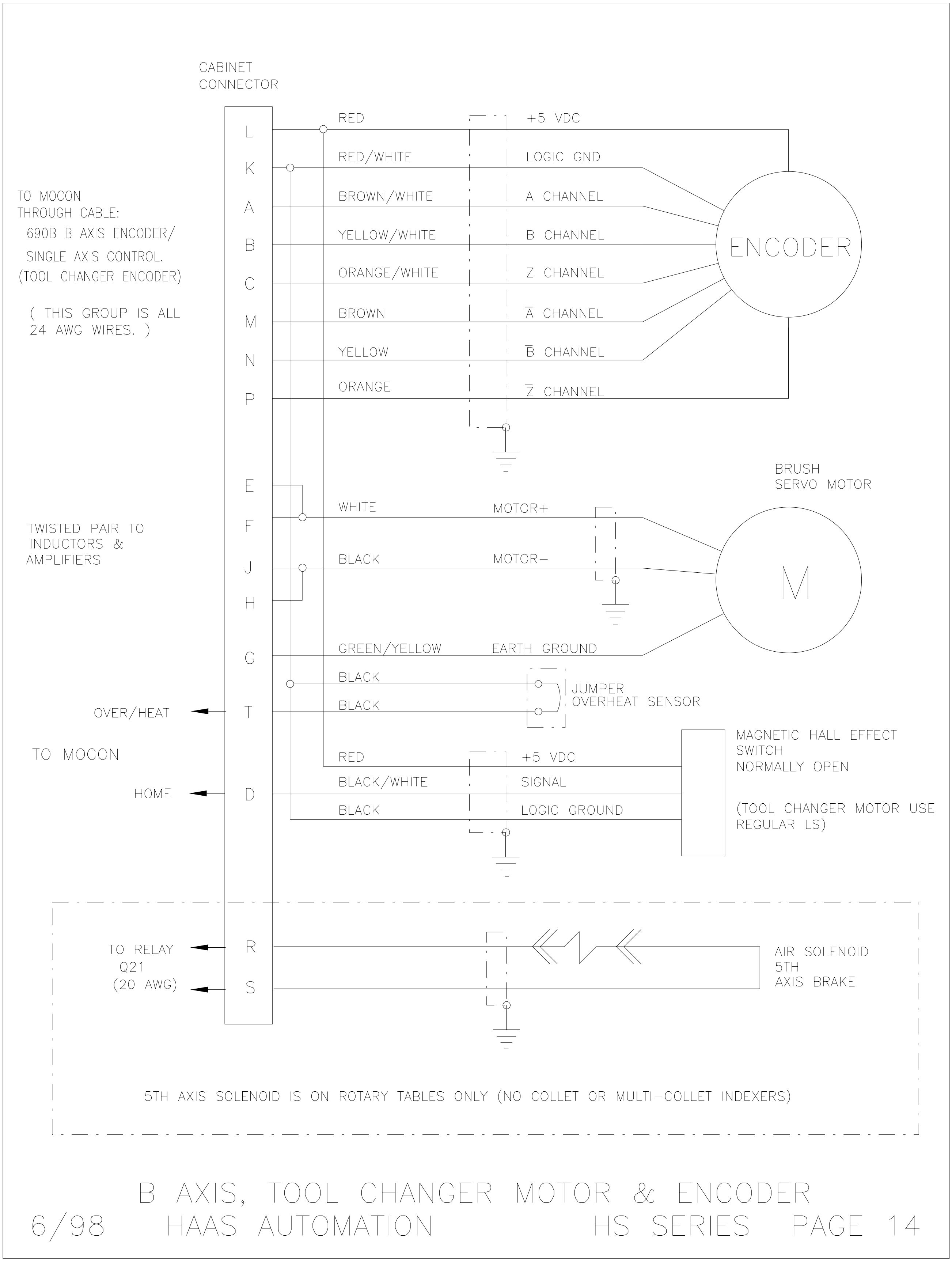


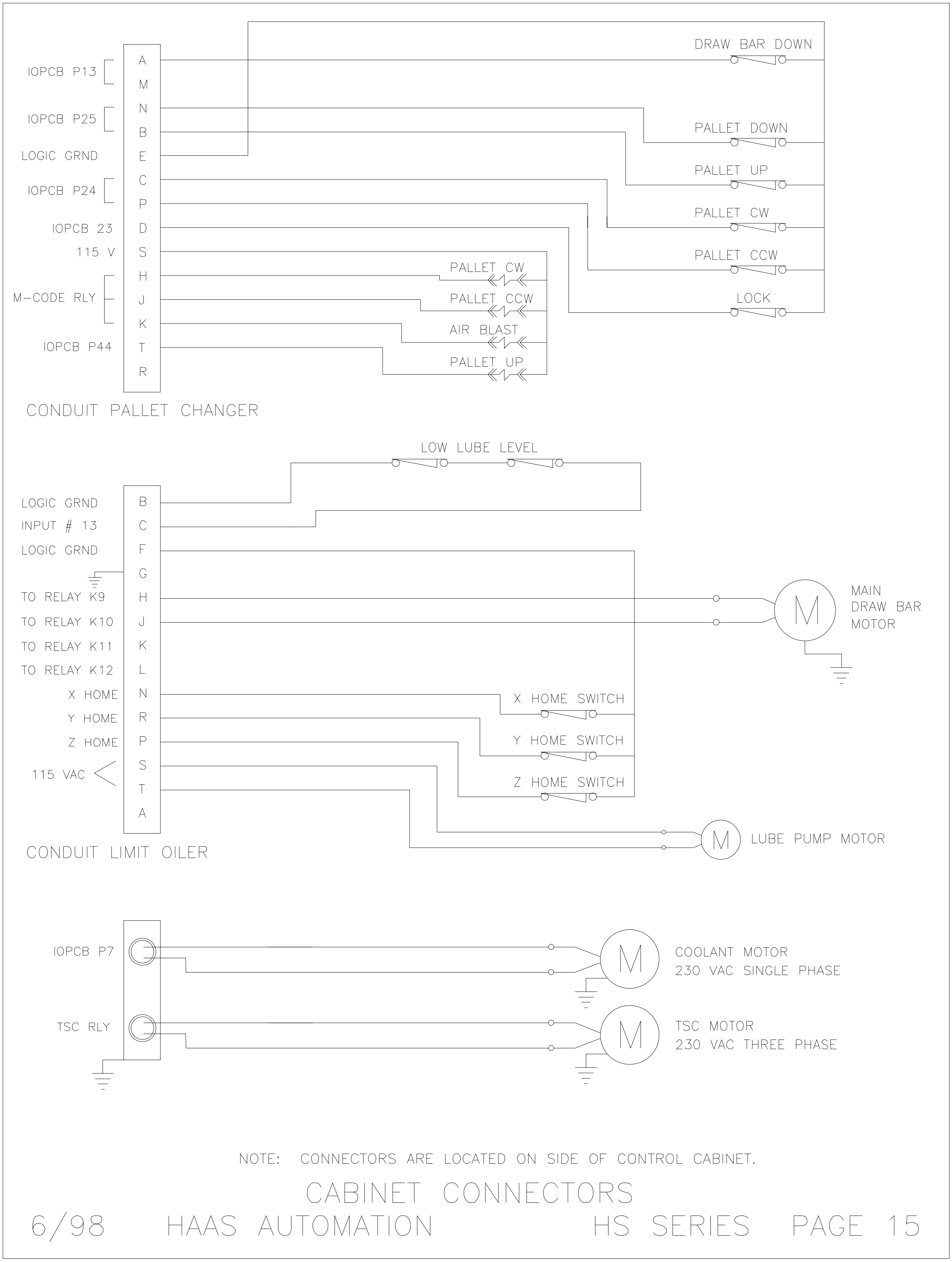
E
94
95
96
115 VAC
MAIN XFORMER
WORK LIGHT
2X40 WATTS
FLUORESCENT
LIGHT
FUSE 5 A
POWER
SUPPLY PCB
LOW VOLTAGE
POWER SUPPLY
IOPCB
P36
PSU PCB
P90
115 VAC
(IN)
+5/+12/GND
E
+5V
+12V
-5V
-12V
GND
863
861
864
862
865
860
860
860
860
TO PROCESSOR
BOARD
ASSEMBLY
MODULE
TO IOPCB P58 & P12
TO MOCON
P17 C 640C
HAAS
VECTOR DRIVE
Y- △
CONTACTORS
TO IOPCB P18
OVER VOLTAGE
TO IOPCB P20
NC OVERHEAT
J3
J1
U V W X Y Z
POWER
TO SERVO AMPS
DC BUS
SENSOR
125°C
REGEN
RESISTOR
1 2 3 4 5 6 7 8 9 10 11
R + − A B C A B C
+ − R S T G G U V W
SPINDLE MOTOR
X
Y
Z
M
G
U V W
R S T
230 VAC
HAAS VECTOR DRIVE UNIT
6/98 HAAS AUTOMATION HS SERIES PAGE 12

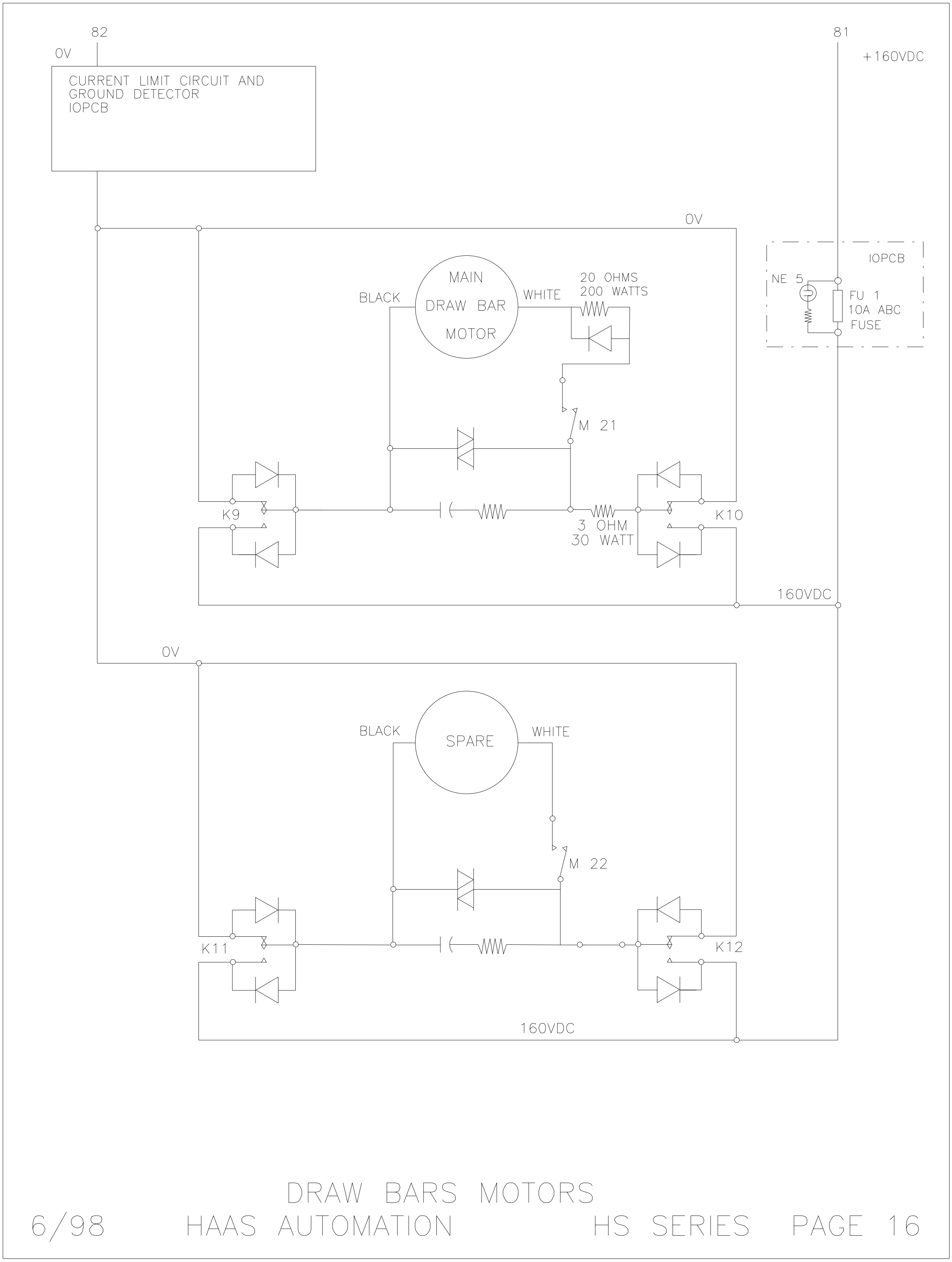


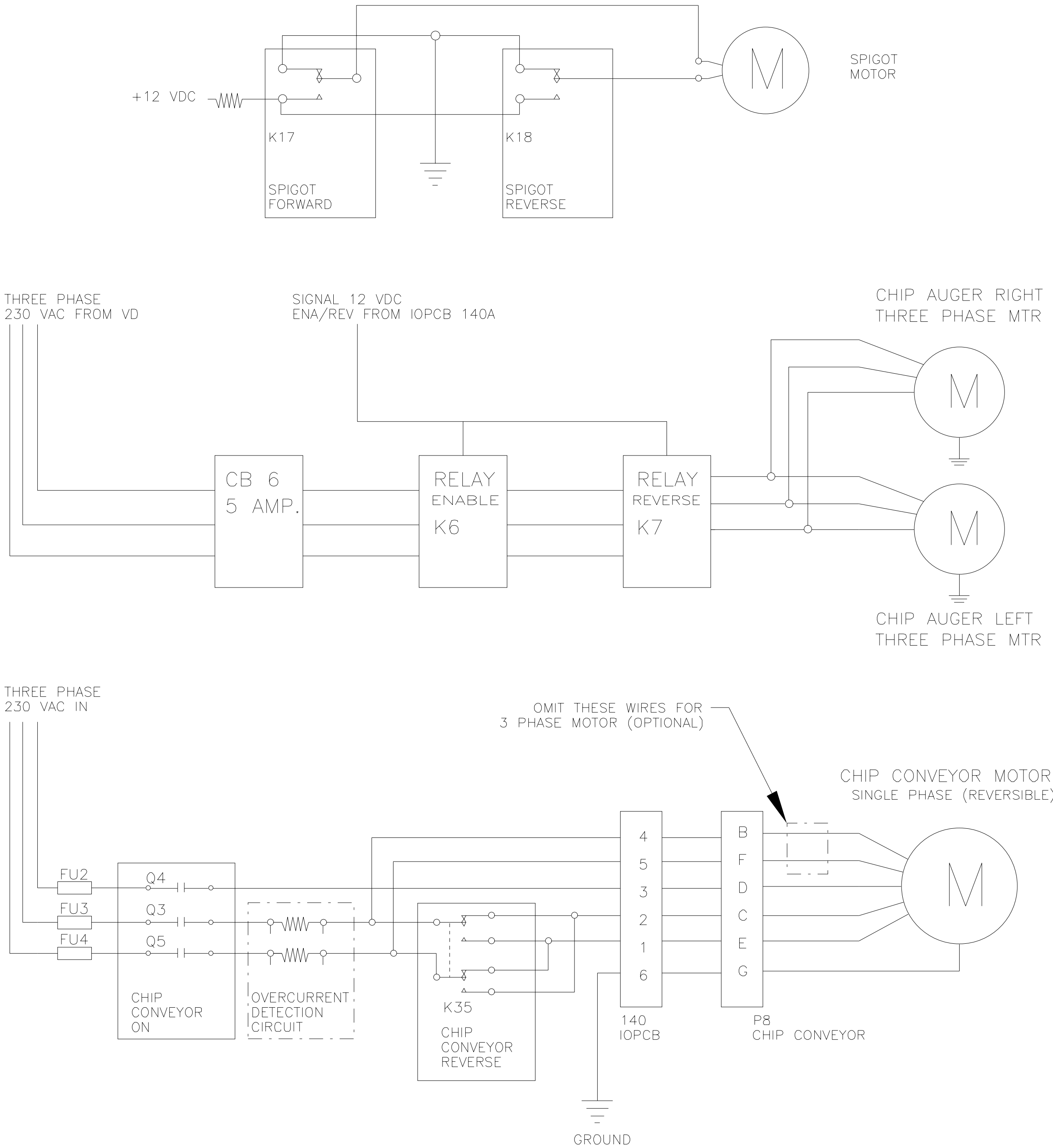
X, Y, Z, A AXIS MOTOR & ENCODER

6/98 HAAS AUTOMATION HS SERIES PAGE 13


CABINET CONNECTOR
L
K
A
B
C
M
N
P
E
F
J
H
G
T
D
R
S
RED
+5 VDC
RED/WHITE
LOGIC GND
BROWN/WHITE
A CHANNEL
YELLOW/WHITE
B CHANNEL
ORANGE/WHITE
Z CHANNEL
BROWN
$\overline{A}$ CHANNEL
YELLOW
$\overline{B}$ CHANNEL
ORANGE
$\overline{Z}$ CHANNEL
ENCODER
TO MOCON THROUGH CABLE: 690B B AXIS ENCODER/ SINGLE AXIS CONTROL. (TOOL CHANGER ENCODER)
(THIS GROUP IS ALL 24 AWG WIRES.)
BRUSH SERVO MOTOR
TWISTED PAIR TO INDUCTORS & AMPLIFIERS
WHITE
MOTOR+
BLACK
MOTOR–
M
GREEN/YELLOW
EARTH GROUND
BLACK
BLACK
JUMPER
OVERHEAT SENSOR
OVER/HEAT
TO MOCON
HOME
RED
+5 VDC
BLACK/WHITE
SIGNAL
BLACK
LOGIC GROUND
MAGNETIC HALL EFFECT SWITCH NORMALLY OPEN
(TOOL CHANGER MOTOR USE REGULAR LS)
TO RELAY Q21 (20 AWG)
AIR SOLENOID 5TH AXIS BRAKE
5TH AXIS SOLENOID IS ON ROTARY TABLES ONLY (NO COLLET OR MULTI-COLLET INDEXERS)
B AXIS, TOOL CHANGER MOTOR & ENCODER
6/98 HAAS AUTOMATION HS SERIES PAGE 14

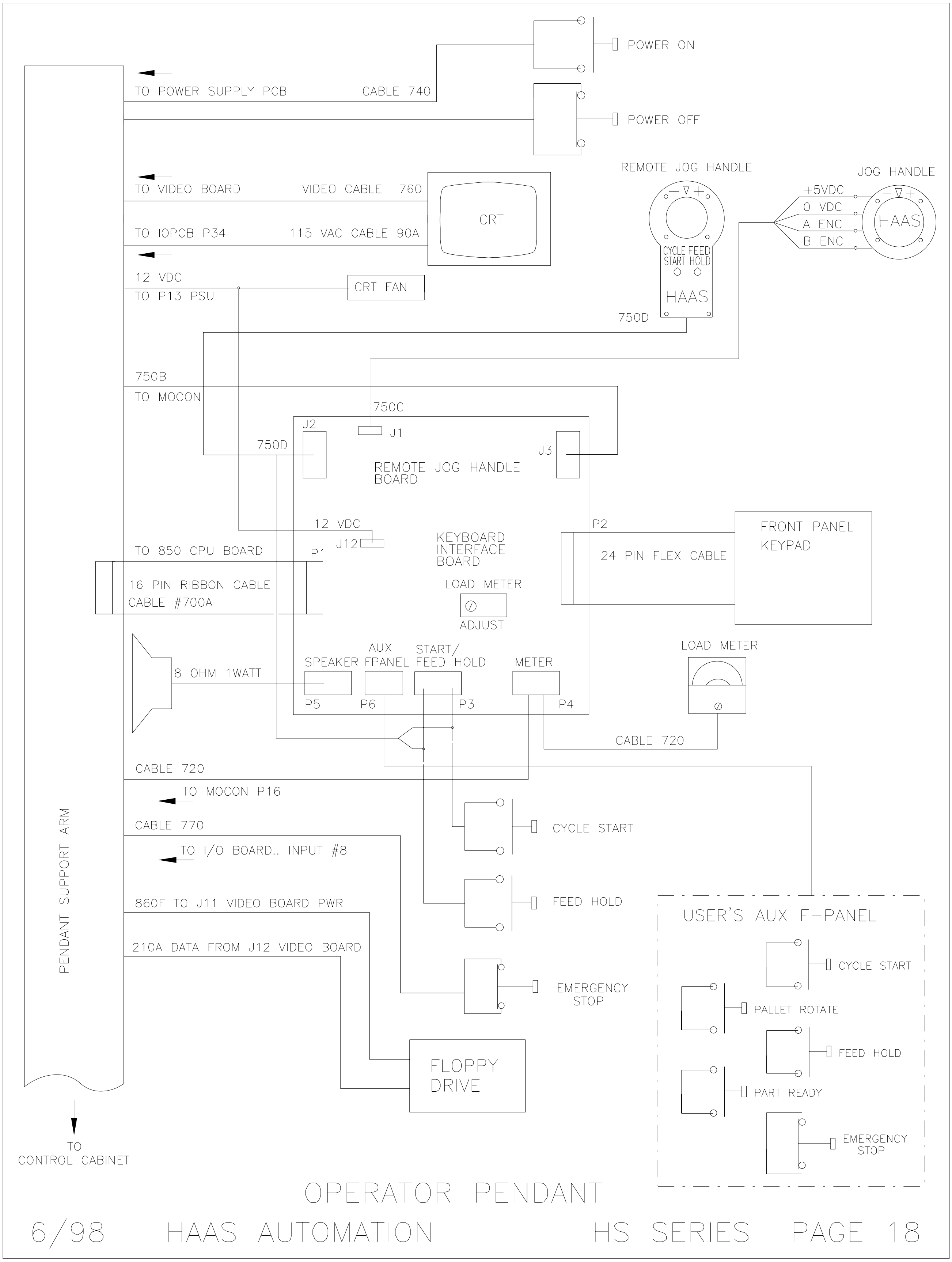

IOPCB P13
IOPCB P25
LOGIC GRND
IOPCB P24
IOPCB 23
115 V
M-CODE RLY
IOPCB P44
A
M
N
B
E
C
P
D
S
H
J
K
T
R
DRAW BAR DOWN
PALLET DOWN
PALLET UP
PALLET CW
PALLET CCW
LOCK
PALLET CW
PALLET CCW
AIR BLAST
PALLET UP
CONDUIT PALLET CHANGER
LOW LUBE LEVEL
LOGIC GRND
INPUT # 13
LOGIC GRND
TO RELAY K9
TO RELAY K10
TO RELAY K11
TO RELAY K12
X HOME
Y HOME
Z HOME
115 VAC
B
C
F
G
H
J
K
L
N
R
P
S
T
A
M
MAIN
DRAW BAR
MOTOR
X HOME SWITCH
Y HOME SWITCH
Z HOME SWITCH
M
LUBE PUMP MOTOR
CONDUIT LIMIT OILER
IOPCB P7
TSC RLY
M
COOLANT MOTOR
230 VAC SINGLE PHASE
M
TSC MOTOR
230 VAC THREE PHASE
NOTE: CONNECTORS ARE LOCATED ON SIDE OF CONTROL CABINET.
CABINET CONNECTORS
6/98 HAAS AUTOMATION HS SERIES PAGE 15

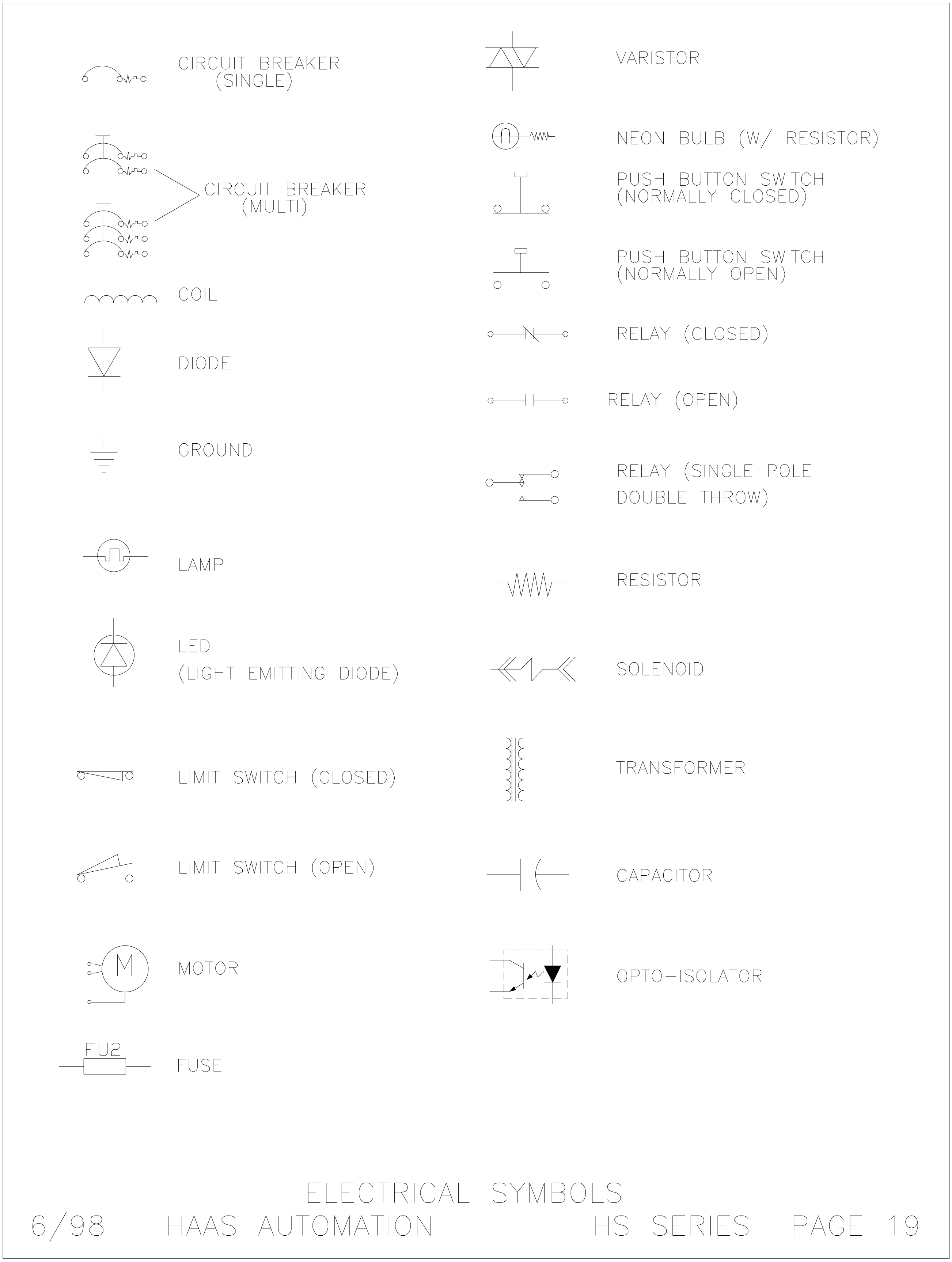

82
0V
CURRENT LIMIT CIRCUIT AND
GROUND DETECTOR
IOPCB
81
+160VDC
0V
IOPCB
NE 5
FU 1
10A ABC
FUSE
MAIN
DRAW BAR
MOTOR
BLACK
WHITE
20 OHMS
200 WATTS
M 21
K9
K10
3 OHM
30 WATT
160VDC
0V
SPARE
BLACK
WHITE
M 22
K11
K12
160VDC
DRAW BARS MOTORS
6/98 HAAS AUTOMATION HS SERIES PAGE 16

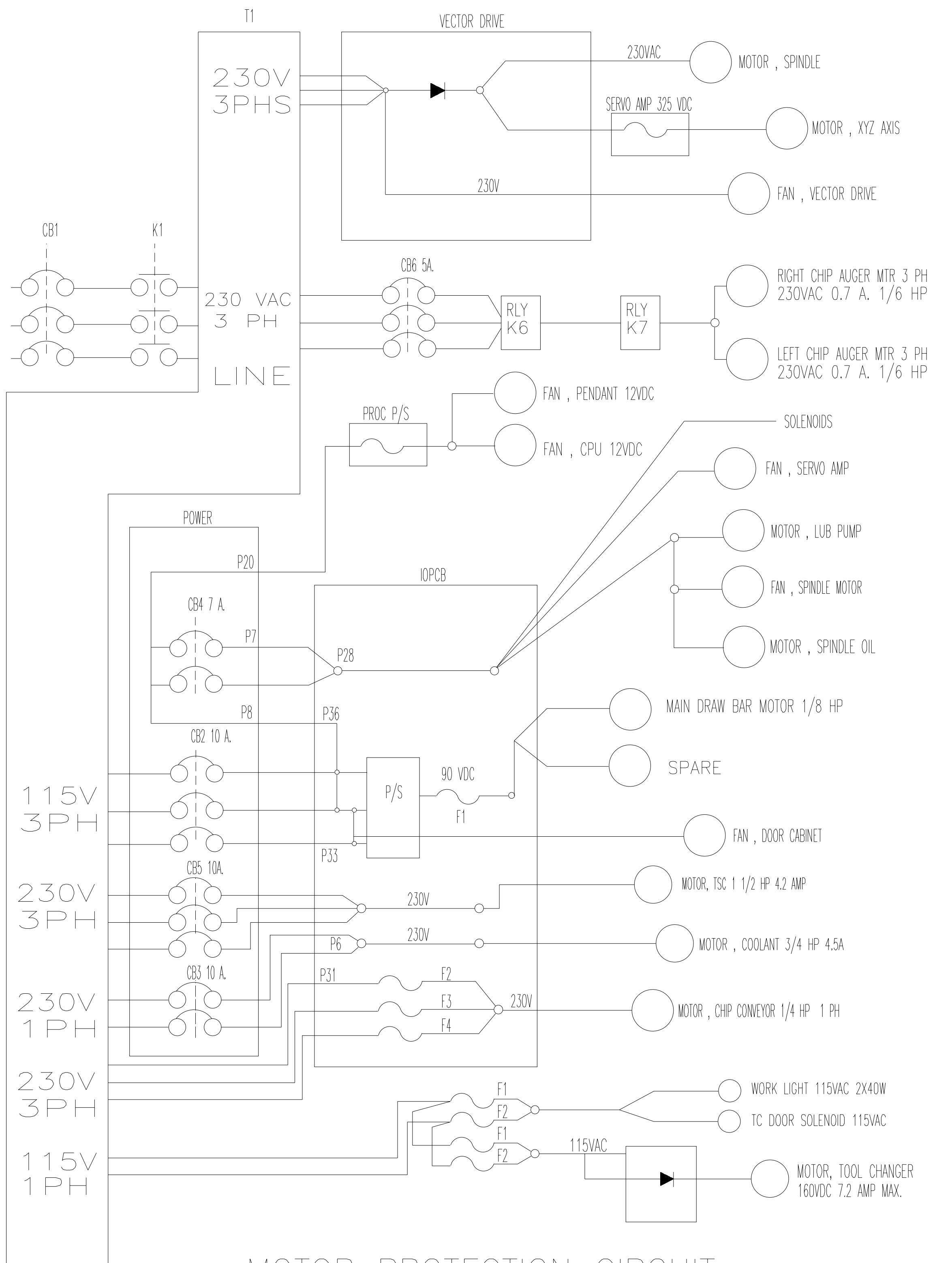


CHIP CONVEYOR AND SPIGOT MOTORS

6/98 HAAS AUTOMATION HS SERIES PAGE 17


POWER ON
POWER OFF
TO POWER SUPPLY PCB
CABLE 740
TO VIDEO BOARD
VIDEO CABLE 760
CRT
TO IOPCB P34
115 VAC CABLE 90A
12 VDC
TO P13 PSU
CRT FAN
REMOTE JOG HANDLE
CYCLE START
FEED HOLD
HAAS
750D
JOG HANDLE
+5VDC
0 VDC
A ENC
B ENC
HAAS
750B
TO MOCON
750C
J2
J1
750D
J3
REMOTE JOG HANDLE BOARD
12 VDC
J12
KEYBOARD INTERFACE BOARD
P2
FRONT PANEL KEYPAD
24 PIN FLEX CABLE
TO 850 CPU BOARD
P1
16 PIN RIBBON CABLE
CABLE #700A
LOAD METER
ADJUST
8 OHM 1WATT
SPEAKER
AUX FPANEL
START/ FEED HOLD
METER
P5
P6
P3
P4
LOAD METER
CABLE 720
CABLE 720
TO MOCON P16
CABLE 770
TO I/O BOARD.. INPUT #8
CYCLE START
FEED HOLD
860F TO J11 VIDEO BOARD PWR
210A DATA FROM J12 VIDEO BOARD
EMERGENCY STOP
FLOPPY DRIVE
PENDANT SUPPORT ARM
TO CONTROL CABINET
USER'S AUX F-PANEL
CYCLE START
PALLET ROTATE
FEED HOLD
PART READY
EMERGENCY STOP
OPERATOR PENDANT
6/98 HAAS AUTOMATION HS SERIES PAGE 18

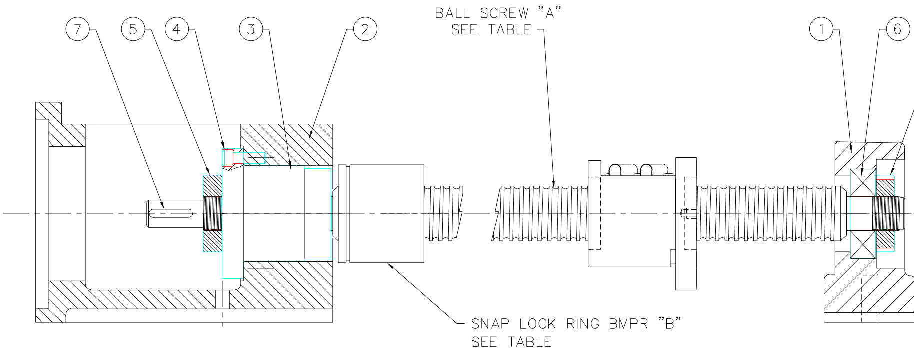

CIRCUIT BREAKER (SINGLE)
CIRCUIT BREAKER (MULTI)
COIL
DIODE
GROUND
LAMP
LED (LIGHT EMITTING DIODE)
LIMIT SWITCH (CLOSED)
LIMIT SWITCH (OPEN)
M
MOTOR
FU2
FUSE
VARISTOR
NEON BULB (W/ RESISTOR)
PUSH BUTTON SWITCH (NORMALLY CLOSED)
PUSH BUTTON SWITCH (NORMALLY OPEN)
RELAY (CLOSED)
RELAY (OPEN)
RELAY (SINGLE POLE DOUBLE THROW)
RESISTOR
SOLENOID
TRANSFORMER
CAPACITOR
OPTO-ISOLATOR
ELECTRICAL SYMBOLS
6/98 HAAS AUTOMATION HS SERIES PAGE 19

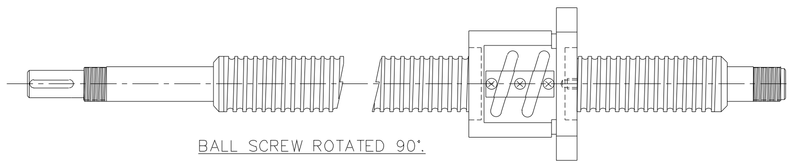


MOTOR PROTECTION CIRCUIT

6/98 HAAS AUTOMATION HS SERIES PAGE 20

ASSEMBLY DRAWINGS AND PARTS LIST





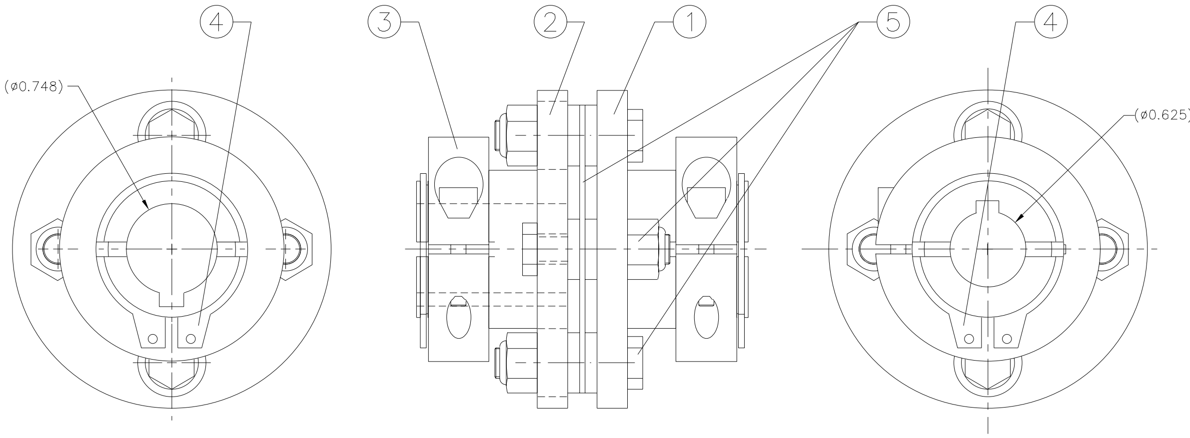
30-1100A BALL SCREW ASSEMBLY 32mm

ITEM	QTY	PART NO.	TITLE
1.	1	20-7009	BEARING HOUSING
2.	1	20-7010A	MOTOR MOUNTING
3.	1	30-1221	BALL SCREW SUPP. BRNG ASSY
4.	6	40-0008	SHCS, 1/2-20 X 3/4" W/PATCH
5.	2	51-2012	BEARING LOCKNUT
6.	1	51-2025	BEARING, FAFNIR RADIAL #304PP
7.	1	51-2025	PLUG

	BALL SCREW ASS'Y	BALL SCREW "A"	SNAP LOCK RING BMPR "B"	APPLICATION
	30-1100A BS ASS'Y 32mm (1.26) X 25.650	24-7146 BALLSCR 32mm (1.26) X 25.650	NONE	HL-5,6,VF-1,2,0 (X)
	30-0116 BS ASS'Y 32mm (1.26) X 33.268	24-9013 BALLSCR 32mm (1.26) X 33.268	20-0142 SNAP LOCK RING BMPR 6.00	HL-1,2 (Z)
	30-0117 BS ASS'Y 32mm (1.26) X 48.228	24-9012 BALLSCR 32mm (1.26) X 48.228	20-0143 SNAP LOCK RING BMPR 7.00	HL-3,4 (Z)
	30-0118 BS ASS'Y 32mm (1.26) X 25.650	24-0118 BALLSCR 32mm (1.26) X 25.650	20-0141 SNAP LOCK RING BMPR 4.00	HL-5,6 (X)
	30-1110A BS ASS'Y 32mm (1.26) X 35.650	24-7147 BALLSCR 32mm (1.26) X 35.650	NONE	VF-2, OEB (X)
	30-1200A BS ASS'Y 32mm (1.26) X 48.228	24-9012 BALLSCR 32mm (1.26) X 48.228	NONE	VF-3 (Y) (Z)
	30-1210A BS ASS'Y 32mm (1.26) X 33.268	24-9013 BALLSCR 32mm (1.26) X 33.268	NONE	HS-1,1R,1RP,2RP,VF-3,4 (Y) (Z)
⚠1	30-1295A BS ASS'Y 32mm (1.26) X 16.475	24-8765 BALLSCR 32mm (1.26) X 16.475	NONE	HL-3,4 (X)
⚠1	30-1290A BS ASS'Y 32mm (1.26) X 13.525	24-9548 BALLSCR 32mm (1.26) X 13.525	NONE	HL-1,2 (X)

⚠1 ADD ITEM 7 (THESE ASSEMBLIES ONLY)

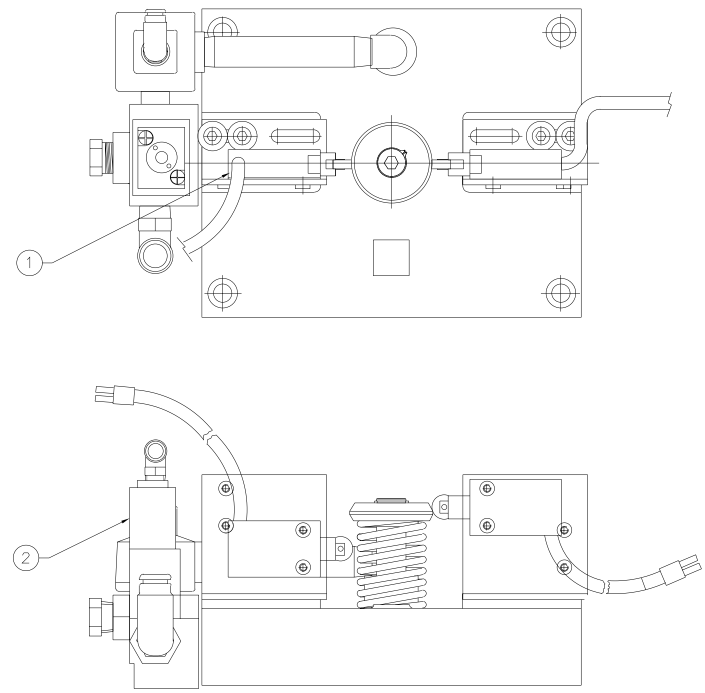
30-1100A Ball Screw Assembly 32mm



30-1220A COUPLING ASSEMBLY

ITEM	QTY	PART No.	TITLE
1	1	20-7403	COUPLING, SERVO DRIVE
2	1	20-7615	COUPLER, BRUSHLESS
3	2	51-2014	BEARING LOCKNUT, CL18F
4	2	56-0065	SNAP RING, (5100-112)
5	1	59-2060	FLEXPAK FOR AJ05

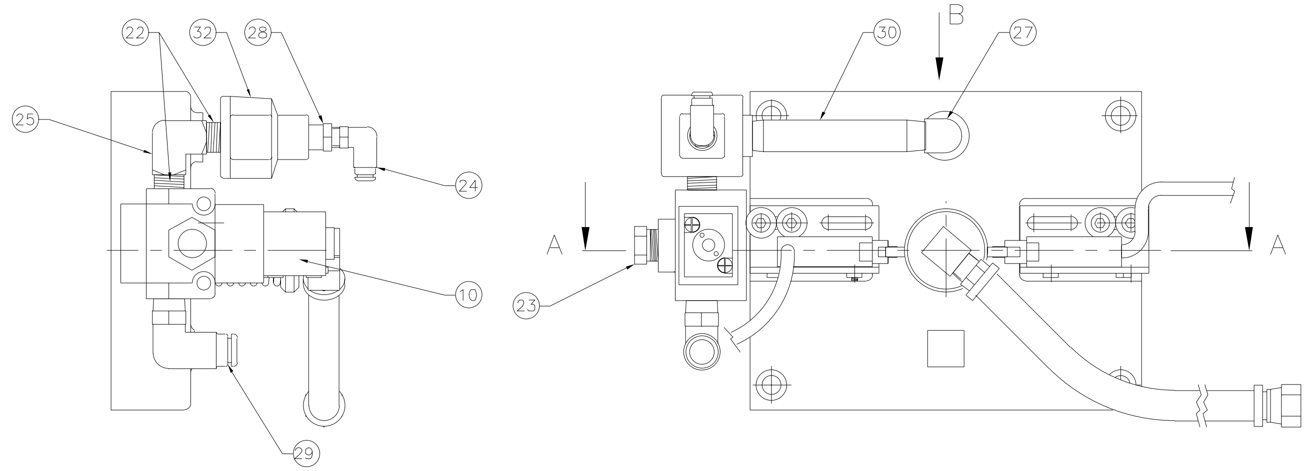
WHERE USED	APPLICATION
30-0116 BS ASSY ø32mm(1.26) x 33.27	HL-1, 2 (Z)
30-0117 BS ASSY ø32mm(1.26) x 48.23	HL-3, 4 (Z)
30-0118 BS ASSY ø32mm(1.26) x 25.65	HL-5, 6 (X)
30-1110A BS ASSY ø32mm(1.26) x 35.65	VF-0EB, 2B (X)
30-1200A BS ASSY ø32mm(1.26) x 48.23	VF-3B, (X) (Z)
30-1210A BS ASSY ø32mm(1.26) X 33.27	VF-3B, 4B, HL-1, 2 (Y) (Z)
30-1270A BS ASSY ø32mm(1.26) x 58.47	VF-4B (X)
30-1290A BS ASSY ø32mm(1.26) x 13.53	HL-1, 2 (X)
30-1295A BS ASSY ø32mm(1.26) x 16.78	HL-3, 4 (X)
30-1100A BS ASSY ø32mm(1.26) x 25.65	HL-5,6, VF-1,2,0

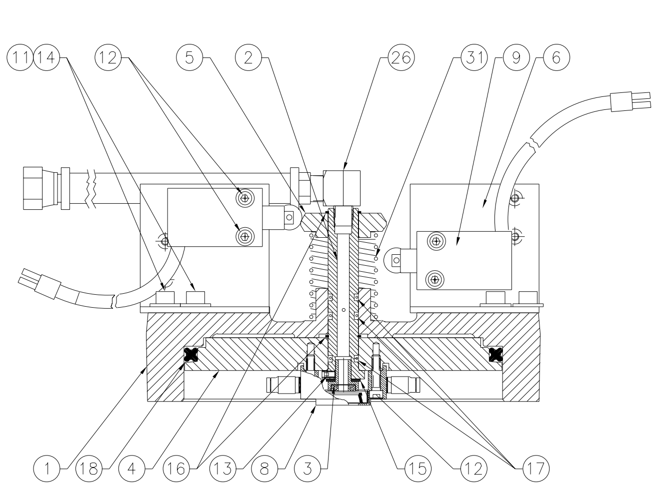


30-3296 TOOL RELEASE PISTON ASSEMBLY

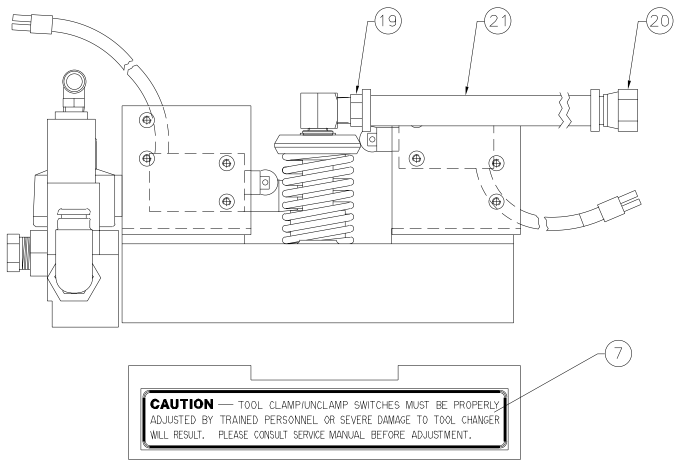
1. 32-2010 TELEMECHANIQUE SWITCH ASSEMBLY
2. 32-5620 TRP SOLENOID VALVE ASSEMBLY

HS Tool Release Piston





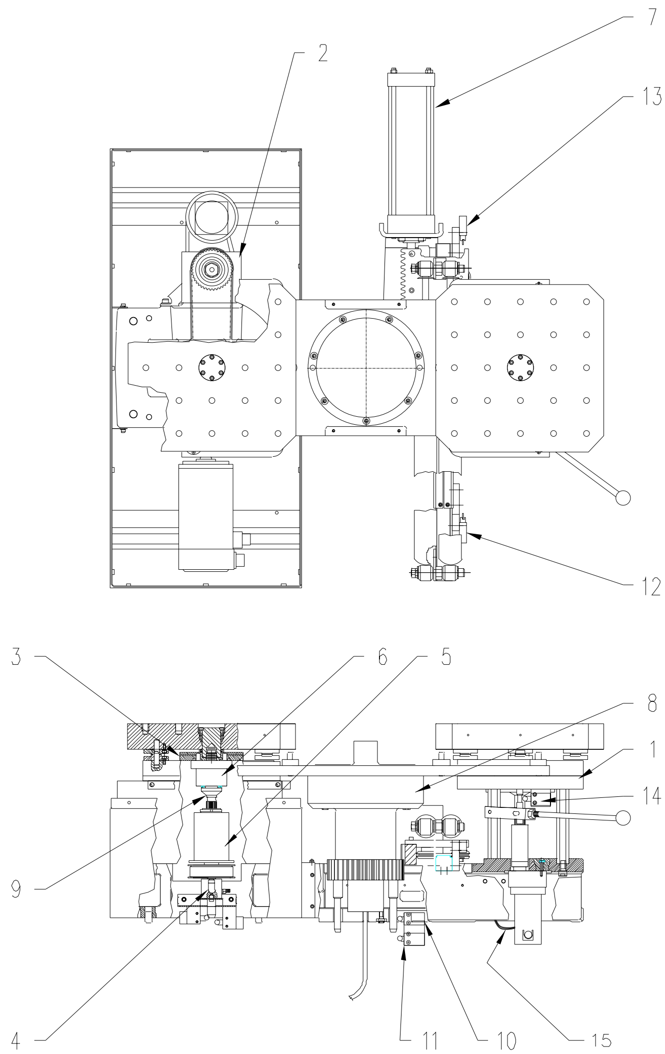
SECTION A–A
(OUT OF POSITION)



VIEW B
(OUT OF POSITION)

30-3297C TOOL RELEASE PISTON ASS'Y, HS TSCHP

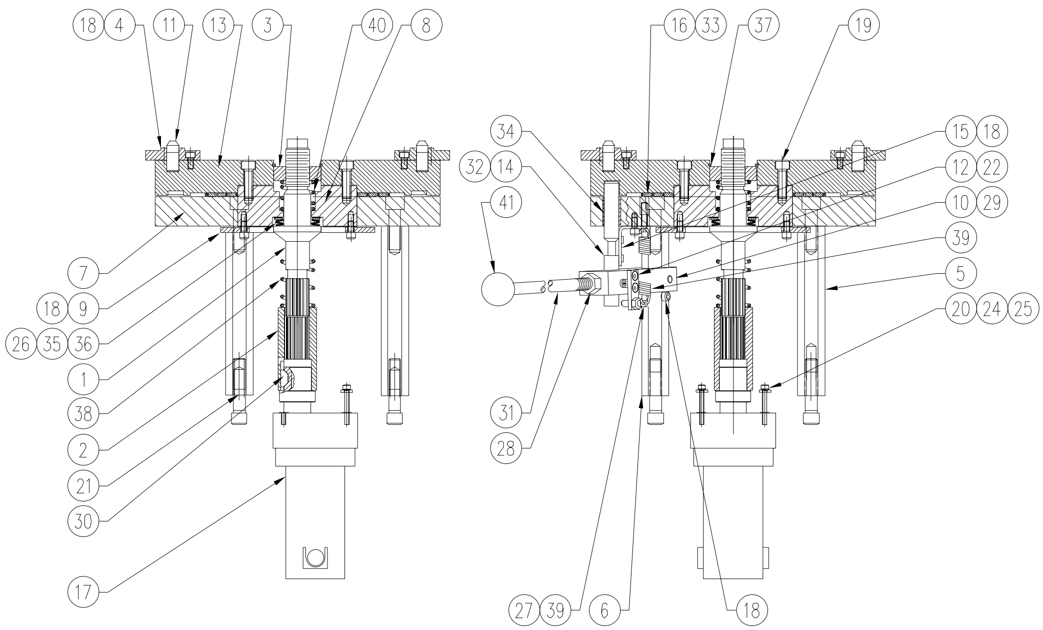
ITEM	PART NO.	DESCRIPTION	QTY	ITEM	PART NO.	DESCRIPTION	QTY
1	20-7007A	CYLINDER HOUSING MACHINED	1	17	57-0040	O-RING 2-111 BUNA	3
2	20-7626	SHAFT TRP TSC	1	18	57-2156	QUAD-RING Q4-440 BUNA	1
3	20-7627A	COOLANT TIP CARBIDE	1	19	58-0028	HOSE BARB 3/8PL-1/4MP	1
4	20-7630A	TR PISTON RECTANGLE TSC	1	20	58-0032	HOSE BARB 3/8PL-3/8SAE-F	1
5	22-7045A	SPRING RETAINER TRP 30DEG	1	21	58-2046	HOSE 3/8ID PUSHLOC 300PSI	2
6	25-7050B	SWITCH MOUNT TOOL RELEASE	2	22	58-2165	FITTING CLOSE NIPPLE 1/4	2
7	29-7397	LABEL, TOOL RELEASE PISTN	1	23	58-2265	AIR MUFFLER 3/8 FLAT	1
8	30-3298	SEAL HOUSING ASSY TSC-HA	1	24	58-3050	ELBOW 1/4 NYLON TUBING	1
9	32-2010	24 LIMIT SWITCH	2	25	58-3056	90 DEG 1/4 NPT ELBOW	1
10	32-5620	TRP SOLENOID VALVE ASSY	1	26	58-3614	1/4 F-1/8 M STREET ELBOW	1
11	40-1632	SHCS 1/4-20 X 1/2	4	27	58-3618	1/4 STREET ELBOW, 90 DEG	1
12	40-1800	SHCS 8-32 X 3/4	8	28	58-3670	1/4 NPT M - 1/8 F REDUCER	1
13	44-1614	SSS FLAT PT 6-32 X 1/4	3	29	58-3685	1/4NPT M-3/8 TUBE-SVL LBO	1
14	45-0040	WASHER BLK HARD 1/4 A325	4	30	58-3729	NIPPLE BR 1/4 NPT X 4 1/2	1
15	45-2000	WASHER, SHIM 1/4 ,010 THK	5	31	59-2760	COMP. SPRING/LARGE WIRE	1
16	56-0040	SNAP RING N5100-62	2	32	59-2832B	QUICK EXHAUST 1/4	1



PARTS LIST

1. 30-9411A – LOAD STATION ASSEMBLY
2. 30-9413 – CLUTCH/MOTOR ASSEMBLY
3. 30-9414A – AIR BLAST MANIFOLD ASSEMBLY
4. 30-9415A – LUBE TUBE ADAPTER ASSEMBLY
5. 30-9416 – BEARING SLEEVE ASSEMBLY
6. 30-9417 – NUT HOUSING ASSEMBLY
7. 30-9418 – ROTATING CYLIDER ASSEMBLY
8. 30-9419 – LIFT CYLINDER ASSEMBLY
9. 30-9420 – MAIN DRAWBAR ASSEMBLY
10. 33-8010 – LIMIT SWITCH, PALLET UP
11. 33-8011 – LIMIT SWITCH, PALLET DOWN
12. 33-8012 – LIMIT SWITCH, PALLET CW
13. 33-8013 – LIMIT SWITCH, PALLET CCW
14. 33-8015 – LIMIT SWITCH LOAD STATION, LOCKED
15. 33-8023 – LOAD STATION, MTR. CBL.

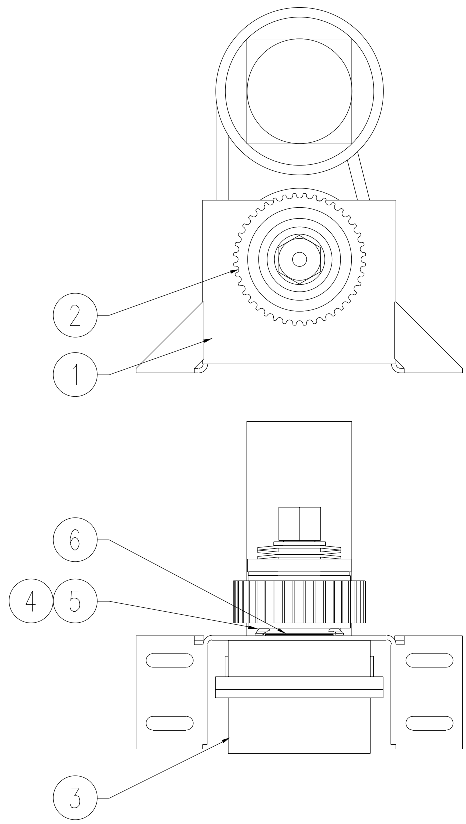
HS Pallet Changer



LOAD STATION ASSEMBLY
30-9411A

ITEM	QTY	DWG_NUMBER	TITLE
1	1	20-9444	MANIFOLD, AIR BLAST
2	1	57-2257	O-RING (326)
3	1	57-2835	O-RING (2-236)
4	4	58-2100	COMPRESSION SLEEVE
5	4	58-2110	SLEEVE NUT
6	4	58-9427A	TUBING, AIR BLAST

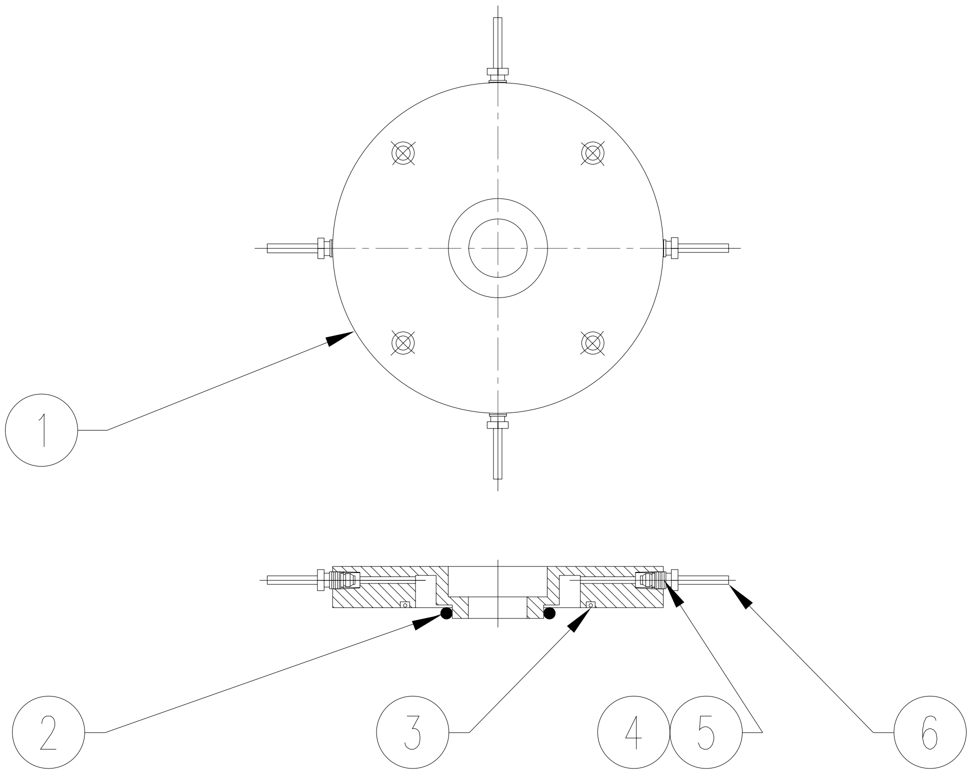
Load Station Assembly



30-9413 CLUTCH/MOTOR ASSEMBLY

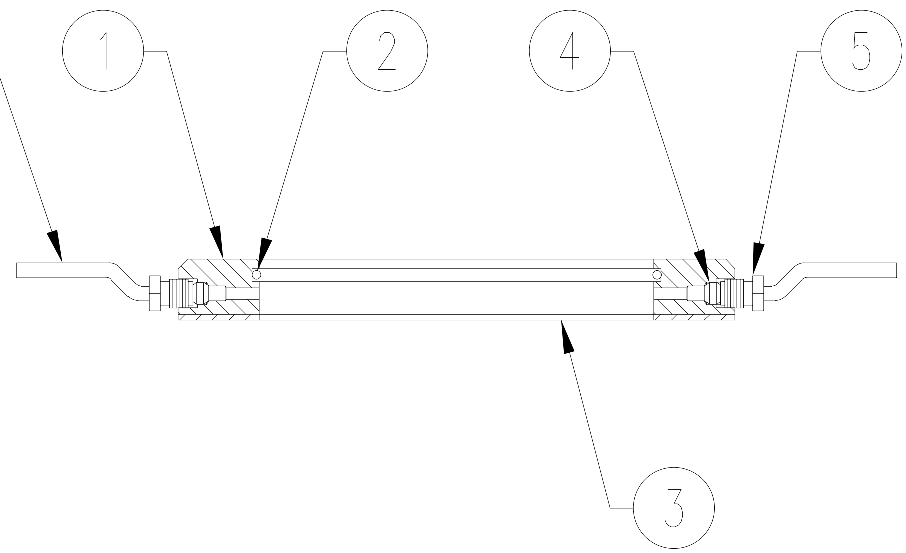
ITEM	QTY	DWG_NUMBER	TITLE
1	1	25-9443B	BRACKET MOTOR MOUNT
2	1	30-9412	CLUTCH ASSEMBLY
3	1	32-0301A	DRAW BAR MOTOR EP 3318
4	4	40-1976	BHCS, 1/4-20 x 3/4''
5	4	45-16390	WASHER, 1/4'' ID x 5/8'' OD. SAE
6	2	45-2020	WASHER, NYLON

Clutch Motor Assembly



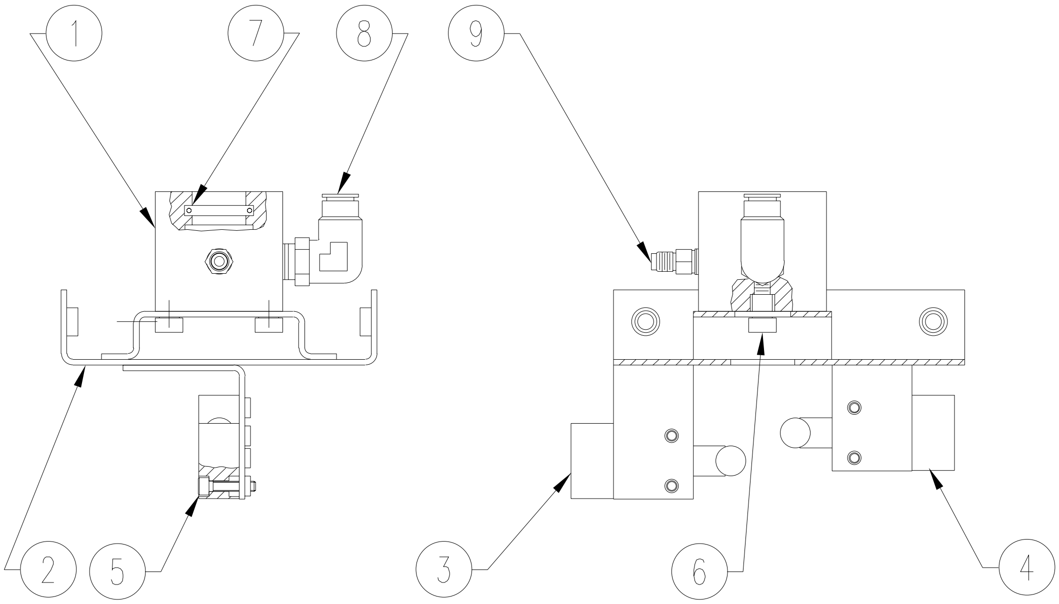
AIR BLAST MANIFOLD ASSEMBLY
30-9414A

ITEM	QTY	DWG_NUMBER	TITLE
1	1	20-9444	MANIFOLD, AIR BLAST
2	1	57-2257	O-RING (326)
3	1	57-2835	O-RING (2-236)
4	4	58-2100	COMPRESSION SLEEVE
5	4	58-2110	SLEEVE NUT
6	4	58-9427A	TUBING, AIR BLAST



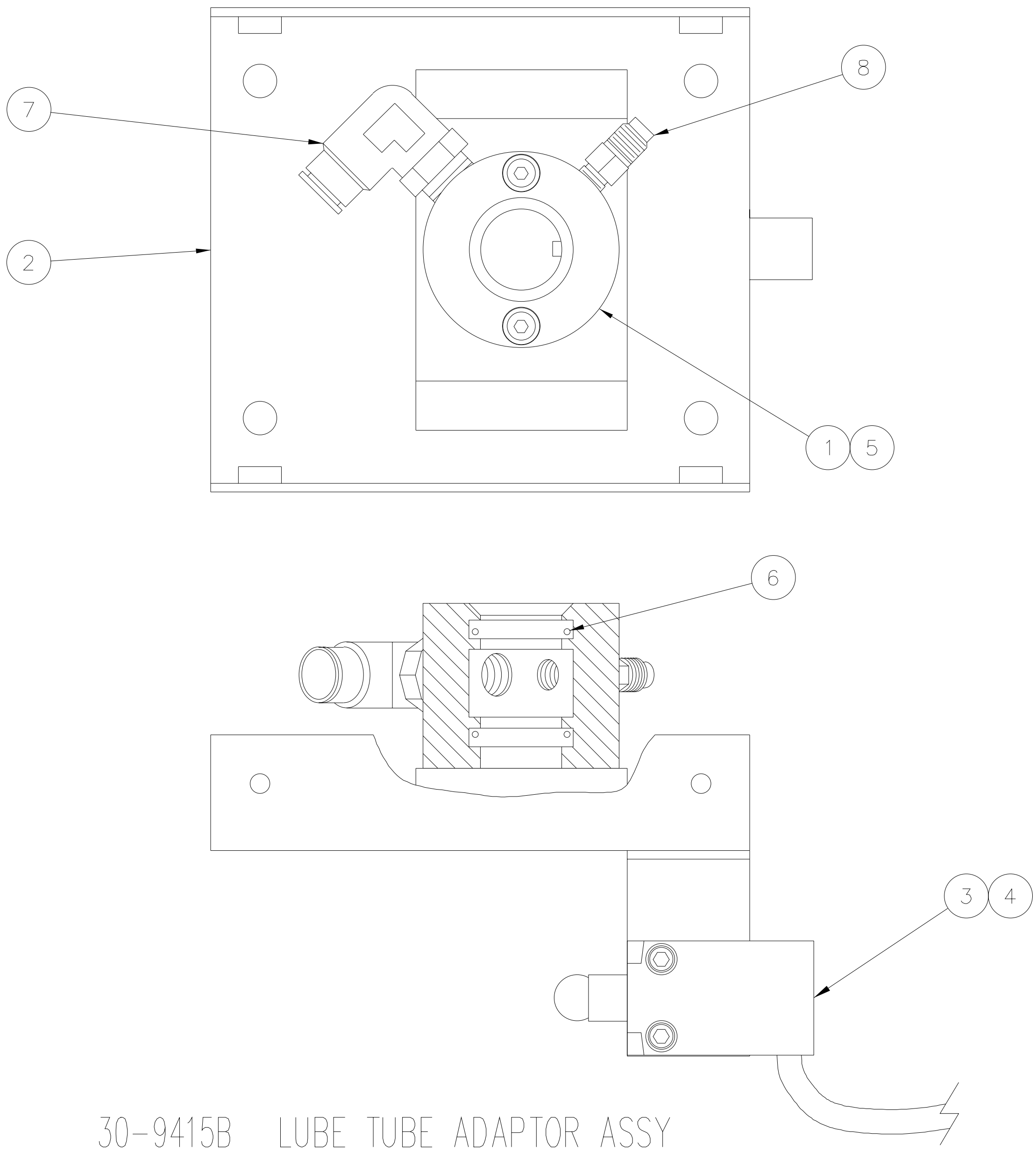
30-9414B AIR BLAST MANIFOLD ASSY

ITEM	QTY	PART NO.	DESCRIPTION
1.	1	20-6449	AIRBLAST MANIFOLD ASS'Y
2.	1	57-2250	O-RING 2-156 VITON
3.	1	57-6452	GASKET, MANIFOLD
4.	4	58-2100	SLEEVE LUBE ASS'Y
5.	4	58-2110	SLEEVE NUTS LUBE ASS'Y
6.	4	58-9427B	TUBING AIR BLAST HS-1RP



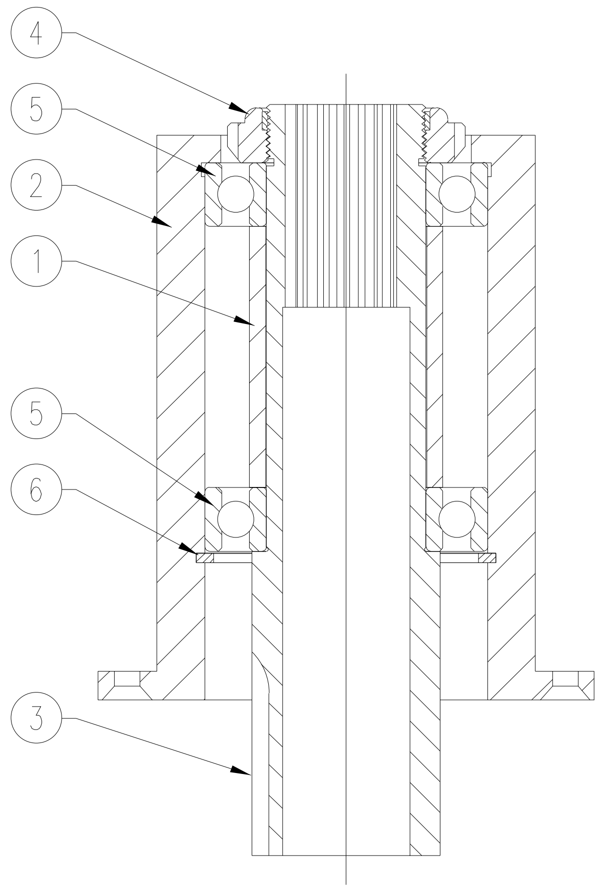
LUBE TUBE ADAPTER ASSEMBLY
30-9415A

ITEM	QTY	DWG_NUMBER	TITLE
1	1	20-9449	ADAPTER, LUBE TUBE
2	1	25-9445A	AIR BLAST ADAPTER PLATE
3	1	33-8009	LIMIT SWITCH, MAIN DB. DOWN
4	1	33-8014	LIMIT SWITCH, MAIN DB. UP
5	4	40-1800	SHCS, 8-32 x 3/4"
6	2	49-1012	SHLDR SCREW, 1/4-20 x 5/16"
7	2	57-2259	O-RING, 211 VITON, AIR
8	1	58-3685	1/4NPT M-3/8 TUBE SVL. LBO.
9	1	58-4020	FLOW METER, FSA-3/0



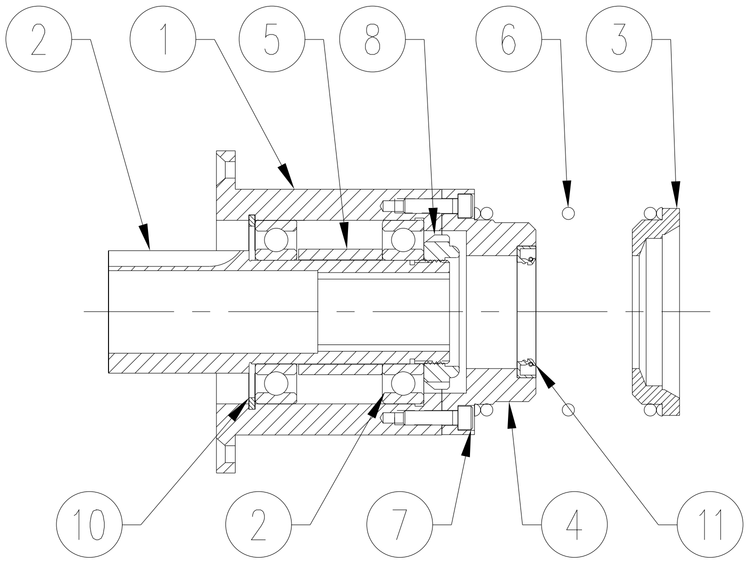
30-9415B LUBE TUBE ADAPTOR ASSY

ITEM	QTY	PART NO.	DESCRIPTION
1	1	20-6456	LUBE TUBE ADAPTOR HS-1RP
2	1	25-6457	AIR BLAST ADAPTER PLATE
3	1	33-8009	MAIN DB DOWN LS
4	2	40-1800	SHCS 8-32 X 3/4
5	2	49-1004	SHLDR SCREW,1/4-20 X 5/16
6	2	57-2259	O-RING 2-211 VITON
7	1	58-3685	1/4NPT M-3/8 TUBE-SVL LBO
8	1	58-4020	FLOWMETER, FSA-3/0



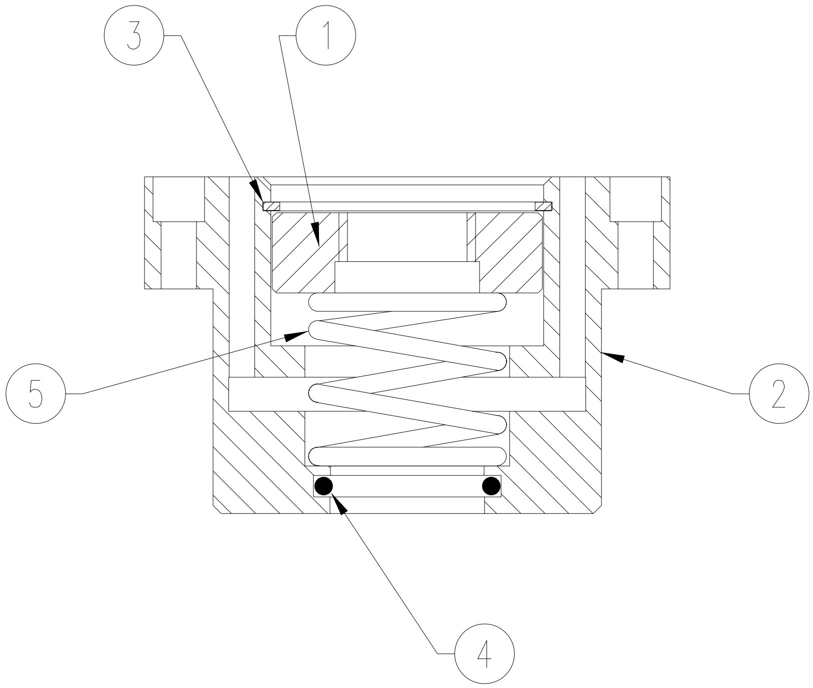
BEARING SLEEVE ASSMEBLY
30-9416

ITEM	QTY	DWG_NUMBER	TITLE
1	1	20-9486	BEARING SLEEVE
2	1	20-9490	DRIVE SHAFT, ROT. TABLE
3	1	22-9485	SPACER, BEARING
4	1	51-2015	BRNG. LOCK NUT, BH-07
5	2	51-7003	BALL BRNG.
6	1	56-2083	SNAP RING



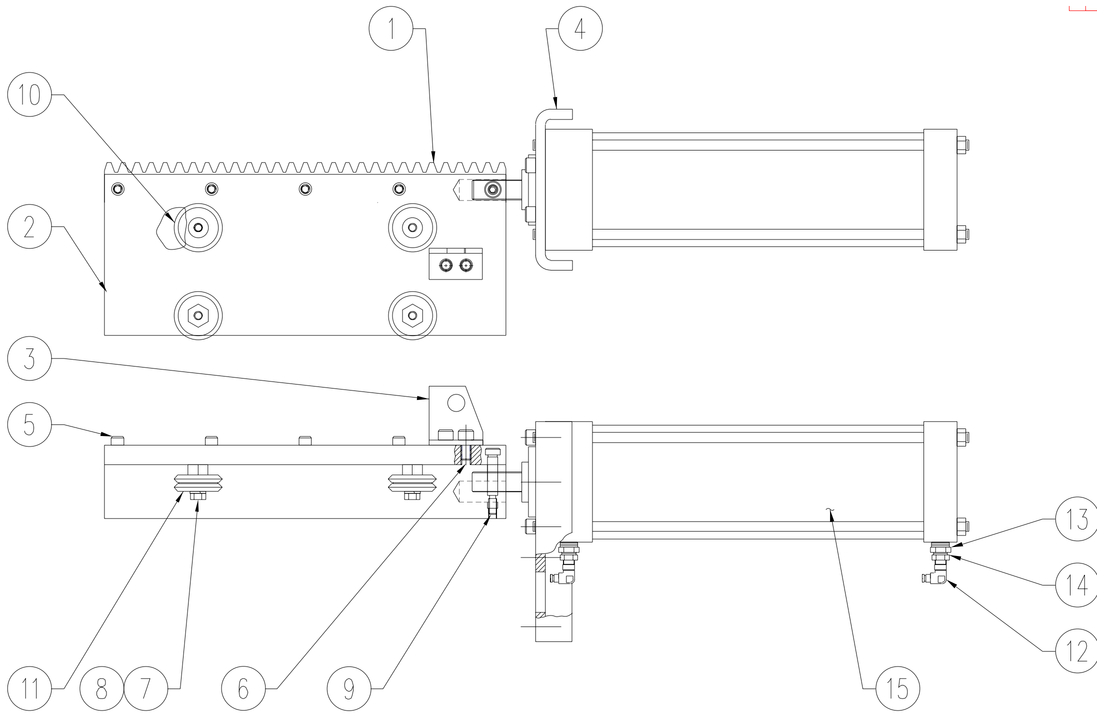
30-9416A BEARING SLEEVE ASSY

ITEM	PART NO.	DESCRIPTION	QTY
1.	20-6441	BEARING SLEEVE HS-1RP	1
2.	20-6442	DRIVE SHAFT ROTARY TABLE	1
3.	20-6450	SPRING CUP DRAWBAR HS-1RP	1
4.	20-6451	AIRBLOCK DRAWBAR HS-1RP	1
5.	20-6454	SPACER BEARING HS-1RP	1
6.	24-6437	SPRING DRAWBAR RETURN	1
7.	40-1950	SHCS 10-32 X 3/4	4
8.	51-2015	BRNG. LOCKNUT, BH-07	1
9.	51-7003	BALL BRNG. #6007-DD	2
10.	56-2083	SNAP RING N5000-244	1
11.	57-0042	SHAFT SEAL CR12360	1



NUT HOUSING ASSEMBLY
30-9417

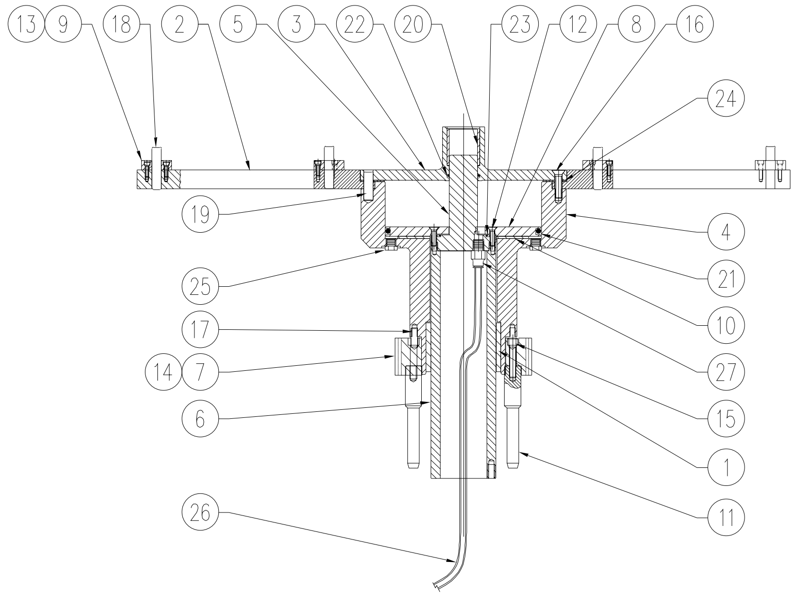
ITEM	QTY	DWG_NUMBER	TITLE
1	1	20-9487	NUT, DRAWBAR
2	1	20-9489	NUT HOUSING
3	1	56-2096	SNAP RING
4	1	57-2258	O-RING
5	1	59-0002	COMPRESSION SPRING, 2"



ROTATING CYLINDER ASSEMBLY

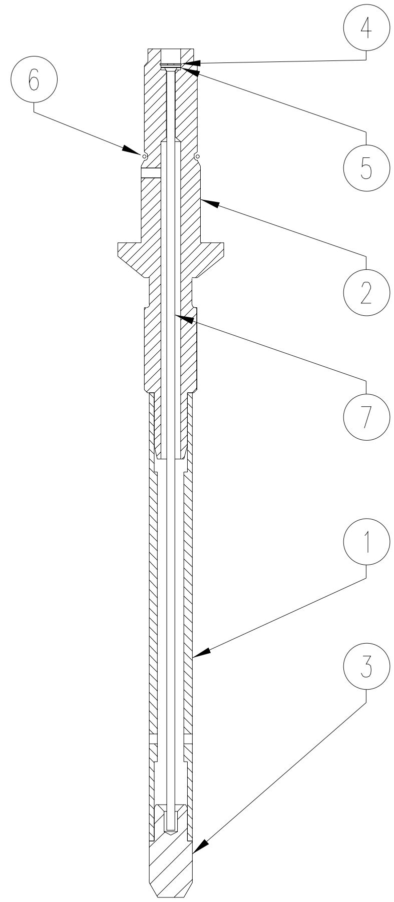
30-9418

ITEM	QTY	DWG_NUMBER	TITLE
1	1	20-9795A	RACK MOD.
2	1	20-9796A	ROLLER MTG. PLATE
3	1	25-9573	SHOCK MOUNT, RACK END
4	1	25-9797A	ROTATE CYLINDER MOUNT
5	5	40-16385	SHCS, 5/16-18 x 3/4''
6	2	40-2030	SHCS, 3/8-16 x 3/4''
7	4	43-7000	HHB, 5/16-18 x 1 3/4''
8	4	45-1600	5/16'' LOCK WASHER
9	1	49-1010	SHOULDER SCREW 3/8 X 1 1/2
10	2	54-0020	BUSHING, GUIDE WHEEL
11	2	54-0040	STD. BUSHING, GUIDE WHEEL
12	2	58-3659	AIR FITTING 1/8" PIPE 5/32" TUBE
13	2	58-3665	1/4NPT FEMALE TO 3/8M
14	2	58-3670	1/4NPTM TO 1/8F REDUCER
15	1	59-2750	FACE MOUNT, ROT CYL.



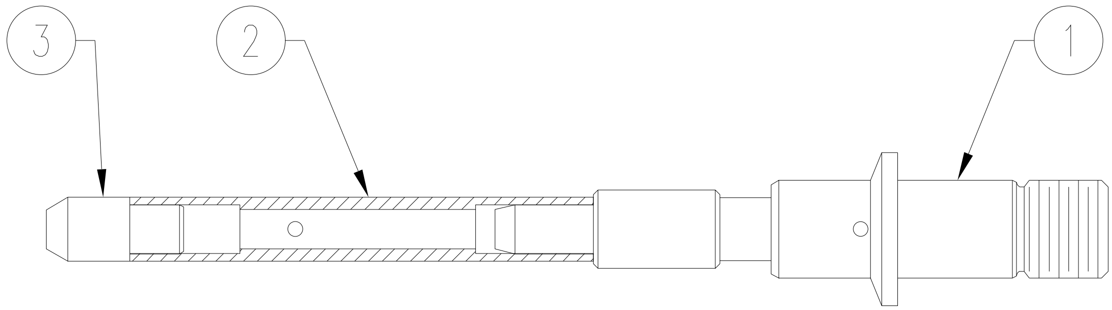
LIFT CYLINDER ASSEMBLY
30-9419

ITEM	QTY	DWG_NUMBER	TITLE
1	1	20-9439	BUSHING, MAIN LIFT CYLINDER
2	1	20-9767	H-FRAME
3	1	20-9768	CAP, CYLINDER
4	1	20-9769	BODY, CYLINDER
5	1	20-9770	PILOT, CYLINDER ROD
6	1	20-9771A	ROD, PISTON
7	1	20-9772	PINION MOD
8	1	20-9773	PISTON, CYLINDER
9	6	20-9793	SPACER, H-FRAME PALLET
10	1	22-9483	WASHER, CYLINDER NYLON THRUST
11	2	22-9615B	SHAFT, MECH. INTERLOCK
12	6	40-1617	FHCS, 1/4-20 x 1"
13	18	40-1645	SHCS, 10-32 x 5/8"
14	6	40-1676	SHCS, 5/16-18 x 2"
15	2	40-1960	SHCS, 3/8-16 x 1 3/4"
16	7	40-1969	FHCS, 3/8-16 x 1 1/2"
17	2	48-0040	DOWEL PIN, 3/8 x 1"
18	6	48-1666	DOWEL PIN, 1/2 x 2 1/4"
19	2	48-1750	DOWEL PIN, 1/2 x 1 1/2"
20	1	51-2134	BRONZE BEARING
21	1	57-2254	O-RING, PISTON
22	1	57-2255	O-RING, CAP
23	1	57-2256	O-RING, PILOT
24	1	57-9482	GASKET, CYLINDER
25	2	58-0002	1/4 NPT BREATHER VENT
26	15ft	58-2020	3/8 OD. NATURAL TUBING
27	1	58-3680	1/4 NPT M-3/8 STRT. TUBING



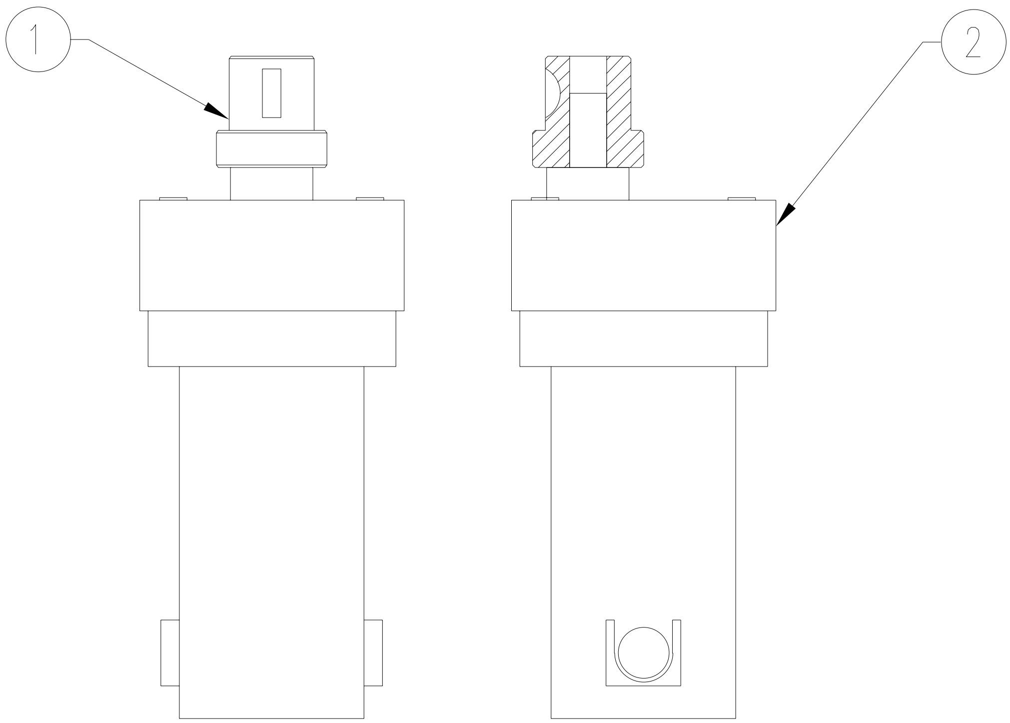
MAIN DRAW BAR ASSEMBLY
30-9420

ITEM	QTY	DWG_NUMBER	TITLE
1	1	20-9450	TUBE, AIR BLAST
2	1	20-9491	DRAW BAR, ROT. TABLE
3	1	22-9451A	PLUG, AIR LUBE TUBE
4	1	56-0051	SNAP RING
5	1	56-0110	RETAINING RING
6	1	57-0020	O-RING, 2-210 BUNA
7	1	58-9446	TUBE, LUBE



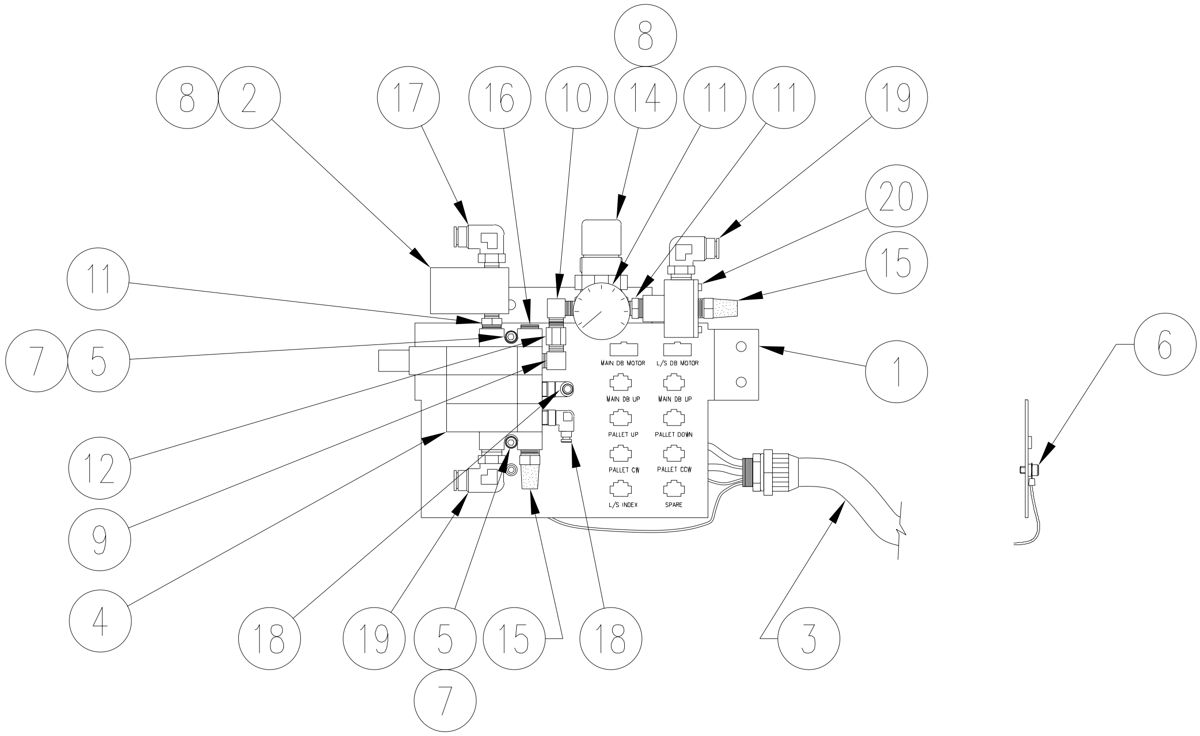
30-9420A MAIN DRAWBAR ASS'Y HS-1RP

ITEM	PART NO.	DESCRIPTION	QTY
1.	20-6445	DRAWBAR ROTARY TABLE	1
2.	20-6446	AIR BLAST TUBE HS-1RP	1
3.	22-9451A	PLUG, AIR LUBE TUBE	1



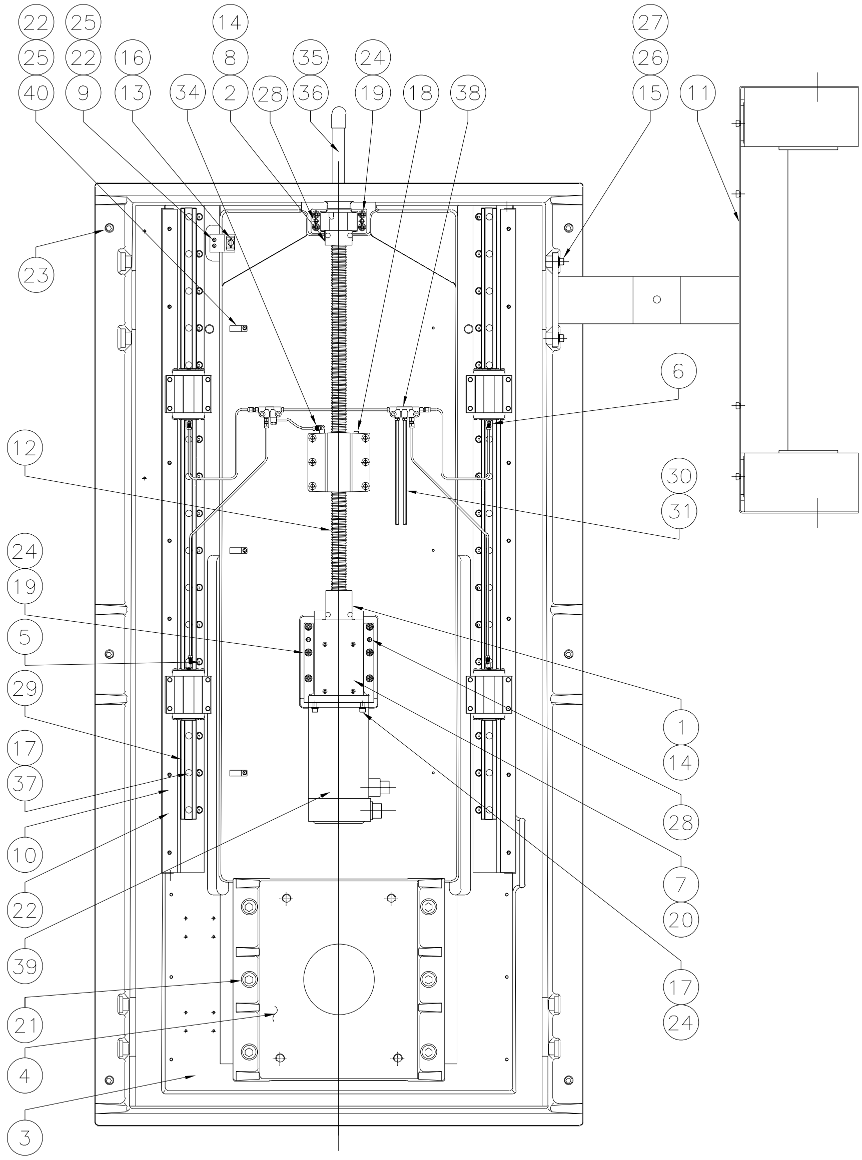
GEAR MOTOR ASSEMBLY
30-9421A

ITEM	QTY	DWG NO.	TITLE
1.	1	20-9463A	COUPLING, GEARMOTOR
2.	1	32-1900A	TURRET MOTOR ASS'Y (37 RPM)



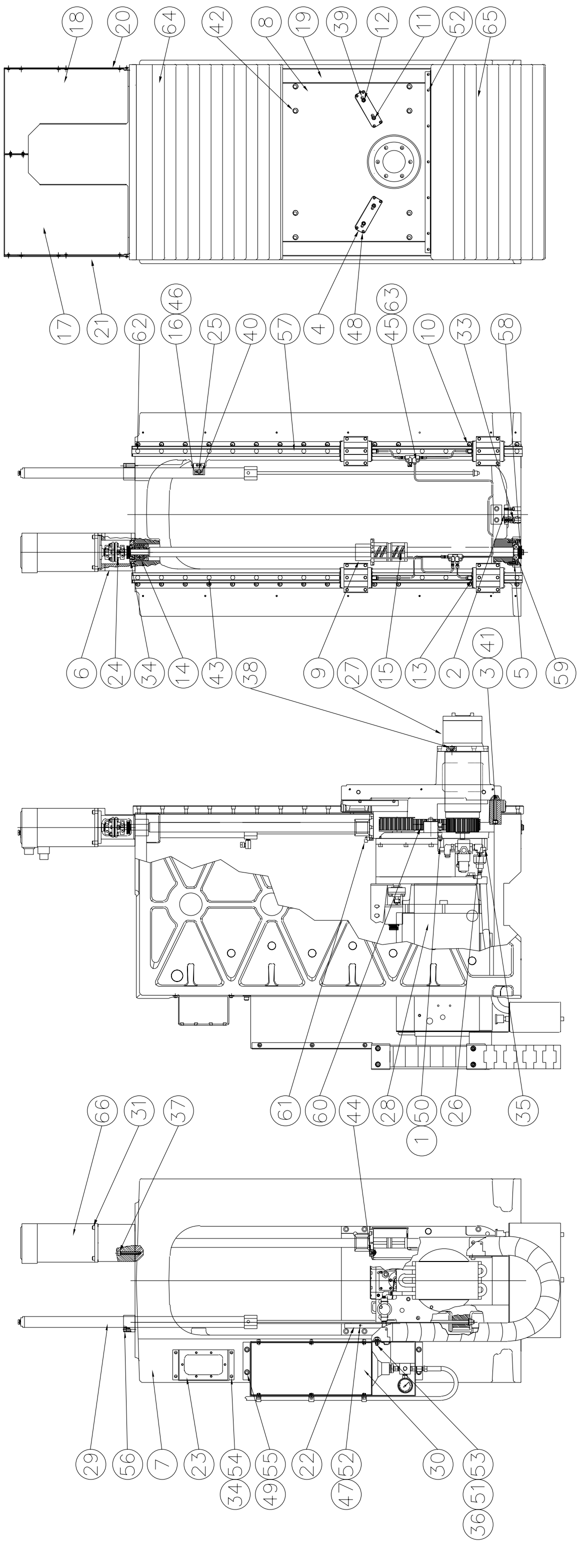
RP VALVE ASSEMBLY
30-9422

ITEM	QTY	DWG. NO.	TITLE
1	1	25-9448	MOUNTING BRACKET
2	1	32-5651	AIR SOLENOID
3	1	33-8019	CONDUIT, PALLET CHANGER
4	1	36-30675	SOLENOID ASS'Y, WP
5	2	40-16204	SHCS, 10-32 X 1 5/8
6	1	40-1850	SHCS, 10-32 X 3/8
7	2	45-1620	WASHER, SPLT LOCK, #10
8	2	58-1627	1/8-27 PIPE PLUG
9	1	58-16700	STREET ELBOW, 1/8 NPT
10	1	58-16705	1/8 X 1/8 MALE ELBOW
11	2	58-1674	1/4 NPT MALE ADAPTER
12	1	58-2255	1/8 FEMALE X 1/8 MALE
13	1	58-27395	AIR PRESSURE GAUGE
14	1	58-2740	AIR REGULATOR
15	2	58-3069	1/4 NPT MUFFLER
16	1	58-3105	PIPE PLUG, 1/4 NPT
17	1	58-3658	1/8 NPT X 3/8 TUBE SWVL.
18	2	58-3659	AIR FITTING, 1/8 NPT X 5/32
19	2	58-3685	1/4 NPT M 3/8 TUBE
20	1	59-2832A	QUICK EXHAUST, TRP


22
25
40
25
22
9
16
13
34
14
8
2
28
35
36
24
19
18
38
27
26
15
11
23
6
12
30
31
24
19
5
29
17
37
10
22
39
21
4
3
1
14
28
7
20
17
24

HS Base

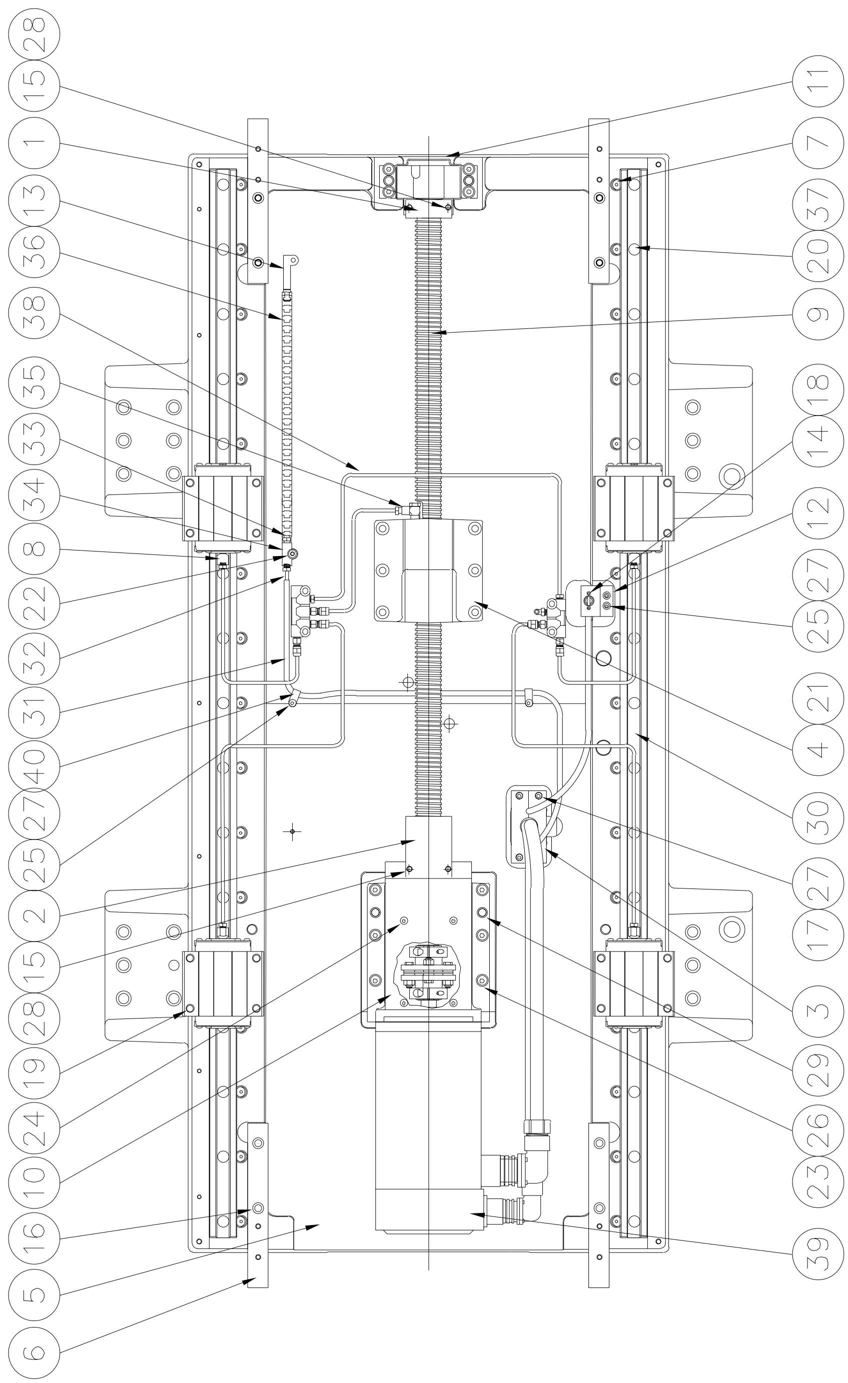
ITEM	QTY	DWG_NUMBER	TITLE
1	1	20-7187	BUMPER, Z AXIS, MOTOR END
2	1	20-7474	BUMPER, X AXIS, VF-2
3	1	20-9502B	BASE, MACHINING
4	1	20-9595A	SPACER, TABLE
5	32	22-7458	CAM, LINEAR GUIDE
6	4	24-7325	METRIC, LIN. GUIDE, M6 TO 5/16-24
7	1	25-7042B	COVER PLATE, LEAD SCREW
8	1	25-7080	BUMPER BRACKET, BEAR. HSG.
9	1	25-7267	SWITCH BRACKET, TRIP
10	2	25-9620B	CHIP GUARD, Z-AXIS
11	1	25-9645A	CONTROL BOX SUPPORT
12	1	30-1210A	LEAD SCREW ASSY, VF-3 Y,Z
13	1	32-5060	SWITCH, TELEMECH., TRIP
14	4	40-1632	SHCS, 1/4-20 x 1/2"
15	4	40-1636	SHCS, 3/8-16 x 1 1/4"
16	2	40-16413	MSHCS, M3 x 5
17	36	40-1667	SHCS, 5/16-18 x 1 1/4"
18	5	40-1697	SHCS, 1/4-20 x 3/4"
19	10	40-1715	SHCS, 5/16-18 x 1 1/2"
20	4	40-1750	BHCS, 10-32 x 3/8"
21	6	40-1819	SHCS 3/4-16 X 2"
22	17	40-1850	SHCS, 10-32 x 3/8"
23	6	44-1701	SSS, 3/4-10 X 4" CUP POINT
24	14	45-1600	WASHER, SPLIT LOCK, 5/16"
25	5	45-1620	WASHER, SPLIT LOCK, #10
26	4	45-1730	3/8" BLACK HARD WASHER
27	4	45-1820	3/8 SPLIT LOCK WASHER
28	4	48-0045	PIN, PULL, 3/8 x 1 1/2"
29	1	50-3400	X-AXIS GUIDE, VF-2
30	15.5FT	58-2000	NYLON TUBING, 1/4" CL., 0.5 FT LG.
31	15.5FT	58-2010	TUBING, NYLON, 5/32, 0.5 FT LG.
32	1	58-2100	SLEEVE, LUBE ASSY
33	1	58-2110	SLEEVE NUT, LUBE ASSY
34	1	58-3031	M6-1 TO 5/16-24 ELBOW
35	1	58-3054	90 DEG. 1/2" NPT ELBOW
36	1	58-3505	DRAIN PIPE, BASE
37	32	59-6600	HOLE PLUGS, LIN. GUIDE
38	1	59-7176A	BASE OIL LINE ASSEMBLY
39	1	62-0013	SERVO MOTOR YASKAWA
40	3	63-1032	CABLE CLAMP, KEYSTONE



HS Column

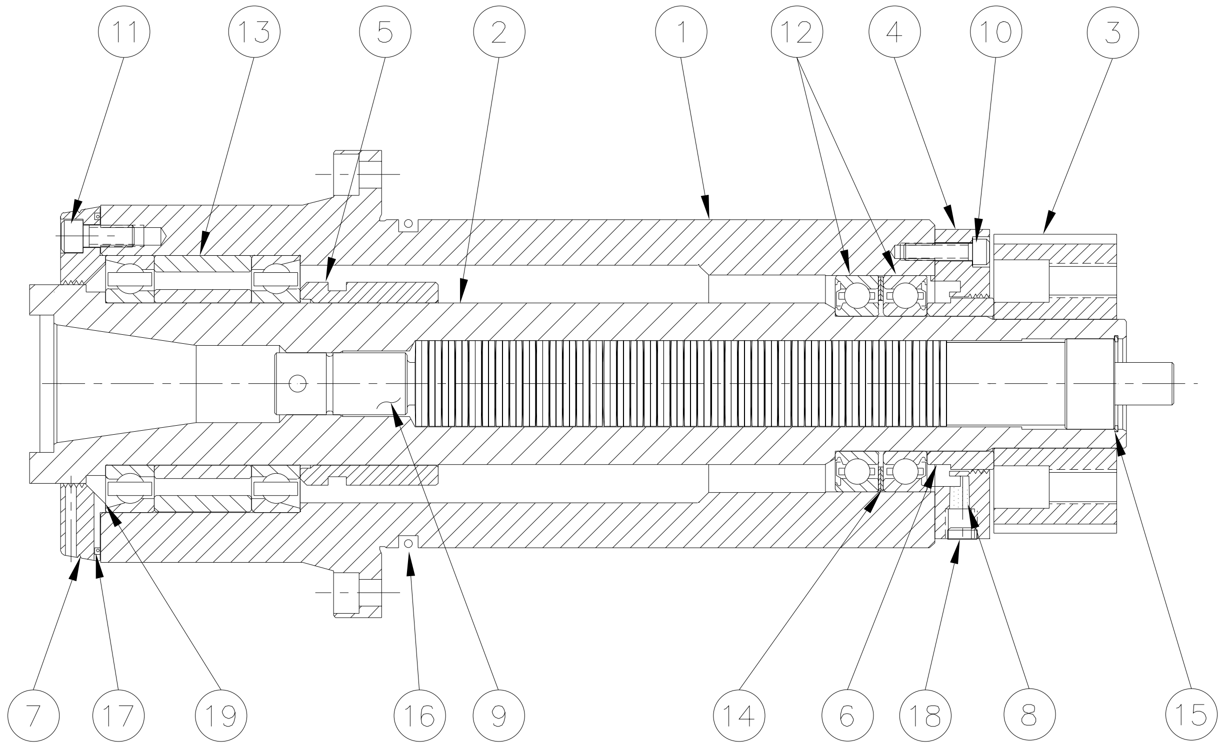
ITEM	QTY	DWG_NUM	TITLE
1	2	20-9364	SPACER
2	1	20-9390	BUMPER, COLUMN
3	1	20-9391	HARDSTOP, SPINDLE HEAD
4	2	20-9392	COOLANT MANIFOLD
5	1	20-9393	BEARING PLATE, COLUMN
6	1	20-9435A	MOTOR MOUNT
7	1	20-9501B	COLUMN, MACHINING
8	1	20-9505B	SPINDLE HEAD, MACHINING
9	1	20-9669A	BUMPER STOP, Y AXIS
10	34	22-7458	CAM SCREW, LINEAR GUIDE
11	2	22-8730	NOZZLE, COOLANT, T/H
12	2	22-8739	NOZZLE, COOLANT, ANGLE, T/H
13	4	24-7325	STR FIT METRIC, LINEAR GUIDE
14	1	24-7478	BALL SCREW SPT. BRG. ASSY
15	1	24-9514B	LEAD SCREW, Y AXIS
16	1	25-7267	Y AXIS MOUNT BRACKET
17	1	25-9371	INTERMEDIATE SHIELD, LEFT
18	1	25-9387A	INTERMEDIATE SHIELD, RIGHT
19	2	25-9563B	CHIP GUARD, Y AXIS
20	1	25-9609B	GUDE RIGHT, Y AXIS WAY
21	1	25-9610B	GUIDE LEFT, Y AXIS WAY
22	1	25-9614A	TRIP BRACKET, Y AXIS
23	1	25-9665A	BRACKET, Z AXIS CABLE CARR.
24	1	30-1220A	COUPLING ASSY
25	1	32-5050	LIMIT SWITCH ASSY, Y AXIS
26	1	30-3296	TOOL RELEASE PISTON ASSY
27	1	30-3800C	SPINDLE ASSY
28	1	30-3840	GEARBOX ASSY
29	1	30-3971	HYDRAULIC CYLINDER ASSY
30	1	30-3972	HYDRAULIC TANK ASSY
31	4	40-1500	SHCS, 5/16-18 x 1"
32	8	40-1609	BHCS, 10-32 x 1/2"
33	6	40-1610	SHCS, 1/4-20 x 1"
34	10	40-1632	SHCS, 1/4-20 x 1/2"
35	2	40-16373	SHCS, 3/8-16 x 1 5/8"
36	4	40-16385	SHCS, 5/16-18 x 3/4"
37	4	40-16388	SHCS, 5/16-18 x 2 1/2"
38	6	40-1639	SHCS, 3/8-16 x 1"
39	4	40-1703	FHCS, 10-32 x 1/2"
40	2	40-16413	MSHCS, M3 x 5
41	2	40-16437	SHCS, 3/8-16 x 3 1/4"
42	16	40-1658	SHCS, M10 x 4
43	34	40-1667	SHCS, 5/16-18 x 1 1/4"
44	5	40-1697	SHCS, 1/4-20 x 3/4"
45	4	40-1705	FHCS, 10-32 x 1"
46	2	40-1750	BHCS, 10-32 x 3/8"
47	2	40-1850	SHCS, 10-32 x 3/8"
48	8	40-2026	SHCS, 10-32 x 1"

ITEM	QTY	DWG_NUM	TITLE
49	4	40-2030	SHCS, 3/8-16 x 3/4"
50	2	43-7105	HHB, 3/8-16 x 2 3/8"
51	4	45-1600	WASHER, SPLIT LOCK, 5/16 MED.
52	16	45-1620	WASHER , SPLIT LOCK, #10
53	4	45-1731	WASHER, FLAT, 5/16"
54	4	45-1800	WASHER, SPLIT LOCK 1/4"
55	4	45-1820	WASHER, LOCK 3/8" MED.
56	2	49-1004	SHOULDER SCREW, 1/4-20 x 5/16"
57	2	50-3400	LINEAR GUIDE
58	2	51-0012	BEARING LOCKNUT, BH-06
59	1	51-2025	BEARING, RADIAL #304PP
60	1	54-2660	GT SPINDLE DRIVE BELT
61	1	58-3031	BANJO ELBOW, 5/16 F x M6 M
62	34	59-6650	PLUG, GUIDE RAIL
63	1	59-7178A	COLUMN OIL LINE
64	1	59-9607A	Y-AXIS BELLOWS, UPPER
65	1	59-9608A	Y-AXIS BELLOW, LOWER
66	1	62-0013	SERVO MOTOR, YASKAWA


28
15
1
13
36
38
35
33
34
8
22
32
31
40
27
25
2
15
28
19
24
10
16
5
6
11
7
37
20
9
18
14
12
27
25
21
4
30
27
17
3
29
26
23
39

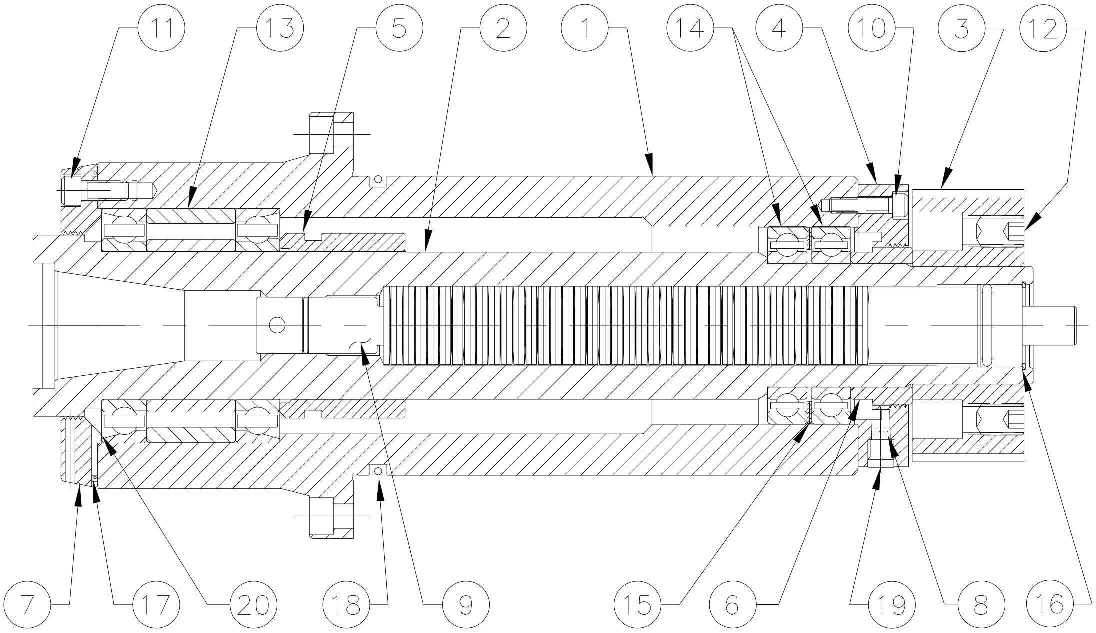
HS Saddle

ITEM	QTY	PART_NO	TITLE
1	1	20-7185	BUMPER, 7/8"
2	1	20-7186	BUMPER, 3"
3	2	20-7456	CONDUIT STRAIN RELIEF
4	1	20-9007	NUT HOUSING
5	1	20-9503C	SADDLE, MACHINED
6	4	20-9557B	EXTENDER BAR
7	34	22-7458	CAM SCREW, LINEAR GUIDE
8	4	24-7325	STR FIT METRIC, LINEAR GUIDE
9	1	24-9514B	LEAD SCREW
10	1	25-7042	COVER PLATE, LEAD SCREW
11	1	25-7080	BUMPER BRACKET, BRG HSG
12	1	25-7267	Y AXIS MOUNT BRACKET
13	2	25-7486	BRACKET, OIL LINE CARRIER (R)
14	1	32-5040	LIMIT SWITCH ASSEMBLY, Y AXIS
15	4	40-1632	SHCS, 1/4-20 x 1/2"
16	8	40-16385	SHCS, 5/16-18 X 3/4"
17	4	40-1640	SHCS, 10-32 x 1/2"
18	2	40-16413	MSHCS, M3 x 5
19	16	40-1658	SHCS, M10 x 60
20	34	40-1667	SHCS, 5/16-18 x 1 1/4"
21	5	40-1697	SHCS, 1/4-20 x 3/4"
22	5	40-1705	FHCS, 10-32 x 1"
23	10	40-1715	SHCS, 5/16-18 x 1 1/2"
24	4	40-1750	BHCS, 10-32 x 3/8"
25	5	40-1850	SHCS, 10-32 x 3/8"
26	10	45-1600	WASHER, SPLIT LOCK, 5/16
27	5	45-1620	WASHER, SPLIT LOCK, #10
28	4	45-1800	WASHER, SPLIT LOCK, 1/4"
29	4	48-0040	PIN, DOWEL, 3/8 x 1"
30	2	50-3400	LINEAR GUIDE
31	37.5"	58-2000	NYLON TUBING, 1/4" CL
32	39.5"	58-2010	NYLON TUBING, 5/32" CL
33	4	58-2130	SLEEVE, COMP. NYLON TUBING
34	1	58-2760	FITTING MANIFOLD, 2 WAY
35	1	58-3031	BANJO ELBOW, 5/16 F x M6 M
36	23"	59-6150	PLASTIC CARRIER
37	34	59-6600	PLUG, GUIDE RAIL
38	1	59-7177A	SADDLE OIL LINE ASSEMBLY
39	1	62-0013	SERVO MOTOR, YASKAWA
40	3	63-1031	CABLE CLAMP, 1/4"



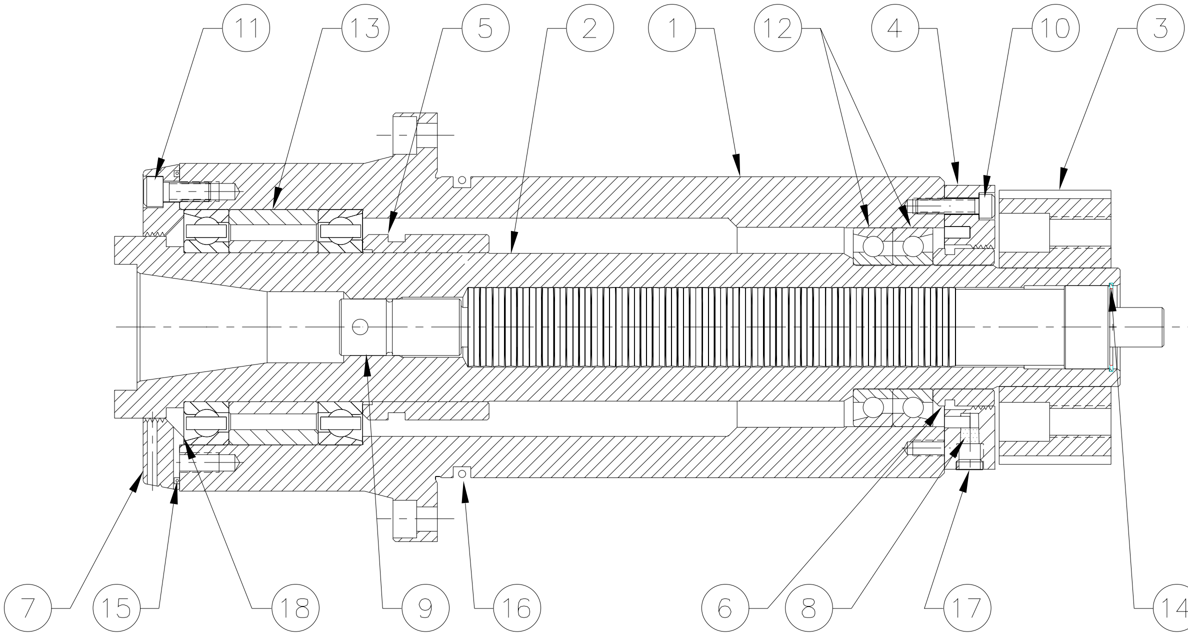
30-3800D SPINDLE ASSEMBLY

ITEM	QTY	P/N	DESCRIPTION
1	1	20-7016B	SPINDLE HOUSING
2	1	20-7018L	SPINDLE SHAFT
3	1	20-7373	1 7/8 DIA PULLEY
4	1	20-7442C	OIL INJECT. COVER
5	1	20-7530	LOCK, 60 mm BEARING
6	1	20-7531	LOCK, 50 mm RADIAL BEARING
7	1	20-9763A	SPINDLE LOCK
8	1	24-4200	BRONZE FILTER ELEMENT
9	1	30-3410D	DRAW BAR ASS'Y, HIGH CLAMP
10	4	40-1610	SHCS, 1/4-20 x 1"
11	6	40-16385	SHCS, 5/16-18 x 3/4"
12	2	51-0033	BRNG 6010Z 20-30% NBU15
13	1	51-1012B	112 ANGULAR CONTACT DUPLEX
14	1	55-0020	WAVE WASHER, W3118-035
15	1	56-0075	SNAP RING, 5000-131
16	1	57-2984	O-RING, 2-158 VITON
17	1	57-2990	O'RING, 2-157 BUNA
18	1	58-1627	1/8-27 PIPE PLUG
19	1	59-0005	BEARING SHIELD



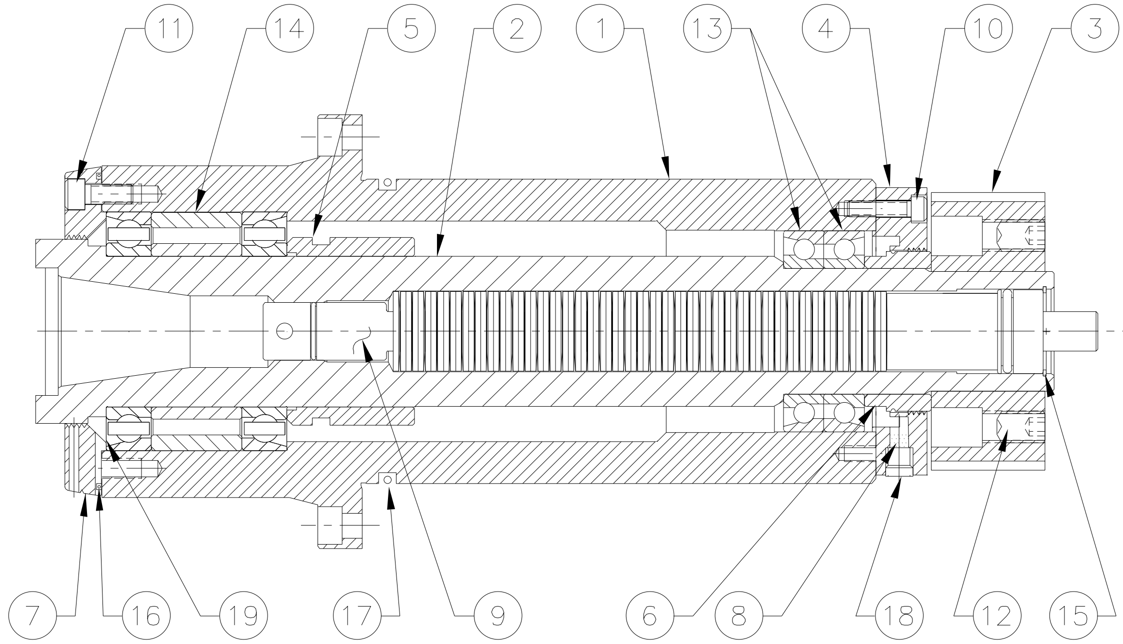
30-3805F SPINDLE ASSY, HS 7.5K TSCHP

ITEM	QTY	PART NO.	DESCRIPTION	ITEM	QTY	PART NO.	DESCRIPTION
1	1	20-7016B	SPINDLE HOUSING	11	6	40-16385	SHCS 5/16-18 X 3/4
2	1	20-7018L	SPINDLE SHAFT	12	2	44-1698	SSS 1/2-13 X 3/4
3	1	20-7373	1 7/8 PULLEY	13	2	51-0033	6010Z 20-30% NBU15
4	1	20-7442C	OIL INJECTION COVER	14	1	51-1012B	MD DUPLEX GRSPK 36MM SP
5	1	20-7530	LOCK 60MM BEARING	15	1	55-0020	WAVE WASHER W3118-035
6	1	20-7531	50MM LOCK 7500 SPINDLE	16	1	56-0075	SNAP RING N5000-131
7	1	20-9763A	SPINDLE LOCK TAPERED	17	1	57-2984	O-RING 2-158 VITON
8	1	24-4200	BRONZE FILTER ELEMENT	18	1	57-2990	O-RING 2-348 BUNA
9	1	30-3415F	DRAWBAR ASSY HC TSC CARB	19	1	58-1627	1/8-27 PIPE PLUG
10	4	40-1610	SHCS 1/4-20 X 1	20	1	59-0005	BEARING SHIELD .005 BRASS



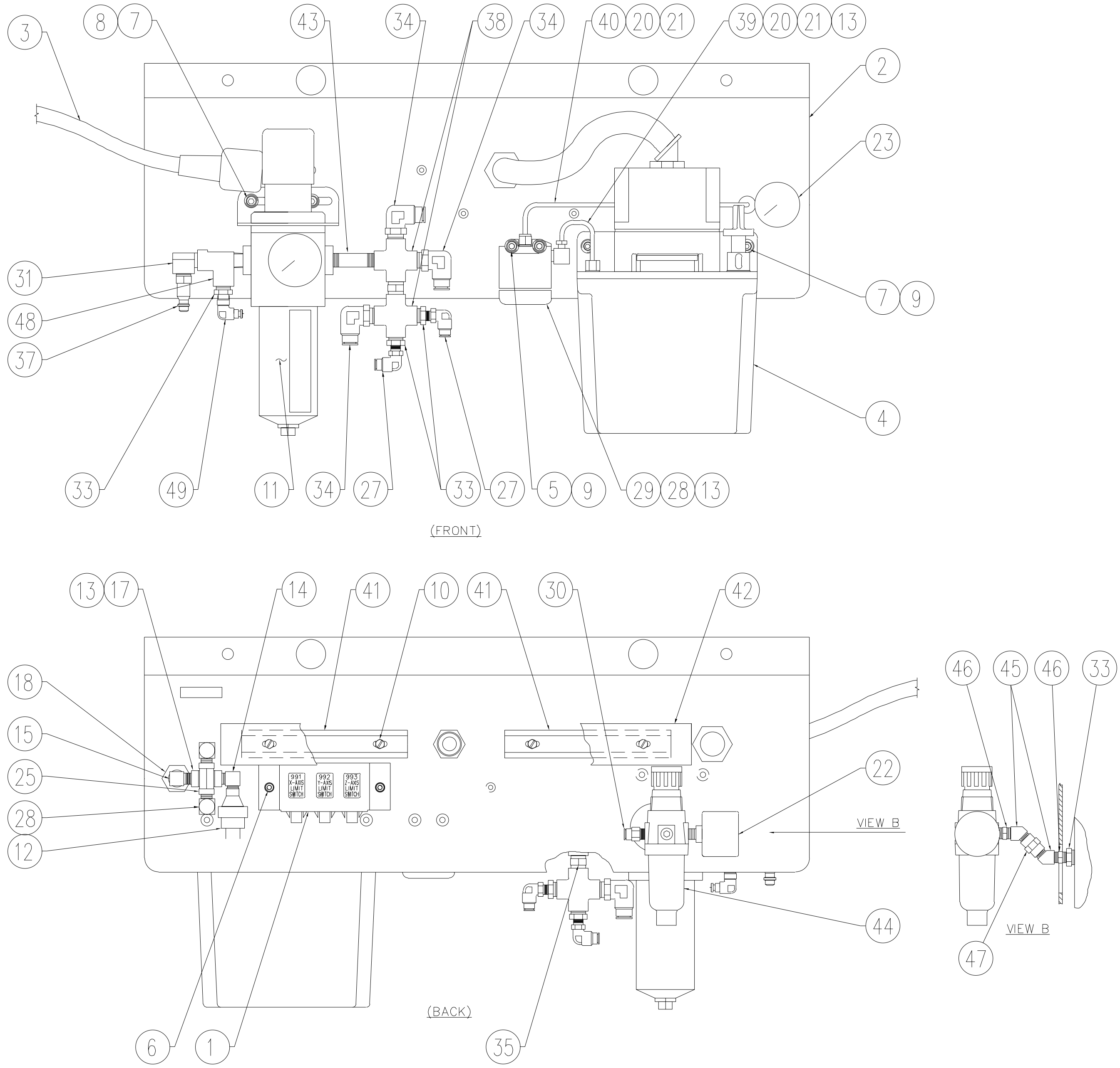
30-3810E 10K SPINDLE ASSEMBLY

ITEM	QTY	PART NO.	DESCRIPTION
1	1	20-7016B	SPINDLE HOUSING
2	1	20-7018L	SPINDLE SHAFT
3	1	20-7373	1 7/8 PULLEY
4	1	20-7442C	OIL INJECTION COVER
5	1	20-7530	LOCK 60MM BEARING
6	1	20-7532	LOCK 50MM ANG CNTACT BRNG
7	1	20-9763A	SPINDLE LOCK TAPERED
8	1	24-4200	BRONZE FILTER ELEMENT
9	1	30-3410D	DRAWBAR ASSY HIGH CLAMP
10	4	40-1610	SHCS 1/4-20 X 1
11	6	40-16385	SHCS 5/16-18 X 3/4
12	1	51-1003	LT ANG CONT GRSPK DUPLEX
13	1	51-1012C	LT DUPLEX GRSPK 36MM SP
14	1	56-0075	SNAP RING N5000-131
15	1	57-2984	O-RING 2-158 VITON
16	1	57-2990	O-RING 2-348 BUNA
17	1	58-1627	1/8-27 PIPE PLUG
18	1	59-0005	BEARING SHIELD .005 BRASS



30-3815G SPINDLE HS ASSY,10K,TSCHP CARB.

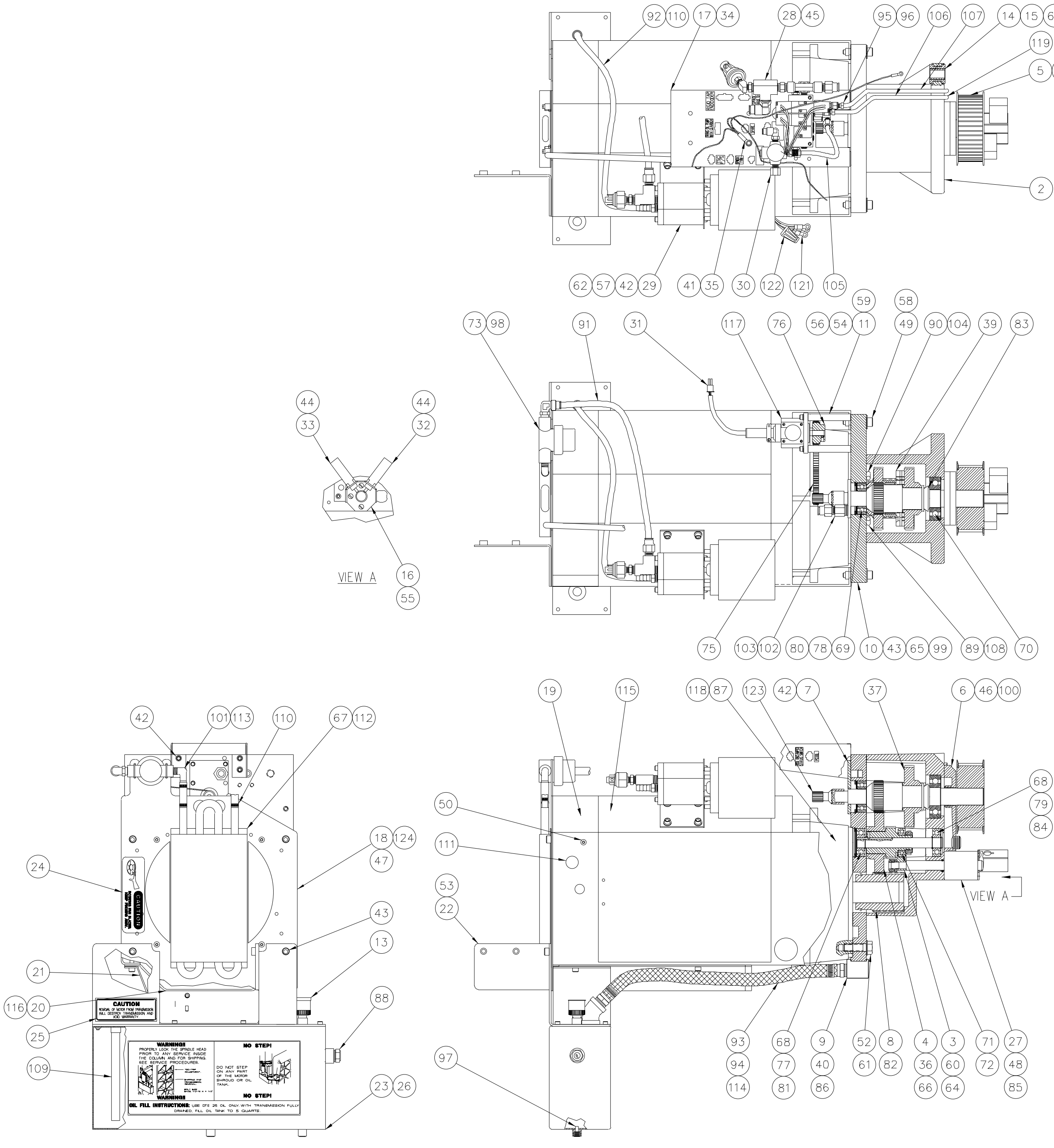
ITEM	QTY	PART NO.	DESCRIPTION
1	1	20-7016B	SPINDLE HOUSING
2	1	20-7018L	SPINDLE SHAFT
3	1	20-7373	1 7/8 PULLEY
4	1	20-7442C	OIL INJECTION COVER
5	1	20-7530	LOCK 60MM BEARING
6	1	20-7532	LOCK 50MM ANG CNTACT BRNG
7	1	20-9763A	SPINDLE LOCK TAPERED
8	1	24-4200	BRONZE FILTER ELEMENT
9	1	30-3415F	DRAWBAR ASSY HC TSCHP CARB
10	4	40-1610	SHCS 1/4-20 X 1
11	6	40-16385	SHCS 5/16-18 X 3/4
12	2	44-1698	SSS 1/2-13 X 3/4
13	1	51-1003	LT ANG CONT GRSPK DUPLEX
14	1	51-1012C	LT DUPLEX GRSPK 36MM SP
15	1	56-0075	SNAP RING N5000-131
16	1	57-2984	O-RING 2-158 VITON
17	1	57-2990	O-RING 2-348 BUNA
18	1	58-1627	1/8-27 PIPE PLUG
19	1	59-0005	BEARING SHIELD .005 BRASS



30-4810B AIR REG/LUBE ASSY

30-4810B AIR REG/LUBE ASSY

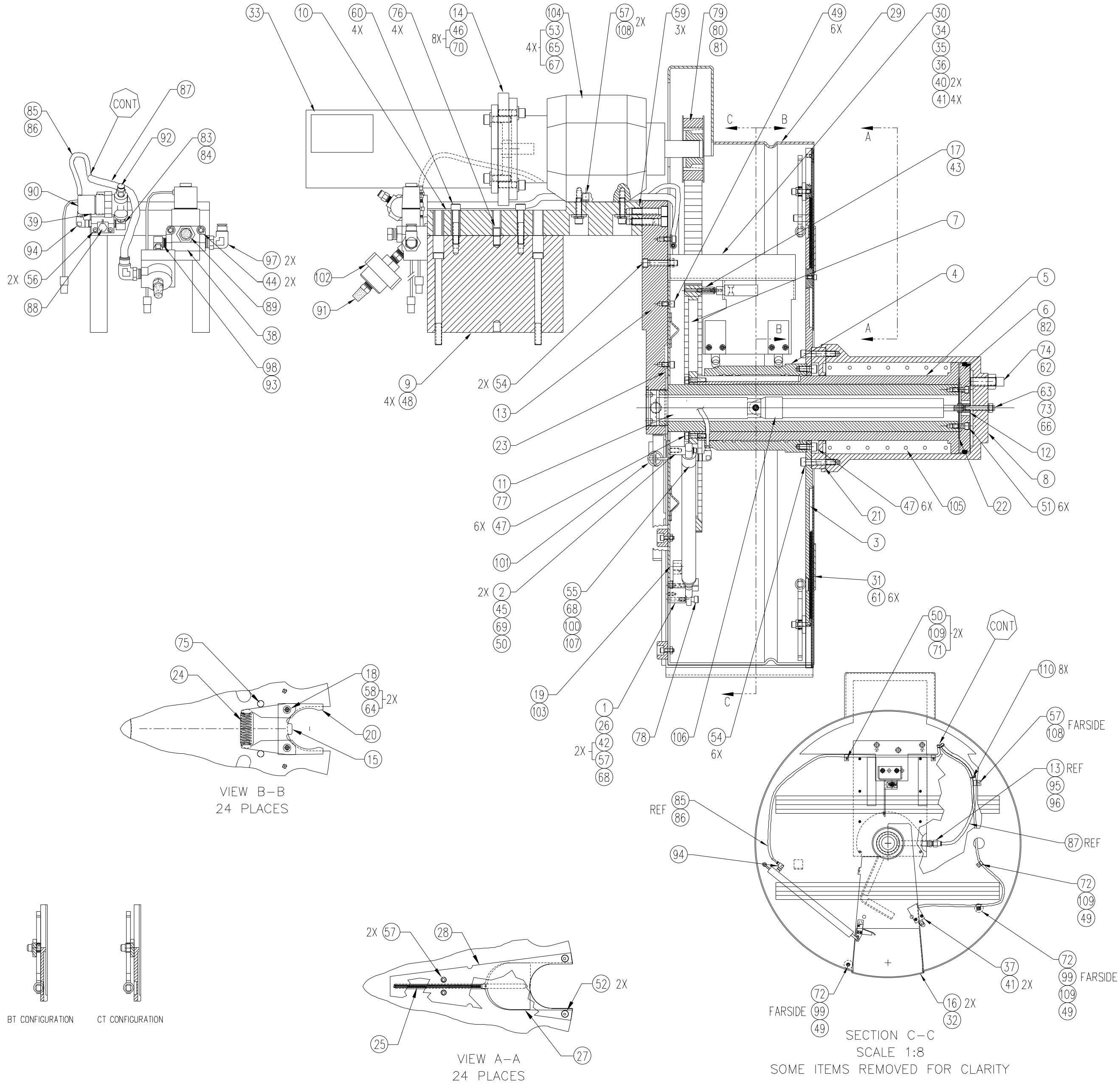
ITEM	QTY	DWG. NO.	TITLE
1	1	25-7161	SWITCH CON. BRKT.
2	1	25-7195K	LUBE MOUNT BRKT.
3	1	32-8025A	COND. ASS'Y, LIMIT/ OILER "B"
4	1	36-3090B	OILER PUMP ASS'Y
5	2	40-1679	SHCS, 1/4-20 X 2 1/2"
6	2	40-1850	SHCS, 10-32 X 3/8"
7	4	40-2000	SHCS, 1/4-20 X 5/8"
8	2	45-0040	WASHER, BLK, HARD 1/4"A325
9	4	45-1800	WASHER. SPLIT LOCK 1/4" MED
10	4	49-4100	HHS, WASHER, SLTD 10-32 X 3/8"
11	1	53-2110A	FILTER REGULATOR, NORGREN
12	1	53-3002	PRESSURE SWITCH PS-126
13	3	58-1550	1/8 NPT CONN.
14	1	58-16700	STREET ELBOW, 1/8"
15	1	58-16705	MALE ELBOW, 1/8" MALE TO MALE
* 16	1	58-1671	LONG NIPPLE, 1/8-27 NPT
17	1	58-1676	1/8" NPT CROSS FITTING
18	1	58-16760	FLUID CONNECTOR
* 19	1	58-1690	QUICK DETACH COUPLER 1/4
20	4	58-2100	SLEEVE, LUBE ASS'Y
21	4	58-2110A	SLEEVE NUTS, LUBE ASS'Y
22	1	58-2730	AIR PRESSURE GAUGE, 0-15 PSI
23	1	58-27395	AIR PRESSURE GAUGE
* 24	1	58-2740	AIR REGULATOR
25	1	58-2743	MALE 'T' BRANCH, 1/8"
* 26	1	58-3015	CLOSER PLUG
27	2	58-3050	ELBOW, 1/4" NYLON TUBING
28	3	58-3058	5/32" TUBE, ELBOW
29	1	58-3059	PRESSURE FILTER TYPE 25P
30	1	58-3070	FITTING, 1/8" NPT-1/4"
31	1	58-3618	1/4 STREET ELBOW, 90°
32	2	58-3665	1/4 NPT FEMALE TO 3/8 MALE
33	4	58-3670	1/4 NPT M-1/8 F REDUCER
34	3	58-3685	1/4 NPT M-3/8 TUBE-SVL ELBOW
35	1	58-3691	1/4 NPT MALE HEX JT 1 3/8"
* 36	1	58-3695	1/4 NPT FEMALE TEE
37	1	58-3710	QUICK RELEASE FTG MALE
38	2	58-3740	1/4" NPT FEMALE CROSS
39	1	58-7322C	COPPER TUBING-YH
40	1	58-7323B	COPPER TUBING- YI (REV B)
41	1.333FT	79-1000	WIRE CHANNEL 1" X 2"
42	1.416FT	79-1001	COVER, 1" WIRE CHANNEL
43	1	58-0004	1/4 NPT X 2 BRASS NIPPLE
44	1	58-0005	1/8 NPT AIR FILTER/REG
45	2	58-1670	STREET ELBOW 1/8 45°
46	2	58-16732	1/8 X 1/8 MALE HEX JOINT
47	1	58-2746	1/8 1/8 FEMALE COUPLER
48	1	58-3001	1/4 STREET TEE
49	1	58-3659	AIR FIT 1/8 PIPE 5/32 TUBE



30-5600 TRANS ASSY HS 15HP VD

30-5600 TRANS ASSY HS 15HP VD

ITEM	QTY	PART	DESCRIPTION	ITEM	QTY	PART	DESCRIPTION
1*	1	20-0064	"REMOVED" ADAPTER ENCODER PULLEY	64	1	46-1654	NUT, HEX 7/16-20
2	1	20-7011D	HOUSING GEARBOX MACHINING	65	2	48-0020	PIN, DOWEL 1/4 X 1
3	1	20-7062	BRG FORK, GEAR CLUSTER	66	1	48-0050	PIN, DOWEL 1/8 X 7/16
4	1	20-7064	TRANSFER SHAFT	67	3	49-2510	POP RIVET 3/16 X .315 LG
5	1	20-7374	1 1/8 SPROCKET	68	2	51-2031	BRNG. RADIAL OPEN 6303
6	1	20-7430A	OIL CATCH PAN	69	1	51-2032	BRNG. RADIAL OPEN 6205
7	1	20-7435	OILER PLATE	70	1	51-2033	BRNG. RADIAL OPEN 6306
8	1	20-9125A	MOTOR SHAFT GEAR	71	1	51-2034	BRNG. RADIAL OPEN 6005
9	1	20-9370	OIL DRAIN BLOCK	72	1	51-2041	BRNG LOCKNUT BH-05
10	1	20-9399	TOP PLATE GEARBOX	73	1	53-1005	OIL FILTER
11	4	22-7260	ENCODER STANDOFF	74*	1	54-1013	"REMOVED" DRIVE SPROCKET .250 RTAP
12	2	22-7376	SPROCKET FLANGE	75	1	54-2125	DRIVE BELT HTD 300-3M-09
13	1	22-7487	OIL FILL CAP MODIFIED	76	1	54-7127	DRIVE SPROCKET.375 RTAP
14	12	22-7520A	ISOLATOR TRANS	77	2	55-0035	SPRING WASHER, BS-204
15	6	22-7521B	SPACER TRANS	78	2	55-0036	SPRING WASHER, BS-205
16	1	25-7264	SWITCH MOUNTING BRACKET	79	3	56-0060	SNAP RING, N5100-66
17	1	25-7336	SOLENOID MOUNTING BRACKET	80	1	56-0070	SNAP RING N5000-187
18	1	25-9129A	FAN BRACKET GEAR BOX	81	1	56-2087	SNAP RING, N5000-206
19	1	25-9130A	MOTOR SHROUD VF-3	82	1	57-0006	O-RING 2-328 BUNA
20	1	25-9175	MOTOR SHROUD COVER	83	1	57-0013	V-RING SEAL CR 400280
21	1	25-9383	BRACE RESEVOIR	84	2	57-0058	O-RING, 2-014 BUNA
22	1	25-9400	OIL RESEVOIR MOUNT HS-1XX	85	1	57-0105	QUAD RING, Q4-114 VITON
23	1	25-9457A	OIL RESEVOIR GEARBOX	86	1	57-2220	O-RING, 2-152 BUNA
24	1	29-0022	SHROUD CAUTION DECAL	87	1	57-7573A	TRANS MOTOR GASKET (WITH BALDOR MOTOR ONLY)
25	1	29-7399	TRANSMISSION MOTOR LABEL	88	1	58-1640	3/8 NPT SIGHT GLASS
26	1	29-9396A	DECAL HS-1 TRANS SERVICE	89	1	58-16752	90 DEG. COMPRESSION TILT
27	1	30-3130C	SHIFTER ASSY	90	1	58-16755	MALE AIR FITTING, 1/8
28	1	30-3146	AIR SOLENOID ASSY MAC TP	91	5FT	58-2001	POLYU HOSE 1/2OD X 3/8ID
29	1	30-3260A	OIL GEAR PUMP ASSY	92	2FT	58-2020	3/8 OD NATURAL TUBING
30	1	30-3270A	PRECHARGE REGULATOR ASSY	93	15"	58-2049	PVC BRAIDED HOSE 3/4 ID
31	1	32-1455D	RTAP ENCODER CABLE	94	2	58-2066	HOSE BARB 3/4X1/2 NPT STR
32	1	32-2010	24 LIMIT SWITCH	95	4	58-2100	SLEEVE LUBE ASSY
33	1	32-2011	TELMECH. 30 IN CABLE ASSY	96	4	58-2110	SLEEVE NUTS LUBE ASSY
34	1	33-3200	SOLENOID BRKT CABLE ASSY	97	2	58-2745	MAGNETIC OIL PLUG
35	1	33-5010	GRND WIRE SPND MTR HS-1	98	1	58-2747	MAGNET OIL FILTER
36	1	35-7065A	TRANSFER GEAR ASSY	99	1	58-3105	PIPE PLUG 1/4 NPT
37	1	35-7170A	DRIVE SHAFT ASSY	100	1	58-3108	STEEL PIPE PLUG 1/2 NPT
38*	1	36-3035A	"REMOVED" SPINDLE MOTOR FAN ASSY	101	2	58-3616	3/8 90 DEG.ELBOW 1/4 NPT
39	2	40-1602	FHCS, 1/4-28 X 5/8	102	1	58-3657	1/4 FEMALE 1/8 MALE ADPT
40	2	40-1610	SHCS 1/4-20 X 1	103	1	58-3685	1/4NPT M-3/8 TUBE-SVL LBO
41	1	40-1630	SHCS, 1/4-20 X 5/16	104	1	58-7357	TOP PLATE TUBE - A
42	16	40-1632	SHCS 1/4-20 X 1/2	105	1	58-7377	AIR REG / SOLENOID TUBE
43	12	40-16385	SHCS 5/16-18 X 3/4	106	1	58-7635	LOW GEAR TUBE VF-3
44	4	40-16413	MSHCS, M3 X 5	107	1	58-7636	HIGH GEAR TUBE VF-3
45	2	40-1644	SHCS, 10-32 X 1 1/2	108	1	58-9398	TOP PLATE, TUBE C
46	5	40-16455	SHCS, 10-32 X 7/8	109	1	58-9508A	PICK UP TUBE
47	5	40-1669	BHCS, 8-32 X 3/8	110	3	59-0027	HOSE CLAMP 1/2 HOSE
48	4	40-1700	SHCS, 10-32 X 2	111	4	59-1482	NYLON FINISH PLUG, 13/16 (FINAL ASSEMBLY)
49	4	40-1715	SHCS, 5/16-18 X 1 1/2	112	1	59-2910	OIL COOLER
50	1	40-1750	BHCS, 10-32 X 3/8	113	2	59-4006	HOSE CRIMP, 35/64
51*	1	40-1800	"REMOVED" SHCS 8-32 X 3/4	114	2	59-4009	HOSE CLAMP 61/64 - 1 5/64
52	3	40-1830	HHB, 1/2-13 X 1 3/4	115	1	59-9135A	SOUNDCOAT MTR/GEAR SHRD
53	7	40-1850	SHCS 10-32 X 3/8	116	1	59-9179	SOUNDCOAT FRONT SHRD CVR
54	4	40-1950	SHCS, 10-32 X 3/4	117	1	60-1810	SHAFT ENCODER 2000 LINE
55	3	41-1500	PPHS, 8-32 X 3/8	118	1	62-3010	SPINDLE MTR, 10 HP
56	4	44-1715	SSS, CUP PT 1/4-20 X 3/4	119	2	63-0001	NYLON CABLE CLAMP 1/2
57	4	45-0040	WASHER BLK HARD 1/4 A325	120	25	70-0020	PLT1.5M CABLE TIES
58	4	45-1600	WASHER SPLIT LOCK 5/16MED	121	3	76-2420	CRIMP RING, 12-10 10 STUD
59	4	45-1620	WASHER SPLIT LOCK #10 MED	122	1	77-8001	WIRE NUT, IDEAL #30-076
60	1	45-1682	WASHER,SPLIT LOCK 7/16MED	123	1	20-0125	DRIVE SPROCKET ENCODER
61	3	45-1740	WASHER, BLACK HARD 1/2	124	1	29-9128	LABLE TRANSMISSION
62	4	45-1800	WASHER SPLIT LOCK 1/4 MED	125	1	36-3035	SPINDLE FAN ASSY
63	6	45-1851	WASHER TRANS	126	1	57-0049	(PENDING APPROVAL NOT SHOWN) RUBBER STUD BUMPER



30-9800C 24 TOOL CHANGER ASSEMBLY

30-9800C 24 TOOL CHANGER ASSEMBLY

ITEM	QTY	PART NO	DESCRIPTION
1	1	20-9415	FRONT MOUNT CYLINDER HS
2	1	20-9416	REAR PIVOT CYLINDER HS-1
3	1	20-9545B	24 TOOL CAROUSEL
4	1	20-9547A	RECIPROCATING SLEEVE
5	1	20-9585A	ROTATING SLEEVE
6	1	20-9599	LOCKING CAP
7	1	20-9601	LARGE PULLEY MODIFIED
8	1	20-9602	CYLINDER MACHINED
9	2	20-9654A	TOOL CHANGER SPACER
10	1	20-9657A	TOOL CHANGER TOP PLATE
11	1	20-9682	REAR SHOCK MOUNT
12	1	20-9687	SHOCK MOUNT FRONT
13	1	20-9747A	SHAFT ASSY TOOL CHANGER
14	1	20-9786	BRUSH AXIS MTR ADAPT PLT
15	24	22-7067F	KEY EXTRACTOR SPRING LOAD
16	2	22-7163	RIDER-TRAP DOOR
17	1	22-7255A	TOOL #1 STANDOFF
18	48	22-9256	BUSHING EXTRACTOR
19	1	22-9417	SLIDER DOOR STOP
20	48	22-9574A	CT EXTRACTOR SPRING LOAD
21	1	22-9586A	SPRING SEAT HS-1
22	1	22-9637	SPACER WASHER
23	1	22-9742A	DOOR WASHER
24	24	24-2010A	COMPRESSION SPRING
25	24	24-9674	SPRING EXTRACTOR HORIZ
26	1	25-6461	TRIP BRACKET TC DOOR HS
27	24	25-7249	SLIDING PANEL
28	24	25-9535	24 TOOL SLIDING PANEL CVR
29	1	25-9583	COVER TOOL CHANGER HS
30	1	25-9605A	SHUTTLE SWITCH BRACKET
31	1	25-9676	NUMBER RING TOOL CHANGER
32	1	25-9723A	TRAP DOOR GRAY
33	1	32-1820A	TOOL CHANGER MTR/CBL ASSY
34	1	32-5030	LIMIT SWITCH MOTOR T/C
35	1	32-5031	LIMIT SWITCH T/C IN
36	1	32-5032	LIMIT SWITCH T/C OUT
37	1	32-5035	LIMIT SWITCH T/C DOOR HS
38	1	32-5620	TRP SOLENOID VALVE ASSY
39	1	36-30672	SOLENOID ASSEMBLY
40	2	40-0022	MSHCS M3 X 8
41	6	40-1606	BHCS 6-32 X 1/2
42	2	40-1609	BHCS 10-32 X 1/2
43	1	40-16091	BHCS 10-32 X 1
44	2	40-1615	SHCS 1/4-20 X 1 1/2
45	7	40-1632	SHCS 1/4-20 X 1/2
46	8	40-1636	SHCS 3/8-16 X 1 1/4
47	12	40-16385	SHCS, 5/16-18 X 3/4
48	4	40-16439	SHCS 3/8-16 X 5
49	3	40-1645	SHCS, 10-32 X 5/8
50	3	40-1677	BHCS, 8-32 X 1/2
51	6	40-1697	SHCS 1/4-20 X 3/4
52	48	40-1704	FHCS 10-32 X 1/4
53	4	40-1715	5/16-18 X 1-1/2"
54	8	40-1716	SHCS 5/16-18 X 1 3/4
55	1	40-1801	SHCS 8-32 X 3/8
56	2	40-1803	SHCS, 8-32 X 1-1/4
57	53	40-1850	SHCS 10-32 X 3/8
58	48	40-1860	SHCS 1/4-20 X 7/8
59	3	40-1960	SHCS 3/8-16 X 1 3/4
60	4	40-1961	SHCS 3/8-16 X 2
61	6	40-1981	FBHCS, 1/4-20 X 1/2
62	1	40-7080	SSS OVAL PT 1/2-13 X 2
63	1	44-1717	SSS CUP PT 1/4-20 X 1 3/4
64	48	45-0045	WSHR,BLK HRD 1/4X1/8 THK
65	4	45-1600	WASHER SPLIT LOCK 5/16MED
66	1	45-16390	WASHER 1/4 ID X5/8 OD SAE
67	4	45-1730	WASHER BLK HRD 3/8 1/8THK
68	2	45-1741	#10 HARDEN FLAT WASHER
69	1	45-1800	WASHER SPLIT LOCK 1/4 MED
70	4	45-1820	WASHER LOCK 3/8 MEDIUM
71	2	46-1617	NUT, 1/4-20
72	3	46-16175	NUT, HEX 10-32
73	1	46-1625	NUT HEX BLK OX 1/4-20
74	1	46-1721	JAM NUT, HEX 1/2-13
75	24	48-0004	SPRING PIN 3/8 X 1
76	4	48-0040	PIN, DOWEL 3/8 X 1
77	1	49-1003	SHLDR SCREW 10-24 X 3/4
78	1	49-1015	SHOULDER BOLT,1/4 X 1/2
79	1	54-9505	DRIVE BELT, 3/8 PITCH
80	1	54-9510	TIMING PULLEY,TL-30-L-100
81	1	54-9520	TAPER BUSHING 1610 X 1
82	1	57-0005	O-RING 124ID X 5MM BUNA
83	1	58-16700	STREET LBO 1/8 INCH
84	1	58-16732	1/8 X 1/8 MALE HEX JOINT
85	46"	58-2000	NYLON TUBING 1/4 INCH CL
86	42"	58-2010	NYLON TUBING 5/32 INCH CL
87	36"	58-2020	3/8 OD NATURAL TUBING
88	1	58-2069	1/8 NPT FIXED ORAFICE
89	1	58-2265	AIR MUFFLER 3/8 FLAT
90	1	58-2740	NOR VALVE R07-100-RNKA
91	1	58-3065	AIR MUFFLER, 1/4 NPT
92	1	58-3070	FITTING, 1/8 NPT - 1/4
93	1	58-3618	1/4 STREET ELBOW, 90 DEG
94	2	58-3659	AIR FIT,1/8PIPE,5/32 TUBE
95	1	58-3665	1/4 NPT FEMALE TO 3/8 MAL
96	1	58-3680	1/4NPT M-3/8 STRT TUBE
97	2	58-3685	1/4NPT M-3/8 TUBE-SVL LBO
98	1	58-3690	1/4 NPT MALE HX JNT 1 1/8
99	2	59-1056	BUMPER, SUPPORT ARM 5/8 L
100	1	59-2738	AIR CYLINDER T/C DOOR
101	1	59-2761	DOOR SPRING, TOOL CHANGER
102	1	59-2832	QUICK EXHAUST, TOOL CHGR
103	1	59-3023	COMP.SPRING, LC-026E-3
104	1	59-4151	GEARBOX FLEXOLIN
105	1	59-9438	SPRING, TOOL CHGR
106	1	59-9545	SHOCK ABSORBER, HS-1
107	1	59-9562	BALL JOINT ROD END
108	3	63-1029	WIRE CLAMP 3/8
109	4	63-1031	CABLE CLAMP 1/4
110	8	70-0020	PLT1.5M CABLE TIES