HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

HL-Series Service Manual 96-8710 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 machine 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 machine 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 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.
- Check main circuit breaker at top right of electrical cabinet; switch must be at the on position.
- Check overvoltage fuses.
- 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.
- IOPCB may need replacement.
- POWER PCB may need replacement.

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

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

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 the machine (possible bad monitor).
- Check video cable (760) from VIDEO PCB to CRT.
- Check for lights on the processor.
- Replace CRT.

Any LED on Microprocessor PCB goes out (except HALT).

- Replace Microprocessor PCB.
- Replace VIDEO PCB.
- Replace MOTIF PCB.

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

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

VIBRATION

Vibration is a subjective evaluation with perceptions varying among individuals, making it difficult to determine in mild cases if there is an actual problem. In obvious cases, it is a matter of determining the source which is not easy, since all parts rotate together and sound can be transferred readily. Vibrations also need to be distinguished from noise such as a bad bearing. We will assume that vibrations would be something that could be felt by putting your hand on the spindle ring. One crude method of measurement would be to take an indicator on a magnetic base extended 10 inches between the turret and spindle ring 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 spindle is on and is not cutting. Sometimes only at specific RPM.

If the spindle alone causes vibration of the machine this is usually caused by the belt/pulley drive system or the chuck jaws are not centered correctly.

Machine vibrates while jogging the axis with the jog handle.

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. 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.

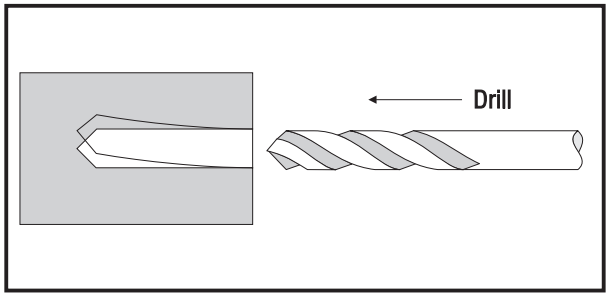
ACCURACY

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* 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 test points to the sheet metal of the spindle head.
- *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.
- 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.

Diameters are out of round

- Check that tooling and machining practices are correct. Bores will be out of round due to tool deflection much more frequently than due to spindle bearing problems.



Diameters are incorrect in X-axis

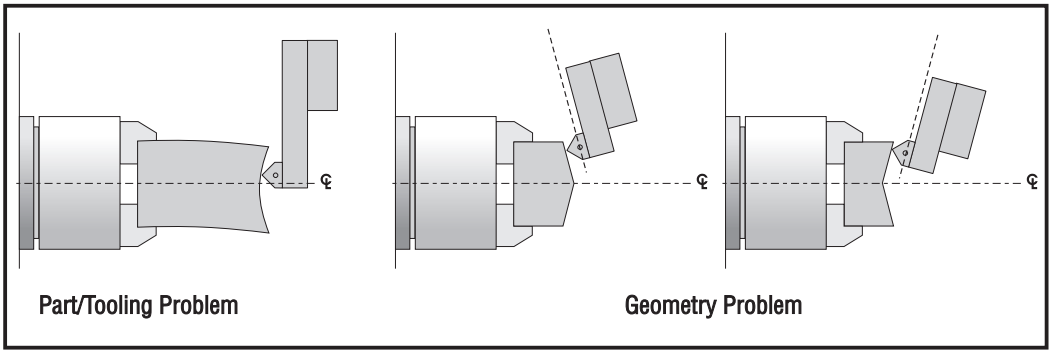
- Ensure the tool probe is set up correctly (settings, etc.).
- Ensure tool offsets are correct. Note that the coordinate system (FANUC, YASNAC, HAAS) must be selected *before* setting tools.
- Ensure Parameter 254, Spindle Center, is set correctly.
- Check for thermal growth of the X-axis leadscrew (see "Thermal Growth" section).

Center holes are malformed

- Ensure tooling is tight.
- Ensure Parameter 254, Spindle Center, is set correctly.
- Check spindle to turret pocket alignment. It may be out of alignment due to a crash or misadjustment.
- Check for thermal growth of the X-axis leadscrew (see "Thermal Growth" section).

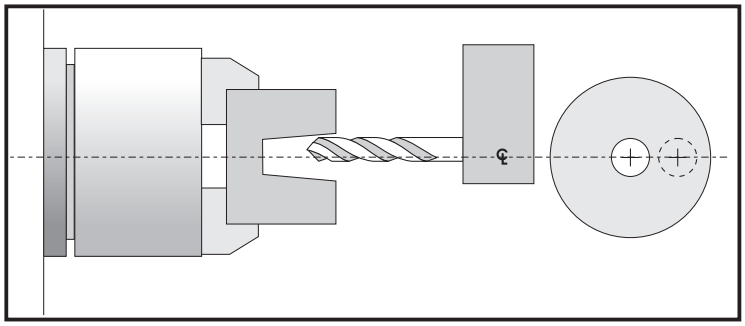
Part faces are conical

- Wedge may be out of alignment due to a crash.
- Check tooling setup. Turning long, unsupported parts may cause conical part faces.
- Check for thermal growth of the leadscrews (see "Thermal Growth" section).



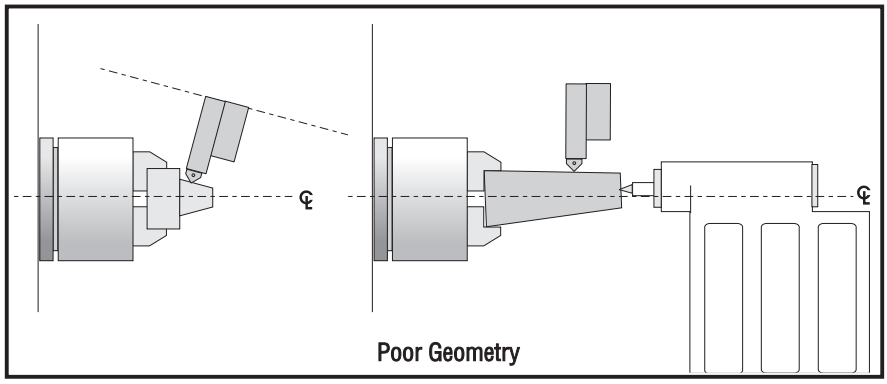
Bores are tapered

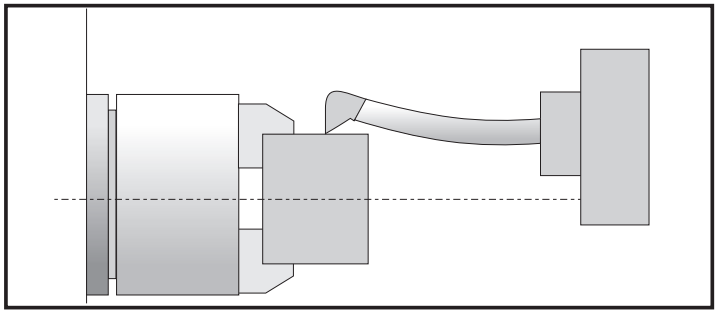
- Check that tooling and machining practices are correct. Bores will be tapered if the tooling is inappropriate, the speeds and feeds are incorrect, or coolant is not getting to the cutting tool when required.
- Although it is rare, the spindle may be out of alignment due to a crash.
- Check that the turret face is parallel with x-axis.

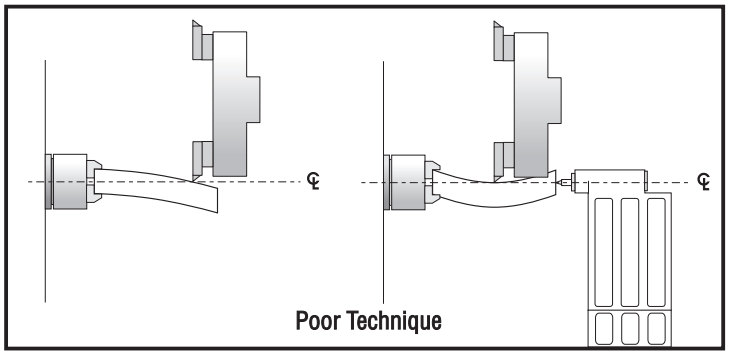


Outside diameter (O.D.) is tapered

- Check tooling setup. Turning long, unsupported parts can cause a tapered O.D.
- Check tailstock setup. Excessive hold pressure on the tailstock can distort parts.
- Tailstock may not be aligned to spindle center.
- Spindle to Z-axis may be out of alignment (not parallel).

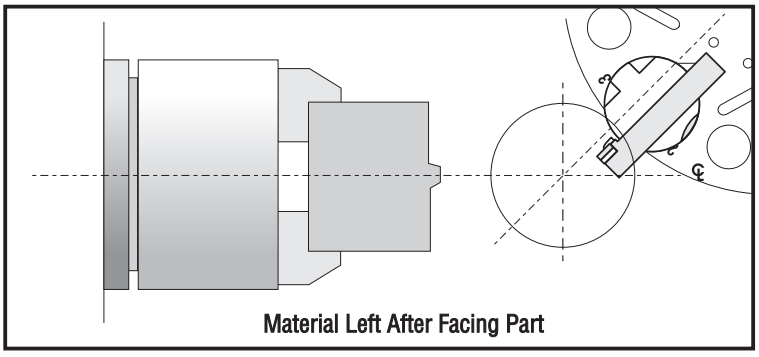






Material left after facing a part

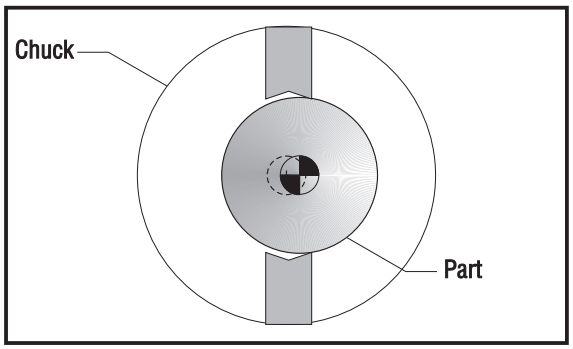
- Ensure tooling is correct.
- Ensure turret is aligned to X-axis travel.
- Ensure Parameter 254, Spindle Center, is set correctly.



FINISH

Machining yields a poor finish.

- Check the condition of the tooling and the spindle.
- Ensure turret is clamped.
- Ensure tooling is tight.
- Check tooling for chatter or lack of rigidity.
- Check the balance of the chuck, part, and fixture.
- Check for backlash.
- Check turret alignment.



THERMAL GROWTH

A possible source of accuracy and positioning errors is thermal growth of the leadscrews. As the machine warms up, the leadscrews expand in both linear axes (X and Z), causing accuracy and positioning errors. This is especially critical in jobs that require high accuracy.

Note: Thermal growth will be more noticeable in the X-axis, since errors will be doubled when cutting a diameter.

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. Select the X axis and press the ORIGIN key to zero it.
3. Press the OFSET key, then scroll down to G110 (or any unused offset). Cursor to X and press the PART ZERO SET key. This will set X0 at this position.
4. Enter a program that will start at the new zero position, rapid a certain distance in the X direction, feed the final .25 inches slowly, and then repeat the X movement.
5. In order to set up the indicator, run the program in SINGLE BLOCK mode, and stop it when X is at the end of it's set travel. Set the magnetic base on the spindle retainer ring or other rigid surface, with the indicator tip touching the turret 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 the end of it's set travel, 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 Z-axis.

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 before the part. 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, see "Alarms" section.
- Check that the spindle turns freely when machine is off.
  - If spindle drive does not light the RUN LED, check forward/reverse commands from IOPCB.
  - Check that the drawtube piston is not bound against the spindle shaft on air cylinder style.
- Check the wiring of analog speed command from MOTIF PCB to spindle drive (cable 720).
- If spindle is still not turning, replace MOTIF PCB.
- Disconnect the drive belt. If the spindle will not turn, it is seized and must be replaced.

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

NOISE

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

Excessive noise coming from the spindle head area.

- Remove the left end covers and check the machine's drive belt tension.
- Run the motor with the drive belt disconnected. If the noise persists, the problem lies with the motor. If it disappears, go on to the next step.
- Check for the correct amount of lubrication to the spindle bearings (1cc per hour) in an air mist lubricated spindle.

1.3 TRANSMISSION (HL-3/4)

The transmission cannot be serviced in the field and must be replaced as a unit. Never remove the motor from the transmission, as this will damage the transmission and void the warranty.

Noise

Excessive or unusual noise coming from transmission.

Operate the machine in both high and low gears. Monitor for noise in both gear positions, and determine if the noise varies with the motor or 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 transmission, and it must be replaced.
- If the noise occurs in both gear positions, disconnect the drive belts (see "Transmission" section, Mech. Service) and repeat the previous step. If the noise persists, the transmission is damaged and must be replaced.
- Disconnect the drive belts (see "Transmission" section, Mech. Service) and run the machine in high gear. Command a change of direction and listen for a banging noise in the transmission as the machine slows down to zero RPM and speeds back up in reverse. If the noise occurs, the motor has failed and the transmission must be replaced.

Gears Will Not Change

Machine will not execute a gear change.

- Check the voltage to the gear shifter motor. The voltage between pins 2 and 3 should beapproximately +28V when high gear is commanded and -28V when low gear is commanded. If these voltages are correct, the gear shifter motor has failed and the transmission must be replaced. If these voltages are incorrect, the cabling or transmission power supply is at fault.

Incorrect Gear Selected or Sensed

Spindle speed is not consistent with selected gear.

- Monitor the discrete inputs and outputs SP HIG and SP LOW on the Diagnostics display while commanding high and low gear. The output SP HIG should be 1 when high gear is selected, and SP LOW should be 1 when low gear is selected. The inputs SP HIG and SP LOW should be 0 when that gear is engaged, and should both be 1 when the transmission is between gears. These inputs should never read 0 at the same time.

  If any of these inputs/outputs are incorrect, either the gear change limit switches or the wiring to the I/O PCB is at fault. The limit switches are located inside the transmission, and cannot be replaced.

1.4 SERVO MOTORS / LEADSCREWS

Not Operating

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

Servo motor is not functioning.

- Check the power cable from rear electrical cabinet to ensure connection is tight.
- Encoder is faulty or contaminated (Alarms 139-142, 153-156, 165-168, 182-185). Replace motor assembly on brusless machines, replace the encoder on brush machines.
- Open circuit in motor (Alarms 139-142, 153-156, 182-185).
- Motor has overheated, resulting in damage to the interior components (Alarms 135-138, 176).
- 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 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.
- Check for broken or loose coupling between the servo motor and the lead screw.
- Check for a damaged lead screw.

Note: If a lead screw fails, it is most often due to a failed bearing sleeve.

Noise

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

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

Servo motor noise.

- Noise is caused by bearings. Rolling, grinding sound is heard coming from the motor.
- If motor noise is caused by motor bearings, replace motor.

Lead screw noise.

- Ensure oil is getting to the lead screw through the lubrication system.
- Check for damage to the bearing sleeve.
- Disconnect the servo motor from the lead screw and rotate the lead screw by hand. If the noise persists, the lead screw may need replacing.
- 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.

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 Z-axis 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 lathe ON. ZERO RET the machine and move the carriage to the approximate center of its travel in the Z-axis. Move the turret to the approximate center of the X-axis travel.

X-AXIS:

1. Place a dial indicator and base on the spindle retaining ring with the tip of the indicator positioned on the outside diameter of the turret, as shown in Fig. 1-1.

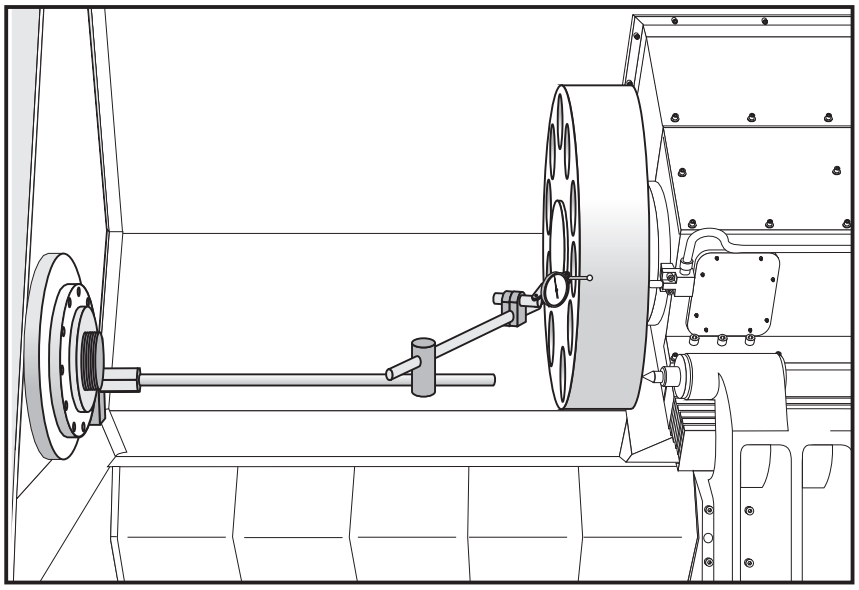


Fig. 1-1. Dial indicator in position to check X-axis.

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

   The “Distance to go” display on the lower right hand corner should read: X=0 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. 4-1 and manually push on the turret in both directions. The dial indicator should return to zero after releasing the turret.

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

Z-AXIS:

1. Place a dial indicator and base on the spindle retaining ring with the indicator tip positioned on the face of the turret as shown in Fig. 1-2.

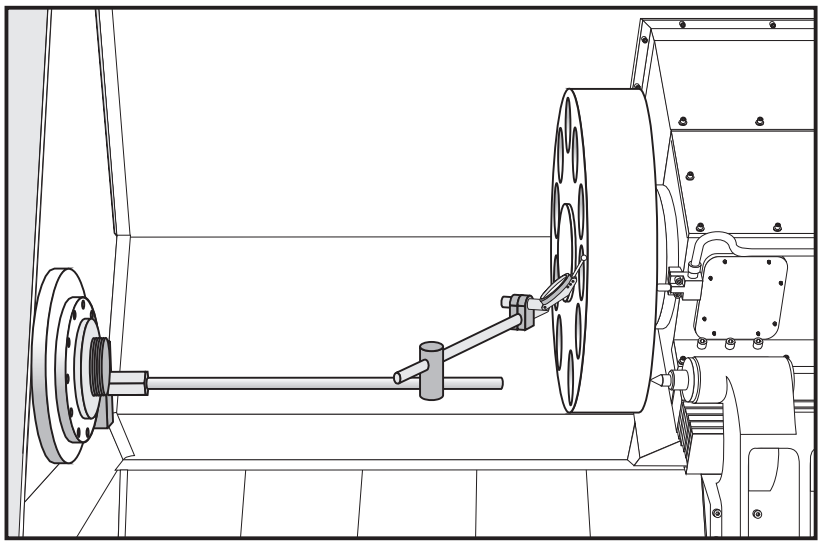


Fig. 1-2 Dial indicator in position to check Z-axis.

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 button on the control panel.
   - Press the HANDLE JOG button on the control panel. The “Distance to go” display on the lower right hand corner should read: X=0 , 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.

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. 4-2 and manually push on the turret in both directions. The dial indicator should return to zero after releasing the turret.

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

VIBRATION

Excessive servo motor vibration.

- Check all Parameters of the suspected axis against the Parameters as shipped with the machine. If there are any differences, correct those and determine how the Parameters were changed. 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 chassis.

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.

SERVO ERROR

"Servo Error Too Large" alarms occur on one or more axes sporadically.

- Check motor wiring for shorts.
- Driver card may need replacement.
- Servo motor may need replacement.
- Check for binding in motion of lead screw.

1.5 HYDRAULIC SYSTEM

HYDRAULIC PRESSURE

"Low hydraulic pressure" alarm (134).

- Check for any leaks.
- Check that the oil level is above the black line.
- Check that the oil pressure is within 50-500 psi. If the hydraulic unit needs to be replaced, see "Hydraulic Unit Removal/Installation" section.
- Check that the temperature is less than 150 degrees. If the hydraulic unit needs to be replaced, see "Hydraulic Unit Removal/Installation" section.
- Phasing changes cause the hydraulic unit to change directions resulting in alarm 134.

HYDRAULIC CHUCK

Chuck won't clamp/unclamp.

- Check for alarm condition.
- Check display for "Low Hydraulic Pressure" alarm (134).
- Check that the oil pressure gauge is within 50-500 psi.
- Use a voltage meter to check the solenoid circuit breaker.
  - ➢ Replace solenoid valve if faulty.

Noise in Hydraulic Power Unit

Hydraulic power unit noise.

Note: Noise in hydraulic unit should decrease a few minutes after start up.

- Check for leaks in hose.
- Check that the oil level is above the black line.
- Check for loose pieces/hardware.
- Check for debris in motor/cooling fins.

Hydraulic Tailstock

Tailstock pulsates as it moves.

- Check operating pressure. **(Minimum operating pressure is 120 psi)**
- Check for leaks at hydraulic cylinder.
- Check for leaks at hose fittings.

1.6 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 alarm occurs when the difference between the commanded axis position and the actual position becomes larger the 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 low voltage cable from MOTIF PCB.

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

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

- Processors LED's Normal - then Run goes out.

Remove the Data & or Address buss from the MOTIF PCB.

- Processors LED's Normal - then Run goes out.

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

- Processors LED's - CRT and Run are out.

KEYBOARD DIAGNOSTIC

	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 Servos Off alarm.
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	Turret Unlock Fault	The turret took longer to unlock and come to rotation position than allowed for in Parameter 62. The value in Parameter 62 is in milliseconds. This may occur if the air pressure is too low, the tool turret clamp switch is faulty or needs adjustment, or there is a mechanical problem.
114	Turret Lock Fault	The turret took longer to lock and seat than allowed for in Parameter 63. The value in Parameter 63 is in milliseconds. This may occur if the air pressure is too low, the tool turret clamp switch is faulty or needs adjust ment, or there is a mechanical problem.
115	Turret Rotate Fault	Tool motor not in position. During a tool changer operation the tool turret failed to start moving or failed to stop at the right position. Parameters 62 and 63 can adjust the time-out times. This alarm can be caused by anything that jams the rotation of the turret. A loss of power to the tool changer can also cause this, so check CB5 and relays 1-8, 2-3, and 2-4.
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 high gear sensor was not detected in time. Parameters 67, 70 and 75 can adjust the time-out times. Check 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 low gear sensor was not detected in time. Parameters 67, 70 and 75 can adjust the time-out times. Check 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 of time 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 machine and below control cabinet. Also check connector on the side of the control cabinet. Check that the lube lines are not blocked.
122	Regen Overheat	The control 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	Tool Turret Fault	Turret has not seated itself properly. There may be something obstructing the turret between the housing and the turret itself.
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	Door Fault	The control failed to detect a high signal at the Automatic DOOR input after an M85 was commanded and the Automatic DOOR input was not received before a certain period of time. The units are in milliseconds.
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	Chuck Unclamped	The control detected that the chuck is unclamped. This is a possible fault in the air solenoids, relays on the I/O 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 com manded. Check the solenoid that controls the air to the lock, relay 2-8, the wiring to the sense switch, and the switch.
134	Low Hydraulic Pressure	Hydraulic pressure is sensed to be low. Check pump pressure and hydraulic tank oil level.
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 per formed. 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	I Mode Out Of Range	Internal software error; call your dealer.
152	Self Test Fail	Control has detected an electronics fault. All motors and solenoids are shut down. This is most likely caused by a fault of the processor board stack 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 hard tapping synchronization.
174	Tool Load Exceeded	The tool load monitor option is selected and the maximum load for a tool was exceeded in a feed. This alarm can only occur if the tool load monitor function is installed in your machine.
175	Ground Fault Detected	A ground fault condition was detected in the 115V AC supply. This can be caused by a short to ground in any of the servo motors, the tool change motors, the fans, or the oil pump.
176	Overheat Shutdown	An overheat condition persisted for 4.5 minutes and caused an automatic shutdown.
177	Over voltage Shutdown	An overvoltage condition persisted for 4.5 minutes and caused an automatic shutdown.

178	Divide by Zero	Software error, or parameters are incorrect. Call your dealer.
179	Low Pressure Spindle Coolant	Spindle coolant oil is low or low pressure condition in lines.
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	Trying to feed while spindle is in the stopped position.
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 145.
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 165.
195	B Cable Fault	Same as 182.
197	100 Hours Unpaid Bill	Call your dealer.
198	Spindle Stalled	Control senses that no spindle fault has occurred, the spindle is at speed, yet the spindle is not turning. Possibly the belt between the spindle drive motor and spindle has slipped or is broken.
199	Negative RPM	Internal software error; call your dealer.
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.
216	Probe Arm Down While Running	Indicates that the probe arm was pulled down while a program was running.
217	X Axis Phasing Error	Error occurred 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 217.
219	Z Axis Phasing Error	Same as 217.
220	A Axis Phasing Error	Same as 217.
221	B Axis Phasing Error	Same as 217.
222	C Axis Phasing Error	Same as 217.
223	Door Lock Failure	In machines equipped with safety interlocks, this alarm occurs when the control senses the door is open but it is locked. Check the door lock circuit.
224	X Transition Fault	Illegal transition of 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 224.
226	Z Transition Fault	Same as 224.
227	A Transition Fault	Same as 224.
228	B Transition Fault	Same as 224.
229	C Transition Fault	Same as 224.
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.
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.
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.

265	Macro Variable File CRC Error	Macro variables lost maybe by low battery. Check for a low battery and low battery alarm. Reload the macro variable file.
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.
292	Mismatch Axis with I, K Chamfering	I, (K) was commanded as X axis (Z axis) in the block with chamfering.
293	Invalid I,K or R in G01	The move distance in the block commanded with chamfering, corner R is less than the chamfering, corner R amount.
294	Not G01 after Chamfering, Corner R	The command after the block commanded with chamfering, corner R is not G01.
295	Invalid Move After Chamfering	The command after the block commanded with chamfering, corner R is either missing or wrong. There must be a move perpendicular to that of the chamfering block.
296	Not One Axis Move with Chamfering	Consecutive blocks commanded with chamfering, corner R (i.e., G01 Xb Kk; G01 Zb Ii). After each chamfering block, there must be a single move perpendicular to the one with chamfering, corner R
302	Invalid R Code	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, B, 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 and must be a valid **N** number.
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.
308	Invalid Tool Offset	A tool offset not within the range of the control was used.

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, G70, 71, 72, and 73.
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	Goto or **P** Line 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. Two or more **I,K, R** are commanded in the same block with chamfering, corner rounding
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	Illegal Spiral Motion	Linear axis path is too long. For helical motions, the linear path must not be more than the length of the circular component.
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.
360	Tool Changer Disabled	Check Parameter 57. Not a normal condition for the Lathe.
361	Gear Change Disabled	Not used.
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 Aux Axis	Only rapid or feed is allowed with aux axes.
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.
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 XBZA in G31 or G36	G31 skip function requires an **X**, **B**, **Z**, or **A** move.
376	No Cutter Comp In Skip	Skip G31 function 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.
383	Inch Is Not Selected	G20 was specified but settings have selected metric input.
384	Metric Is Not Selected	G21 was specified but settings have selected inches.
385	Invalid L, P, or R Code In G10	G10 was used to changes offsets but **L**, **P**, or **R** code is missing or invalid.
386	Invalid Address Format	An address A..Z was used improperly.
387	Cutter Comp Not Allowed With G103	If block buffering has been limited, Cutter comp cannot be used.
388	Cutter Comp Not Allowed With G10	Coordinates cannot be altered while cutter comp is active. Move G10 outside of cutter comp enablement.
389	G17, G18, G19 Illegal in G68	Planes of rotation cannot be changed while rotation is enabled.
390	No Spindle Speed	**S** code has not been encountered. Add an **S** code.
391	Feature Disabled	An attempt was made to use a control feature not enabled by a parameter bit. Set the parameter bit to 1.
392	B Axis Disabled	Same as 333.
393	Invalid Motion In G84 or G184	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	The tailstock (B-axis) has exceeded it's maximum range of travel.
395	Invalid Code In Canned Cycle	Any canned cycle requiring a PQ path sequence may not have an M code in the same block. That is G70, G71, G72, and G73.
396	Conflicting Axes	An Incremental and Absolute command can not be used in the same block of code. For example, X and U cannot be used in the same block.
397	Invalid D Code	In the context that the D code was used it had an invalid value. Was it positive ?
398	Aux Axis Servo Off	Aux. axis servo shut off due to a fault.
399	Invalid U Code	In the context that the U code was used it had an invalid value. Was it positive ?
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 the complete program was received. 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 the complete program was received. 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.
437	TS Under Shoot	The tailstock did not reach it's intended destination point.
438	TS Moved While Holding Part	The tailstock moved more than a preset amount while holding a part (e.g.,the part slips in the chuck).
439	TS Found No Part	During an M21 or G01, the tailstock reached the hold point without encountering the part.
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.
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. In lathe controls, PQ sequences describing part geometry cannot use macro statements in the part path description.
600	Code Not Expected In This Context	During program interpretation, the control found code out of context. This may indicate an invalid address code found in a PQ sequence. It may also indicate faulty memory hardware or lost memory. Look at the highlighted line for improper G-code.
601	Maximum PQ Blocks Exceeded	The maximum number of blocks making up a PQ sequence was exceeded. Currently, no more than 65535 blocks can be between P and Q.
602	Non Monotonous PQ Blocks in X	The path defined by PQ was not monotonic in the X axis. A monotonic path is one which does not change direction starting from the first motion block.
603	Non Monotonous PQ Blocks in Z	The path defined by PQ was not monotonic in the Z axis. A monotonic path is one which does not change direction starting from the first motion block.
604	Non Monotonous Arc In PQ Block	A non-monotonic arc was found in a PQ block. This will occur in PQ blocks within a G71 or G72 if the arc changes it's X or Z direction. Increasing the arc radius will often correct this problem.
605	Invalid Tool Nose Angle	An invalid angle for the for the cutting tool tip was specified. This will occur in a G76 block if the A address has a value that is not from 0 to 120 degrees.
606	Invalid A Code	An invalid angle for linear interpolation was specified. This will occur in a G01 block if the A address was congruent to 0 or 180 degrees.
607	Invalid W Code	In the context that the W code was used it had an invalid value. Was it positive ?
609	Tailstock Restricted Zone	When the axes move into the tailstock restricted zone at any time during program execution. To eliminate the problem, change the program or Settings 93 and 94 to open up the restricted zone.
610	G71/G72 Domain Nesting Exceeded	The number of troughs nested has exceeded the control limit. Currently, no more than 10 levels of trough can be nested. Refer to the explanation of G71 for a description of trough nesting.

611	G71/G72 Type I Alarm	When G71 or G72 is executing and the control detects a problem in the defined PQ path. It is used to indicate which method of roughing has been selected by the control. It is generated to help the programmer when debugging G71 or G72 commands. The control often selects Type I roughing when the programmer has intended to use Type II roughing. To select Type II, add R1 to the G71/G72 command block (in YASNAC mode), or add a Z axis reference to the P block (in FANUC mode).
612	G71/G72 Type II Alarm	This alarm is similar to Alarm 611, but indicates that the control has selected Type II roughing.
613	Command Not Allowed In Cutter Comp.	A command (M96, for example) in the highlighted block cannot be executed while cutter comp. is invoked.
614	Invalid Q Code	A Q address code used a numeric value that was incorrect in the context used. Q used to reference tip codes in G10 can be 0...9. In M96 Q can reference only bits 0 to 31. Use an appropriate value for Q
615	No Intersection to Offsets in CC	While cutter comp was in effect, a geometry was encountered whose compensated paths had no solution given the tool offset used. This can occur when solving circular geometries. Correct the geometry or change the tool radius.
616	Canned Cycle Using P & Q is Active	A canned cycle using P & Q is already executing. A canned cycle can not be executed by another PQ canned cycle.
620	C Axis Disabled	Same as 333.
621	C Over Travel Range	Same as 316.

End Of List

Note: Alarms 1000-1999 are user defined.

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.
7/16 - 14	70 ft. lb
M10 - 100	50 ft. lb.
M12 - 65	100 ft. lb.
1/2 - 13	80 ft. lb.
3/4 - 10	275 ft. lb.
3/4 - 20	500 ft. lb.

3.1 TURRET

Turret Crash Recovery Procedure

1. Change Setting 7, "Parameter Lock", to OFF. Move to Parameter 43 on the Parameters Display. This is the tool turret motor parameters. Change INVIS AXIS from “1” to “0” (zero).

2. Move to the Alarm Display and type “DEBUG” and then press the WRITE key. Verify that the debug line is displayed.

Note: Ensure there is adequate clearance between the turret and chuck before performing the next step.

3. Press PRGRM/CNVRS, then the MDI key. Type “M43” into MDI and press CYCLE START. This will unlock the turret by pushing it in the Z-direction.

4. Press the HANDLE JOG key, and then the POSIT key to get into the Position Display and Jog mode. The A axis should be displayed below the X and Z axes.

5. Press the letter "A", then "HANDLE JOG", and then a jog speed other than ".1". A message should indicate that the A axis is being jogged.

6. Turn the JOG handle until the obstruction is cleared and the turret rotates freely. If an OVERCURRENT alarm is received, press RESET and turn the JOG handle in the opposite direction.

7. Move to Parameter 43 on the Parameter Display and change INVIS AXIS back to “1”. Change Setting 7 back to ON.

8. Turn the control power off and then back on. The turret can now be positioned by pressing either POWER UP/RESTART or AUTO ALL AXES.

Note: If alarms 111 or 164 occur after the obstruction is cleared, you may need to adjust the turret motor coupling.

IMPORTANT!!

After a crash the following procedures should be performed in order to verify proper turret alignment.

1. Turret alignment verification (X-Axis) - Section 1.3
2. Spindle alignment verification - Chapter 2
3. Turret alignment verification (Spindle) - Section 1.5

Turret Removal and Replacement

Removal

1. Remove the sliding tool changer and turret assembly covers.

2. Change Parameter 76 from 500 to 50000 (so you will not trip on a low air pressure alarm).

3. Remove the air line.

4. Put a 3/4 " wrench on the bolt at the end of the air cycle. Pull down (-X) until the turret is fully unclamped.

5. Place a block snugly between the back of the turret shaft and the casting to keep the turret shaft from shifting.

Caution: If the shaft moves back when the turret is disconnected the ball bearings in the turret cam will fall and have to be replaced before the turret can be reassembled.

6. Empty the oil from the turret assembly. Remove the screw from the bottom of the plate located just behind the turret on the turret assembly and allow the oil to drain into a bucket.

7. Remove the four bolts from the turret retainer and remove the retainer.

Note: If a shaft extension is available install it at this time. Using the extension gives you greater movement of the turret and allows you to remove and easily install the key, washers and needle bearings

Caution: The turret is heavy and could be slippery. Be careful to not lose the key as it will be facing down at this point.

8. Remove the turret from the shaft.

9. The two washers, needle bearing, and key should be removed from the shaft and put aside at this time.

Installation

1. Put a small amount of grease on one side of the washers.

2. Place the washer on the surface of the turret and center it using your fingers. Be sure to keep grease off the surface facing the needle bearing.

3. Put a small amount of grease on both sides of the second washer.

4. Place the washer on the spring retainer on the lip of the turret shaft. Clean any grease that may have gotten on the shaft.

5. Place the needle bearing on the lip and stick it to the washer. Be sure the other surface of the bearing is clean and free of grease.

6. Put a small amount of grease on the turret key to hold it in place.

7. Place the turret on the shaft. (align the turret key)

Note: Check that the turret key did not fall off.
Check that the washer is centered on the turret.
Check that the washer and needle bearing are still on the shaft lip.

8. Slide the turret fully on the shaft.

9. Replace the turret retainer and snug the four bolts.

Note: Check the turret "O" ring. If you can see either the washer or the needle bearing they have slid off the shaft. Return to step 7 of the turret removal section.

10. Tighten the four turret retainer bolts.

11. Replace the screw in the bottom of the plate located just behind the turret on the turret assembly.

12. Pour the oil back in the turret assembly.

13. Remove the brace from between the turret shaft and the casing.

14. Connect the air. The turret should clamp.

15. Change Parameter 76 back to 500.

16. Replace the turret assembly and sliding tool change covers.

17. Exercise the tool changer to verify proper operation.

Turret Motor Coupling Adjustment

Note: The turret must be at tool #1 and clamped to perform this procedure.

1. Remove the sliding tool changer cover.

2. Go to Setting 7 and turn off the Parameter Lock.

3. Go to Parameter 43 and change “Z CH ONLY” to “1”.

4. Loosen the turret motor coupling clamp screw closest to the motor. (Refer to Figure 3-1)

5. Press the ZERO RET key, then the A key, and the ZERO SINGL AXIS key. This will cause the motor to go to the first encoder Z pulse.

6. With the servos on, move the turret motor coupling back and forth to find the center of it’s backlash, and tighten the clamp screw as close to the center of the backlash as possible.

Note: If it is tight (no backlash) it will be necessary to force it in one direction or the other until it pops into it's backlash area. If it gets tighter when it is turned, STOP; this is the wrong direction.

7. Change Parameter 43, "Z CH ONLY" back to "0" (zero).

8. Press the ZERO RET key, A key, and ZERO SINGL AXIS key. This will home the turret at tool #1.

9. Press the EMERGENCY STOP button and turn the turret motor coupling back and forth to verify that the backlash is centered.

10. Go to Setting 7 and turn on the Parameter Lock.

11. Replace the sliding tool changer cover.

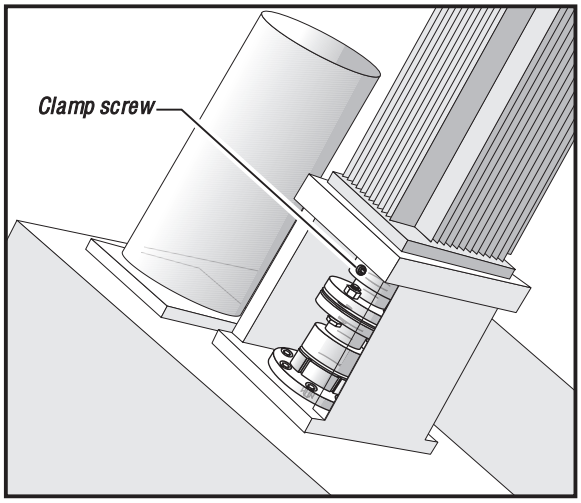


Figure 3-1. Turret motor adjustment..

TURRET ALIGNMENT VERIFICATION (X-AXIS)

TOOLS REQUIRED:

3 **MAGNETIC INDICATOR BASE** 3 **DIAL INDICATOR (0.0005" OR LESS RESOLUTION)**

1. Remove all tool holders and fittings from the turret.

2. Jog the X-axis to the center of its travel.

3. Place the magnetic indicator base on the spindle retainer ring. Position the indicator tip on the turret face so there is at least 3.5" of travel in each direction from the center of the X axis and 1/4" below the center cap. Refer to Figure 3-2.

4. Jog the X axis so the indicator is at one end travel then zero the indicator.

5. Jog the X-axis to the other end of travel and check your reading (tolerance 0.0003" TIR)

6. If the reading is *greater* than the tolerance specified the turret needs to be realigned.

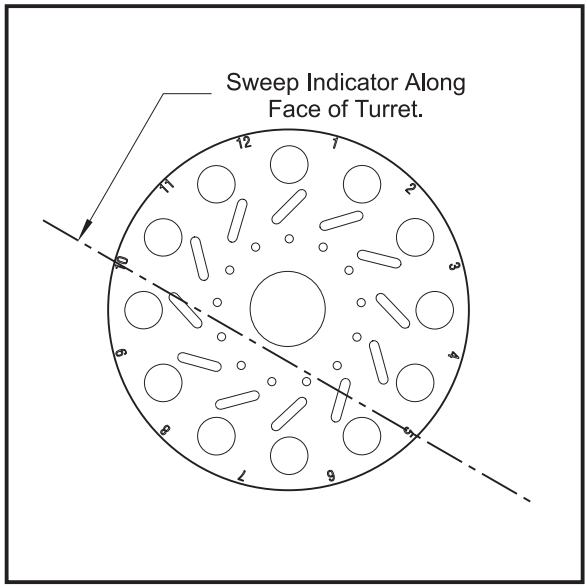


Figure 3-2. Turret alignment verification (X-axis)

TURRET ALIGNMENT (X-AXIS)

It is recommended that you read the following sections in their entirety before starting the alignment procedures.

1. Remove the rear cover.

2. Remove the sliding toolchanger cover.

Note: Be sure to remove the 4 SHCS located behind the turret. The X-axis wiper may also need to be replaced if damaged.

3. Remove top plate cover to the turret housing. Be sure to check the gasket and see if it needs replacement.

4. Remove the SHCS that mount the coolant adapter block to the turret housing. The turret must be in the unclamped position(M43) in order to lift the coolant line over the black access plate.

5. Remove the black access plate. The plate may need to be pried off with a screwdriver.

Note: Have a bucket ready to catch oil draining from the housing.

6. Loosen all turret housing mounting bolts except for the front left bolt nearest the turret.

7. Clamp the turret (M44) and jog to the center of the X-travel.

8. Tap on the turret casting in order to bring the face of the turret into alignment.

Note: In order to help keep the turret housing from slipping down during the alignment procedure, keep the turret housing bolts as snug as possible.

Note: Verify the turret alignment.

9. Apply Loctite and torque all turret housing mounting bolts to 50 FT LBS.

10. Recheck the turret face to ensure the measurement did not change.

INSTALLATION-

11. Install the access cover and gasket.

12. Pour 10 cups of oil (DTE 25) into gear side of turret housing.

13. Install the Coolant Adapter Block.

Note: The turret must be in the UNCLAMPED position

14. Install Turret Housing Top plate.

15. Install Sliding Tool Changer Cover.

16. ZERO RETURN machine.

After the turret face has been realigned it is important to verify that the spindle is still in alignment. Proceed to Chapter 2, Spindle Alignment Verification.

Note: All alignments done could change spindle centerline. Verify and enter new spindle centerline position in Parameter 254.

TURRET ALIGNMENT VERIFICATION (SPINDLE)

This procedure should be performed after spindle alignment has been checked.

TOOLS REQUIRED:

3 **SPINDLE ALIGNMENT TOOL OR A DIAL INDICATOR AND MAGNETIC BASE**
3 **DIAL INDICATOR (0.0005" OR LESS RESOLUTION)**

1. Remove all tool holders and fittings from the turret.

2. Clean the turret pockets and tool holders.

3. Mount the spindle alignment tool onto the spindle retainer ring with the dial indicator mounted to the end of the tool. Refer to Figure 3-3.

4. Jog the X axis to the spindle center line (value stored in Parameter 254).

5. Position the indicator tip just inside pocket #1 so that it is parallel to the X- axis. Zero the indicator, then rotate the spindle180^0 The indicator should read ZERO.

Note: Use the jog handle in tenths mode to zero the pocket.

6. Next, rotate the spindle and take readings at both the top and bottom of the pocket.

7. If the reading exceeds .0010" from the centerline or .0020" TIR, the inner coupling may need adjustment.

8. Perform turret motor coupling adjustment.

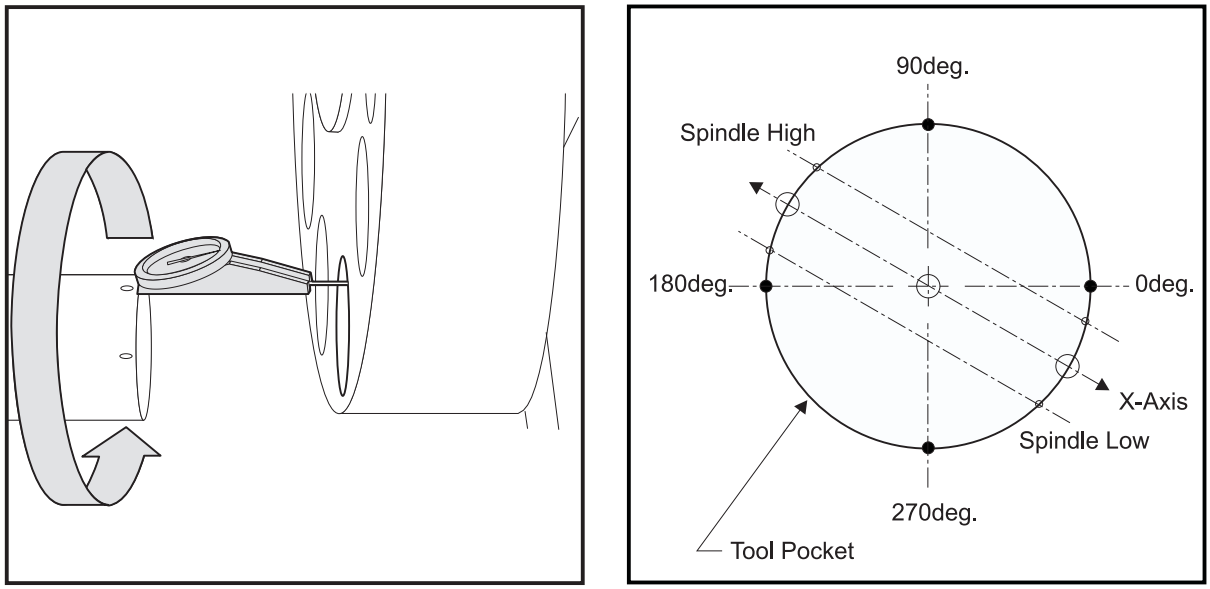


Figure 3-3. Turret Pocket Alignment

Turret Alignment Verification (Parallelism of X-Axis)

TOOLS REQUIRED:

3 **MAGNETIC INDICATOR BASE** 3 **DIAL INDICATOR (0.0005" OR LESS RESOLUTION)**

3 **A BAR APPROXIMATELY 12"x 4"x 1" (GROUND TO WITHIN 0.0001" ON THE 1" WIDTH SIDE)**

1. Remove all tool holders and fittings from the turret.
2. Clean the turret pockets and tool holders then command tool #1 to the cutting position.
3. With the turret in the clamped position loosen all (10) turret bolts.
4. Place a clean and undamaged tool holder loosely (do not thread nuts) in the nearest pocket to the spindle and the other in the opposite tool holder.
5. Place the 12" x 4" x 1" bar across the small diameter of the two tool holders (ground side down).

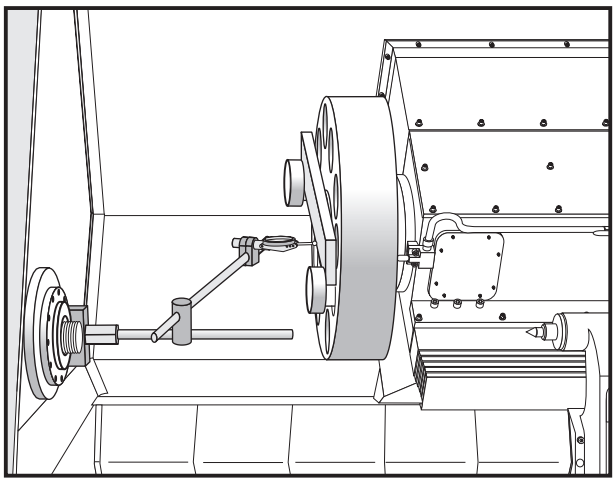


Figure 3-4. Turret Bar Sweep.

6. Jog the X axis to the center of it's travel.

7. Mount the indicator to the spindle retainer ring. Position the indicator tip at the on the bottom edge of the bar.

8. Jog the X axis so the indicator is at one end of the bar, and zero the indicator.

9. Jog the X axis to the other end of the bar, and check your reading (tolerance is 0.0003" TIR).

10. Tap on the turret until the readings are within tolerance.

11. Retighten all (ten) turret bolts.

- If the reading is within tolerance, proceed to Chapter 2, Spindle Alignment Verification.

- If the reading is <u>greater</u> than the tolerance specified, proceed to the appropriate coupling adjustment procedure.

Centering Inner Turret Coupling (Without Brass Plug)

This procedure should only be performed if there is not enough adjustment to perform an outer coupling alignment.

Note: If the turret has a 1/4" brass plug, proceed to the next section.

1. Before starting, make sure tool pocket #1 is at top position.

2. Pull the turret air cylinder all the way forward (unclamp) and place something snugly between the back of the turret shaft and the casting to keep the turret shaft from shifting.

3. Remove the four bolts from the center turret shaft cover.

4. To gain access to the rear coupling, either remove the turret or install a turret shaft extension and slide the turret onto it. (Be careful not to loosen the key way, it will be facing down at this point.)

5. Loosen the 10 bolts on the inner coupling and center the coupling to the bolt holes. Retighten them to to the required specifications. (Refer to torque chart at beginning of the section)

6. Install the thrust bearing and both thrust bearing washers to the shoulder of the turret shaft.

7. Go to Parameter 43 and change the INVIS AXIS to zero (0). Then go to the Alarms page, type “DEBUG” and press the WRITE key. Press the HANDLE JOG key. Press the key in the lower right corner of the jog keys (it’s unmarked and directly below the “Z+” jog key). Then jog the A axis so the key way slot is on top.

Note: This can only be done while the turret is unclamped.

8. Reinstall the turret and turret shaft cover. Make sure that the turret makes it over the O-ring before the bolts are tightened completely. If the bolts tighten up and the O-ring is still visible, one of the thrust washers is not on the shoulder of the turret shaft.

9. Return to Step 1 of the "Turret Alignment Verification" section and verify your readings.

10. When the turret alignment is complete, go to the Alarms page and type “DEBUG”, then press the WRITE key. Change Parameter 43, “INVIS AXIS” to 1.

Note: All alignments done could change spindle centerline. Verify and enter new spindle centerline position in Parameter 254.

Centering Inner Turret Coupling (With 1/4" Brass Plug)

This procedure is only to be performed if there is not enough adjustment to perform an outer coupling alignment.

Note: This procedure is only to be performed if the turret is equipped with a 1/4" brass plug.

1. Remove the 1/4" brass plug to gain access to the rear coupling.

2. Pull the turret air cylinder all the way forward (unclamp) with a wrench.

3. Go to Parameter 43 and change the INVIS AXIS to zero. Then go to the Alarms page, type “DEBUG” and press the WRITE key. Press the HANDLE JOG key. Press the key in the lower right corner of the jog keys (it’s unmarked and directly below the “Z+” jog key).

Note: This can only be done while the turret is unclamped.

4. Loosen, then lightly retighten all 10 inner coupling bolts (jogging the A axis for access) and center the coupling to the bolt holes.

5. Clamp the couplings by pushing the turret air cylinder back to it’s original position.

6. Return to Step 1 of the "Turret Alignment Verification" section and verify your readings.

7. When coupling is in place, unlock the turret, as in Step 2.

8. Tighten all 10 inner coupling bolts (jogging the A axis for access) and torque them to the required specifications. Refer to torque chart at beginning of section.

9. Replace the 1/4" brass plug.

10. Relock the turret.

11. Repeat Step 6.

12. When the turret alignment is complete, go to the Alarms page and type “DEBUG", then press the WRITE key. Change Parameter 43, “INVIS AXIS” to 1.

Note: All alignments done could change spindle centerline. Verify and enter new spindle centerline position in Parameter 254.

Converting Spindle Centerline to Encoder Step

1. Jog the X-axis to the spindle center in the usual way

2. Press ALARMS, enter "DEBUG", press WRITE.

3. Press POSIT, and PAGE UP until you see the debug screen POS-RAW DAT 1.

4. Observe the x axis COMMAND position. This will be encoder steps. Ignore the negative sign and the decimal point.

5. Copy this number to parameter 254 as a positive number with no decimal point.

6. ALARMS, enter "DEBUG," press WRITE. Or simply turn the power off and back on. This deactivates debug mode.

Turret In / Out Adjustment

Note: Alarms 113 and 114, "Turret Unlock Fault" and "Turret Lock Fault", can indicate that a turret in/out adjustment is necessary. These alarms occur when the Turret Clamp and Unclamp switches sense a turret positioning error.

1. Before hooking the cylinder end to the lever cam, manually insure that the Turret is in its furthest clamped position.

2. Screw the cylinder rod end in so that the lever cam mounting hole aligns with the rod end attachment.

3. Start the mounting bolt with the spacer through the cylinder rod end and into lever cam, then tighten.

4. If the turret travel is not .150", ensure there is no mechanical problem or obstruction affecting the travel. If no problem is found, the air cylinder rod travel needs to be adjusted. To make this adjustment, loosen the two jam nuts, and screw the extension sleeve ***away*** from the air cylinder to increase the turret travel, or ***towards*** the air cylinder to decrease the turret travel. When adjustment is complete, tighten the jam nuts to the extension sleeve.

5. Once the turret travel is set, the Clamp/Unclamp switches must be adjusted. Enter the diagnostic data page in order to monitor the TT UNL (Turret Unlocked) and TT LOK (Turret Locked) discrete inputs.

For the following procedures follow:

Section I - *For production units making turret in / out adjustments with trip switches.*
Section II - *For production units making turret in / out adjustments using air cylinder mounted reed switches*

Section I

a. In MDI, enter an M43 (Unlock Turret). The Turret Unclamp switch should be tripped at this point, and discrete input TT UNL should read "1".

b. Place a 0.160" gage block between the Turret Clamp switch and the side of the cam, ensuring it is flat against the cam. The Turret Clamp switch should trip and the discrete input TT LOK should read "1". Remove the gage block.

   If either switch does not trip when the gage block is in place, the switches need to be adjusted. Adjust the switches by loosening the two SHCS and moving the entire switch bracket; DO NOT move the individual switches unless absolutely necessary.

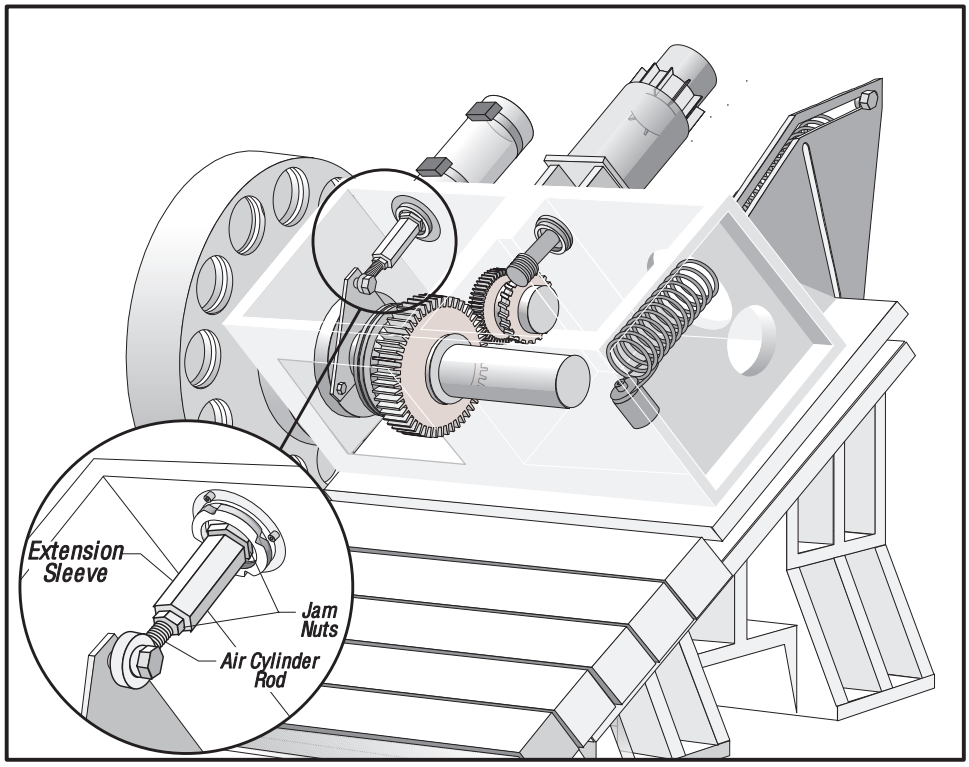


Figure 3-5. Turret travel adjustment components.

c. Enter an M44 (Lock Turret). The Turret Clamp switch should be tripped at this point, and discrete input TT LOK should be "1".

d. Place a 0.160" gage block between the Turret Unclamp switch and the side of the cam, ensuring it is flat against the cam. The Turret Unclamp switch should trip and discrete input TT UNL should read "1". Remove the gage block.

e. If either switch does not trip when the gage block is in place, the switches need to be adjusted. Adjust the switches by loosening the two SHCS and moving the entire switch bracket; DO NOT move the individual switches unless absolutely necessary. Refer to Figure 3-6.

Section II

a. In MDI, enter an M43 (Unlock Turret). The Turret Unclamp switch should be tripped at this point, and discrete input TT UNL should read "1".

   If this does not occur, the upper air cylinder mounted reed switch needs to be adjusted by loosening the worm drive clamp retaining the sensor and moving it into position until this discrete input appears consistently. Retighten sensor. When the turret is in any other position than Unlock Turret, the discrete input should read "0."

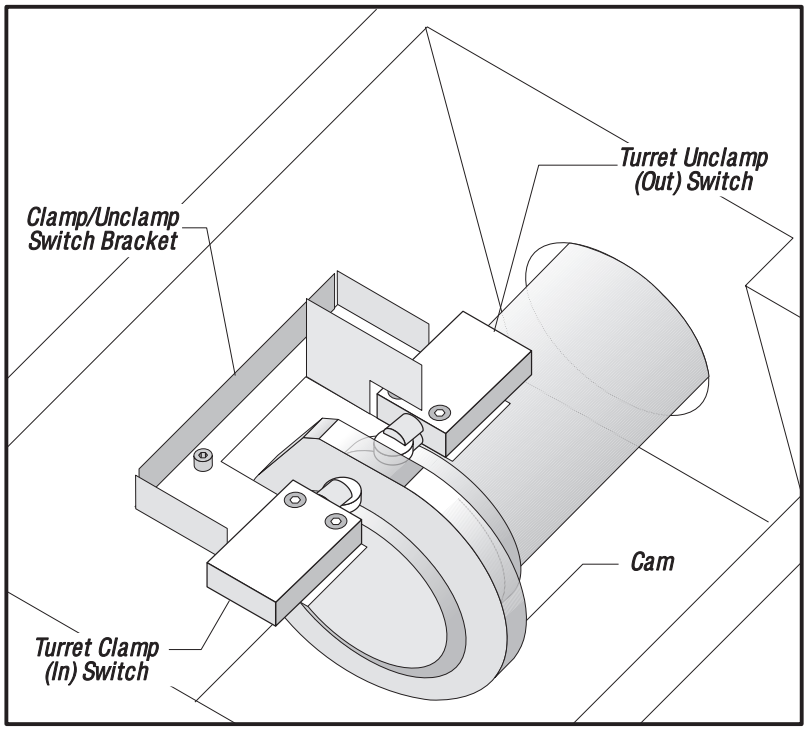


Figure 3-6. Turret Clamp/Unclamp switches.

b. In MDI, enter an M44 (Lock Turret). The Turret Clamp switch should be tripped at this point, and discrete input TT LOK should read "1".

   If this does not occur the lower air cylinder mounted reed switch needs to be adjusted by loosening the worm drive clamp retaining the sensor and moving it into position until this discrete input appears consistently. Retighten sensor. When the turret is in any other position than Lock Turret, the discrete input should read "0."

6. Install the turret housing top plate.

7. Install the sliding tool changer cover.

Lathe Turret Removal & Replacement

Turret Removal

1. Remove the gearbox cover plate

2. Rotate turret until it is on tool number one, and position X axis for easy removal of turret.

3. In MDI mode enter and execute M43 to unclamp the turret then E-stop the machine.

4. Block the shaft so it cannot slide back.

5. Remove retainer plate and O-ring from the turret (either four or eight bolts).

6. Remove turret.

Caution: Turret is heavy and can be slippery.

7. Remove key from shaft.

8. Remove thrust washers and needle bearings inspect these before installation.

Turret Replacement

1. Grease (red grease) and install thrust washers and needle bearings.

2. Install turret key and put the turret on the shaft.

3. Install O-ring and retainer plate of turret. Start bolts and run them up flush with retainer plate.

4. Remove the block from the rear of the shaft.

5. Tighten and torque retainer plate bolts.

6. In MDI mode enter and execute M44 to clamp the turret.

7. Replace the gearbox cover plate.

Turret Shaft Removal and Replacement

Turret Shaft Removal

1. Remove turret as described in previous section.

2. Mark the retaining ring and turret casting for alignment purposes.

3. Remove coolant tube bracket and move out of the way.

4. Remove inspection plate which will allow the gearbox oil to drain. Catch oil in a bucket.

5. Remove the bolt that holds the rod end to the lever cam. **Do not** adjust the rod end

6. Remove the lever cam.

7. Remove the switch bracket.

8. Remove the two set screws on the home switch cam at the back of the shaft, then remove the key. Turn the motor shaft to gain access to key or set screws. (servos off, E-stop).

9. Remove back half of curvic coupling (10-12 bolts), inspect O-ring.

10. Remove assembly (coupling holder and shaft) being careful to keep tension on the assembly to hold the cam and bearings in place.

Turret Shaft Replacement

Tools required: Installation tool for coupling mount

1. Apply grease to the ball bearing areas of the cam.

2. Install coupling mount (cams and bearing) using the installation tool, and line up key way with the bolt that is equidistant between the springs (or previous marked alignment).

3. Install turret shaft assembly (align mark on retaining ring with the mark on the casting).

4. Align of keyway and bolt facing up.

5. Install back half of curvic coupling on to gearbox snug two bolts and center the play between the bolt holes. Install the remainder of the bolts and torque to specifications.

6. Install lever cam

7. Install key for limit switch cam.

8. Install limit switch cam.

9. Install limit switch bracket.

10. Attach actuator to lever cam.

11. Install inspection plate.

12. Install coolant tube bracket.

13. Add oil to the gear box 8 cups (2500 ml).

14. Install turret as described in previous section.

Turret motor coupling adjustment procedure must be completed for proper alignment.

3.2 SPINDLE

Spindle Alignment Verification

This procedure should be performed after the turret face has been realigned.

TOOLS REQUIRED:

3 **SPINDLE ALIGNMENT TEST BAR (P/N# T-1312)**

1. Mount a 0.0001" indicator (*short setup*) to face of turret.

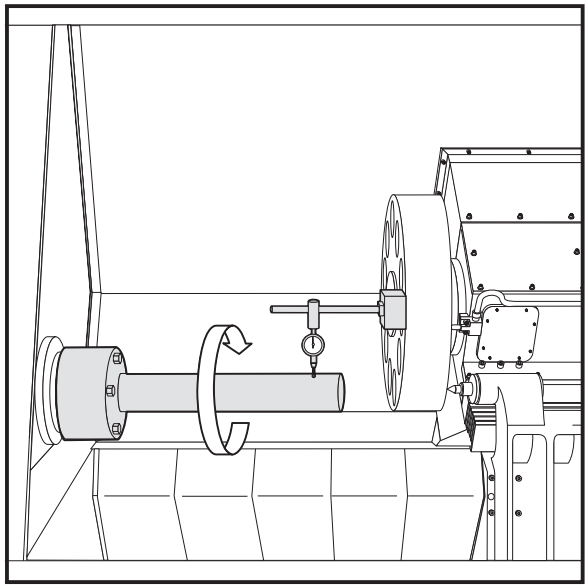


Figure 3-7. Checking runout.

2. Install Spindle Alignment Test Bar. Take up any slack between bolts with washers.

3. Place the indicator tip onto the test bar near the spindle. Rotate the spindle to determine the runout. The tolerance is .0001"

   - If the tolerance is greater than .0001 then loosen the test bar mounting bolts, rotate the spindle and tap on the mounted end of the fixture until the runout within tolerance.

4. Tighten the bolts to the test bar being careful not to alter the alignment.

5. Move the indicator tip to the end of the test bar and check for runout. Tolerance should not exceed 0.0005".

   - If the reading is greater than 0.0005" remove the test bar, clean both mating surfaces.

6. Next rotate the test bar until the reading is 1/2 of the total runout. Using the Z-axis, jog the indicator tip over 10 inches of the test bar to determine if the spindle is high or low. Tolerance should not exceed (0.0004/10")

   - If the measurement is greater than the allowable tolerance then the spindlehead casting must be realigned. Before realigning the spindlehead, perform a coupling adjustment
   - If the measurement is within the allowable tolerance, go to step 7.

7. Position the indicator tip on the backside of the test bar. Jog the indicator tip over 10 inches of the test bar to determine spindle parallelism. The maximum allowable tolerance is 0.0004/10".

- If this tolerance is out, call HAAS Automation Service Department..
- If the spindle is in alignment, proceed to Turret Alignment Verification section.

SPINDLE REMOVAL

Note: POWER OFF THE MACHINE BEFORE PERFORMING THE FOLLOWING PROCEDURE.

1. Remove the chuck or collet nose from the Lathe and the necessary covers to gain access to the spindle assembly.

2. Disconnect oil return hose and coolant drain hose after powering OFF machine.

3. Loosen the clamp and unclamp hoses, then remove.

4. Loosen the SHCS from the adapter, and detach the hydraulic cylinder.

5. Loosen the eight SHCS on the inside of adapter and detach from spindle shaft.

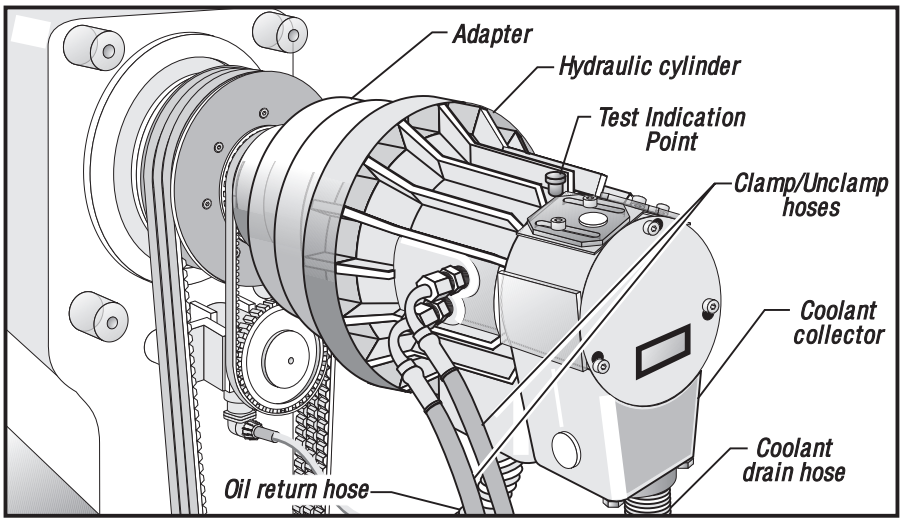


Figure 3-8. Hydraulic cylinder.

6. Unplug the encoder. Unscrew the encoder bracket, remove the encoder, then remove the belt.

7. Loosen the four SHCS holding the spindle motor. Slide the motor up by squeezing the belts. Tighten the SHCS and remove the drive belts from the spindle assembly.

8. Loosen the six SHCS and remove the spindle drive pulley.

9. Disconnect the two lubrication hoses and unscrew the fittings from the spindle housing. Note the direction of the flat sides of the fittings for lubricating the spindle bearings.

10. Unscrew the six SHCS holding the spindle retaining ring and remove. Also remove the O-ring.
11. Remove Spindle Carefully. (For HL-5/6 spindle removal, contact HAAS Service for removal tool)

SPINDLE INSTALLATION

Tools Required:

3 **(1) Blue Loctite** 3 **(1) 1/2" Torque Wrench (Up to 250 ft-lbs)**

3 **(1) HAAS Belt Tensioning Tool P/N# T1510 (HL1/2), P/N# T1537 (HL3/4/5/6)**

1. Install spindle into housing. Check location of oil holes for proper alignment.

2. Place the retainer ring on the spindle with the O-ring toward the spindle. Ensure that the drain holes are at the bottom of the retainer ring and that the O-ring remains in place.

3. Apply blue Loctite to the six retainer ring mounting bolts and install them. Place a .001 shim between the spindle and retainer ring. Torque the mounting bolts to 50 FT-LBS.

Note: The bolts should be torqued in a star pattern and in increments of 10, 20, 30,40 and finally 50 FT-LBS. Check alignment of the spindle and retaining ring with a .001 shim at each torque value.

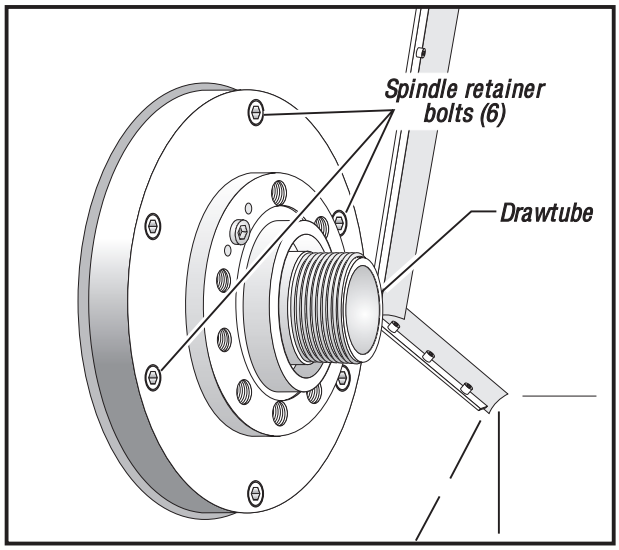


Figure 3-9. Spindle retaining bolts.

4. Ensure that the spindle can spin freely and the spindle and housing oil mist holes are aligned. If not, remove the retainer ring and spindle and reinstall.

5. Screw the oil mist nozzles in by hand until they bottom. Then back off the nozzles 1.5- 2 turns ensuring that the holes on the nozzles and spindle housing are aligned correctly and pointed towards the bearings. Make sure the nozzles do not come into contact with spindle shaft.

6. Tighten the hex nut on the nozzles, ensuring the nozzles do not spin. After tightening the nuts, verify the nozzle oil mist holes are still positioned correctly.

7. Attach the two 1/4" nylon tubes onto the swivel fittings.

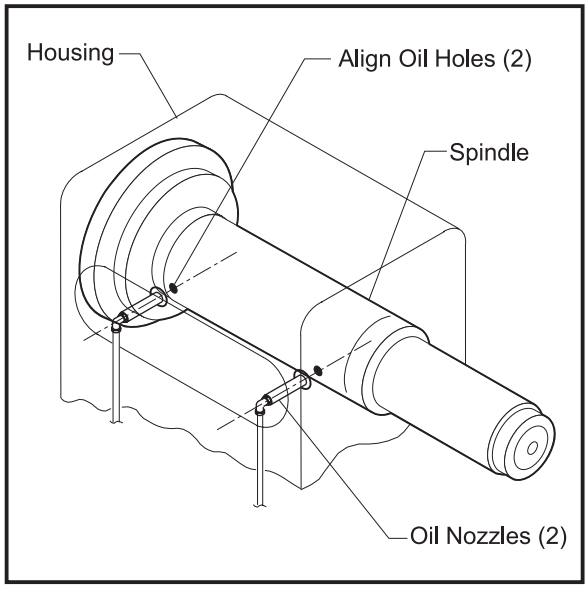


Figure 3-10. Alignment of oil mist holes.

8. Install the spindle drive pulley.

9. Install the drive belts onto the spindle and motor pulleys.

10. Apply proper tension to belts by wedging the T-shaped belt tensioner tool underneath the spindle head casting web, between the spindle head pulleys and motor / gearbox pulleys and the motor / gearbox mounting plate. Attach the 1/2" drive torque wrench to tensioner tool and apply the required torque value. The path of the applied torque should be inline with the motor assembly. The following chart includes values for proper belt tensioning.

Lathe	Tool P/N#	Torque Value
HL 1 / 2	T1510	95ft-lb
HL 1 / 2 BB	T1510	95ft-lb
HL 3 / 4	T1537	150ft-lb
HL 5 / 6	T1537	230ft-lb

11. While applying correct torque amount, tighten the four mounting motor / gearbox plate bolts.

CAUTION! This procedure should be performed with two service persons. One will apply correct torque amount and the other will tighten mounting bolts simultaneously.

12. Place the 3/8" timing belt on the spindle pulley, with the other end on the encoder pulley.

13. Mount the encoder onto the spindle housing below the spindle shaft with four mounting bolts.

14. Align and attach the encoder adapter onto the spindle shaft with two mounting bolts. Tolerance on the face of the adapter plate .0007". Check tolerance of large I.D. bore .002".

15. Slide the hydraulic cylinder into spindle shaft. Insert and tighten the mounting bolts.

16. Attach and clamp the oil drain hose and coolant drain hose onto hydraulic cylinder drawtube.

17. Attach and screw in clamp and unclamp hoses.

18. Set the magnetic base on top of the spindle housing with the indicator touching the top of the hydraulic cylinder indication point.

19. Spin the hydraulic cylinder and verify that the runout is under 0.003 inches. If runout us over 0.003 inches, spin the hydraulic cylinder to its high point and tap cylinder with a rubber mallet.

20. Replace the left end panel with the panel mounting screws.

Spindle Head Alignment

Tools Required:

3 **(1) Dual Indicator Stand**

Depending on lathe model, the following sheet metal pieces may need to be removed:

- **a.** The front left panel
- **b.** The front bottom panel
- **c.** The drain rail
- **d.** The front door

1. Loosen all spindle head mounting bolts.

2. Loosen the locknuts on the two jack screws (adjustment bolts) underneath the spindle head casting.

3. Bolt spindle alignment bar tool to spindle and attach a 0.0001" indicator onto the face of the turret.

4. Jog indicator such that the indicator runs tangent to alignment bar along the Z-axis.

5. Level the spindle head assembly by adjusting the jack screws up or down and jogging the indicator along the alignment bar in the Z-axis. The tolerance reading should be .0001" within 10".

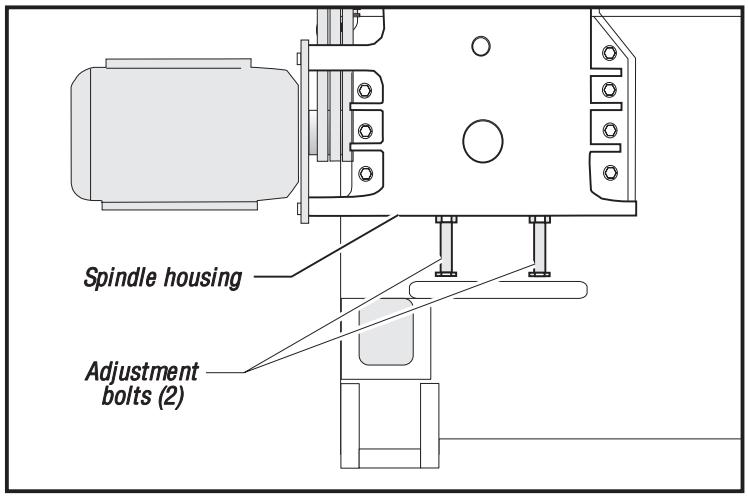


Figure 3-11. Adjustment bolts.

6. Once the spindle head assembly is level, setup dual indicators on the large magnetic base and place on the base casting to the rear. Indicate them at the machined bosses to maintain the spindle head level. See Figure 3-12.

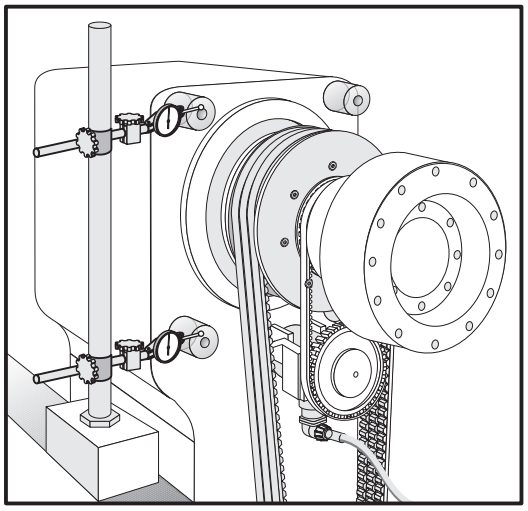


Figure 3-12. Indicator setup.

Note 1: This setup is to ensure the spindle remains parallel in the Z-axis plane while raising the spindlehead. It is recommended to only turn the jackscrews a quarter turn each time so that the spindle head does not become positioned too high above the turret pocket. Should this happen, you will have to start the procedure again.

Note 2: If the boss on the spindle head casting is not machined, then an alternate method to set up the indicators is to retract the B-axis waycover from the left side and mount the mag base to the base casting. Then position two indicators on the machined surface beneath the spindle head casting.

7. Place the tenths indicator at the end of the spindle alignment bar and jog tool turret in the Z- axis towards the spindle until the indicator rest on the inside of the tool pocket.

8. Align the tool pocket holder along the X-axis with the spindle alignment bar by rotating the spindle and sweeping the indicator 180° along the axis. Refer to Figure 3-3.

9. Jog the turret along the X-axis until a measurement reading within .001" is indicated.

Note 3: Use the jog handle in tenths mode to zero pocket

10. Next, zero the spindle alignment at the top and bottom of the turret pocket by sweeping the indicator at those positions and adjusting the jack screws equally. See Notes 1 and 2.

11. Rotate the spindle 180° and adjust the jackscrews until the indicator reads within a .001" at the top and bottom of pocket. Repeat Steps 8 and 9, to ensure the X-axis is zeroed for each adjustment in the vertical direction.

12. Torque the spindle head mounting bolts to 500 ft-lbs carefully so as not to change the spindle's position.

13. Once the pocket is zero, X-axis value on the screen becomes the new machine spindle centerline.

14. Tighten the jam nuts on the jack screws under the spindle head.

Note 4: The x-axis value in the Positions page is the new machine centerline. This value should be stored in Parameter 254.

15. Repeat Steps 3-5 to ensure that the shaft has remained horizontal. If the shaft has moved, return to Step 11 and recheck the pocket position.

16. Test the other pockets in the same way as pocket #1 (Step 11) without moving the x-axis position. The tolerances for the other pockets are 0.003 inch from the centerline.

17. Replace the following sheet metal pieces if removed:

    a. The front left panel
    b. The front bottom panel
    c. The drain rail
    d. The front door

Note 5: All alignments done could change spindle centerline. Verify and enter new spindle centerline position in Parameter 254. (Refer to Section 1.9)

3.3 TAILSTOCK ALIGNMENT

Tailstock alignment procedures should only be done after the X and Z axes have been checked for proper alignment.

Tailstock Alignment Verification

Tools Required:

- ✓ **Spindle Alignment Test Bar (P/N# T-1312)**
- ✓ **Tailstock Taper Bar (P/N# T-1416)**
- ✓ **.0001" Indicator and Magnetic Base**

1. Mount the spindle alignment test bar to the spindle.

Note: Make sure all contact surfaces, including the test bar, are clean.

2. Mount a tenths indicator to the end of the test bar.

3. Insert the tailstock taper alignment test bar.

4. Place the indicator tip at the base of the tailstock test bar (closest to the tailstock). Check the total runout at base of the test bar by rotating the indicat 360^0. Max. tolerance is .001" from centerline.

- If this measurement is out of tolerance from top to bottom (90^0 and 270^0), then proceed to the Tailstock Leveling Procedure.

- If this measurement is out of tolerance from side to side (0^0 and 180^0), then the insert needs to be replaced and realigned as described in the Tailstock Insert Removal and Installation section.

5. Jog the tailstock back and measure the runout at the end of the tailstock test bar.

Tailstock Leveling Procedure

This procedure should only be performed after the tailstock In/Out has been checked.

Tools Required:

- ✓ **(2) Tenths Indicator**
- ✓ **(1) Tailstock Alignment Tool (Test Bar P/N# T-1416)**
- ✓ **(1) Tailstock Leveling Assembly (Leveling Stand P/N# 93-6001)**
- ✓ **(1) Round Rigid Bar (1", diameter min.)**

1. Carefully remove the center from tailstock (TS) and thoroughly inspect the tapered insert for damage or debris. Clean tapered insert and firmly install Test Bar.

2. Loosen the mounting bolts that attach the TS to the linear guide trucks, allowing TS to rest on bolts. Place the Leveling Stand under the bottom edge of TS and manually raise the jack bolts. (Refer to Figure 3-13)

3. Attach a tenths indicator to the face of the turret. Level the TS by jogging the indicator along the test bar in the Z-axis and level to within .0005" by adjusting the jack bolts.

4. Clamp the rigid bar into the chuck or collet and mount the tenths indicator at the end. Sweep the diameter of the Test Bar and note the vertical runout. Refer to Figure 3-13.

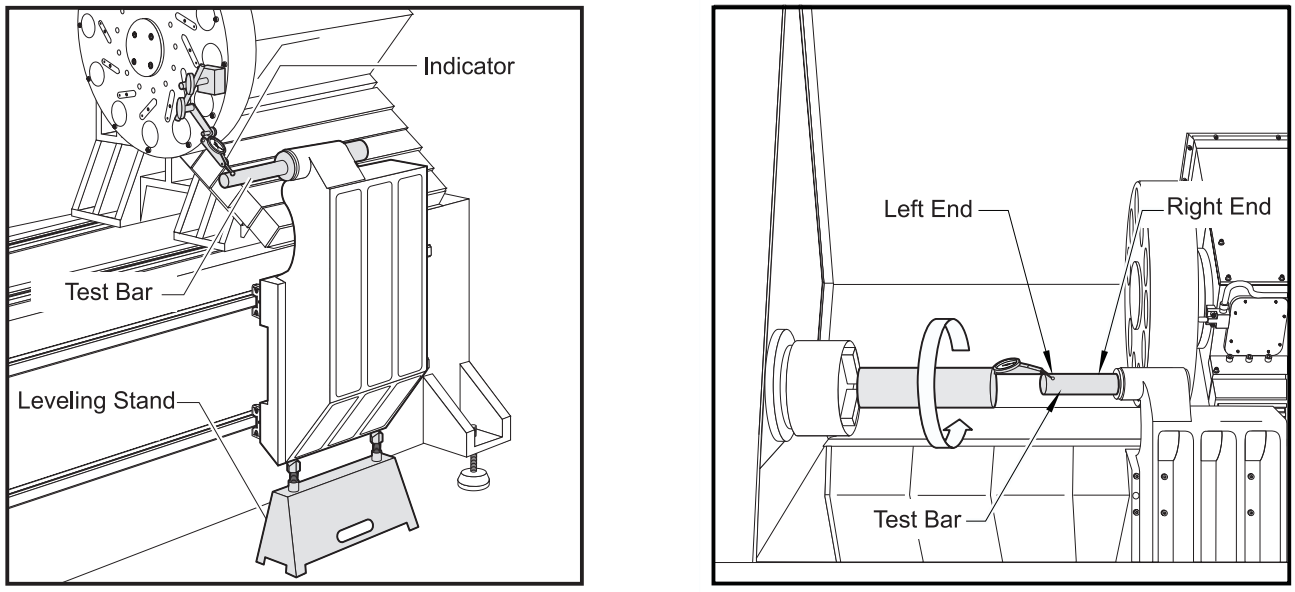


Figure 3-13. Tailstock leveling indicator setup.

5. Raise the TS and bring up to center by equally turning the jack bolts (do not turn one jack bolt more than 1/4 turn without turning the other). Adjust to within .0003" and lightly snug bolts during procedure.

Note: Check tailstock parallelism each time the tailstock is raised.

6. Check for TS level change. Adjust by setting the indicator to zero at the right end of the Test Bar and jog the indicator over to left end of bar. Snug bolts in upper left corner and loosen the others. Adjust the right-hand jack bolt only and bring the indicator to within .0005".

7. Once the TS is leveled, the mounting bolts should be torqued to 50 ft-lbs in a clockwise fashion (first, the inner mounting bolts than the outside). If the horizontal runout is unacceptable, the tapered insert may have to be reset as described in the following section

Note: These steps may have to be repeated to achieve proper alignment.

Tailstock Insert Removal and Installation

CAUTION! Contact HAAS before attempting this procedure.

Tools Required:

- ✓ **Press Fixture and Spacer**
- ✓ **Spindle Alignment Test Bar (P/N# T-1312)**
- ✓ **Tailstock Taper Alignment Bar (P/N# T-1416)**
- ✓ **Blow torch**
- ✓ **Devcon liquid steel (P/N# 99-4530)**

Removal -

1. Remove the six screws that mount the back plate to the tailstock insert.

2. Remove the 3 screws that mount the insert to the casting.

3. Run the screw nut completely down to its farthest travel (far right).

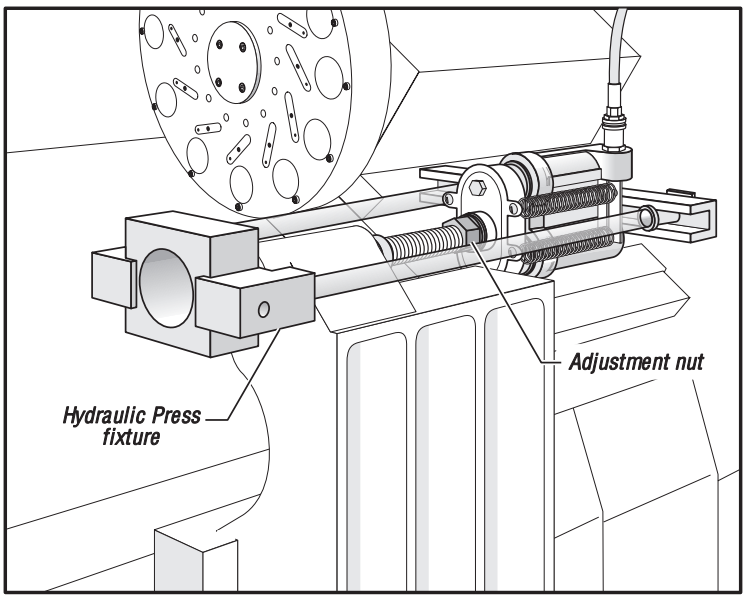


Figure 3-14. Tailstock insert press.

4. Mount the fixture to the tailstock casting as shown.

5. Pump the hydraulic press a few times so that the fixture stabilizes itself against the tailstock.

WARNING! Keep hydraulic lines away from the blow torch flame or serious injury could result.

6. Use the blow torch to heat the insert casting. This will take approx. 30 minutes.

7. Pump the hydraulic press to its maximum pressure while continuing to heat the casting.

Note: When the pressure on the gauge begins to drop the insert should begin to slip out. Once the press is fully extended, run the nut down again and repeat step 6.

Note: Use a spacer if the adjustment screw on the press is not long enough to remove the insert.

8. Once the insert is removed, use a small screw driver or chisel to remove any Devcon. Make sure fill hole is clear.

Installation -

1. Clean the tailstock bore and all mounting surfaces.

2. Mount the spindle alignment test bar (short 8" test bar) onto the spindle.

3. Then mount a tenths indicator to the nose of the test bar.

4. Install the tailstock insert and three mounting screws.

5. Insert the tailstock taper alignment bar.

6. Position the indicator tip at the base of the tailstock test bar.

7. Adjust the insert until the runout at the base of the test bar is less than .0003" TIR. Then tighten all three screws.

8. Install the rear insert plate. Tighten the three 1/4 x 20 but leave the three 10 x 32 screws loose.

9. Position the indicator at the end (far left) of the tailstock taper alignment bar.

10. Insert a pry bar into the rear of insert and adjust the runout at the end of the shaft until the reading is .001" from centerline. Then tighten the remaining screws.

11. Before injecting the Devcon solution make sure the fill hole at the back of the tailstock casting is not clogged. Inject the Devcon and let stand overnight.

HYDRAULIC TAILSTOCK CYLINDER

WARNING! Before performing any service on the hydraulic cylinder or pump, the machine should be powered off.

REMOVAL -

1. Remove front and rear waycovers.

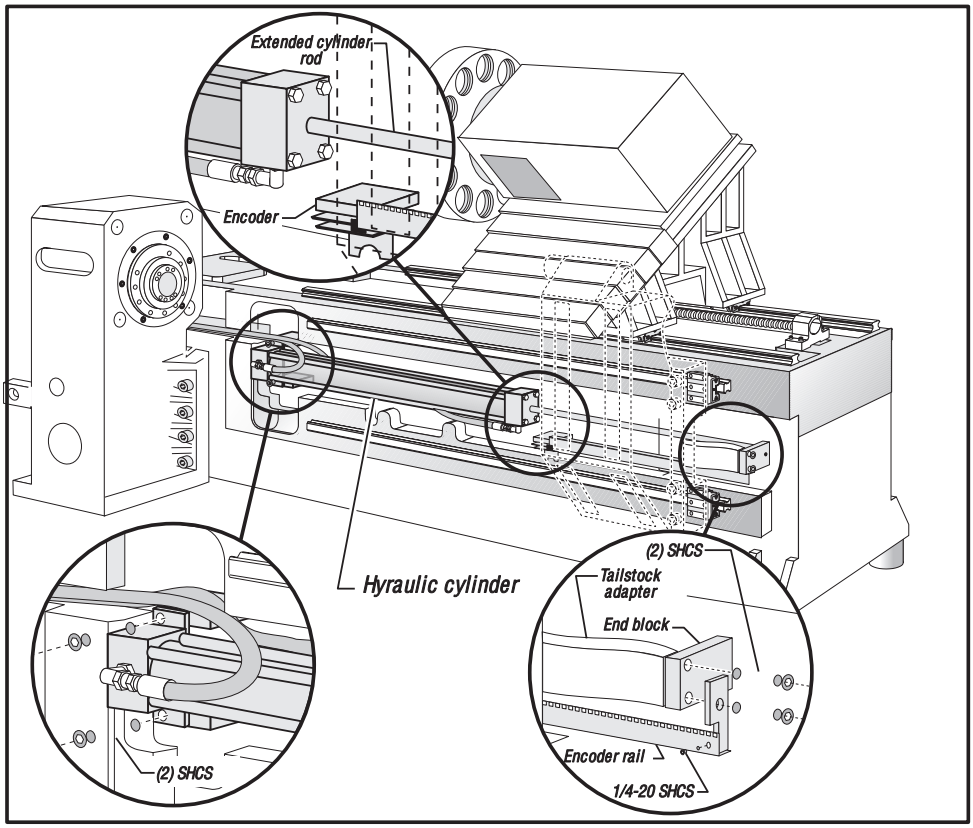


Figure 3-15. Hydraulic cylinder replacement.

2. Disconnect the hydraulic lines from both ends of the cylinder.

CAUTION! Although the hydraulic system is not under pressure oil will spill out of the hydraulic lines once disconnected from the cylinder. Have a bucket ready to catch any oil that spills out.

3. Push the tailstock to about mid-travel.

4. Remove the (2) SHCS that mount the cylinder rod end block to the rear of the hydraulic tailstock adapter.

5. Remove the 1/4 - 20 SHCS that mounts the encoder rail to the bottom of the cylinder rod end block

6. Remove the (2) SHCS that mount the hydraulic cylinder body to the base casting.

7. Extend the cylinder shaft so that you can place a wrench on the end of the cylinder rod in order to unscrew

it from the end block.

8. Unscrew the end block from the cylinder.

9. Collapse the hydraulic cylinder then push the tailstock to the rear of travel.

10. Pull the hydraulic cylinder out from the frontside of the tailstock.

INSTALLATION -

11. With the new cylinder in position, push the tailstock to the front of travel.

12. Thread the end block onto the end of the cylinder rod and tighten.

13. Install the (2) SHCS that attach the end block.

14. Install the 1/4 - 20 SHCS that holds the encoder rail to the bottom of the mounting block.

15. Install the (2) SHCS the mount the cylinder body to the base casting. Before tightening move the tailstock to the front end of travel.

16. Attach the hydraulic lines to both the front and rear of the cylinder.

17. Reinstall waycovers.

18. Check the fluid level at the hydraulic tank to determine how much fluid needs to be added.

3.4 TRANSMISSION

Removal

Tools Required:

- ✓ **Hoist and lifting straps OR floor jack and (4) wood blocks**

1. Power off the machine.

2. Remove the left side panel to access the spindle motor and transmission assembly.

Note: If you are using a floor jack, the bottom left front panel needs to be removed.

3. Disconnect all electrical lines from the motor and transmission assembly.

4. Position the hoist directly to the rear of the motor and place the lifting straps around the motor and transmission. Make sure there is enough tension on the straps so that when you loosen the mounting bolts, the motor assembly doesn't shift.

Note: If you are using a floor jack, slide the jack under the transmission assembly from the front side of the machine. Being careful not to damage any components, place the wood block supports under the transmission and motor .

5. Remove the four transmission mounting plate bolts. Raise the transmission enough to remove the drive belts, then slide the entire assembly out.

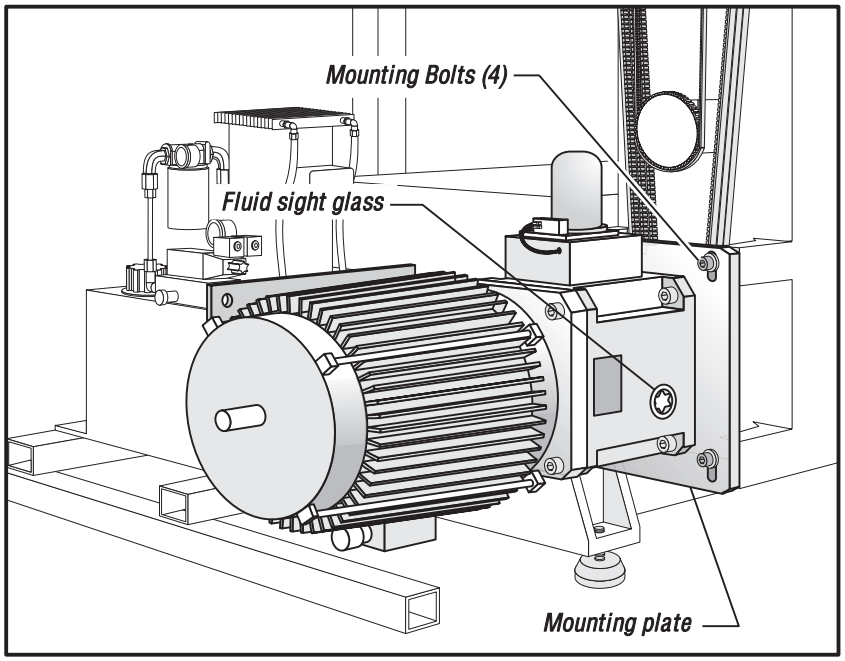


Figure 3-16. Lathe transmission mounting plate.

Transmission Installation

1. Place lifting straps under new transmission assembly and lift just enough to put tension on the cables.

Note: If you are using a floor jack, slide the jack under the front side of the machine. Being careful not to damage any components, place the wood block supports on the jack and slide the transmission and motor onto the jack.

2. Ensure the new transmission is seated securely on the straps and lift up slowly. Lift only high enough to install the drive belts, then gently swing the assembly into place.

3. Insert the four bolts that secure the transmission mounting plate to the spindle head.

4. Adjust the drive belt tension, then tighten down screws completely. Refer to the Spindle Installation section, for proper belt tension procedures and tension chart.

5. Reattach all electrical lines at this time.

6. Replace the left side panel.

Note: If you are using a floor jack, replace the bottom left front panel.

3.5 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 are; X-axis =.236, Z-axis=.118, B-axis = .050 (This equals ½ of a revolution of the encoder).

SETTING THE OFFSET -

1. Set the grid offset to zero. (Parameter 125, 127, 129, 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, Z, or A).

3. Calculate the grid offset using the following formula, and write the result in Parameter 125, 127, or 128 (depending on the axis being set).

   (DISTANCE TO GO - .236) x Ratio = Grid Offset

The Ratio (steps/unit) for the X, Z, and A axes are the values in Parameters 5, 33, and 47, 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.

3.6 LUBE AIR PANEL

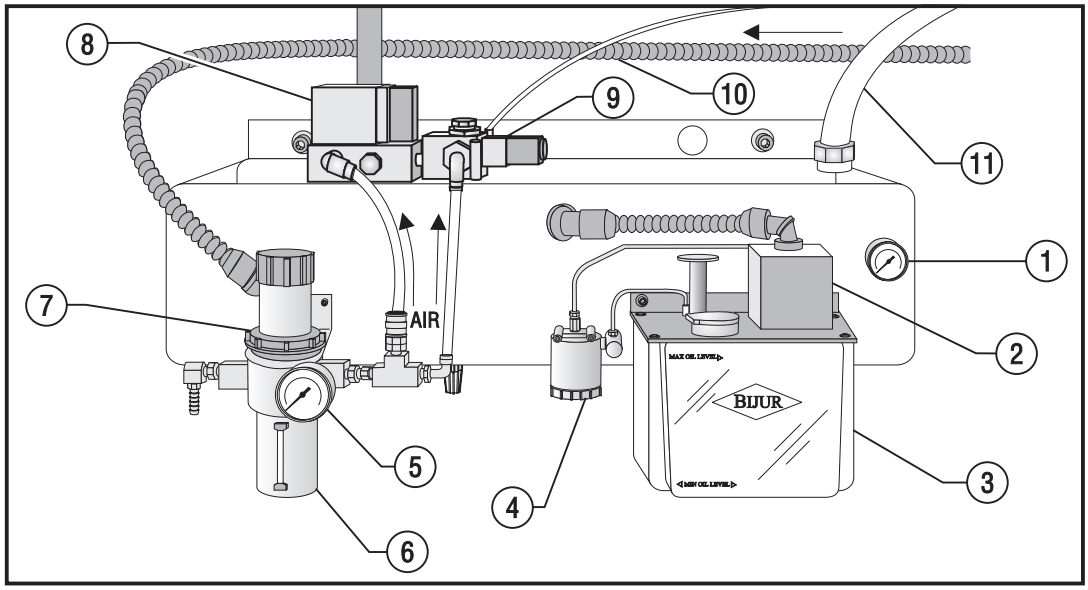


Figure 3-17. Lube Air Panel (Front View).

LUBE AIR PANEL COMPONENTS

The following is a list of the Lube Air Panel Assembly components, each with a description of its specific function.

1. **Oil Pressure Gauge** - Indicates the pressure (in psi) at which the oil is pumped from the reservoir.

2. **Oil Pump** - Pumps the oil from the reservoir to various parts of the lathe. Every 30 minutes the pump cycles and pumps 2.8 to 3.8 cc of oil (at approximately 20 psi).

3. **Oil Reservoir** - Stores the oil (Vactra #2) that is used for lubrication in the linear guides and lead screws. Oil is also mixed with air and sent to the spindle bearing for lubrication and cooling.

4. **Oil Filter** - Filters the oil from the reservoir before it is pumped to the necessary areas.

5. **Air Pressure Gauge** - Indicates the pressure (in psi) at which the air is being regulated.

6. **Air Filter** - Filters the air before it is sent to the solenoid valves.

7. **Air Pressure Regulator** - Maintains the air supplied from the outside source (via the main air line) at a constant, desired pressure (approximately 85-90 psi).

8. **Air Solenoid Assembly** - 4-way 2-position valve that controls the air to the turret air cylinder.

9. **Air Solenoid Assembly-** 3-way 2-position valve that controls the air to the drawtube air cylinder. This assembly is only on machines equipped with a pneumatic drawtube.

10. **Power Cable** - Supplies power to the Lube Air Panel from the main control box.

11. **Power Cable** - Supplies power to the chuck actuator foot pedal.

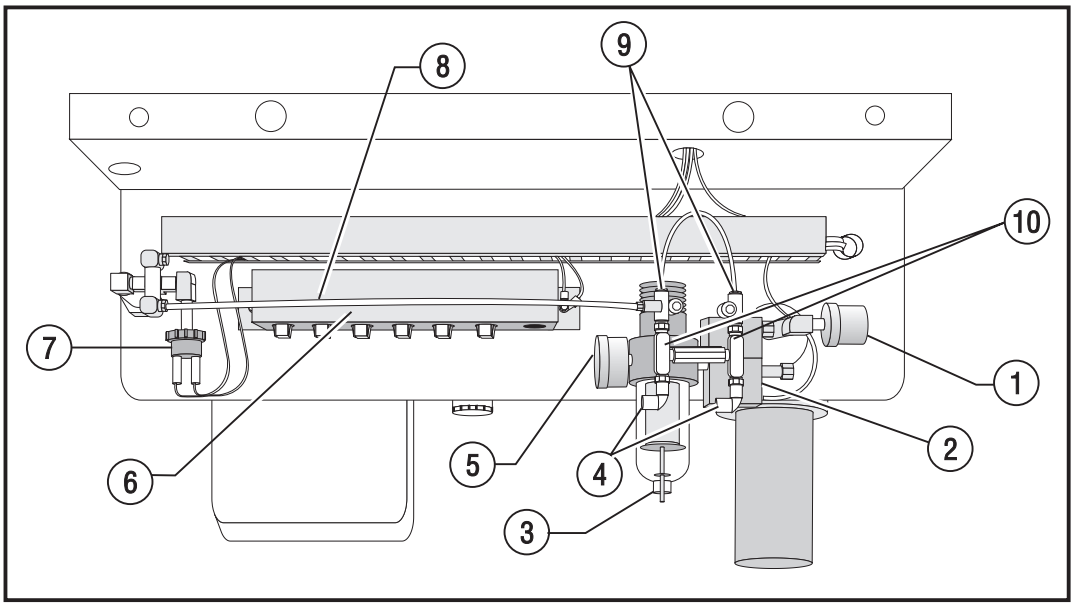


Figure 3-18. Lube Air Panel (Rear View).

The following is a list of the Lube Air Panel Assembly components on the rear of the panel, each with a description of it's specific function.

1. **Air Pressure Switch** - Monitors the air supply pressure, and sends a signal to the control panel to "alarm out", or stop, the machine when the air pressure falls below 70 psi.

2. **Solenoid Valve** - Opens when the spindle is turning to permit air to be sent to the spindle bearings.

3. **Air Regulator** - Maintains the correct air pressure (15 psi) being sent to the spindle bearings.

4. **Oil Mist Ports** - Connect to nylon tubing that carries the oil-air mist to the spindle bearings. One port supplies the front spindle bearing, and one supplies the rear bearing.

5. **Air Pressure Gauge** - Indicates the pressure of the air being mixed with oil and supplied to the spindle bearings.

6. **Connector Plate** - Contains all of the connectors for the Lube Air Panel.

7. **Pressure Switch** - Monitors the oil supply pressure, and sends a signal to the control panel to stop the machine if the pressure drops below the minimum level for a set period of time.

8. **Oil Line** - Carries oil to the ports, where it is then sent to the lead screws, linear guides, and spindle bearings.

9. **Oil Ports** - Connect to nylon tubing that carries the oil to the lead screws and linear guides.

10. **Flowmeters** - Maintain the correct amount of oil dropping from the upper ports to the lower ports where they are mixed with air and sent to the spindle bearings.

Lube Panel Removal

IMPORTANT! POWER OFF THE MACHINE BEFORE PERFORMING THE FOLLOWING PROCEDURE.

1. Remove the rear panel.
2. Disconnect the main air line.
3. Disconnect all switches.
4. Disconnect spindle air line.
5. Disconnect oil line at lube panel.
6. Disconnect fan wire and remove the connector from the conduit.

NOTE: All plastic ties must be cut in order to remove the lube air panel.

7. Disconnect limit switches from lube panel.
8. Remove all conduits.
9. Remove the mounting screws located at the top of the lube panel.
10. Disconnect main oil line.

3.7 HYDRAULIC POWER UNIT

Removal

CAUTION! POWER OFF THE MACHINE BEFORE PERFORMING THIS PROCEDURE.

1. Remove necessary panels to access the hydraulic unit.
2. Loosen and disconnect the drawtube clamp and unclamp hoses.
3. If the unit comes with a hydraulic tailstock solenoid, disconnect the 2 hoses that lead to the tailstock cylinder. Remember to mark the hoses or else the tailstock and chuck will not function properly.

Note: Right clamp/unclamp hose of hydraulic unit is attached to bottom port of hydraulic cylinder and left hose is attached to top port. The ports are located on the side of the hydraulic cylinder.

4. Unclamp and remove oil return hose from hydraulic unit and hydraulic cylinder.

Note: The oil return hose is shrink-fitted and should be replaced with a new one whenever removed.

5. Disconnect pressure switch cable and solenoid valve cable.

6. Disconnect pump motor cable.

7. Loosen and remove the four bolts from base of unit, then slide hydraulic unit out.

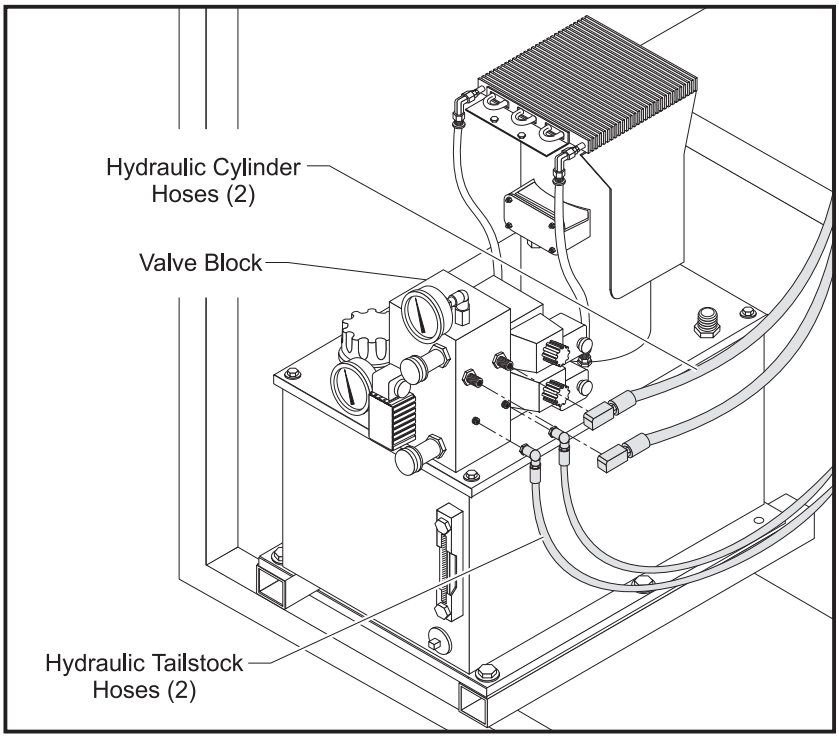


Figure 3-19. Hydraulic power unit.

Installation

CAUTION! POWER OFF THE MACHINE BEFORE PERFORMING THIS PROCEDURE.

1. Slide hydraulic power unit into place and attach with four mounting bolts.

2. Connect pump motor cable.

3. Connect pressure switch cable and solenoid valve cable.

4. Replace oil return hose and clamp to hydraulic unit and hydraulic cylinder.

Note: The oil return hose is shrink-fitted and should be replaced with a new one if damaged during removal.

5. Connect the clamp and unclamp hoses.

Note: Right clamp/unclamp hose of hydraulic unit is attached to bottom port of hydraulic cylinder and left hose is attached to top port. The ports are located on the side of the hydraulic cylinder.

6. Replace any panels that were removed to access the hydraulic unit.

3.8 INTERIOR WORKLIGHT

Bulb Replacement

1. Jog the Z-axis all the way to the left (negative direction).
2. TURN OFF power to the machine at the main breaker.
3. Loosen the 14 BHCS that attach the light lens retainer
4. Remove the retainer and the light lens.
5. Remove the light bulb and replace with a 24", 20 watt (F20T12-CW) bulb.
6. Replace the light lens and retainer then tighten down the 14 BHCS.
7. Restore power to the machine.

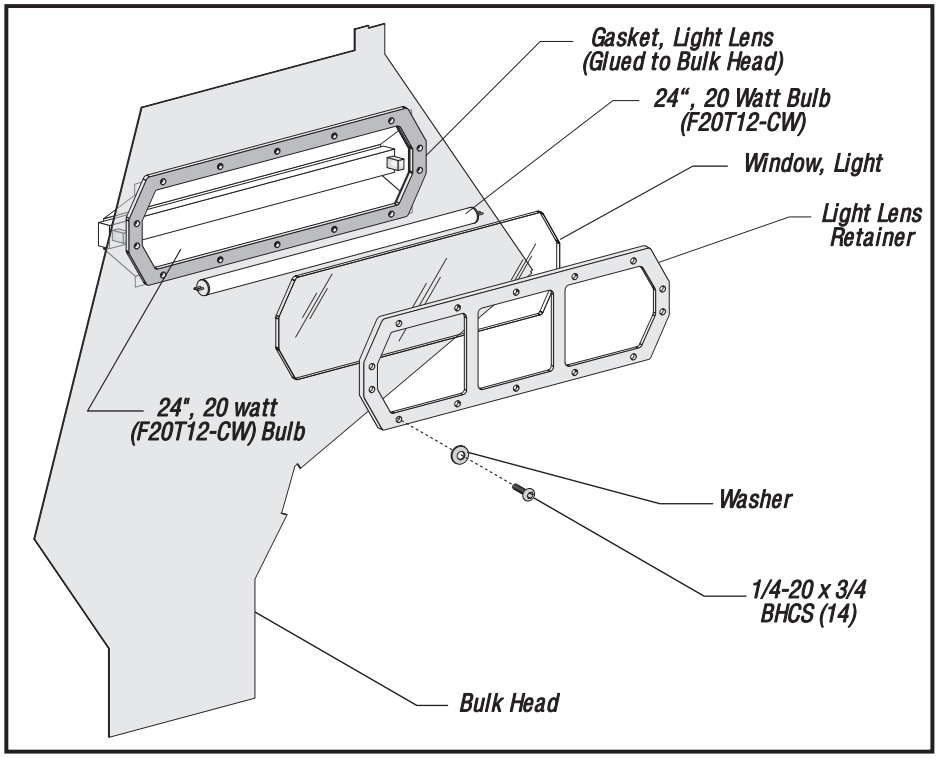


Figure 3-20. Interior worklight assembly.

3.9 TURRET CROSS-SLIDE SPRING

WARNING! Power on machine, but **DO NOT PRESS EMERGENCY STOP,** or turret will fall during spring removal.

REPLACEMENT

1. Remove sliding tool changer cover, located in the back of the machine, to gain access to spring.
2. Unbolt X-axis waycover from tool changer box.
3. Jog the turret to top of X-axis travel.
4. Insert a wood block between ballscrew support and ballscrew nut to safely block the assembly.

Note: If replacing old style bracket and spring, then skip to Step 5.

5. Loosen 3/8" SHCS that holds lower pivot arm to spring bracket, then loosen 3/4" nut of upper pivot arm of spring bracket.
6. Place a 3/4" wrench on the pivot arm and push the spring forward slowly to relieve the spring tension.

WARNING! Be careful not to release tension too fast.

Note: Recommend using 3/4" wrench with cheater bar for leverage when relieving spring tension.

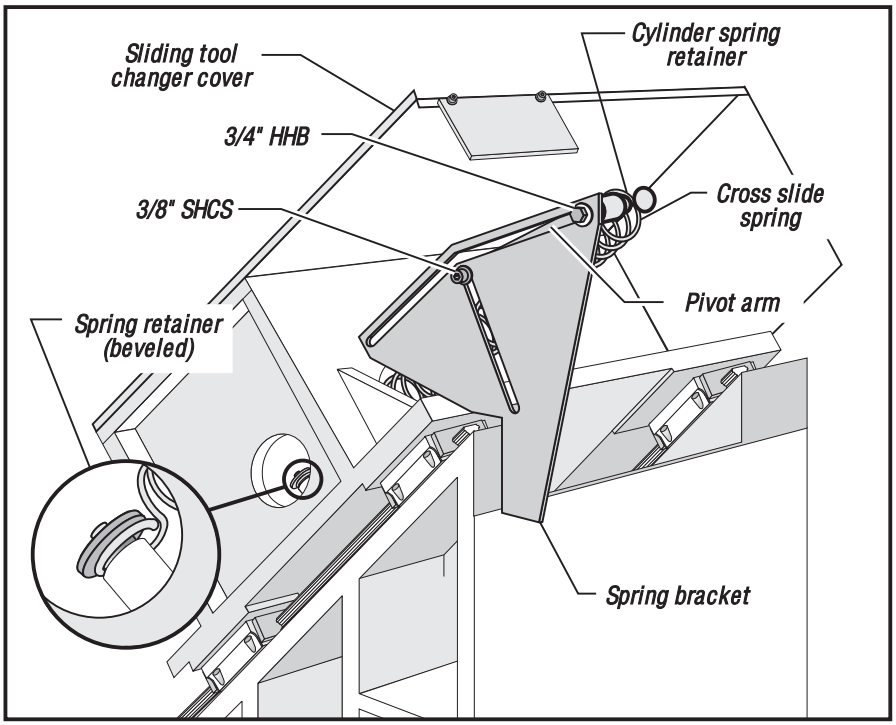


Figure 3-21. Cross-slide spring components.

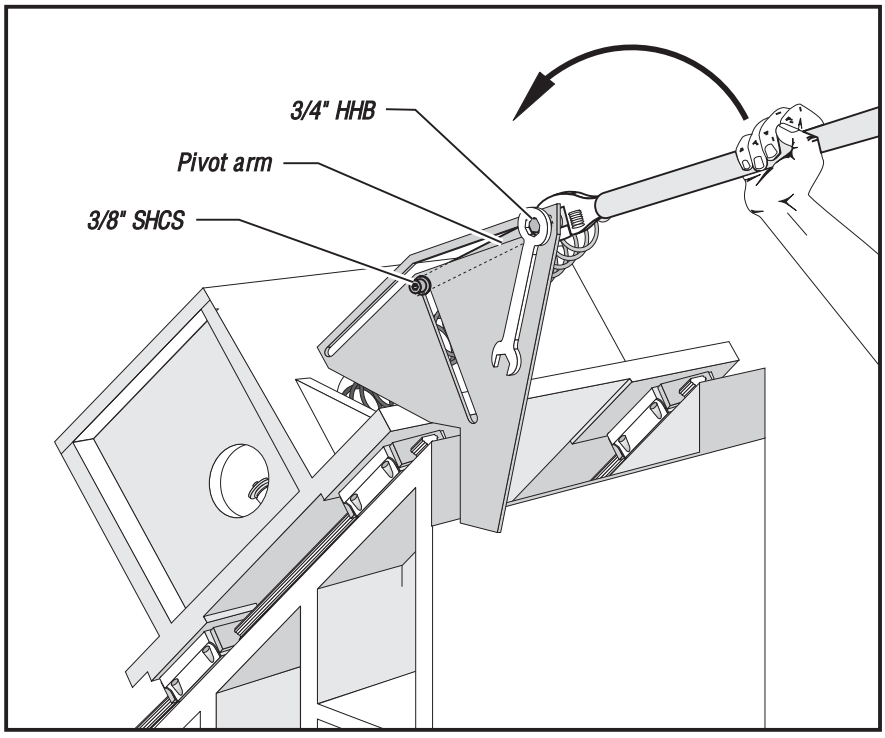


Figure 3-22. Spring tension relief.

5. Remove cross slide spring and remove spring retainer located inside turret housing. Use access hole located on the opposite side of turret to remove spring retainer. Replace used spring retainer with new beveled spring retainer.

Note: Old style bracket is not equipped with a cylinder spring retainer. Remove the two mounting bolts and old style bracket then replace with new bracket equipped with pivot arm and remount with two mounting bolts. Skip to Step 7.

---

6. Remove cylinder spring retainer attached to pivot arm and replace with new cylinder spring retainer.

7. Install new cross slide spring. Attach spring to spring retainer in turret housing and cylinder spring retainer of pivot arm.

8. Place 3/4" wrench on pivot arm then pull towards rear of bracket until pivot arm locks to restore spring tension.

9. Tighten 3/8" SHCS of lower pivot arm and 3/4" nut of upper pivot arm on spring bracket.

10. Remove the wood safety block.

11. Re-attach the X-axis way cover.

3.10 PARTS CATCHER

REMOVAL

CAUTION! POWER OFF THE MACHINE BEFORE PERFORMING THE FOLLOWING. PROCEDURE

1. Disconnect the main air line.
2. Remove necessary panels to access the parts catcher unit
3. Loosen 1 1/2" shaft collar that locates the parts catcher tray, and slide out tray and inner shaft.
4. Unclamp outer retaining ring that retains the shaft collar on the outer shaft, remove shaft collar and inner retaining ring.
5. Remove rubber seal from outer shaft.
6. Detach 5/32" airlines attached to the barrel end and rod end ports of the air cylinder.
7. Remove 7/16" hex nut that attaches the air cylinder to the parts catcher shaft.
8. Loosen and remove 1/4" SHCS and washer that attaches air cylinder to cylinder mount and remove air cylinder.
9. Remove 3/8" SHCS holding the parts catcher pivot mount assembly to the spindle head casting and slide out mount assembly.

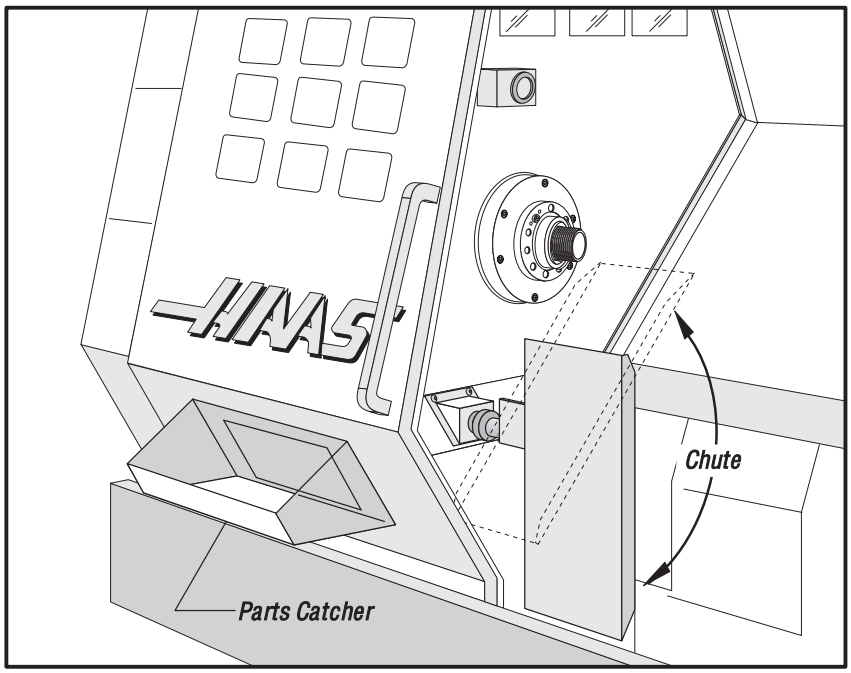


Figure 3-23. Front view of parts catcher/tray

INSTALLATION

1. Slide parts catcher pivot mount assembly through the sheet metal seal and attach to spindle head casting using 3/8" SHCS.

2. Install air cylinder to cylinder mount using 1/4" SHCS and washer.

3. Attach air cylinder rod in its fully retracted position to parts catcher shaft with the hex nut.

4. Connect air lines to air cylinder ports.

5. Install rubber seal on outer shaft.

6. Place inner retaining ring on outer shaft, slide shaft collar on and attach outer retaining ring.

7. Connect main air line.

Note: Machine must be powered up and controlled in MDI mode to check for proper activation and deactivation of parts catcher. It must be stopped with the rod fully extended to properly position chute assembly to the collector door.

8. Slide the inner shaft of the tray assembly into outer shaft of pivot assembly. Locate tray assembly far back enough to catch the part and clear chuck.

9. Rotate the tray position to open the sliding door of the collector. Tighten the shaft collar to the parts catcher shaft. Step through MDI program and check tray operation

10. Install necessary panels that were removed.

3.11 LATHE TOOL PROBE

Probe Setting

1. Power off the machine and unfasten the forward end panel on the left side of the machine.

2. Loosen all fasteners and set screw on the mounting block.

3. Lower tool setter arm to horizontal position. Install a turning tool in the cutting position pocket on the turret and jog the 'Z' axis in slow motion until the tool tip touches the square tip of the probe.

4. By tightening 1/4-20 set screw on the mounting block, adjust the height of probe so the tip of the turning tool touches the middle of the side of square tip. After proper alignment, tighten all four 3/8-16 screws on mounting block and torque them to **50 ft/lb**. Also tighten the 1/4-20 nut on the set screw against the mounting block.

5. Install .0001" indicator on a safe place on the turret, align the tip of probe within **.0005"** to 'X' and 'Z' axes by loosening the four 4-40 clamping screws and rotating the probe body. Tighten the clamping screws.

6. Rotate tool setter arm to vertical position (home position) and check the alignment of probe, ball stud and home switch actuator groove to home assembly. If there is misalignment, loosen the two 1/4-20 button head screws and let home assembly self center to the ball stud. Tighten screws after proper alignment.

7. Home position verify by jog functions normal on 'X' and 'Z' axes.

8. Move turret away and pull down tool setter arm. Control should switch to Tool set offset screen. 'X' and 'Z' will jog only in slow motion. Using your finger, trigger probe, speaker should beep and diagnostics input should change from 0 --> 1 --> 0. Using slow jog button, move 'X' or 'Z' clear of the part, tap the probe, the motion in current direction should stop, offset should update.

Probe Tip Replacement

1. Install stylus tip with supplied wrenches. Additional information can be found in the probe manufacturer's manual.

2. Install .0001" indicator on a safe place on the turret, align the tip of probe within **.0005"** to 'X' and 'Z' axes by loosening the four 4-40 clamping screws and rotating the probe body. Finally tighten the clamping screws.

Setting Probe Offsets

Setting 'X' offsets.

1. Clamp a piece of material in the chuck and take a finish cut on the outside diameter. Move away in the Z, do not move in the X.

2. Measure the diameter of the part using a micrometer and record the measurement on a piece of paper.

3. With the tool tip positioned to the outside diameter of the part and using the **origin** key, zero the 'X' register of the **operator position** display.

4. Using the **operator position** display as a guide move the tool in the 'X' direction until the display reads the same value as the measured diameter and using the **origin** key, zero the 'X' register of the display.

5. Move the tool to a safe position and lower the tool setter arm and touch the tool tip using the jog handle in the .0001 mode.

Note: While jogging, when the tool comes in contact with the probe the control will beep and jogging in the current direction will stop.

6. Record the value shown in the 'X' operator position display into **Setting 59 PROBE OFFSET X+.**

7. Subtract 2 times the probe width from the 'X' operator position display and store this value into **Setting 60 PROBE OFFSET X-.**

Setting 'Z' offsets.

1. The value of **Setting 61 PROBE OFFSET Z+** should be Zero. The value of **Setting 62 PROBE OFFSET Z-** should be the width of the probe (i.e. if the probe measures .3937 **Setting 62 PROBE OFFSET Z-** would be **.3937**).

3.12 LEAD SCREW REPLACEMENT

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

TOOLS REQUIRED:

Spanner Wrench (32mm or 40/50mm) **Shaft Lock (32mm or 40/50mm)**

Z-Axis Lead Screw Removal

1. Turn the machine ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.

2. Remove rear and right side covers. Remove the hard stops from the bearing support and motor end of the lead screw.

3. Remove the cover from the motor housing. Disconnect the oil line from the lead screw nut.

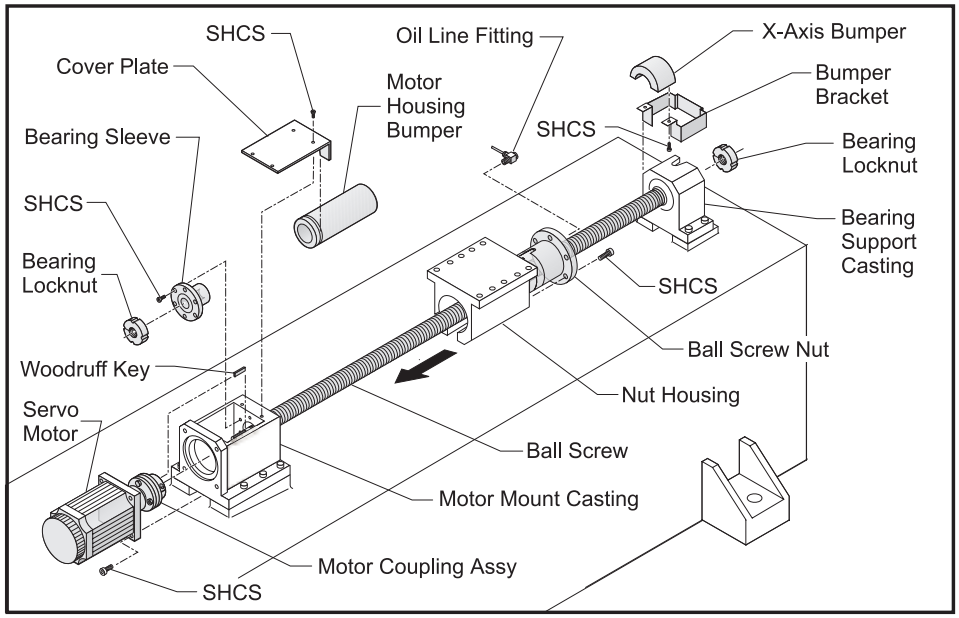


Figure 3-24

For 32mm Lead Screw:

a. At the bearing support side, loosen the clamp nut screw. Unscrew the clamp nut an 1/8" and retighten clamp nut screw. Attach shaft lock tool to bearing support side of lead screw.

b. At the motor end, loosen the motor coupling on the lead screw side of the coupling. Remove the four motor mount SHCS and the motor. Remove the Woodruff key from the key way on the lead screw.

c. In the motor housing, loosen the clamp nut screw, attach the spanner wrench to the clamp nut and remove the nut from the lead screw in the motor housing. Unfasten the six ¼-20 x 1" SHCS from the bearing sleeve and remove the bearing sleeve from the motor housing. On the bearing support side, remove bearing support clamp nut.

d. Push the wedge towards the motor end until the lead screw clears the bearing support by approximately six inches (6"). Underneath the wedge, remove the SHCS that attach the lead screw nut to the nut housing. Pull the lead screw forward to clear the nut from the housing and angle the lead screw towards the right of the bearing support. Carefully remove lead screw.

CAUTION!: Be careful during removal or installation of lead screw, to protect the surfaces.

40mm Lead Screws:

a. At the bearing support side, loosen the clamp nut screw. Unscrew the clamp nut an 1/8" away from the bearing support and retighten clamp nut screw. Attach shaft lock tool.

b. At the motor end, loosen the motor coupling on the lead screw side of the coupling. Remove the four motor SHCS and the motor. Remove the Woodruff key from the key way on the lead screw. In the motor housing, loosen the clamp nut screw and attach the spanner wrench. Remove the clamp nut.

c. Underneath the wedge, remove the SHCS from the lead screw nut and push the wedge towards the motor housing.

d. On the bearing support side, remove the shaft lock tool and clamp nut. Remove the alignment pins and the SHCS from the bearing support casting. Make note of any shims. Hold the lead screw in place and remove the bearing support. Pull forward on the lead screw and carefully remove.

CAUTION!: Be careful during removal or installation of ball screw, to protect the surfaces.

Z-Axis Lead Screw Installation

Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing and the lead screw 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.

For 32mm Lead Screw:

1. Reinsert the lead screw from the right hand side of the bearing support into the motor housing. Align

the lead screw with the bearing support end and insert the lead screw. Prevent contact with the screw threads, to avoid any possible damage.

2. Hold the lead screw level on the motor side. Slide the bearing sleeve onto the lead screw and insert bearing sleeve into motor housing. Attach bearing sleeve to the housing with six ¼-20 x 1" SHCS. Place a drop of blue Loctite on each of the SHCS before inserting. Torque the bearing sleeve SHCS to **15 FT-LBS**.

CAUTION! Do not use more than one drop of Loctite. An excessive amount will cause a film to develop between the sleeve and housing which could result in backlash.

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

a. On the bearing support end, install the clamp nut an 1/8" away from the bearing. Tighten the clamp nut screw. Install the shaft lock onto the bearing support end of the lead screw.

CAUTION! Do not attach bearing clamp nut against bearing support until the motor side clamp nut is torqued to its proper specification. Damage will occur to the bearing and lead screw on the support side.

b. At the motor side of the lead screw, attach clamp nut.

c. Place a spanner wrench on to the clamp nut in the motor housing and torque it against the bearing to **15 FT-LBS**.

d. Tighten the clamp nut screw and mark with yellow paint.

e. At the bearing support end, remove the shaft lock and loosen the clamp nut screw. Tighten the clamp nut against the bearing to **4 IN-LBS.** Retighten the clamp nut screw and mark with yellow paint.

f. Align the lead screw nut to the nut housing on the wedge. Apply a drop of blue Loctite to the five SHCS and fasten the nut to the housing. Torque the lead screw nut SHCS to **15 FT-LBS**.

g. Place the Woodruff key back into the key way slot on the lead screw.

h. Install the motor with the coupling attached and tighten the four motor mounting SHCS. Torque the motor mounting SHCS to **30 FT-LBS**.

4. Tighten the collar on the motor coupling to the lead screw and torque to **15 FT-LBS**. Replace motor housing cover.

5. Check for binding in the beginning, middle and end of travel. You should be able to rotate the lead screw by hand when the servos are off. Check for backlash or noisy operation.

6. Replace the lead screw hardstops and reconnect oil line to the lead screw nut.

For 40mm Lead Screw:

1. Reinsert the lead screw into the bearing sleeve in the motor housing. (Make sure the lead screw nut will be able to slide in to the wedge nut housing). Support the lead screw on the bearing support end and re-attach the bearing support housing and bearing.

2. Reinsert alignment pins through the housing into the base casting, replace shims if needed. Apply a drop of blue Loctite to the six bearing support housing SHCS and fasten to the base casting. Torque the bearing support housing SHCS to **30 FT-LBS**. Prevent contact with the lead screw threads, to avoid any possible damage.

CAUTION! Do not use more than one drop of Loctite. An excessive amount will cause a film to develop between the sleeve and housing which could result in backlash.

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

a. On the bearing support end, install the clamp nut an 1/8" away from the bearing and tighten clamp nut screw. Install the shaft lock into the bearing support end of the lead screw.

CAUTION! Do not attach bearing clamp nut against bearing support until the motor side clamp nut is torqued to its proper specification. Damage will occur to the bearing and lead screw on the support side.

b. Attach the clamp nut onto the motor side of the lead screw.

c. Place a spanner wrench on the clamp nut at the motor end of the assembly. Torque the clamp nut against the bearing to **50 FT-LBS**.

d. At the motor end, tighten the clamp nut screw and mark with yellow paint.

e. At the bearing support end, remove the shaft lock and loosen the clamp nut screw. Tighten the clamp nut against the bearing to **4 IN-LBS**. Retighten the clamp screw and mark with yellow paint.

f. Align the lead screw nut with the nut housing on the wedge. Apply a drop of blue Loctite to the five SHCS and attach the nut to the housing. Torque lead screw nut SHCS to **15 FT-LBS**.

g. Place the Woodruff key back into the key way slot on the lead screw.

h. Install the motor with the coupling attached to the lead screw and tighten the four motor mounting SHCS. Torque the motor mount SHCS to **30 FT-LBS**.

4. Tighten the collar on the motor coupling and re-torque the collar SHCS to **15 FT-LBS**. Replace the motor housing cover.

5. Check for binding in the beginning, middle and end of travel. You should be able to rotate the lead screw by hand when the servos are off. Check for backlash or noisy operation.

6. Replace the lead screw hardstops and reconnect oil line to the lead screw nut.

4. ELECTRICAL SERVICE

4.1 SOLENOIDS

Please read this section in its entirety before attempting to replace any solenoid assemblies.

PNEUMATIC CHUCK CLAMP/UNCLAMP SOLENOID

REMOVAL -

1. Turn machine power off and remove the air supply from the machine.
2. Disconnect the two air hoses from the pneumatic chuck clamp/unclamp solenoid (see Figure 4-1).
3. Unplug the solenoid electrical lead at the switch bracket (located on the rear of the lube air panel).
4. Remove the two SHCS holding the assembly to the bracket and remove the assembly.

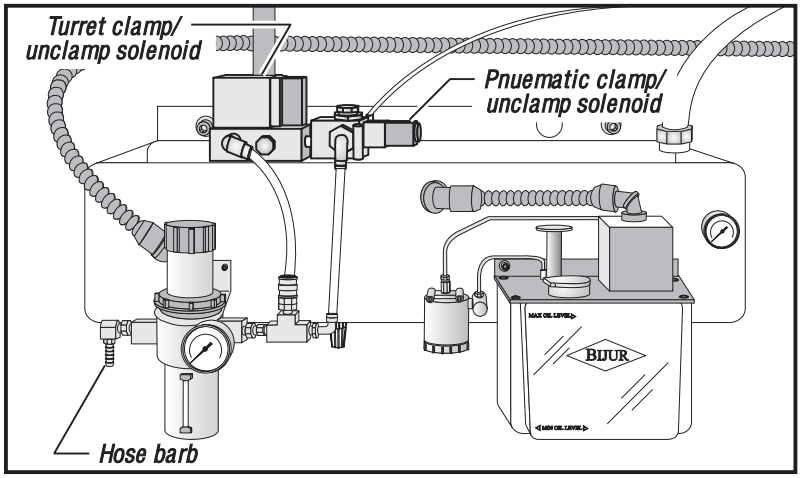


Figure 4-1. Front view of lube/air panel.

INSTALLATION -

5. Replace the air solenoid assembly and attach to the bracket with the two SHCS. Tighten securely.
6. Reconnect the electrical connection to the solenoid at the switch bracket.
7. Reconnect the two air lines, ensuring that all connections are tight and do not leak.
8. Restore the air supply to the machine.

TURRET CLAMP/UNCLAMP SOLENOID

REMOVAL -

1. Turn machine power off and remove the air supply from the machine.
2. Disconnect the three air hoses from the turret clamp/unclamp solenoid (see Figure 4-1).
3. Unplug the solenoid electrical lead at the switch bracket (located on the rear of the lube air panel).
4. Remove the two SHCS holding the assembly to the bracket and remove the assembly.

INSTALLATION -

5. Replace the air solenoid assembly and attach to the bracket with the two SHCS. Tighten securely.

6. Reconnect the electrical connection to the solenoid at the switch bracket.

7. Reconnect the three air lines, ensuring that all connections are tight and do not leak.

8. Restore the air supply to the machine.

Spindle Lube Air Solenoid

REMOVAL -

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

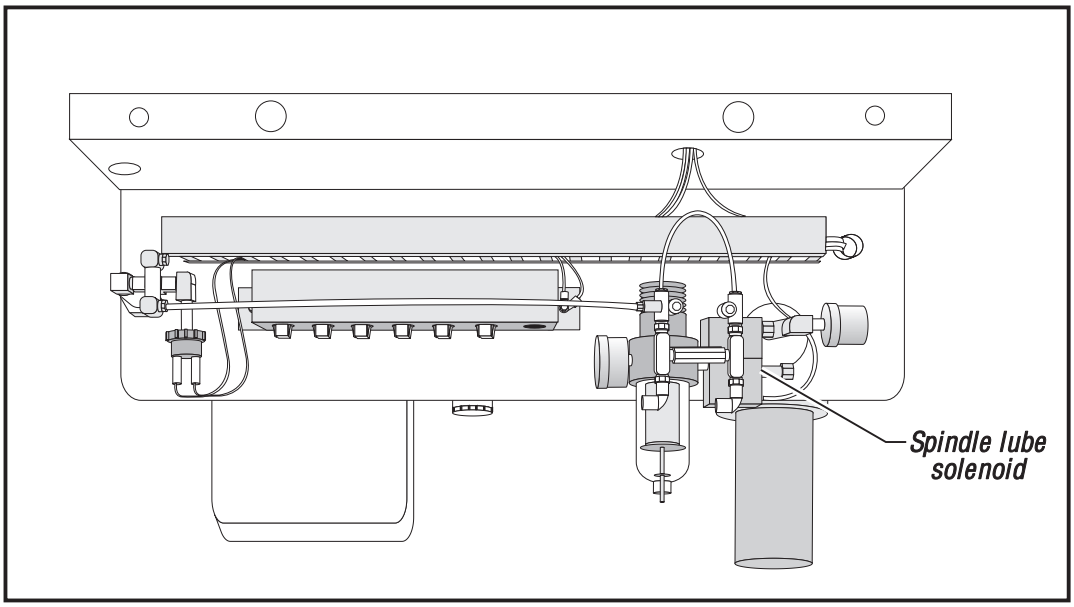


Figure 4-2. Rear view of lube/air panel.

2. Disconnect the lube line from the spindle lube air solenoid assembly.

3. Disconnect the electrical leads from the main air line pressure switch.

4. Unscrew the solenoid assembly pressure gauge from the assembly.

5. Unscrew the entire solenoid assembly from the T-fitting.

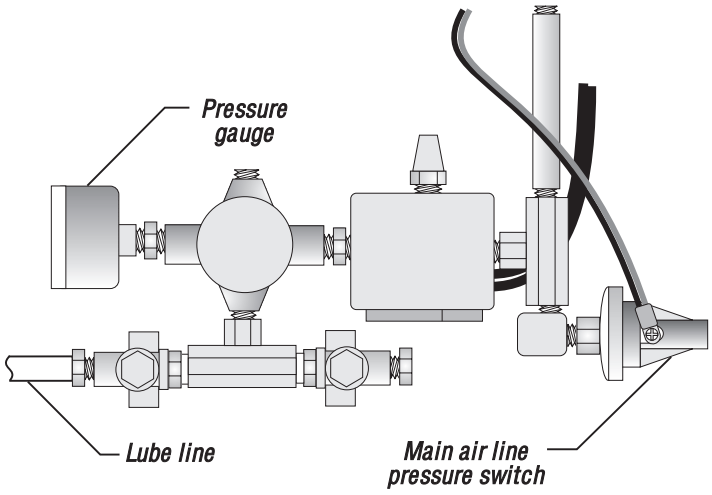


Figure 4-3. Top view of spindle lube/air solenoid assembly.

INSTALLATION -

6. Reattach the solenoid assembly at the T-fitting.
7. Reattach the pressure gauge onto the solenoid assembly.
8. Reconnect the lube line to the assembly.
9. Reconnect the electrical leads to the main air line pressure switch.
10. Restore the air supply to the machine.

4.2. LINE VOLTAGE ADJUSTMENTS

Please read this section in its entirety before attempting to adjust the line voltage.

TOOLS REQUIRED:

- ✓ **LARGE FLAT TIP SCREWDRIVER**
- ✓ **DIGITAL VOLTMETER**

Adjusting Voltage

Note: The machine must have air pressure at the air gauge or an interlock will prevent it from powering up.

CAUTION! Working with the electrical services required for the lathe 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.

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. It is not necessary to be concerned with phase rotation (which wire is connected to L1, L2, and L3).

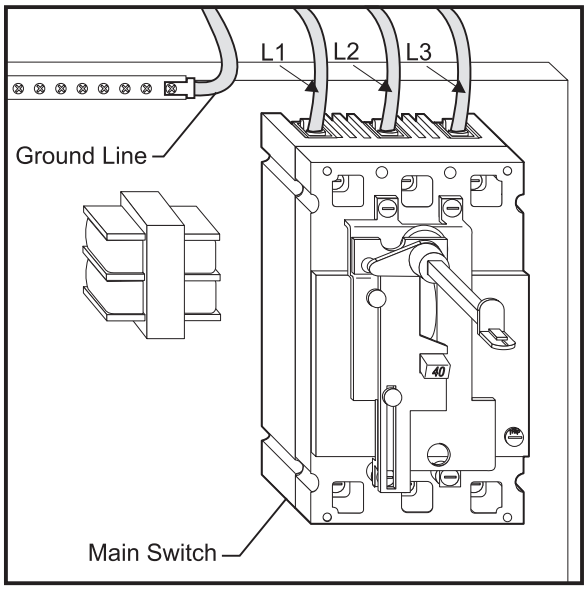


Figure 4-4. Power lines; hookup location.

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 or 353 and 480 volts, depending on which transformer is in the machine.

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.

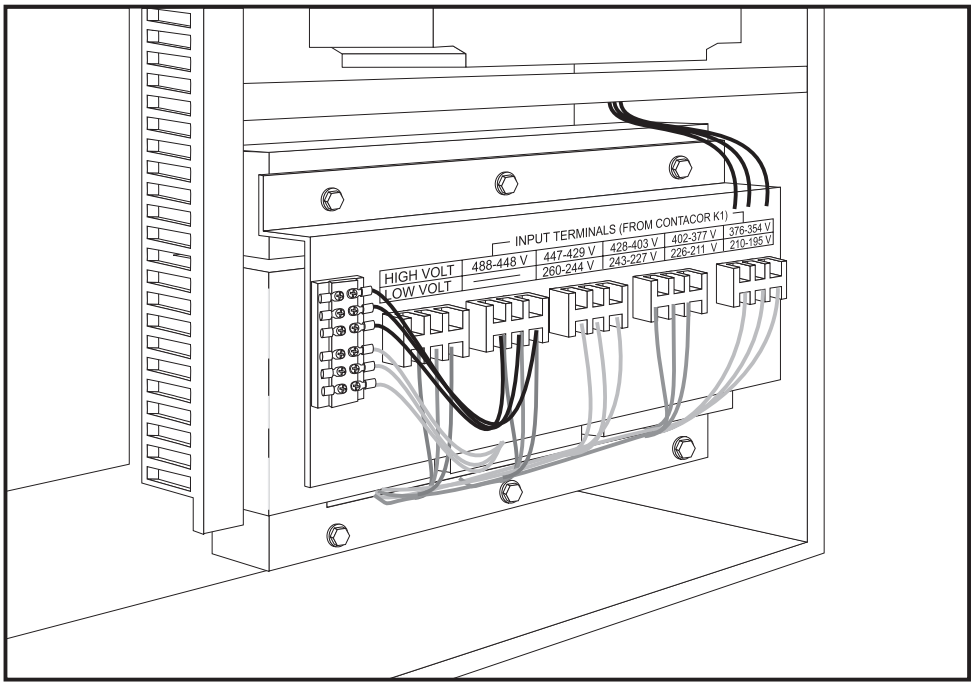


Figure 4-5. Transformer connections.

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:

ELECTRICITY REQUIREMENTS

IMPORTANT! REFER TO LOCAL CODE REQUIREMENTS BEFORE WIRING MACHINES.

ALL MACHINES REQUIRE:
Three phase 50 or 60Hz power supply.
Line voltage that does not fluctuate more than +/-5%

20-15HP SYSTEM	VOLTAGE REQUIREMENTS (195-260V)	HIGH VOLTAGE REQUIREMENTS (360-480V)
- POWER SUPPLY	50AMP	25AMP
- HAAS CIRCUIT BREAKER	40AMP	20AMP
- IF SERVICE RUN FROM ELE. PANEL LESS THAN 100' USE:	8GA. WIRE	12GA. WIRE
- IF SERVICE RUN FROM ELE. PANEL MORE THAN 100' USE:	6GA. WIRE	10GA. WIRE

40-30HP SYSTEM	VOLTAGE REQUIREMENTS (195-260V)	HIGH VOLTAGE REQUIREMENTS (360-480V)
- POWER SUPPLY	100AMP	50AMP
- HAAS CIRCUIT BREAKER	80AMP	40AMP
- IF SERVICE RUN FROM ELE. PANEL LESS THAN 100' USE:	4GA. WIRE	8GA. WIRE
- IF SERVICE RUN FROM ELE. PANEL MORE THAN 100' USE:	2GA. WIRE	6GA. WIRE

WARNING!
- **A separate earth, or cold-water-pipe, ground is required (conduit types are not sufficient)!**
- **Do not connect to 480V, unless machine includes high voltage option.**
- **Maximum voltage leg-to-leg or leg-to-ground should not exceed 260 volts or 540 volts for high voltage machines!**

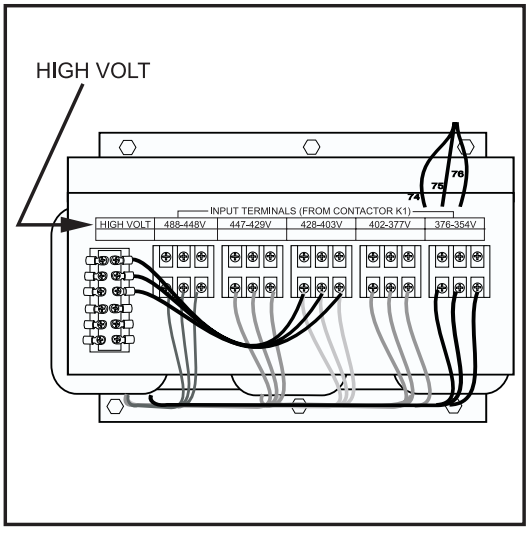


Figure 4-6a. Transformer with 354-488V range

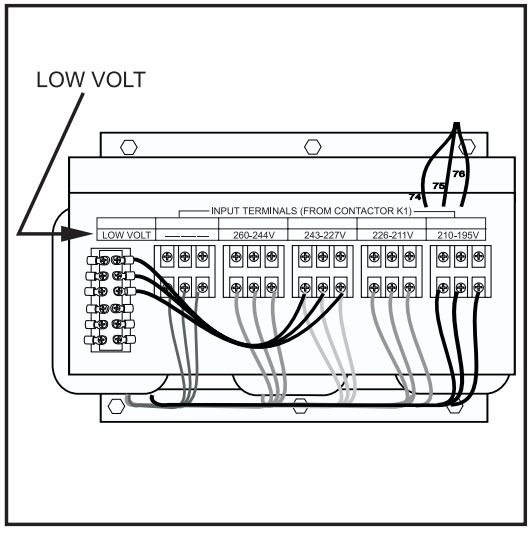


Figure 4-6b Transformer with 195-260V range.

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 problems, call the factory.

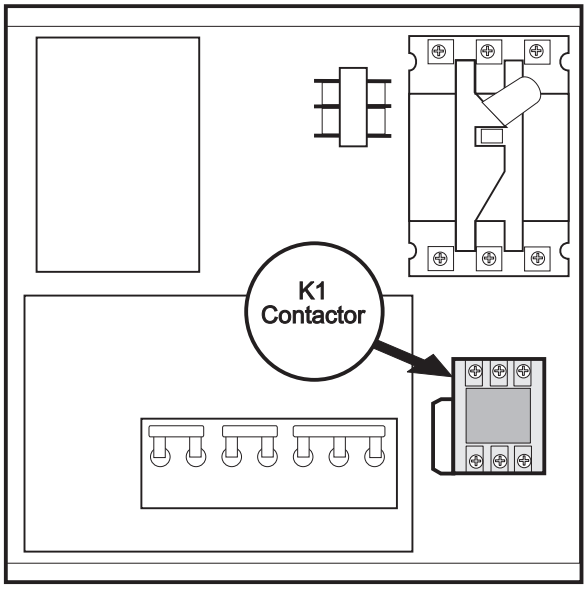


Figure 4-7. Measure voltage here.

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 155 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, latch the latches, and turn the power back on.

4.3 FUSE REPLACEMENT

Please read this section in its entirety before attempting to replace any fuses.

TOOLS REQUIRED:

- ✓ **REPLACEMENT 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.

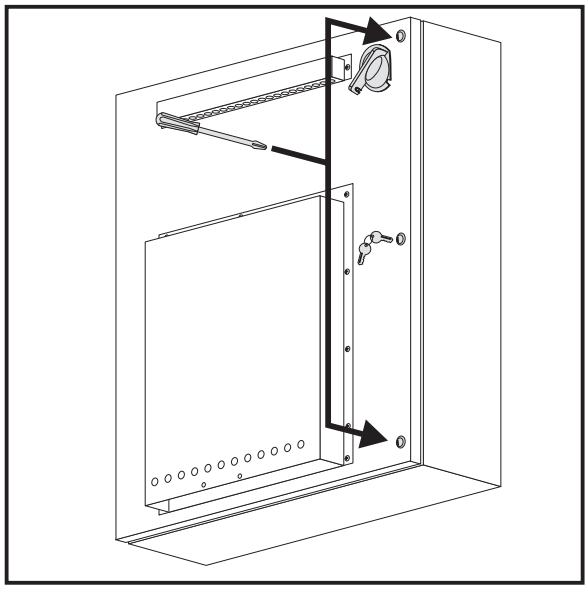


Figure 4-8. Unscrew the two screws to open the cabinet door. (Control cabinets require a key)

3. Using a large flat tip screwdriver, loosen the two screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until at least the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.

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. Using a large flat tip screwdriver, loosen the two screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until at least the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.

3. The Operator's Lamp Fuse is located at the lower left of the Power Supply Board. An orange light will be on to indicate the blown fuse.

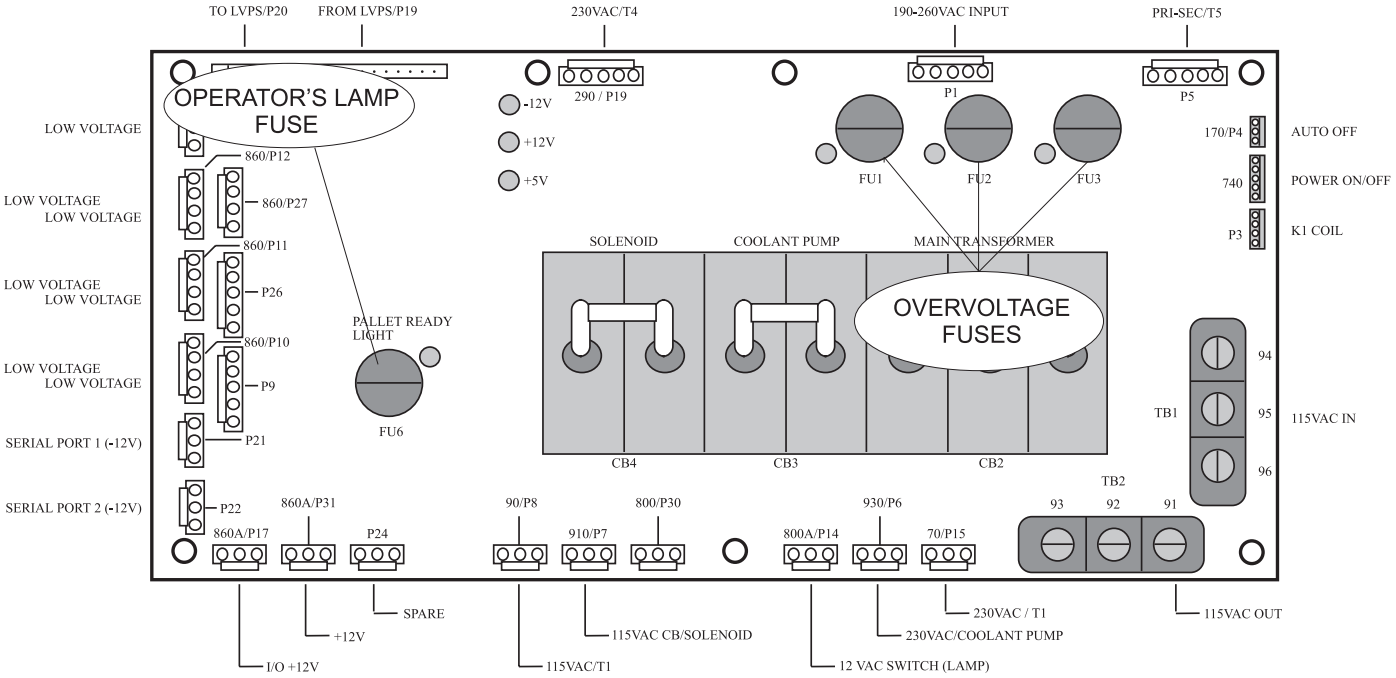


Figure 4-9. Power supply board; fuse locations.

4. Using a flat tip screwdriver, turn the fuse counterclockwise to remove and replace the blown fuse with ones having the same type and rating (operator's lamp: 2 amp, type AGC, 250V).

4.4 PCB REPLACEMENT

Please read this section in its entirety before attempting to replace any PCBs.

MICROPROCESSOR, MOCON (MOTIF), & VIDEO / KEYBOARD

Note: The arrangement of these boards may differ from the order of replacement that follows. The steps for replacement will only differ in which board may need to be removed before getting to the necessary board.

WARNING! The electrical panel will have residual voltage, even after power has been shut off and/or disconnected . Never work inside this cabinet until the small red CHARGE light on the servo amplifiers (servo drive assembly on brush machines) goes out. The servo amplifiers / servo drive assembly is on the left side of the main control cabinet and about halfway down. This light(s) is at the top of the circuit card at the center of the assembly. Until this light goes out, there are dangerous voltages in the assembly EVEN WHEN POWER IS SHUT OFF.

MOCON (or MOTIF) BOARD -

Note: Refer to "Cable Locations" for a diagram of this board.

1. Turn machine power off.
2. Turn the main switch (upper right of electrical cabinet) to the off position.
3. Loosen the two screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until at least the red CHARGE light on the servo amplifiers (servo drive assembly on brush machines) goes out before beginning any work inside the electrical cabinet.
4. Disconnect all leads to the Motor Controller (MOCON), or Motor Interface (MOTIF) board (for brush machines). Ensure all cables are properly labeled for reconnecting later.
5. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.

Note: If the VIDEO / KEYBOARD or PROCESSOR boards need replacing, please skip the next step.

6. Replace the MOCON (or MOTIF) board, attaching it to the VIDEO / KEYBOARD (beneath the MOCON / MOTIF board) with the standoffs.
7. Reconnect all leads (previously removed) to their proper connections.

VIDEO / KEYBOARD -

Note: Refer to "Cable Locations" for a diagram of this board.

8. Remove the MOCON (or MOTIF) board as described in Steps 1-5.
9. Disconnect all leads to the Video / Keyboard. Ensure all cables are properly labeled for reconnecting later.
10. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.

Note: If the PROCESSOR board need replacing, please skip the next step.

11. Replace the Video / Keyboard, attaching it to the PROCESSOR board (beneath the Video / Keyboard) with the standoffs.

12. Reconnect all leads (previously removed) to their proper connections.

PROCESSOR BOARD -

Note: Refer to "Cable Locations" for a diagram of this board.

13. Remove the MOCON (or MOTIF) board as described in Steps 1-5, and the Video / Keyboard as described in Steps 8-9.

14. Disconnect all leads to the Processor board. Ensure all cables are properly labeled for reconnecting later.

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.

INPUT / OUTPUT (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 two 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 two screws on the cabinet door and then open the door enough to safely work on the electrical panel.

4. Disconnect all leads to the Power Distribution (POWER) board and move aside for removal. Ensure all cables are properly labeled for reconnecting later. The illustration on the following page shows all cable numbers and the locations on the POWER board.

5. After all cables have been disconnected, remove the seven screws holding the POWER board to the cabinet and remove the board. Take care to hold the POWER board in place until all screws have been removed.

Note: If you need to replace the LOW VOLTAGE POWER SUPPLY board, please skip the next step.

6. Replace the POWER board, attaching it with the seven screws previously removed. Don't forget to use the lower left screw for a ground connection.

7. Reconnect all cables to the POWER board at their proper location.

LOW VOLTAGE POWER SUPPLY -

8. Remove the Power Distribution (POWER) board as described in Steps 1-5.

9. Disconnect all leads to the Low Voltage Power Supply (LVPS) board. Ensure all cables are properly labeled for reconnecting later.

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.

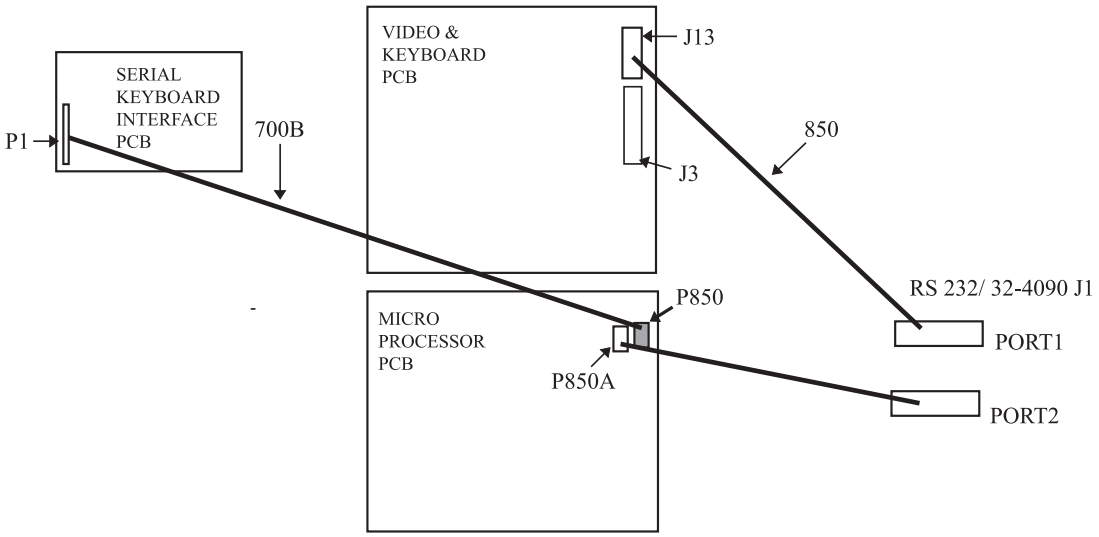
1. Follow all precautions noted previously before working in the electrical cabinet.

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. At this time, remove the end cap on the support arm and unplug the white cable at the connection inside, then unplug the black cable at the connection in the control panel. It may be necessary to cut straps off the black cable's connector to unplug.

4. Unscrew the four hex nuts on the bottom row of the CRT bracket and remove, along with the washers. Set aside in a safe place.

5. While holding up the CRT assembly, remove the four hex nuts on the top row of the CRT bracket, along with the washers.

CAUTION! Take extreme care to not drop or damage the CRT assembly when removing from the control panel.

6. CAREFULLY pull the CRT assembly out toward the rear until it is clear of the control panel and all wiring. Set CRT assembly down in a safe place so as not to damage.

7. Replace by sliding the new assembly onto the eight bolts (four each on top and bottom). Starting with the bottom right, place the washers and hex nuts on the bolts to hold in place. Refer to Fig. 5-1 for the order of replacement.Once all washers have been attached and nuts have been hand-tightened, tighten down completely with the socket.

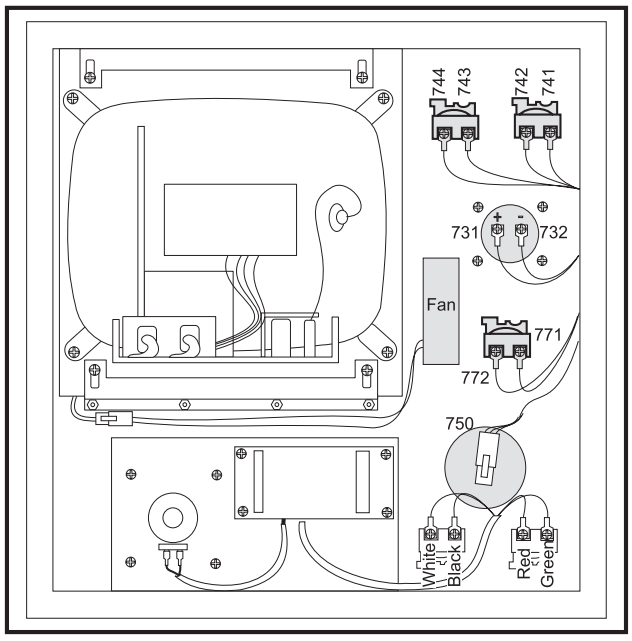


Figure 4-11. Interior of control panel (rear).

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.

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.

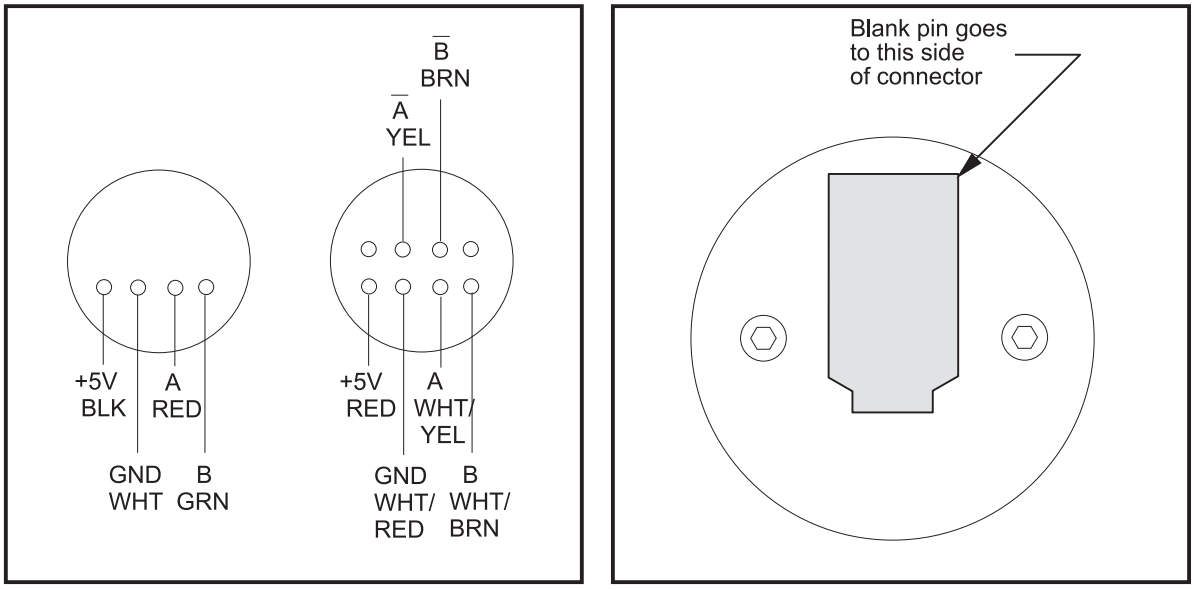


Figure 4-12. Jog handle encoder.

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

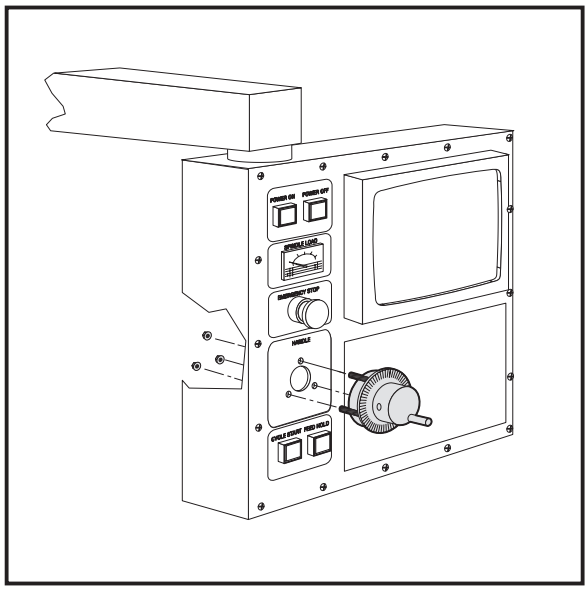


Figure 4-13. Jog handle removal.

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 16 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 counterclockwise to loosen. Separate from the front portion and pull out.

5. For replacement, screw the front and rear portions together (reverse of removal) and tighten down the two small set screws when the switch is properly positioned.

Note: The POWER ON, POWER OFF, and EMERGENCY STOP switches must all have the connectors on the bottom of the switch.

6. Reconnect all leads to the correct switch.

Spindle Load Meter Replacement

1. Turn the power off and disconnect power to the machine.

2. Remove the 16 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 16 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 Serial 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.

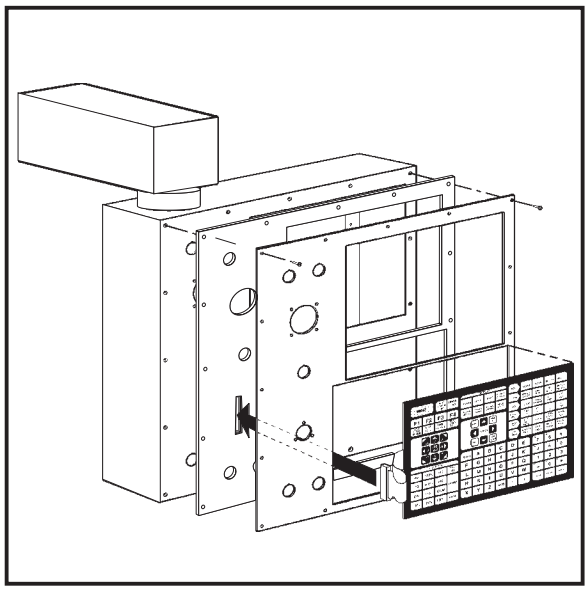


Figure 4-14. Keypad installation.

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 "Front Panel" section).

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. Loosen the eight motor fan panel mounting bolts (on left end of machine), then remove the panel.
2. Loosen the two encoder mounting bolts and slide the encoder up until there is slack in the belt.
3. Remove the encoder.
4. Inspect the encoder belt for any damage. If replacement is necessary, refer to the "Spindle" section for removal.

INSTALLATION -

5. Place the belt onto the pulley.
6. Mount the new encoder and tighten the bolts.

Note: When tightening the bolts, ensure the belt remains loose around the pulleys. If the belt is too tight, it could damage the encoder.

7. Replace the motor fan panel.

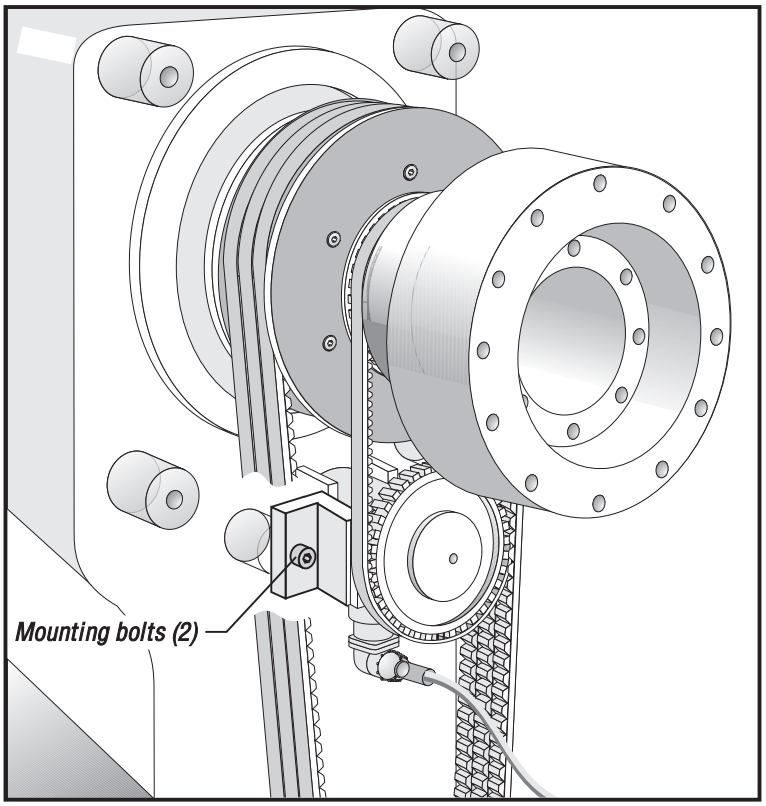


Figure 4-15. Encoder belt locations.

5. TECHNICAL REFERENCE

5.1 SPINDLE

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!

Two **M** codes, M41 (Low Gear) and M42 (High Gear), can be used for gear selection. Spindle speed accuracy is best at the higher speeds and in low gear.

The spindle is hardened and ground with a A2-6, A2-8, A2-11 spindle nose.

5.2 TWO-SPEED GEAR TRANSMISSION (HL-3/4/5/6)

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 pulley. An electric motor drives the gearbox shifter into high or low gear.

LUBRICATION

The gearbox is lubricated and cooled with Mobil DTE 25 oil.

OPERATION

High gear and low gear are selected by programming an M41 (Low Gear) or M42 (High Gear). **The spindle will not change gears automatically.** The spindle will come to a complete stop when changing gears.

The machine will remain in it's current gear (until changed with an M41 or M42) even after the machine is powered off. When the machine is powered up, it will be in the same gear (or between gears) as when it was powered off.

The current gear status is monitored by discrete outputs SP HIG (Spindle High) and SP LOW (Spindle Low). A "0" (zero) in either of these outputs indicates it is the current gear. If the outputs are the same, neither gear is selected. If the gearbox remains in this condition (between gears) for a certain amount of time, Alarm 126, "Gear Fault", is generated. The only way to reset this alarm is to press the POWER UP/RESTART key. The current gear can also be monitored by pressing the CURNT COMDS key. This display will show whether the machine is currently in "HIGH GEAR", "LOW GEAR", or "NO GEAR".

There are a number of parameters related to the gearbox. Their values should not be changed by the operator.

5.3 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, which have already been discussed, 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 anymore, therefore there is no CHARGE light present. Care should still be taken however, since there are high voltages present on the amplifiers, even when power is shut off. The high voltage comes from the vector 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 2.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)

Servo characteristics are explained in detail in the previous section. The following is an example of how to achieve 130 inches/minute.

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

SERVO AMPLIFIERS (BRUSHLESS)

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 current 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 over heat protection.

There is a 15 amp supply fuse for failure protection. This fuse is relatively slow, therefore it can handle the 30 amp peak. Actual continues current limit to the motor is controlled by software.

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.

5.4 INPUT/OUTPUT ASSEMBLY

The IOPCB contains a circuit for electronically turning the tool changer power on and off. This prevents any arcing of the tool changer relays and increases their life tremendously. This includes an adjustable current limit to the tool changer. Potentiometer R45 adjusts the current limit to the tool changer motors. R45 should be set to limit current to between four and six amps.

The IOPCB also contains a circuit for sensing a ground fault condition of the servo power supply. If more than 0.5 amps is detected flowing through the grounding connection of the 160V DC buss, a ground fault alarm is generated and the control will turn off servos and stop.

Relay K6 is for the coolant pump 230V AC It is a plug-in type and is double-pole. Relays K9 through K12 are also plug in types for controlling the tool changer.

The Input/Output Assembly consists of a single printed circuit board called the IOPCB.

The connectors on the IOPCB are:

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 17 to 24 (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)
P12 115V AC to spindle head solenoids (880A)
P13 Turret status inputs (820)
P14 Low TSC (900)
P15 Spindle head status inputs (890)
P16 Emergency stop input (770)
P17 Low Lube input (960)
P18 Over Voltage Input (970)
P19 Low Air Input (950)
P20 Overheat input (830)
P21 Spindle drive status inputs (780)
P22 M-FIN input (100)
P23 Footswitch (190)
P24 Spare 2
P25 Spare 3
P26 Spare terminals for M21 to M24
P27 Door lock (1040)
P28 115V AC from CB4 (910)
P29 A-axis brake solenoid output (390)
P30 Tool changer shuttle motor output (810A)
P31 230 VAC for Chip Conveyor (160)
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 spare (870)
P38 Door open (1050)
P39 Tool changer turret motor output (810)

P40 (770A) A/B
P43 Ground fault sense signal input (1060) Axis Brake
P44 5TH axis brake (319)
P45 HTC Shuttle
P46 Chip Conveyor (140)
P47 Skip input signal (1070)
P48 spare 1
P49 spare 2
P50 Spigot Motor (200)
P51 16 PIN Relay drivers 17-24 (530)
P52 spare 1
P53 Spigot Sense (180)
P54 Servo Brake (350)
P55 Red/green lights (280)
P56 Thru spindle coolant pump (940A)
P57 115V spare
P58 115V spare
P59 Gear Box (370B)
P60 TSC 230 IN 930A

5.5 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 turret, 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 turret should become jammed, the control will automatically come to an alarm state. To correct this, push the EMERGENCY STOP button and remove the cause of the jam. Push the RESET key to clear any alarms. Push the ZERO RETURN and the AUTO ALL AXES keys to reset the Z-axis and turret. Never put your hands near the turret 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-shutdown 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.

Control Cabinet

The following illustration shows the connectors on the side of the control cabinet.

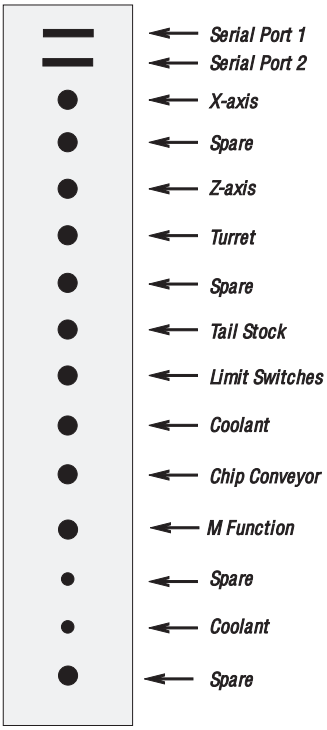


Figure 5-1. Side of control cabinet.

5.6 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 (68EC030)

The Microprocessor PCB contains the 68EC030 processor running at 40 MHz, one 128K EPROM; between 256K and 8MB of CMOS RAM and between 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 placed into the battery holder soldered into the process board. 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 Floppy PCB Without 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 Buss
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)

5.7 SPINDLE DRIVE ASSEMBLY

The spindle drive is located in the main cabinet on the right side and halfway down. It operates from three-phase 200 to 240V AC. It has a 10 H.P. (20 H.P. for HL-3/4/5/6) continuous rating, and a 15 H.P. (30 H.P. for HL-3/4/5/6) 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 supplied documentation for your drive.

HAAS VECTOR DRIVE

The Haas vector drive is a current amplifier controlled by the MOCON software, using the C axis output. The vector drive parameters are a part of the machine parameters and are accessible through the Haas front panel. The spindle encoder is used for the closed loop control and spindle orientation, as well as rigid tapping if the option is available. Spindle speed is very accurate since this is a closed loop control, and the torque output at low speeds is superior to non vector drive spindles.

5.8 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 8.6-ohm (6-ohm for HL-3/4/5/6), 300-watt resistor bank is used by the vector 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.

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.

5.9 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 amps for High Voltage option, 80 amps for HL-3/4/5/6) and is used to protect the vector 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, an auxiliary switch 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 phase 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 (930)
P7 115V AC from CB4 to IOPCB for solenoids (910)
P8 115V AC /T1 (90)

P9 Tool changer fuse circuit from FU5 to IOPCB (840)
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 operator's lamp (800A)
P15 230V AC from contactor K1 for coolant pump (70)
P16 Low voltage power from power supply
P17 +12V DC to IOPCB (860A)
P18 Not used
P19 Connector to op. 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 OP Lamp (800)
P31 +12V (860A)

For older internal transformer with 208/230 taps:
TB1 230V AC from contactor K1
TB2 230V AC to T1 primary

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 115volt 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 is never expected to trip. If it does trip, it is likely caused by a short circuit in the wiring on the I/O assembly or the wiring to the solenoids on the spindle head.

Operator's Lamp

The operator's lamp is using 115 VAC taken from P19 on the main power distribution.

5.10 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.

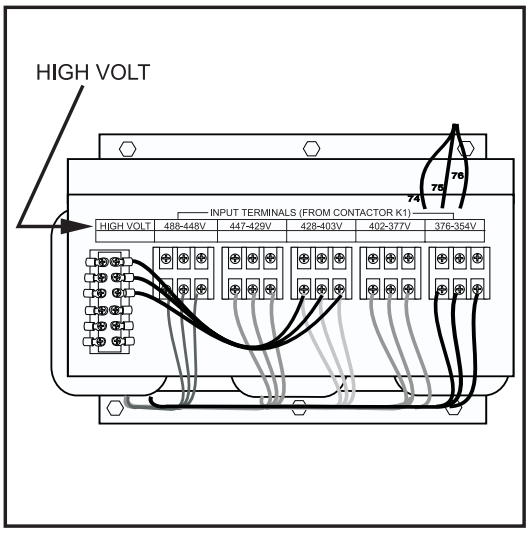


Fig. 5-2a Transformer with 354-488V range

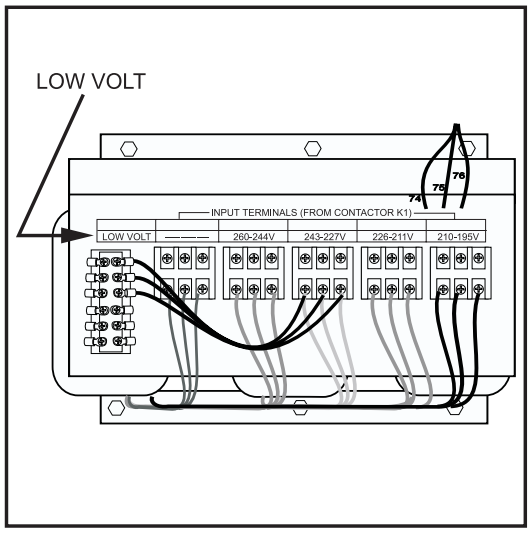


Fig 5-2b Transformer with 195-260V range

Primary Connection To T1

Input power to T1 is supplied through CB1, the 40 amp or 80 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

5.11 FUSES

The brushless amplifier has one fuse, F1 15 amps. This fuse protects the amplifier itself from drastic damage. If this fuse is ever blown, the associated motor will stop. This will only happen if there is a failure of the amplifier card 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).

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	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	
F1	AGC	15	250V	Brushless Amp	

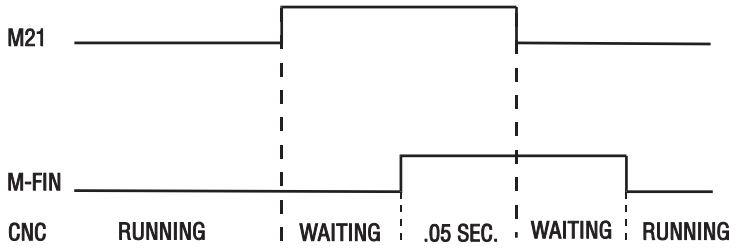
5.12 SPARE USER M CODE INTERFACE

The M code interface uses outputs M21-24 and one discrete input circuit. M codes M21 through M24 will activate relays labeled M21-24. 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 Mcode relay board is installed relays M21-M28 become available on the secondary board. These relays willl be controlled by outputs M21-M28.

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 three of the user M codes.

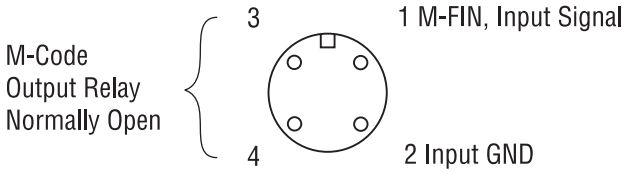
The timing of a user M function must begin with all circuits inactive, that is, all circuits open. The timing is as follows:



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

M Function Relays

The IOPCB contains position for four relays (M21-M24) and the optional M code relay board contains eight (M21-M28), either one of these groups of relays 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: If the optional M code relay board is installed, the relays on the IOPCB are to be left unused.

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

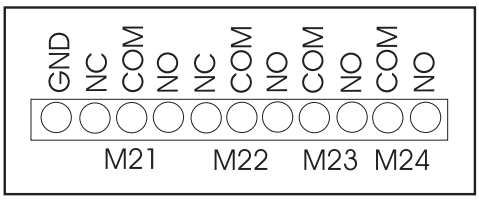
The three optional M code relays can also be separately turned on and off using M codes M51-M54 and M61-M64. M51 to M54 will turn on one of the relays and M61 to M63 will turn the relays off. M51 and M61 correspond to M21, etc.

Note: If the M code relay board is installed then M51 - M58 will turn on the relays and M61-M68 will turn off the relays. M51 and M61 correspond to M21, etc. on the M code relay board.

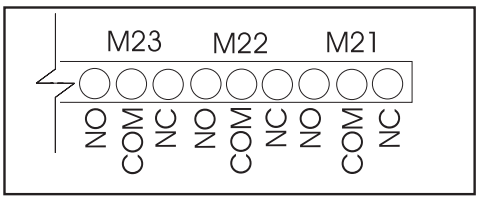
Wiring The Relays

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 figure 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.

5.13 LUBRICATION PUMP

The lubrication pump is powered whenever the spindle is on or any axes are in motion. It operates from 115V AC. On a cyclic basis, it will pump oil to the screws and guides. It cycles at least once every 30 minutes and pumps 2.8cc- 3.8cc of lubrication.

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.

5.14 SWITCHES

Lamp On/Off Switch

An on/off switch is supplied for the operator's lamp. It is located on the side of the control cabinet below all of the motor connectors.

Door Open Sense Switch

The DOOR OPEN sense switch is a magnetic reed switch type. The switch is in the open position when the door is open and closed when the door is fully closed.

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.

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 500 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

TURRET CLAMP/UNCLAMP SWITCHES

There are two switches used to sense the position of the turret. 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 turret is between positions.

The diagnostic display can be used to display the status of the relay outputs and the switch inputs.

DOOR HOLD SWITCH

The switch is normally closed. When the door opens, the switch will open and the machine will stop with a "Door Hold" function. When the door is closed again, operation will continue normally.

If the door is open, you will not be able to start a program. Door hold will not stop a tool change operation, will not turn off the spindle, and will not turn off the coolant pump.

The door hold function can be temporarily disabled with Setting 51, but this setting will return to OFF when the control is turned off.

X AND Z LIMIT SWITCHES

Prior to performing a POWER UP/RESTART or an AUTO ALL AXES operation, there are no travel limits. Thus, you can jog into the hard stops in either direction for X and 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 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.

TURRET HOME SWITCH

The tool rotation turret has a switch that is activated when tool #1 is in the cutting position. At POWER ON this switch indicates that tool #1 is in the cutting position. If this switch is not active at power-on, the first tool change will rotate the turret until the switch engages and then move to the selected tool. The diagnostic display will show this status of this input switch as "TOOL #1". A "1" indicates that tool #1 is in position.

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.

5.15 DIAGNOSTIC DATA

The ALARM MSGS display is the most important source of diagnostic data. At any time after the machine completes its power-up sequence, it will either perform a requested function or stop with an alarm. Refer to the alarms list for , their possible causes, and some corrective action.

If there is an electronics problem, the controller may not complete the power-up sequence and the CRT will remain blank. In this case, there are two sources of diagnostic data; these are the audible beeper and the LED's on the processor PCB. If the audible beeper is alternating a ½ second beep, there is a problem with the main control program stored in EPROM's on the processor PCB. If any of the processor electronics cannot be accessed correctly, the LED's on the processor PCB will or will not be lit.

If the machine powers up but has a fault in one of its power supplies, it may not be possible to flag an alarm condition. If this happens, all motors will be kept off and the top left corner of the CRT will have the message:

POWER FAILURE ALARM

and all other functions of the control will be locked out.

When the machine is operating normally, a second push of the PARAM/DGNOS key will select the diagnostics display page. The PAGE UP and PAGE DOWN keys are then used to select one of two different displays. These are for diagnostic purposes only and the user will not normally need them. The diagnostic data consists of 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:

5.16 DISCRETE INPUTS / OUTPUTS

DISCRETE INPUTS

#	Name	Description	#	Name	Description
1000	TT UNL	Tool Turret Unlock	1016	SP LOK	Spindle Locked
1001	TT LOK	Tool Turret Lock	1017	SP FLT	Spindle Drive Fault
1002	spare		1018	SP ST*	Spindle Not Stopped
1003	LO CNT	Low Coolant	1019	SP AT*	Spindle Not At Speed
1004	A DOOR	Auto door	1020	LO HYD	Low hydraulic pressure
1005	SP HIG	Spindle In High	1021	TS FSW	Foot pedal inputs
1006	SP LOW	Spindle In Low	1022	PROBNH	Probe not home
1007	EM STP	Emergency Stop	1023	spare3	
1008	DOOR S	Door Open Switch	1024	UNCLA*	Remote chuck unclamp
1009	M-FIN*	Not M Func Finish	1025	LOPHSE	Low voltage phase A
1010	OVERVT	Over voltage	1026	spare4	
1011	LO AIR	Low Air Pressure	1027	spare5	
1012	LO LUB	Low Lube Oil	1028	GR FLT	Ground fault
1013	OVERHT	Regen Overheat	1029	SKIP	Skip Signal
1014	spare		1030	spare	
1015	spare		1031	CNVEYR	Conveyor Overload

DISCRETE OUTPUTS

#	Name	Description	#	Name	Description
1100	SRV PO	Servo Power On	1116	SPG CW	Reserved
1101	SP FOR	Spindle Forward	1117	SPG CCW	Reserved
1102	SP REV	Spindle Reverse	1118	RESERV	Reserved
1103	SP RST	Spindle Reset	1119	TS FAST	Tailstock Hi Pressure
1104	A DOOR	Automatic Door	1120	TT OUT	Tool Turret Out
1105	COOLNT	Coolant Pump	1121	TS —>	Tailstock (+) dir.
1106	AUT OF	Auto Turn Off	1122	TS <—	Tailstock (-) dir.
1107	SP LUB	Lube Pump	1123	DOOR L	Door Locked (CE)
1108	spare		1124	M21	
1109	spare		1125	M22	
1110	spare		1126	M23	
1111	spare		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	SP UNC	Spindle Unclamped	1130	CNVENA	Chip conv. enable
1115	SP LOK	Spindle Locked	1131	CNVREV	Chip conv. reverse

The 32 inputs are numbered the same as the 32 connections on the inputs printed circuit board. The last eight outputs are reserved for expansion by HAAS.

The second page of diagnostic data is displayed using the PAGE UP and PAGE DOWN keys. It contains:

INPUTS 2

Name	Description	Name	Description
X Z CH	X-axis Z Channel	X OVRH	X Motor OverTemp
Y Z CH	Y-Axis Z Channel	Y OVRH	Y Motor OverTemp
Z Z CH	Z-axis Z Channel	Z OVRH	Z Motor OverTemp
A Z CH	A-axis Z Channel	A OVRH	A Motor OverTemp
B Z CH	B-axis Z Channel	B OVRH	B Motor OverTemp
C Z CH	C-axis Z Channel	C OVRH	C Motor OverTemp
X HOME	X-axis Home/Lim Switch	X DRVF	X-axis drive fault
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
C HOME	C-axis Home	C DRVF	C-axis drive fault
X CABL	Broken cable to X encoder	S Z CH	Spindle Z Channel
Y CABL	Broken cable to Y encoder		
Z CABL	Broken cable to Z encoder		
A CABL	Broken cable to A encoder		
B CABL	Broken cable to B encoder		
C CABL	Broken cable to C encoder		

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 VECTOR DRIVE

Name	Description
SP FWD	Spindle Forward
SP REV	Spindle Reverse
SP LOK	Spindle Locked
AT SPD	At Speed
SP STP	Speed Stop
SP FLT	Speed Fault
SP STP	Spindle Locked
SP OHT	Spindle Overheat
S CABL	Spindle Encoder Cable

ANALOG DATA

Name	Description
SP LOAD	Spindle load in %
SP SPEED	Spindle RPM CW or CCW
RUN TIME	Total machine run time
TOOL CHANGES	Number of tool changes
VER X.XXX	Software version number
YY/MM/DD	Today's date
MDL HL-__	Model number

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.	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.
DIAMETER PRG	Used to set diameter programming. When set to 1, it will interpret inputs as diameters instead of radii.
TRAVL LIMITS	Travel limits are used.
NO LIMSW ALM	Alarms are not generated at the limit switches.
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.
ROTARY AXIS	When set to 1, the axis is treated as a rotary axis. Position will be displayed in degrees, and inputs will be interpreted as angles.
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		TURRET SWITCHES See Parameter 1 for description. Turret parameters take effect if Setting 30 (TURRET ENABLE) is on.
Parameter	44		TURRET P GAIN See Parameter 2 for description.
Parameter	45		TURRET D GAIN See Parameter 3 for description.
Parameter	46		TURRET I GAIN See Parameter 4 for description.
Parameter	47		TURRET RATIO (STEPS/UNIT) See Parameter 5 for description.

Parameter 48 TURRET MAX TRAVEL (STEPS)
See Parameter 6 for description.

Parameter 49 TURRET ACCELERATION
See Parameter 7 for description.

Parameter 50 TURRET MAX SPEED
See Parameter 8 for description.

Parameter 51 TURRET MAX ERROR
See Parameter 9 for description.

Parameter 52 TURRET FUSE LEVEL
See Parameter 10 for description.

Parameter 53 TURRET BACK EMF
See Parameter 11 for description.

Parameter 54 TURRET STEPS/REVOLUTION
See Parameter 12 for description

Parameter 55 TURRET BACKLASH
See Parameter 13 for description.

Parameter 56 TURRET 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.
POF 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.
SYNC THREADS	Threads will repeat between passes.
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.
UNDEFINED	Not presently used.
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.
UNDEFINED	Not presently used.
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.
UNDEFINED	Not presently used.
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.
VEC DRV ENC	Second spindle encoder
DOOR STOP SP	Enables functions to stop spindle and manual operations at door switch.

Parameter 58 LEAD COMPENS SHIFT
Shift factor when applying lead screw compensation. Lead screw compensation is based on a table of 256 offsets; each +\-127 encoder steps. A single entry in the table applies over a distance equal to two raised to this parameter power encoder steps.

Parameter 59 MAX FEED RATE (INCH)
Maximum feed rate in inches per minute.

Parameter 60 TURRET IN POS DELAY
Amount of time to delay after the turret rotates to the tool position. This delay allows the turret to settle.

Parameter 61 TURRET LOCK DELAY
Amount of time to delay after the turret is sensed to be locked. This delay allows for mechanical settling.

Parameter 62 TURRET UNLK ERRTIME
Maximum delay allowed for tool turret to unlock. Units are milliseconds. After this time, an alarm is generated.

Parameter 63 TURRET LOCK ERRTIME
Maximum delay allowed for tool turret to lock. Units are milliseconds. After this time, an alarm is generated.

Parameter 64 Z TOOL CHANGE OFFSET
For turret, displacement from home switch to tool 0.

Parameter 65 NUMBER OF TOOLS
Number of tool positions in tool changer. This number must be 10 or 12 for the present lathe 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 DRAWBAR 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 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 SPIN STALL DET DLAY
Time to delay after spindle is started before spindle stall checking is started. Each unit represents 1/50 of a second.

Parameter 72 DRAWBAR Z VEL UNCL
This parameter is not used in the lathe.

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 hard 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 is not used.

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 COMPENSAT.
Parameter 140 Z FRICTION COMPENSAT.
Parameter 141 A FRICTION COMPENSAT.
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 is not used in the lathe.

Parameter 143 DRAWBAR Z VEL CLMP
Not presently used.

Parameter 144 RIG TAP FINISH DIST
This parameter sets the finish tolerance for determining the end point of a hard 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
Maximum 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
See Parameter 105 for description.

Parameter 167 B D*D GAIN
See Parameter 109 for description.

Parameter 168 B ACC/DEC T CONST
See Parameter 113 for description.

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 Parameter 134 for description.

Parameter 172 B FRICTION COMPENSAT.
See Parameter 138 for description.

Parameter 173 B ACCEL FEED FORWARD
See Parameter 145 for description.

Parameter 174 B SPINDLE TEMP COEF.
See Parameter 132 for description.

Parameter 175 B AIR BRAKE DELAY
See Parameter 69 for description.

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

Parameter 181 C MAX TRAVEL (STEPS)
See Parameter 6 for description.

Parameter 182 C ACCELERATION
See Parameter 7 for description.

Parameter 183 C MAX SPEED
See Parameter 8 for description.

Parameter 184 C MAX ERROR
See Parameter 9 for description.

Parameter 185 C FUSE LEVEL
See Parameter 10 for description.

Parameter 186 C BACK EMF
See Parameter 11 for description.

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 BACKLASH
See Parameter 13 for description.

Parameter 189 C DEAD ZONE
See Parameter 14 for description.

Parameter 190 C HI SP CURR LIM
At speeds higher than the base frequency, the maximum current that is applied to the motor must be reduced. This is done linearly from base to maximum frequency. The value set in this parameter is the maximum current at the maximum frequency.

Parameter 191 C MAX CURRENT
See Parameter 105 for description.

Parameter 192 C D*D GAIN
See Parameter 109 for description.

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 C SP STOP SPEED
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 GRID OFFSET
See Parameter 125 for description.

Parameter 196 C EXACT STOP DIST.
See Parameter 134 for description.

Parameter 197 SWITCH FREQUENCY
This is the frequency at which the spindle motor windings are switches. Note that there is a hysteresis band around this point, defined by parameter 198

Parameter 198 SWITCH HYSTERESIS
This defines the ± hysteresis band around parameter 197. For example if par. 197 is 85Hz, and par. 198 is 5Hz, switching will take place at 90Hz when the spindle is speeding up, and at 80Hz when the spindle is slowing down

Parameter 199 PRE-SWITCH DELAY
This is the amount of time allowed for the current in the motor to drop before the winding change contactors are switched. Units: ms

Parameter 200 POST SWITCH DELAY
This is the amount of time allowed for the contactors to stabilize after a switch is commanded, before current is applied to the motor. Units: ms

Parameter 206 Reserved

Parameter 207 Reserved

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
This 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:

LATHE T.C. Designates control as a lathe.
RST STOPS T.C. Tool changer can be stopped with RESET button.
UNUSED Not presently used.
ENA CONVEYOR Enables chip conveyor, if machine is so 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.

RESERVED
RESERVED
RESERVED
UNUSED Not presently used.
T SUBROUTINE Reserved for future use.
SPIN Y ENCDR For lathe only. When enabled, spindle encoder input is to the Y-axis.
REV CONVEYOR Reverses the direction of the chip conveyor.

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).

RESERVED — Not presently used.

TC FWD CW — Determines the direction that the turret moves as viewed from the spindle, when the turret is commanded forward. When (1), the turret will rotate clockwise for a forward command, and when (0), it will rotate counterclockwise. The default is 1.

RESERVED — Not presently used.
FLOPPY ENABL — Enables an installed floppy disk drive.
UNDEFINED — Not presently used.
MCD RLY BRD — If set to 1, adds 16 additional relays, for a total of 56.
UNDEFINED — Not presently used.
AUX JOG NACC — Does not allow accumulation on auxiliary axis jog.
UNDEFINED — Not presently used.

RAPID EXSTOP — Default is 1. When this bit is set to 1, the control will execute an exact stop after all rapid motions, regardless of the next motion. When set to zero, the control will exact stop after a rapid only if the next motion is not a rapid move.

HYDRAULICS — This bit must be set to 1 if a lathe has the hydraulic chuck clamping option.

STALL DETECT — Enables detection of spindle stall. If spindle stalls, the spindle motor is stopped and an alarm is generated.

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.

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. When executing short blocks at a high feed rate, the control will use the resources available for interpreting G-code and generation of motion blocks. The display may not update until this time is exceeded. For high speed operation, updating of the display may cause the motion queue to become exhausted. This will manifest itself as a pause in motion. See M76 and M77 to disable the display completely.

Parameter 222 LOW HYD. IGNORE TIM
The amount of time that the control ignores the LO HYD input bit after servos have been engaged. The hydraulic unit requires a short period of time to come up to pressure. The default value is 50, which is equal to 1 second.

Parameter 223 AIR TC DOOR DELAY
This parameter is not used on the lathe.

Parameter 224 ROT AXIS ZERO OFSET
This parameter is not used on the lathe.

Parameter 225 MAX ROT AXIS ALLOW
This parameter is not used on the lathe.

Parameter 226 EDITOR CLIPBOARD
Reserved for future use.

Parameter 227 FLOPPY DIR NAME
When the floppy drive is enabled and a floppy directory is read. The directory listing is placed into a program as comments. The program is then made the current program so the user can read the contents of the floppy drive. This parameter designates what program is used to write the directory listing to. Program O8999 is the default value.

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 234 C LEAD COMP 10E9
This parameter sets the C-axis lead screw compensation signed parts per billion.

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

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

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

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

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

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

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

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

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

Parameter 248 CHUCK UNCLAMP RPM
The RPM above which the chuck will not operate. If the spindle is spinning faster than this value the chuck will not open, and if it is spinning slower than this value the chuck will open. The default is 0, for safety.

Parameter 249 CHUCK CLAMP DELAY
The dwell time that is allowed after clamping the chuck (an M10 command). Program execution will not continue until this time has expired. Units are in milliseconds.

Parameter 250 CHUCK UNCLAMP DELAY
The dwell time that is allowed after unclamping the chuck (an M11 command). Program execution will not continue until this time has expired. Units are in milliseconds.

Parameter 251 A DOOR OPEN ERRTIME
Automatic door open timeout.

Parameter 252 TAILSTOCK OVERLOAD -
Determines the overload limit when the tailstock is traveling in the minus direction, toward the spindle. This is an arbitrary value based on the effective voltage being sent to the tailstock servo motor. If this value is too low, you may not be able to move the tailstock. Increase the value until you are able to move the tailstock. The value for Parameter 252 should be approximately 1/2 the value of Parameter 253. The default is 1500.

Parameter 253 TAILSTOCK OVERLOAD +
Determines the overload limit when the tailstock is traveling in the positive direction, away from the spindle. The value for Parameter 253 should be approximately twice the value of Parameter 252. The default is 3000.

Parameter 254 SPINDLE CENTER
Reserved for service use only.

Parameter 255 CONVEYOR TIMEOUT
The amount of time the conveyor will operate without any motion or keyboard action. After this time, the conveyor will automatically shut off.

Parameter 266 X SWITCHES
Parameter 266 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

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 to zero prior to tool change.
X 2ND HOME BTN	Used to move axis to coordinate specified in Work Ofset G129
X NEG COMP DIR	Used to negate the direction of thermal compensation
X DELAY AXIS 0	Reserved

Parameter 267 Y SWITCHES

Parameter 267 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are

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 to zero prior to tool change.
Y 2ND HOME BTN	Used to move axis to coordinate specified in Work Ofset G129
Y NEG COMP DIR	Used to negate the direction of thermal compensation
Y DELAY AXIS 0	Reserved

Parameter 268 Z SWITCHES

Parameter 268 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

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 to zero prior to tool change.
Z 2ND HOME BTN	Used to move axis to coordinate specified in Work Ofset G129
Z NEG COMP DIR	Used to negate the direction of thermal compensation
Z DELAY AXIS 0	Reserved

Parameter 269 A SWITCHES

Parameter 269 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

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 to zero prior to tool change.
A 2ND HOME BTN	Used to move axis to coordinate specified in Work Ofset G129
A NEG COMP DIR	Used to negate the direction of thermal compensation
A DELAY AXIS 0	Reserved

Parameter 270 B SWITCHES

Parameter 270 is a collection of single-bit flags used to turn servo related functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

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 to zero prior to tool change.
B 2ND HOME BTN	Used to move axis to coordinate specified in Work Ofset G129
B NEG COMP DIR	Used to negate the direction of thermal compensation
B DELAY AXIS 0	Reserved

Parameter 271 C SWITCHES

Parameter 271 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:

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 2ND HOME BTN	Used to move axis to coordinate specified in Work Ofset G129
C NEG COMP DIR	Used to negate the direction of thermal compensation
C DELAY AXIS 0	Reserved

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.	Default is 0. When this bit is set to 1, the sense of the discrete inputs for SP HIG and SP LOW (high and low gear) are inverted.
RESERVED	Not used.
DPR SERIAL	Causes the main serial inputs/outputs to go through the floppy video board.
CK PALLET IN	This bit is not used on the lathe.
CK HIDN VAR	This bit is not used on the lathe.
DISPLAY ACT	When set to 1, displays the actual spindle speed on the Current Commands display page.
TSC PRG ENBL	Not used on the Lathe.
HYDRAULIC TS	This bit enables the hydraulic tailstock
SPND DRV LCK	This bit must be set to 0 if machine is equipped with a Haas vector spindle drive.
CHUCK OPN CS	When set to 1, the user can press CYCLE START and run a program with the chuck unclamped. If the spindle is commanded with this bit set to 1, the spindle will not exceed the CHUCK UNCLAMP RPM (Parameter 248). The default for this bit is 0. This feature is ineffective when the CE safety circuit is enabled.
CNCR SPINDLE	When set to 0, spindle start occurs at the end of a block, as in normal M code operation. When set to 1, spindle start occurs at the beginning of a block and concurrent with axis motion.
TL SET PROBE	This bit must be set to 1 in order to enable the Tool Pre-Setter.
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.
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 291 HYDRAULIC TS NO MOTION
The number in milliseconds that must pass with no B-axis encoder change before the control decides that the tailstock has stopped. The parameter affects homing and alarm situations on the tailstock. If the tailstock pressure is set low and the tailstock does not home properly then increase this parameter.

Parameter 292 HYD TS RTRACT MARGN (Hydraulic Tailstock Retract Margin)
This parameter sets the acceptable range, in encoder steps, for the retract point. When the tailstock stops anywhere within this range, the control assumes it is at the retract point. The default is 5 encoder steps. This means that a 10 encoder step range is set around the retract point.

Parameter 293 HYD TS SLOW DISTNCE (Hydraulic Tailstock Slow Distance)
This parameter sets the distance, before a designated target point, where the tailstock will transition from a rapid movement to a feed. The default is 20 encoder steps. This means that the tailstock will slow down 20 encoder steps before any target point.

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 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. For more information see AUTOFEED under the new features section.

NOTES: When tapping, the feed and spindle overrides will be locked out, so the AUTOFEED feature will be ineffective (although the display will appear to respond to the override buttons.)

The last commanded feed rate will be restored at the end of the program execution, or when the operator presses RESET or turns off the AUTOFEED feature.

The operator may use the feed rate override buttons while the AUTOFEED feature is active. As long as tool load limit is not exceeded, these buttons will have the expected effect and the overridden feed rate will be recognized as the new commanded feed rate by the AUTOFEED feature. However, if the tool load limit has already been exceeded, the control will ignore the feed rate override buttons and the commanded feed rate will remain unchanged.

7. MAINTENANCE SCHEDULE / LUBRICATION CHART

The following is a list of required regular maintenance for the HAAS HL-Series Turning 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. ✓ Check way lube lubrication tank level. ✓ Clean chips from way covers and bottom pan. ✓ Clean chips from turret and housing. ✓ Check hydraulic unit oil level (DTE-25 ONLY). Capacity - 8 gallons.
WEEKLY	✓ Check automatic dump air line's water trap for proper operation. ✓ Check air gauge/regulator for 85 psi. ✓ Clean exterior surfaces with mild cleaner. **DO NOT** use solvents.
MONTHLY	✓ Inspect way covers for proper operation and lubricate with light oil, if necessary. ✓ Remove coolant pump form the coolant tank. Clean sediment from inside the tank. Reinstall the pump.**CAUTION!** Be careful to disconnect the coolant pump from the controller and to POWER OFF the control before working on the coolant tank. ✓ Dump the oil drain bucket. ✓ **(HL-3/4):** Check gearbox oil level. If oil is not visible at the bottom edge of the sight gauge, remove the end panel and add DTE-25 through the top filler hole until it is visible in the sight gauge.
SIX MONTHS	✓ Replace coolant and thoroughly clean the coolant tank. ✓ Replace hydraulic unit oil filter. ✓ Check all hoses and lubrication lines for cracking.
ANNUALLY	✓ With the air pressure OFF, disassemble and clean the small filter at end of lubricator (right side of machine). ✓ Check oil filter and clean out residue at bottom of filter. ✓ **Replace air filter on control box every (2) years.**

LUBRICATION CHART

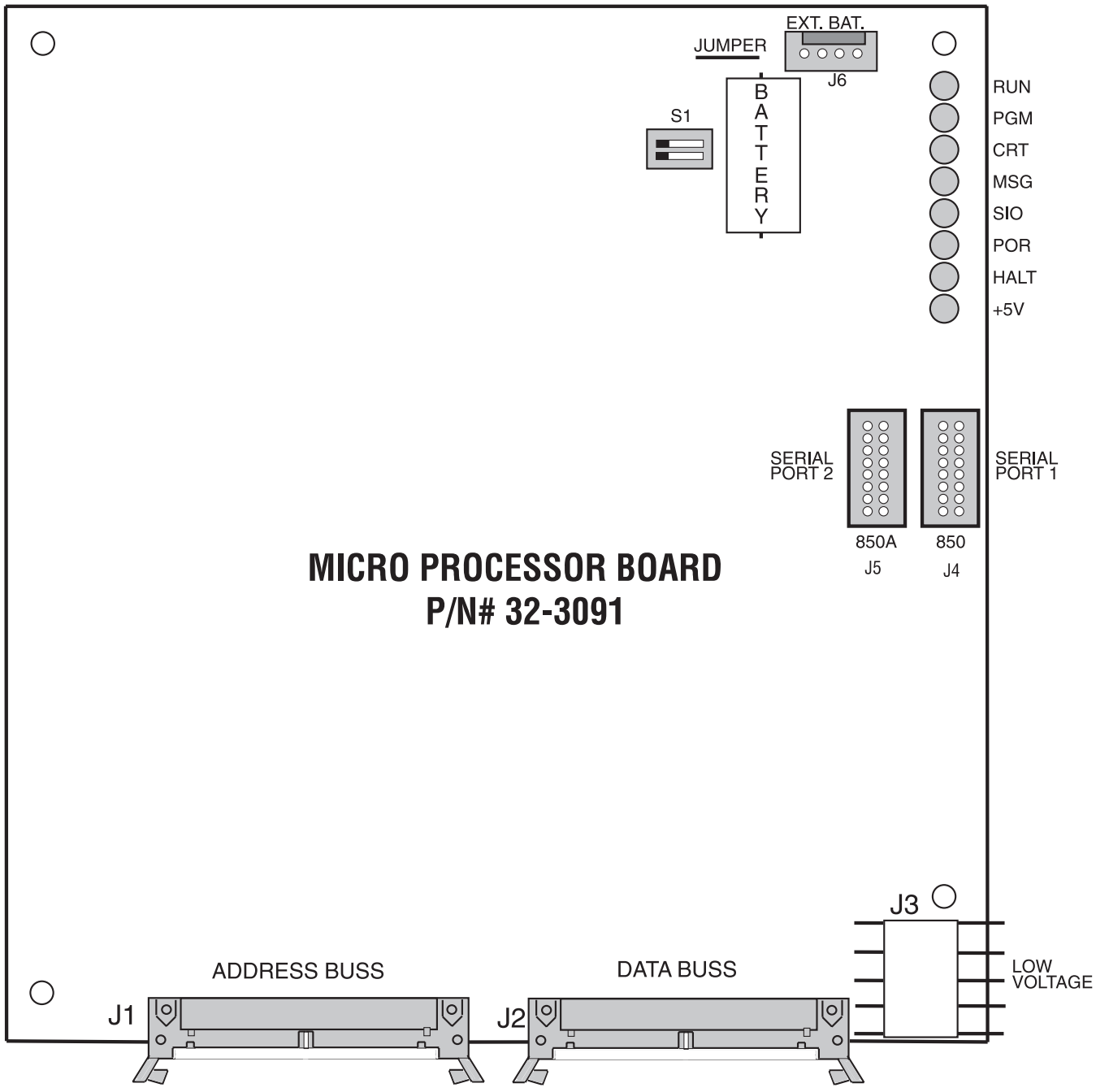
ITEM	CAPACITY	FLUID TYPE
COOLANT	30 gallons (40 for HL-3/4)	Water soluble, synthetic, or cutting oil.
WAY LUBE	Approx. 1 quart	Vactra #2
TRANSMISSION	54 Ounces	MOBIL DTE 25

CHUCK MAINTENANCE

CHUCK MAINTENANCE

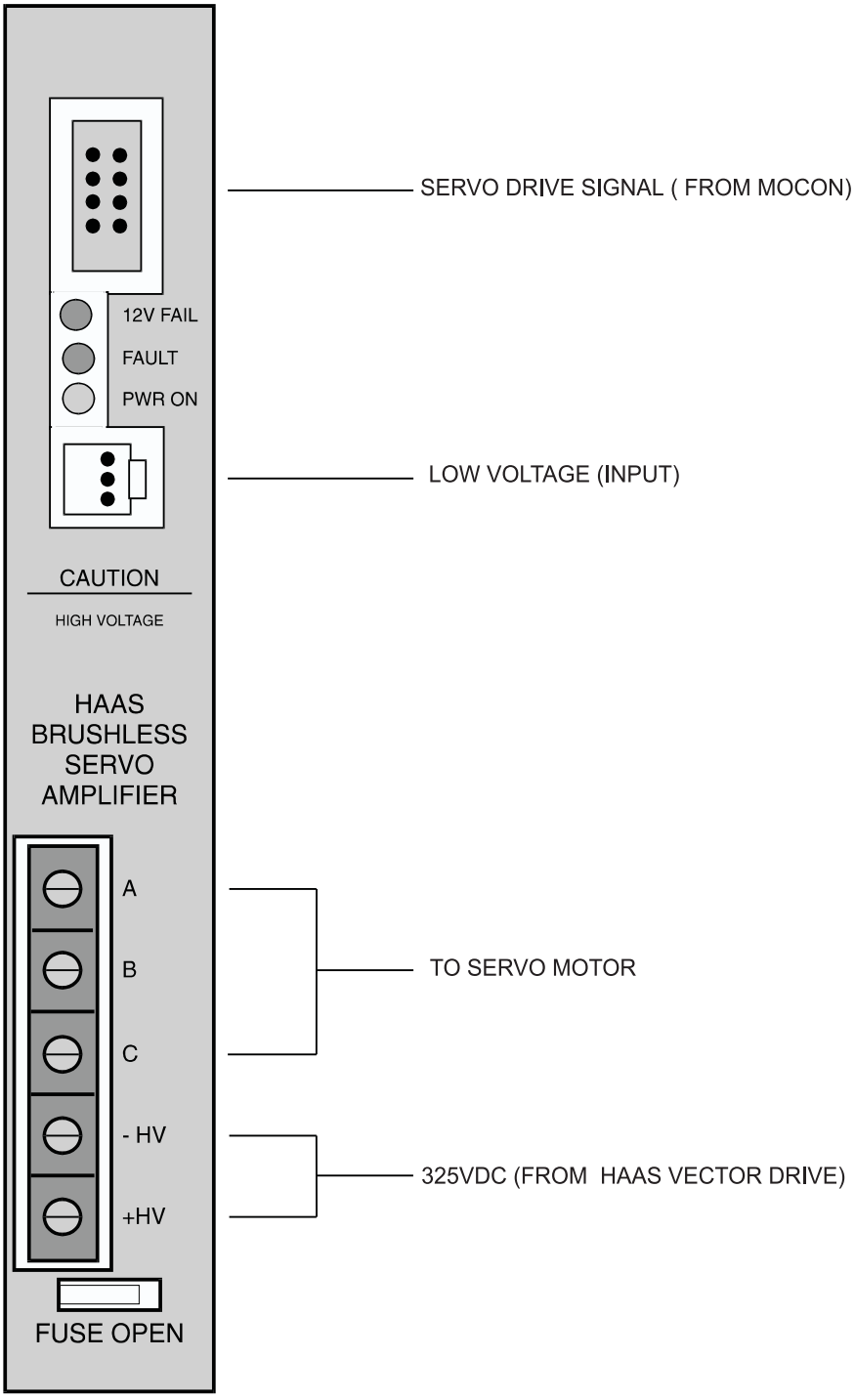
Ensure all moving parts are thoroughly greased.
Check for excessive wear on jaws.
Check T- nuts for excessive wear.
Check front retaining bolts for damage.
Chucks should be broken in according to the manufacturers' specifications.

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
J5
850
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

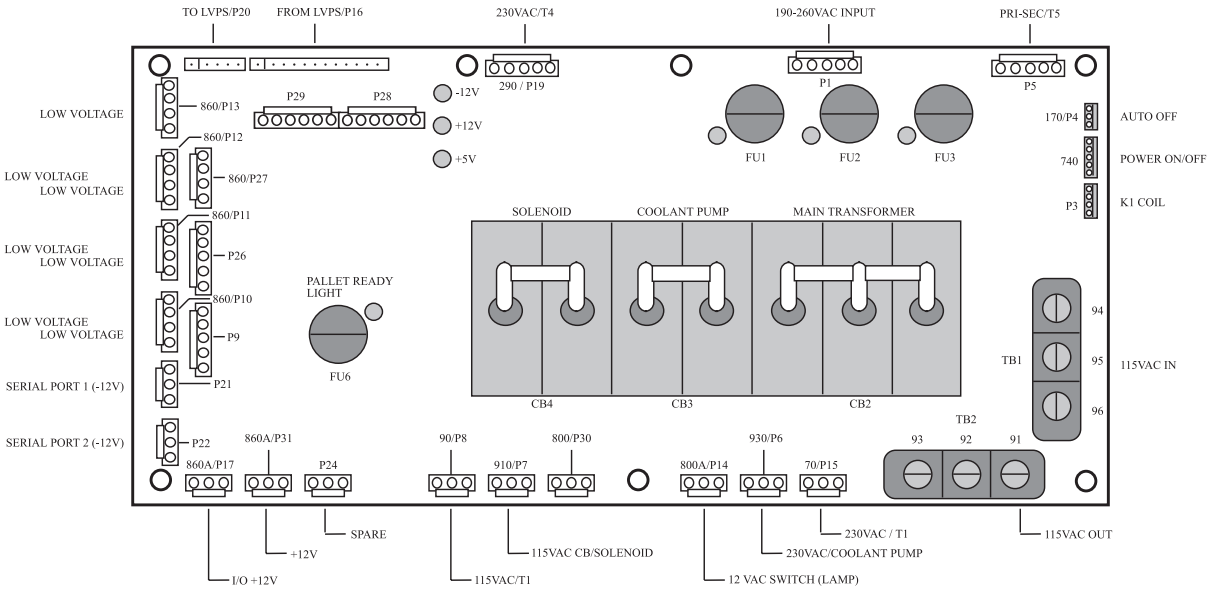
PROC. PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨	LOCATION	PLUG #
J1		ADDRESS BUSS		VIDEO	——
J2		DATA BUSS		MOTIF PCB	——
P3	860	LOW VOLTAGE		POWER SUPPLY PCB	——
J6	N/A	EXTERNAL BATTERY		(EXT. BATTERY)	——
J4	850	SERIAL PORT #1		SERIAL PORT #1	——
J5	850A	SERIAL PORT #2		SERIAL PORT #2	——


SERVO DRIVE SIGNAL (FROM MOCON)
12V FAIL
FAULT
PWR ON
LOW VOLTAGE (INPUT)
CAUTION
HIGH VOLTAGE
HAAS
BRUSHLESS
SERVO
AMPLIFIER
A
B
C
- HV
+HV
TO SERVO MOTOR
325VDC (FROM HAAS VECTOR DRIVE)
FUSE OPEN

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	490	320VDC		SPINDLE DRIVE	———
Y AXIS AMP					
P	570	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	490	320VDC		SPINDLE DRIVE	———
Z AXIS AMP					
P	570	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	490	320VDC		SPINDLE DRIVE	———
A AXIS AMP					
P	570	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	490	320VDC		SPINDLE DRIVE	———



POWER PCB - P/N 32-5010

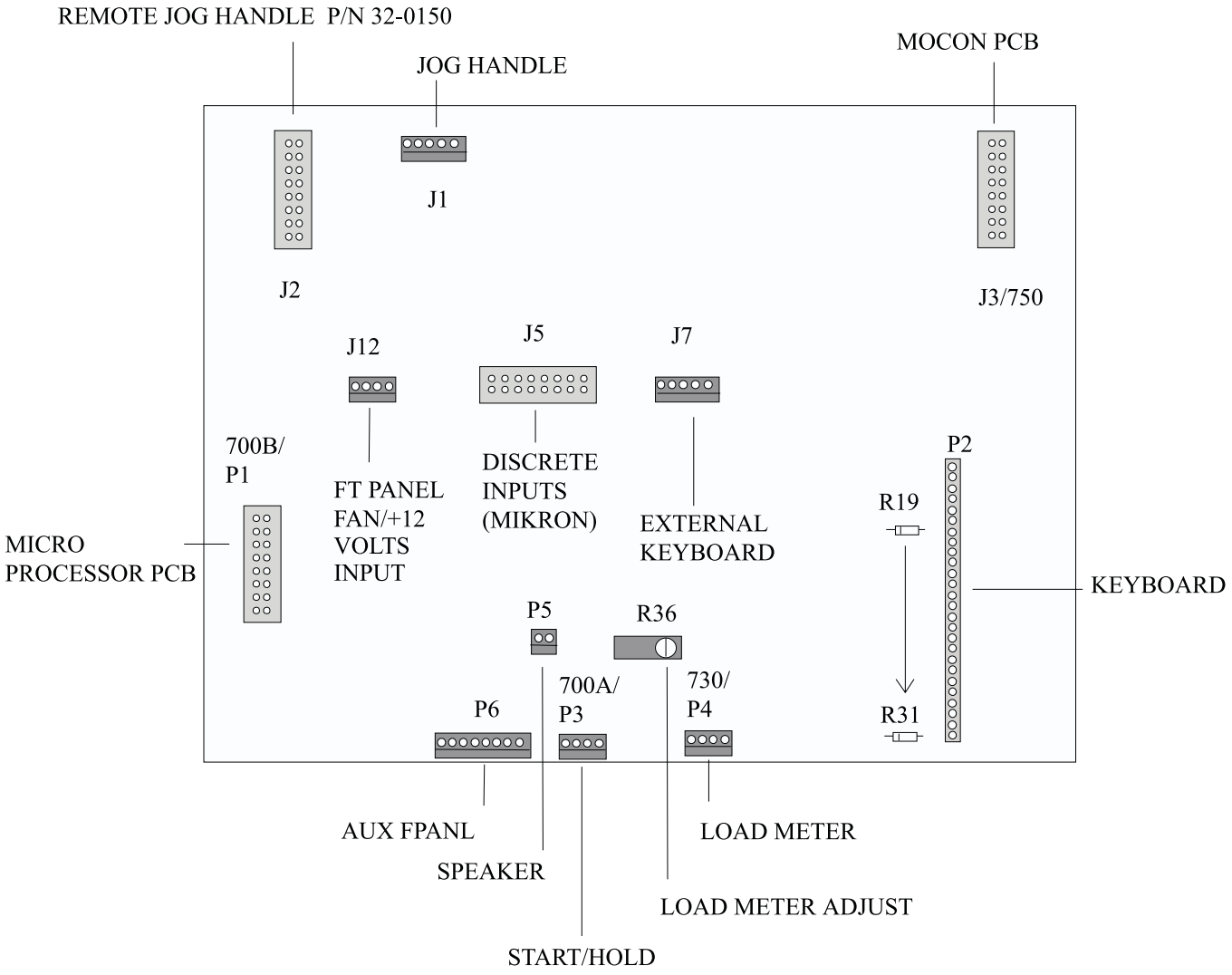
POWER PCB - P/N 32-5010
CABLE CONNECTIONS

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 CB/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	OP LAMP TO SWITCH	OP LAMP SWITCH	——
P15	70	230VAC/K1 CONTACTORS	K1 CONTACTOR	——
P17	860A	I/O +12VDC	POWER	——
P19	290	230VAC/T4	T4	——
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

I/O PCB - P/N 32-3080 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		COOL PUMP	——-
P8	170		POWER PCB	P4
P9	710		SPINDLE DRIVE	——-
P10	300		SP.FAN/GEAR BOX	——-
P11			SPIN LOCK I/F	——-
P12	880A		SPINDLE HEAD	——-
P13	820		TOOL CHANGER	——-
P14	900		TSC PUMP	——-
P15	890		SPINDLE HEAD	——-
P16	770		E-STOP SWITCH	——-
P17	960		AIR/OIL	——-
P18	970		NOT USED	N/A
P19	950		AIR/OIL	——-
P20	830		REGEN RESISTORS	——-
P21	780		SPINDLE DRIVE	——-
P22	100		(EXTERNAL)	——-
P23	190		SHOT PIN	——-
P24	790		SPARE 2	N/A
P25	200		SPARE 3	N/A
P26	M21-24		(EXTERNAL)	——-
P27	1040		DOOR LOCK	——-
P28	910		POWER PCB	P7
P29	390		(EXTERNAL)	——-
P30	810A		SHUTTLE MOTOR	——-
P31	160		CHIP CONVEYOR	——-
P33	90		T1	——-
P34	90A		CRT	——-
P35	90B		FANS	——-
P36	90C		POWER PCB	P8
P37	870		115 VAC SPARE	——-
P38	1050		DOOR SWITCH	——-
P39	810		TURRET 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		(EXTERNAL)	——-
P48	——-		SPARE 1	——-
P49	——-		SPARE 2	——-
P50	200		COOLANT TANK	——-
P51	530		MOCON PCB	P13
P52	——-		SPARE 1	——-
P53	180		SPIGOT SENSE	——-
P54	350		SERVO BRAKE	——-
P55	280		RED/GREEN LTS	——-
P56	940A		TSC PUMP	——-
P57	SPARE		115 VAC SPARE	——-
P58	SPARE		115 VAC SPARE	——-
P60	930A		TSC 230 IN	——-
P61	770B		E-STOP C	——-

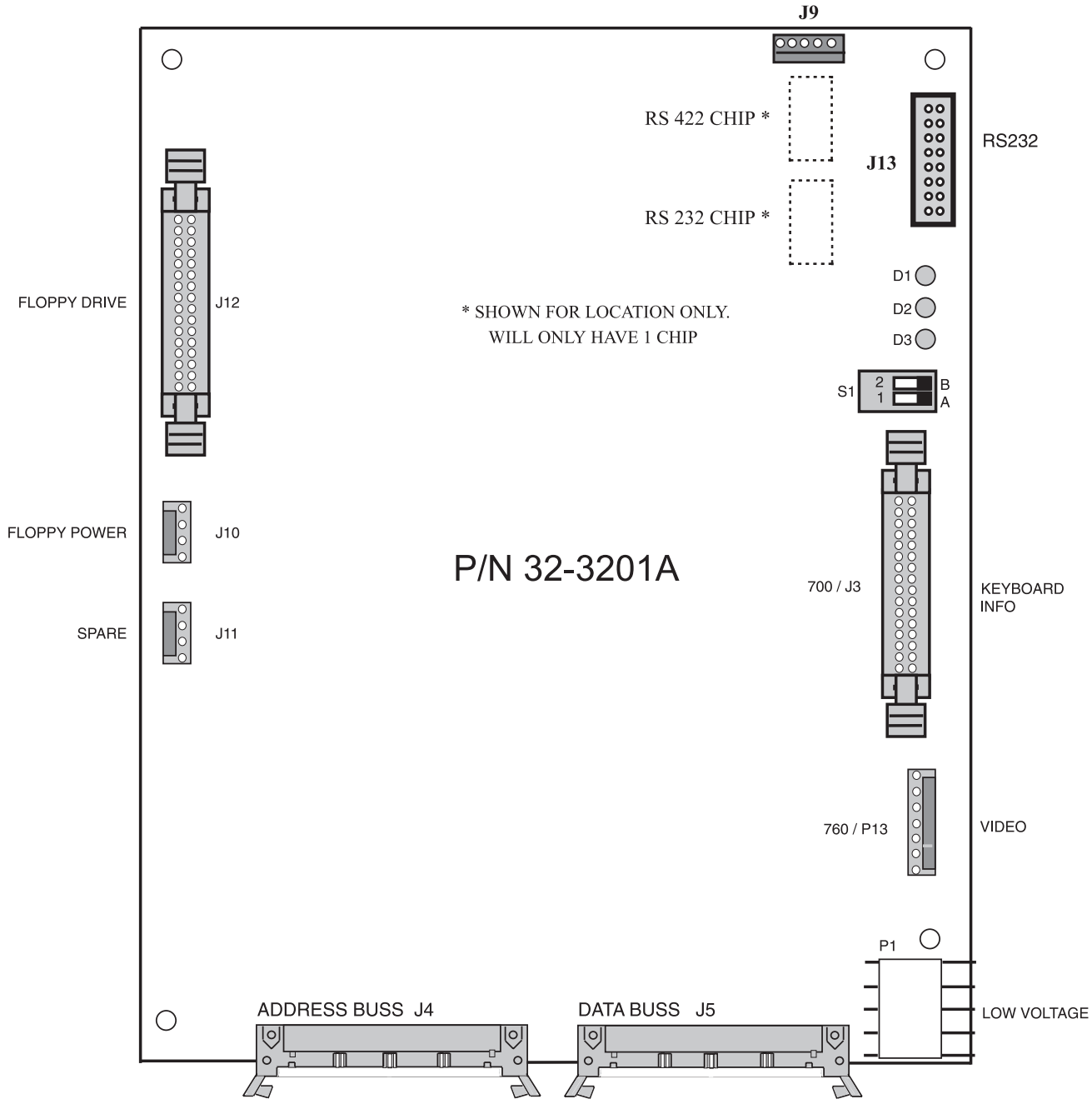


SERIAL KEYBOARD INTERFACE PCB WITH HANDLE JOG P/N 32-4030C

SERIAL KEYBOARD INTERFACE PCB WITH HANDLE JOG
P/N 32-4030C
CABLE CONNECTIONS

PLUG#	CABLE#	⇨ TO ⇨	LOCATION	PLUG#
P1	700		PROCESSOR	850
P2	—		KEYPAD	—
P3	700A		CYCLE START/ HOLD SWITCHES	—
P4	720		SP LOAD METER	P4
P5	705		SPEAKER	P5
P6	—			—
J1	750A		JOG HANDLE	—
J2	150		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.

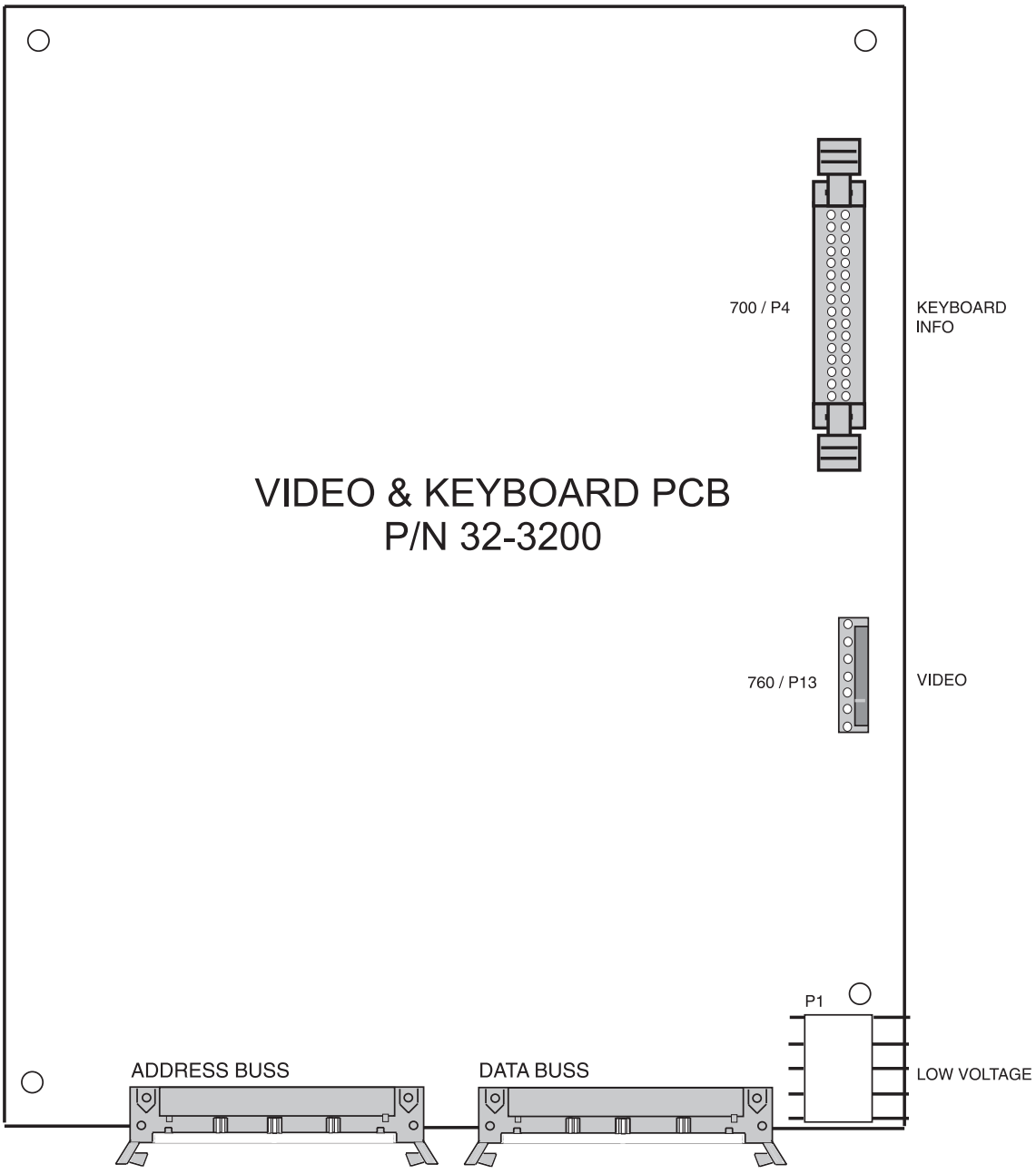


VIDEO & KEYBOARD PCB W/ FLOPPY DRIVE

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

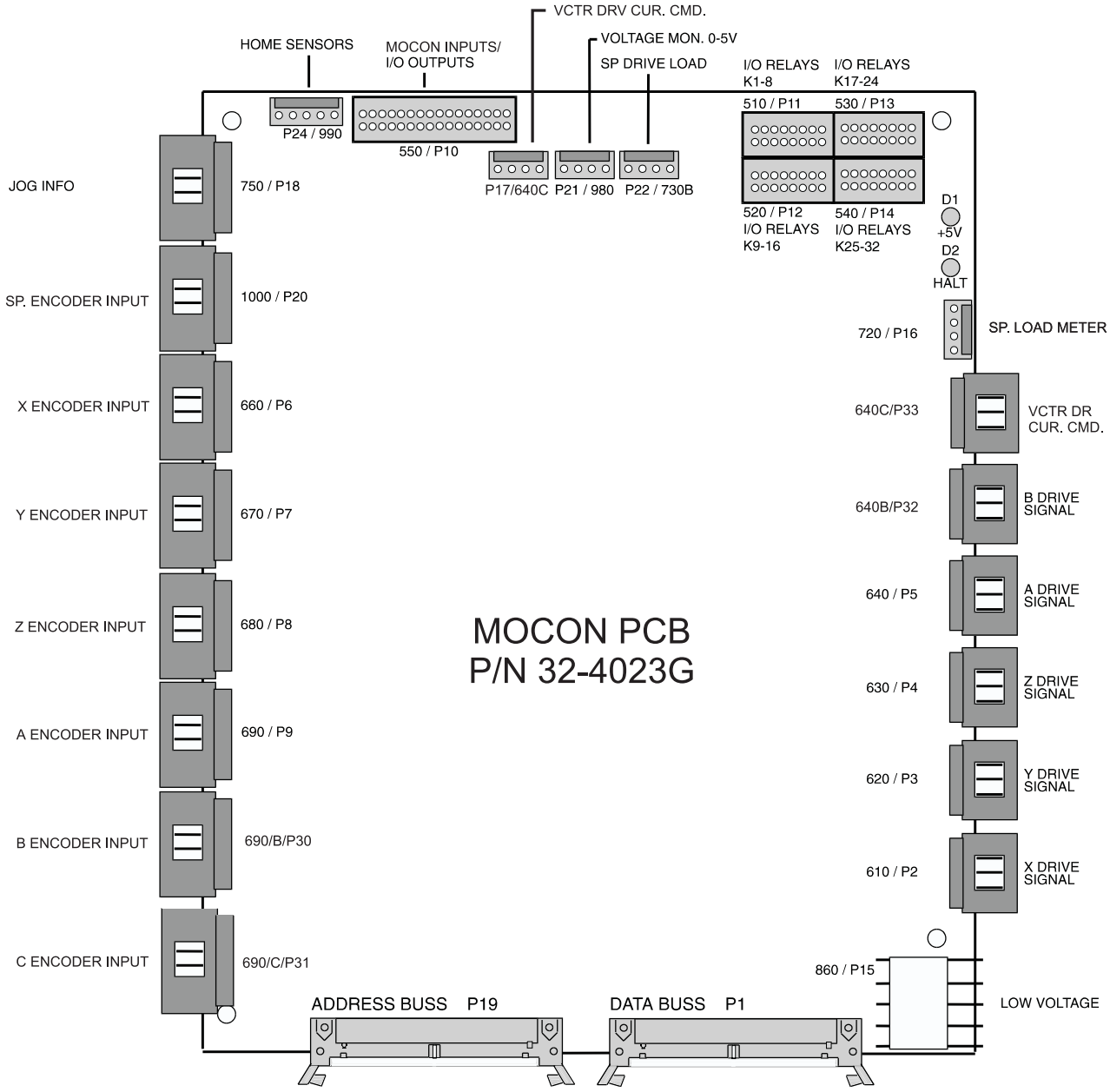
* Not used with Serial Keyboard Interface


700 / P4
KEYBOARD INFO
VIDEO & KEYBOARD PCB
P/N 32-3200
760 / P13
VIDEO
P1
ADDRESS BUSS
DATA BUSS
LOW VOLTAGE

VIDEO & KEYBOARD PCB W/ FLOPPY DRIVE
P/N 32-3200
CABLE CONNECTIONS

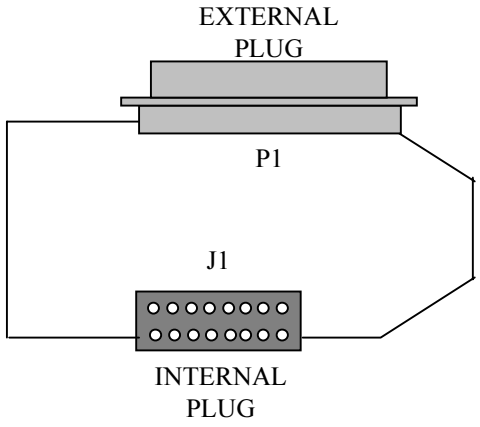
VIDEO PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨	LOCATION	PLUG #
P1	860	LOW VOLTAGE		POWER SUPPLY PCB	———
J3*	700	KEYBOARD INFO.		KEYBOARD INT.	———
J4	———	ADDRESS BUSS		MICRO PROC. PCB	———
J5	———	DATA BUSS		MOTIF PCB	———
J10	———	FLOPPY DR. POWER		FLOPPY DRIVE	———
J11	———	SPARE		N/A	N/A
J12	———	FLOPPY DR. SIGNAL		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


VCTR DRV CUR. CMD.
HOME SENSORS
MOCON INPUTS/
I/O OUTPUTS
VOLTAGE MON. 0-5V
SP DRIVE LOAD
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
720 / P16
SP. LOAD METER
SP. ENCODER INPUT
1000 / P20
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

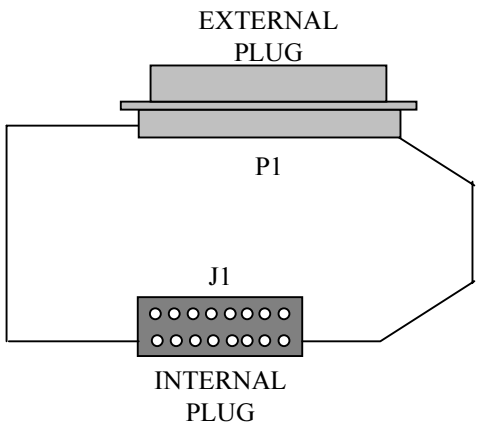
MOCON PLUG #	CABLE #	SIGNAL NAME ⇨ TO ⇨	LOCATION	PLUG #
P1	———	DATA BUSS	VIDEO PCB	———
			MICRO PROC. PCB	———
P2	610	X DRIVE SIGNAL	X SERVO DRIVE AMP.	P
P3	620	Y DRIVE SIGNAL	Y SERVO DRIVE AMP.	P
P4	630	Z DRIVE SIGNAL	Z SERVO DRIVE AMP.	P
P5	640	A DRIVE SIGNAL	A SERVO DRIVE AMP.	P
P32	640B	B DRIVE SIGNAL	B SERVO DRIVE AMP.	P
P33	640C	C DRIVE SIGNAL	VECTOR DR. CMDS. CUR.	
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	———
P31	690C	C ENCODER INPUT	C 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 DRIVE LOAD	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	SPARE		———
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

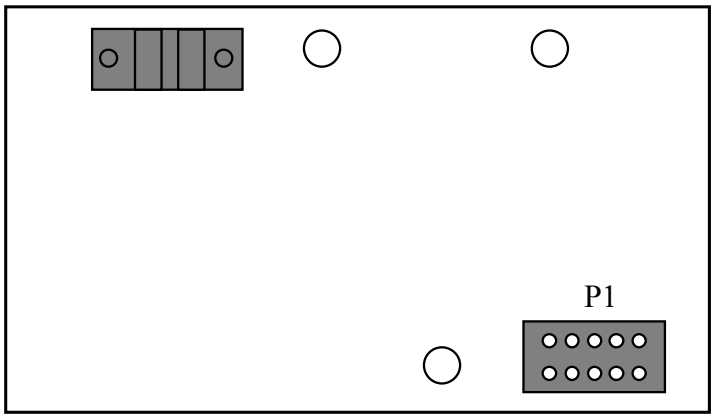
PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1 INTERNAL	850		VIDEO & KEYBOARD	J13
J1 EXTERNAL	———		———	———



RS-422 PORT #1 PCB - P/N 32-4091B

CABLE CONNECTIONS

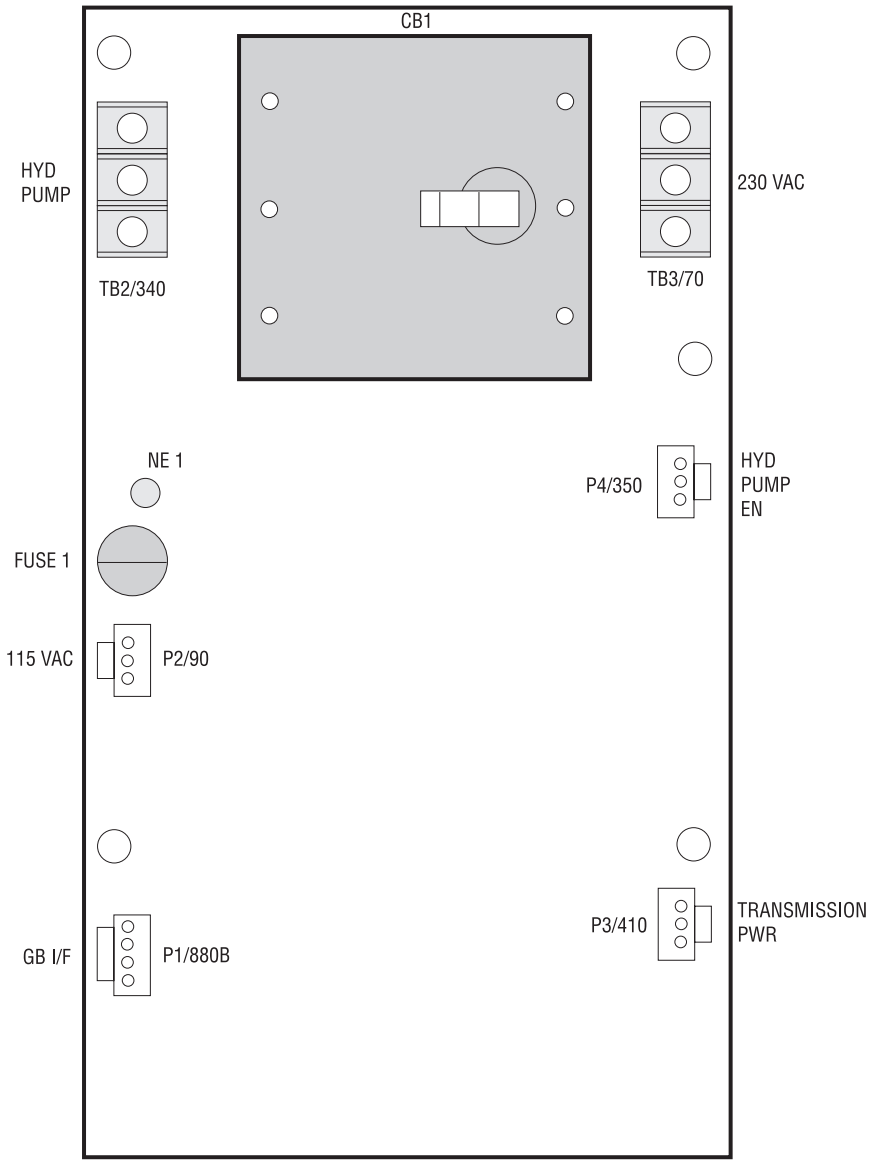
PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1 INTERNAL	850		VIDEO & KEYBOARD	J13
J1 EXTERNAL	———		———	———



OPTICAL ENCODER PCB - P/N 32-5010

CABLE CONNECTIONS

PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1	690B		MOCON	——



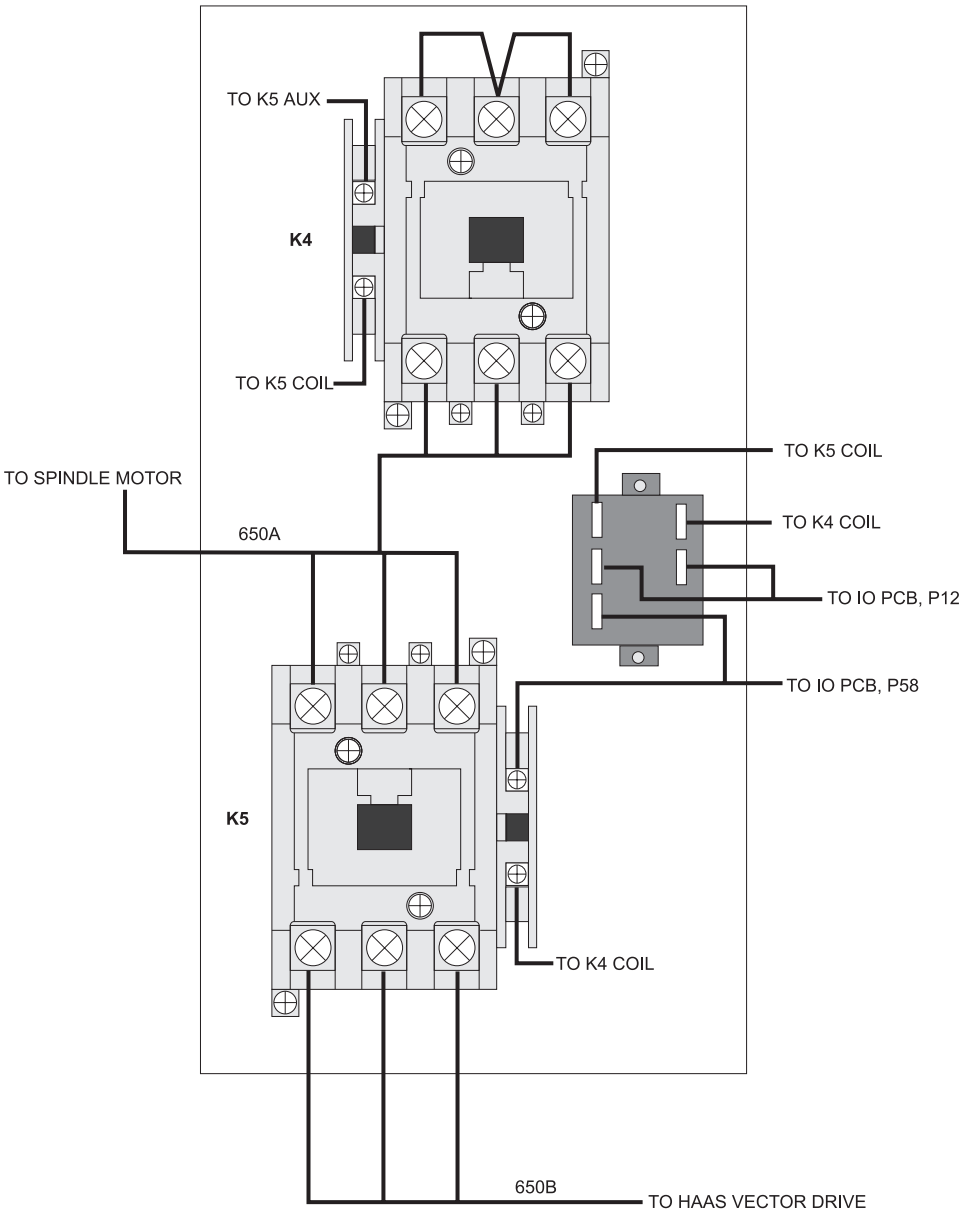
TRANSMISSION P.S. / HYDRAULIC C.B. PCB
P/N 32-4095 REV.B

TRANSMISSION P.S. / HYDRAULIC C.B. PCB P/N 32-4095 REV.B

CABLE CONNECTIONS

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

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



9. CABLE LIST

CNC WIRING OVERALL
6/98

THE FOLLOWING IS A SUMMARY OF THE CABLES USED IN THE WIRING OF THIS CONTROL:

WIRE/ TERMINAL NUMBER	FUNCTION NAME:
	INCOMING POWER 195-260 VAC (354-488 VAC OPTIONAL)
L1	INCOMING 195-260VAC, PHASE 1, TO CB1-1
L2	INCOMING 195-260VAC, PHASE 2, TO CB1-2
L3	INCOMING 195-260VAC, PHASE 3, TO CB1-3
71	PROTECTED 195-260VAC 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 VECTOR DRIVE/CHIP CONV.
78	230VAC PHASE 2, FROM XFORMER T1 TO VECTOR DRIVE/CHIP CONV.
79	230VAC PHASE 3, FROM XFORMER T1 TO VECTOR DRIVE/CHIP CONV.
90	115VAC FROM TB2(CB2 OUTPUT) TO IOPCB P33 - SHIELD + 3
91	115VAC FROM TB2-1TO IOPCB P33 PIN 1
92	115VAC FROM TB2-2 TO IOPCB P33 PIN 2
93	115VAC FROM TB2-3 TO IOPCB P33 PIN 3
94	SHIELD DRAIN
-	115VAC FROM XFORMER T1 TO TB1(CB2 INPUT)
94	STEPPED-DOWN 115 VAC (FROM XFORMER T1)
95	STEPPED-DOWN 115 VAC (FROM XFORMER T1)
96	STEPPED-DOWN 115 VAC (FROM XFORMER T1)
90A	115 VAC TO CRT - SHIELD +2
91A	115VAC #16
92A	RETURN #16
93A	SHIELD DRAIN
90B	115 VAC TO HEAT EXCHANGER - SHIELD +2
91B	115VAC #16
92B	RETURN #16
93B	SHIELD DRAIN
90C	115 VAC TO CB4 - SHIELD +2

91C	115VAC #20
92C	RETURN #20
93C	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
140A	230VAC 3PH POWER IN CONDUIT TO CHIP CONVEYOR
141A	PHASE A 230VAC
142B	PHASE B 230VAC
143B	PHASE C 230VAC
160	3PH 230VAC TO CHIP CONVEYOR CONTROLLER
161	PHASE A 230VAC
162	PHASE B 230VAC
163	PHASE C 230VAC
164	SHIELD DRAIN
170	AUTO OFF FUNCTION - SHIELD +2
171	UNSWITCHED LEG 1 #20
172	SWITCHED LEG 2 #20
173	SHIELD DRAIN
180	SPARE
181	SIGNAL
182	COMMON
190	UNCLAMP FROM SPINDLE HEAD TO IOASM
191	INPUT 25
192	DIGITAL RETURN
193	SHIELD DRAIN
200	SPARE
201	+12VDC
202	RETURN
210	DATA CABLE TO 3" FLOPPY DISK DRIVE (34 PINS)
230	TAILSTOCK FORWARD OPTION
231	115VAC
232	115VAC RETURN
233	SHIELD DRAIN
240	BARFEEDER OPTION
241	END OF BAR #20
242	LOADER OK #20
243	COMMON #20
244	SHIELD DRAIN
250	TAILSTOCK REVERSE OPTION

251 115VAC
252 115VAC RETURN
253 SHIELD DRAIN

260 SPARE 12VDC

270 TAILSTOCK RAPID OPTION
271 115VAC
272 115VAC RETURN
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 CABLE OP LIGHT + SPINDLE MOTOR FAN
291 115VAC
292 115VAC RETURN
293 SHIELD DRAIN

300 115VAC TO OIL PUMP
301 LEG 1 115VAC FUSED AT 3 A #20
302 LEG 2 115VAC FUSED AT 3 A #20
303 SHIELD DRAIN

330 230V 3PH FROM CB6 TO K2 (LATHE HYDRAULICS)
331 PHASE 1 230VAC
332 PHASE 2 230VAC
333 PHASE 3 230VAC

340 230V 3PH FROM K2 TO HYDRAULIC PUMP (LATHE)
341 PHASE 1 230VAC
342 PHASE 2 230VAC
343 PHASE 3 230VAC

350 115VAC HYD PUMP ENABLE - SHIELD +2
351 115VAC
352 115VAC RETURN

390 115VAC TO 4'TH AXIS BRAKE (LATHE PART DOOR) - SHIELD +2
391 115VAC #20
392 115VAC RETURN #20
393 SHIELD DRAIN

410 TAILSTOCK FOOT SWITCH
411 SIGNAL #20
412 RETURN #20
413 SHIELD DRAIN

490 ALL BRUSHLESS AXIS SERVO MOTOR DRIVE POWER CABLE
491 A PHASE
492 B PHASE
493 C PHASE
494 GROUND

490A	320VDC FROM SPINDLE DRIVE TO THE AMPLIFIERS - SHIELD +2
491A	HIGH VOLT P1/+ RED #12
492A	HIGH VOLT N/- BLACK #12
493A	SHIELD DRAIN
490B	320VDC FROM AMPLIFIER TO SERVO POWER SUPPLY
491B	HIGH VOLT + RED #20
492B	HIGH VOLT - BLACK #20
500	OVERTEMP SENSOR FROM SPINDLE MOTOR - SHIELD +2
501	OVERTEMP SIGNAL #20 (N.C.)
502	OVERTEMP COMMON #20
503	SHIELD DRAIN
510	RELAY CARD 1 DRIVE CABLE - 16 WIRE RIBBON #24
520	RELAY CARD 2 DRIVE CABLE - 16 WIRE RIBBON #24
530	RELAY CARD 3 DRIVE CABLE - 16 WIRE RIBBON #24
540	RELAY CARD 4 DRIVE CABLE - 16 WIRE RIBBON #24
550	INPUTS CARD CABLE (MOCON - P10) 34 WIRE RIBBON
570	LOW VOLTAGE BRUSHLESS AMPLIFIER POWER CABLE ASSEMBLY
571	+12VDC #22
572	COMMON
573	- 12VDC #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
630	Z AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD (SAME AS 610-1 THRU 610-10)
640	A 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-1	A PHASE
640C-2	B PHASE
640C-3	ENABLE
640C-4	FAULT
640C-5	320VDC 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 TO DELTA OPTION)
651A	PHASE 1
652A	PHASE 2
653A	PHASE 3
654A	SHIELD DRAIN
650B	230VAC, THREE PHASE POWER, CONTACTOR TO VECTOR DRIVE (WYE TO DELTA OPTION)
651B	PHASE 1
652B	PHASE 2
653B	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
680	Z-AXIS ENCODER CABLE (SAME AS 660-1 THRU 660-16)
690	A-AXIS ENCODER CABLE (SAME AS 660-1 THRU 660-16)
700	KEYBOARD CABLE - 34 WIRE RIBBON WITH IDC (FROM VIDEO P4 TO KBIF P1)
720	ANALOG SIGNAL FROM MOCON TO SPINDLE DRIVE LOAD MONITOR
721	0 TO +10 VOLTS SPINDLE LOAD
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 (+ 5VDC)
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	+5 VDC
752A	0 VDC
753A	ENCODER A CHANNEL
754A	ENCODER B CHANNEL
755A	SHIELD DRAIN
760	MONITOR VIDEO DATA CABLE - SHIELD + 7 (ALL #24) (FROM VIDEO P3 TO CRT)
770	EMERGENCY STOP INPUT CABLE - SHIELD + 2
771	SIGNAL #20
772	RETURN (D GROUND) #20
773	SHIELD DRAIN
770A	SECOND E-STOP (BARFEEDER OPTION)
771A	SIGNAL #20
772A	RETURN (D GROUND) #20
773A	SHIELD DRAIN
790	SPARE INPUTS FROM IOPCB P24(PROBE HOME OPTION)
791	SPARE 1
792	SPARE 2
793	COMMON
794	SHIELD DRAIN
820	TOOL CHANGER STATUS - SHIELD +7(ALL #20)
821	TURRET UNCLAMPED
822	TURRET CLAMPED

823	UNUSED
824	PART LOAD
825	DATA GROUND
826	SHIELD DRAIN
830	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 VOLT POWER TO IOPCB - SHIELD +2 (ALL #20)
861	+12 VOLTS
865	LOGIC POWER RETURN (D GROUND)
863	SHIELD DRAIN
860B	+5 POWER TO 3" FLOPPY DRIVE
860C	+5,+12,-12 POWER TO 68030
870	115VAC TO OILER - SHIELD +2
871	115VAC LEG 1 #18
872	115VAC LEG 2 #18
880A	115VAC TO SPINDLE HEAD SOLENOIDS - SHIELD +6 (ALL #24)
881	SPINDLE LOCK
882	TOOL UNCLAMP
883	LOW GEAR
884	HIGH GEAR
885	115VAC COMMON
886	SHIELD DRAIN
887	PRECHARGE
880B	TRANSMISSION HIGH/LOW GEAR SOLENOIDS FOR LATHE
881	115 VAC SOLENOID COMMON (IO P12-5) #18
882	HIGH GEAR SOLENOID (IO P12-4) #18
883	LOW GEAR SOLENOID (IO P12-3) #18
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	SPINDLE LOCKED SIGNAL
896	COMMON (DATA GROUND)
897	SHIELD DRAIN

900	SPARE - SHIELD +2
901	SIGNAL #20
902	RETURN #20
903	SHIELD DRAIN
910	115 VAC CIRCUIT BREAKER (CB4) TO SOLENOIDS - SHIELD +2
911	115VAC #20
912	RETURN #20
913	SHIELD DRAIN
910A	SPARE 115VAC
911A	115VAC #20
912A	RETURN #20
913A	SHIELD DRAIN
910B	115VAC TO SERVO FAN - SHIELD +2
911B	115VAC #20
912B	RETURN #20
913B	SHIELD DRAIN
910C	115VAC TO CONTACTOR COILS (WYE TO DELTA OPTION)
911C	115VAC #20
912C	RETURN #20
913C	SHIELD DRAIN
910D	115VAC TO PART CATCHER
911D	115VAC #20
912D	RETURN #20
913D	SHIELD DRAIN
930	230 VAC FOR COOLANT PUMP FROM CB3 - SHIELD + 2
931	230VAC #20
932	230VAC RETURN #20
933	SHIELD DRAIN
940	230 VAC SINGLE PHASE POWER TO COOLANT PUMP - SHIELD +2
941	230VAC #20
942	RETURN #20
943	SHIELD DRAIN
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
950A	LOW HYDRAULIC PRESSURE SWITCH FOR LATHE - SHIELD +2
952	LOW HYDRAULIC RETURN (D GROUND) (65) #20
953	LOW HYD PRESSURE SWITCH FOR VERTICAL TRANSMISSION #20
954	SHIELD DRAIN
960	LOW HYD PRESSURE - SHIELD + 2
961	LOW HYD PRESSURE SIGNAL #20
962	COMMON #20
963	SHIELD DRAIN

970 VECTOR DRIVE OVERVOLTAGE - SHIELD +2
971 OVERVOLTAGE SIGNAL #24
972 OVERVOLTAGE RETURN #24
973 SHIELD DRAIN

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
995 SHIELD DRAIN

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 NOT USED
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

1020 SPINDLE TEMPERATURE SENSOR CABLE - SHIELD +3
1021 SIGNAL
1022 ANALOG RETURN
1023 +5 VOLTS TO SENSOR
1024 SHIELD GROUND

1030 SPINDLE LOAD RESISTOR - SHIELD +2
1031 REGEN LOAD RESISTOR FOR SPINDLE DRIVE (B1) #14
1032 REGEN LOAD RESISTOR FOR SPINDLE DRIVE (B2) #14
1033 SHIELD DRAIN

1040 115VAC TO MIKRON DOOR INTERLOCK SWITCH - SHIELD +2
1041 115VAC #20
1042 RETURN #20
1043 SHIELD DRAIN

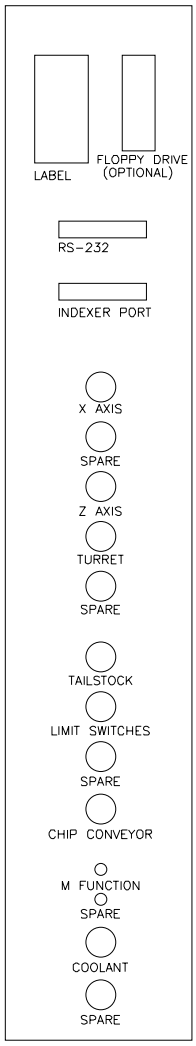
1050 DOOR SWITCH INPUT - SHIELD +2
1051 DOOR OPEN SIGNAL #20
1052 DOOR OPEN RETURN (D GROUND) #20
1053 SHIELD DRAIN

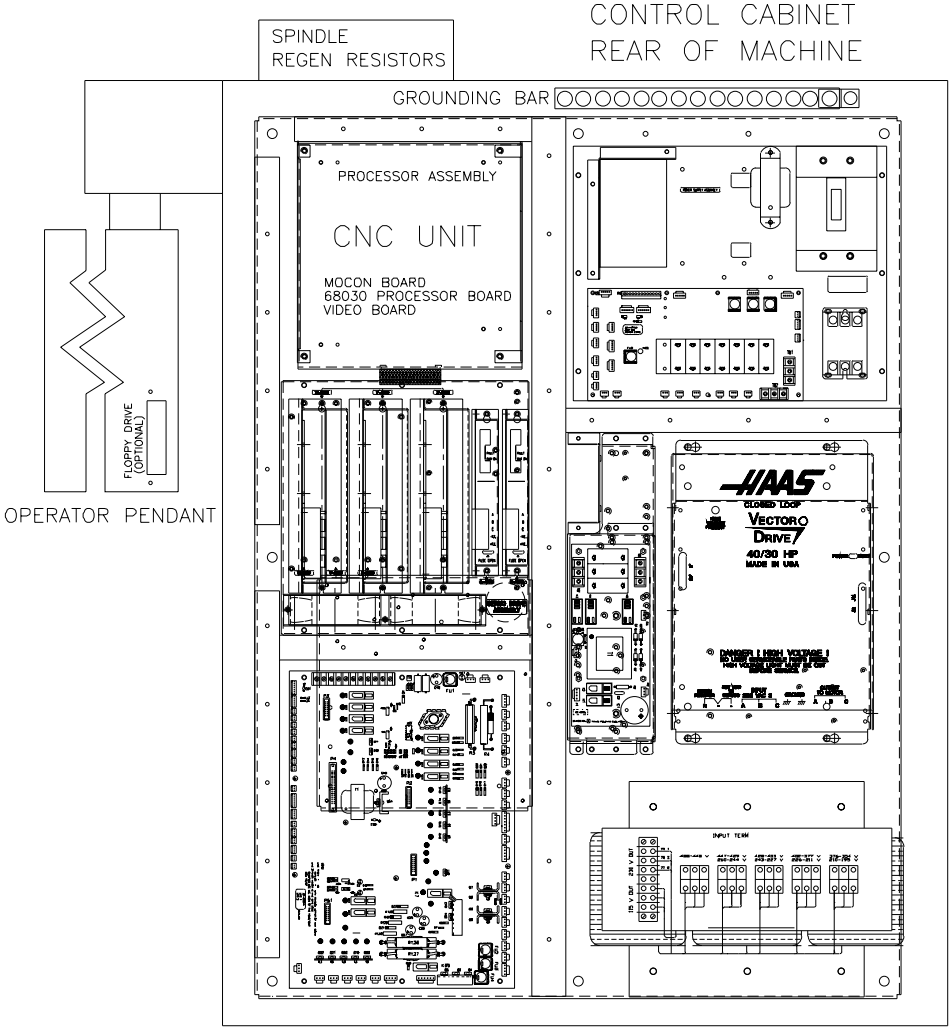
1060 GROUND FAULT DETECTION SENSE INPUT
1061 + INPUT FROM SENSE RESISTOR

1062	- INPUT FROM SENSE RESISTOR
1070	SKIP INPUT FROM SENSOR - SHIELD +2
1071	LOGIC COMMON
1072	SKIP SIGNAL
1073	SHIELD DRAIN

ELECTRICAL

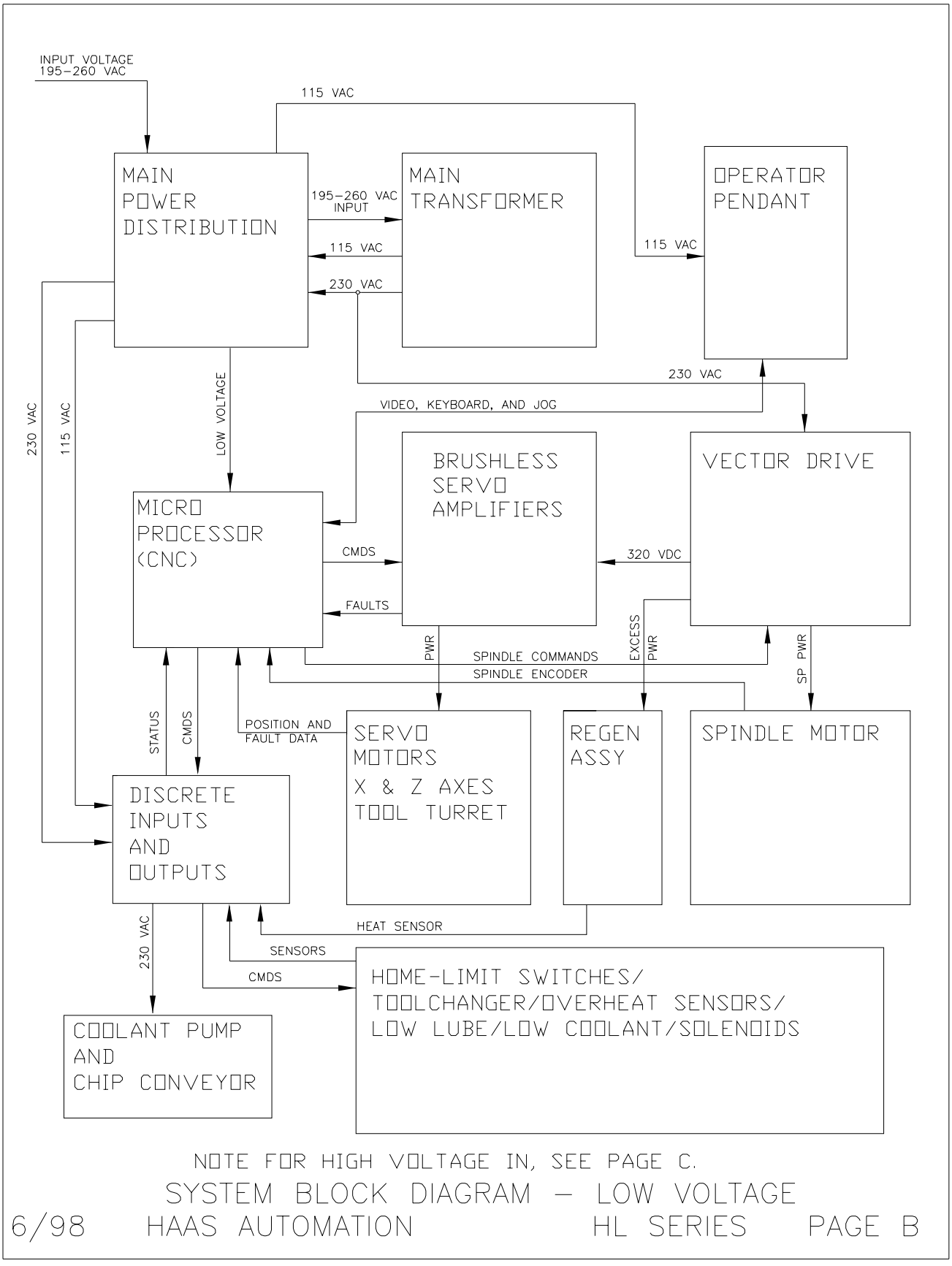
WIRING DIAGRAMS





CONTROL LAYOUT DIAGRAM

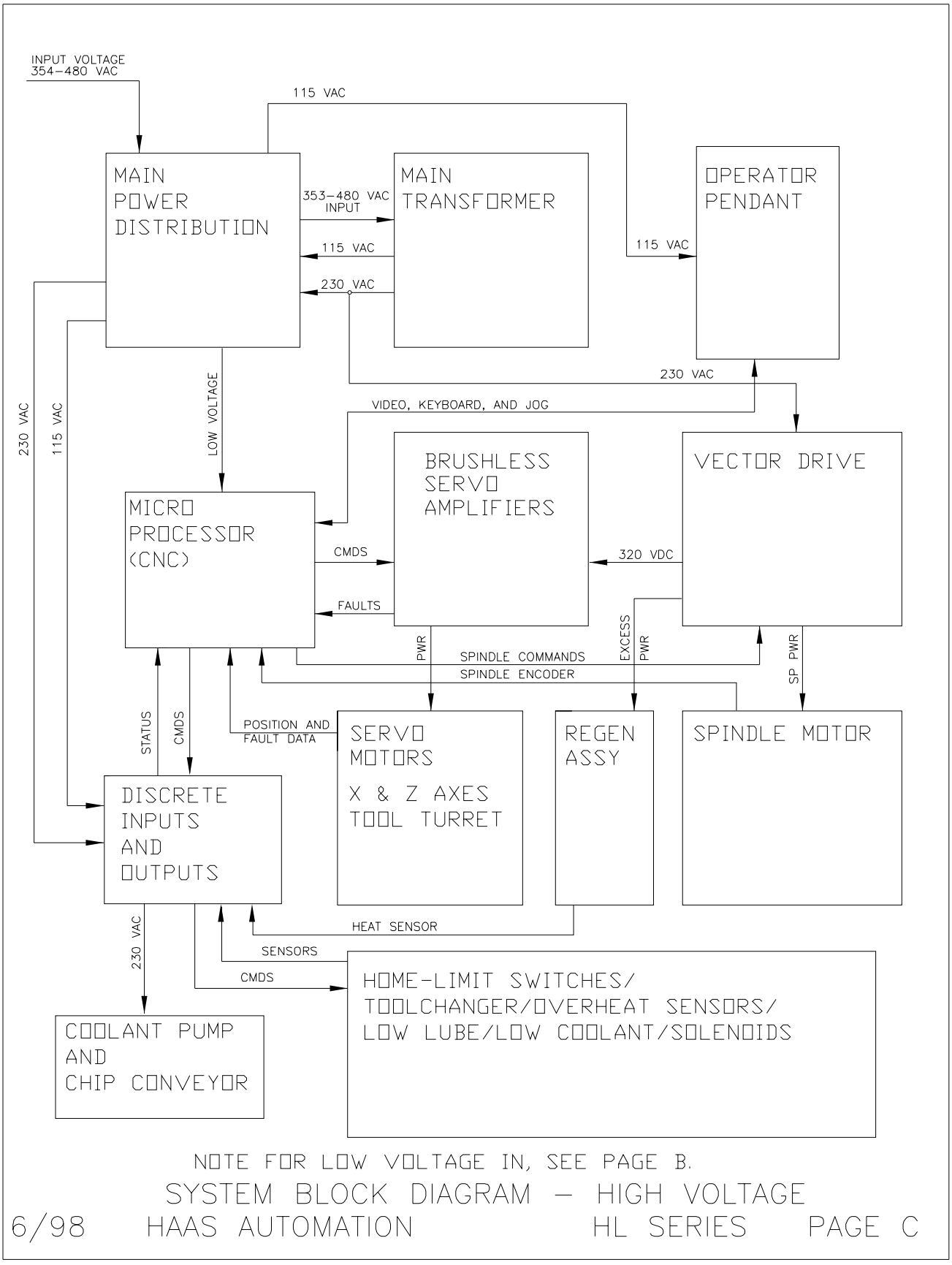
6/98 HAAS AUTOMATION HL SERIES PAGE A



NOTE FOR HIGH VOLTAGE IN, SEE PAGE C.

SYSTEM BLOCK DIAGRAM – LOW VOLTAGE

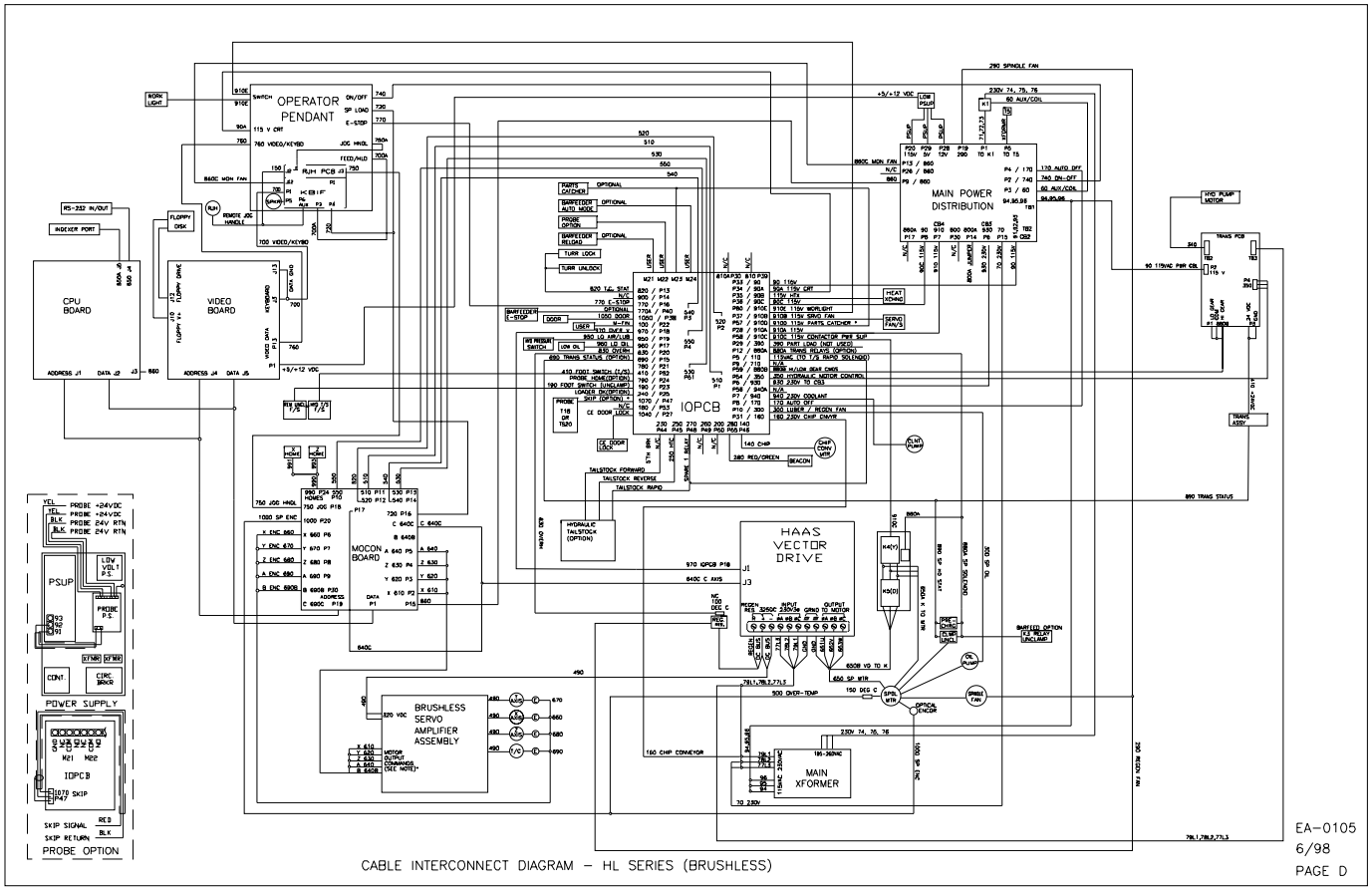
6/98 HAAS AUTOMATION HL SERIES PAGE B



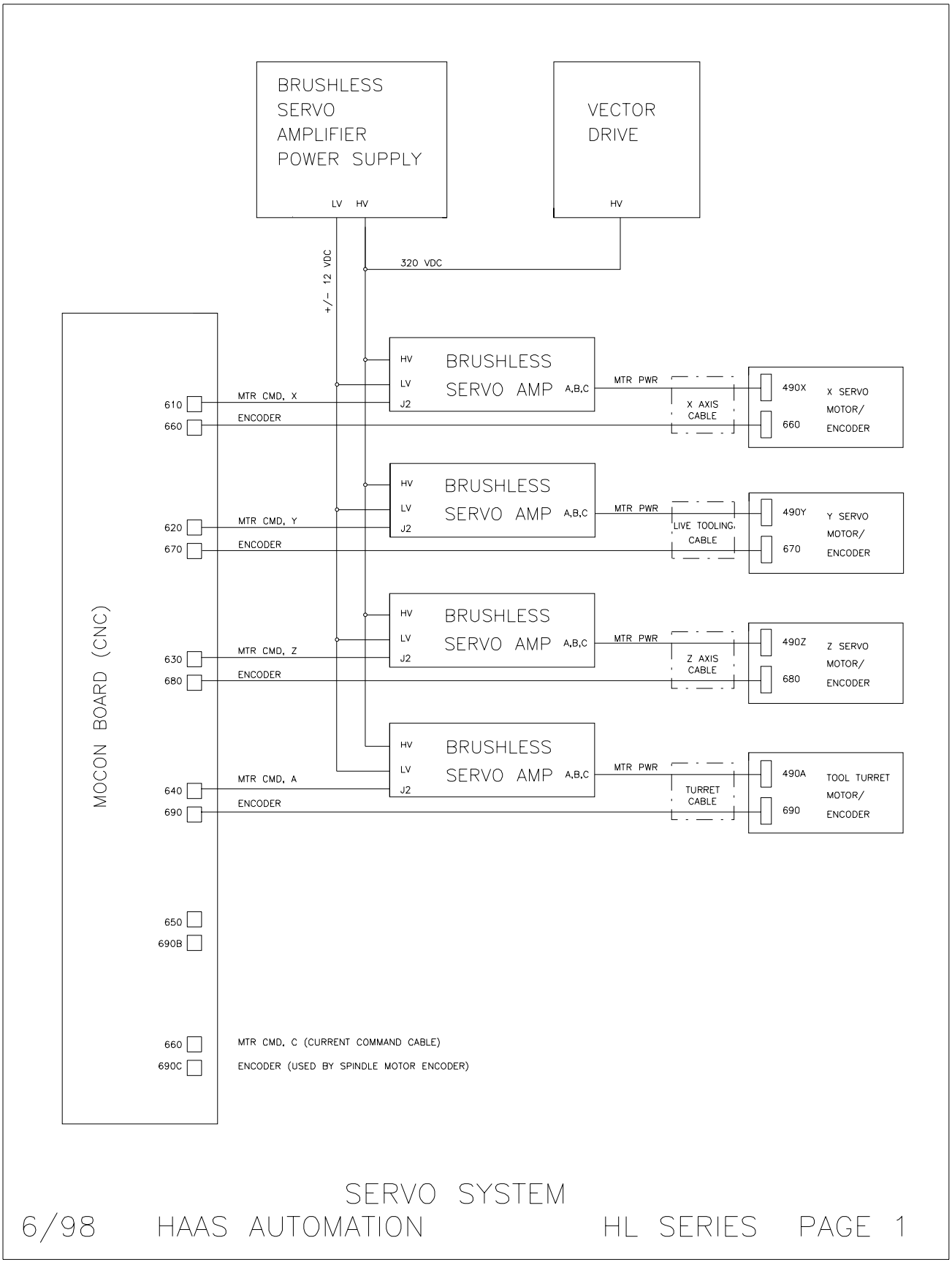
NOTE FOR LOW VOLTAGE IN, SEE PAGE B.

SYSTEM BLOCK DIAGRAM – HIGH VOLTAGE

6/98 HAAS AUTOMATION HL SERIES PAGE C

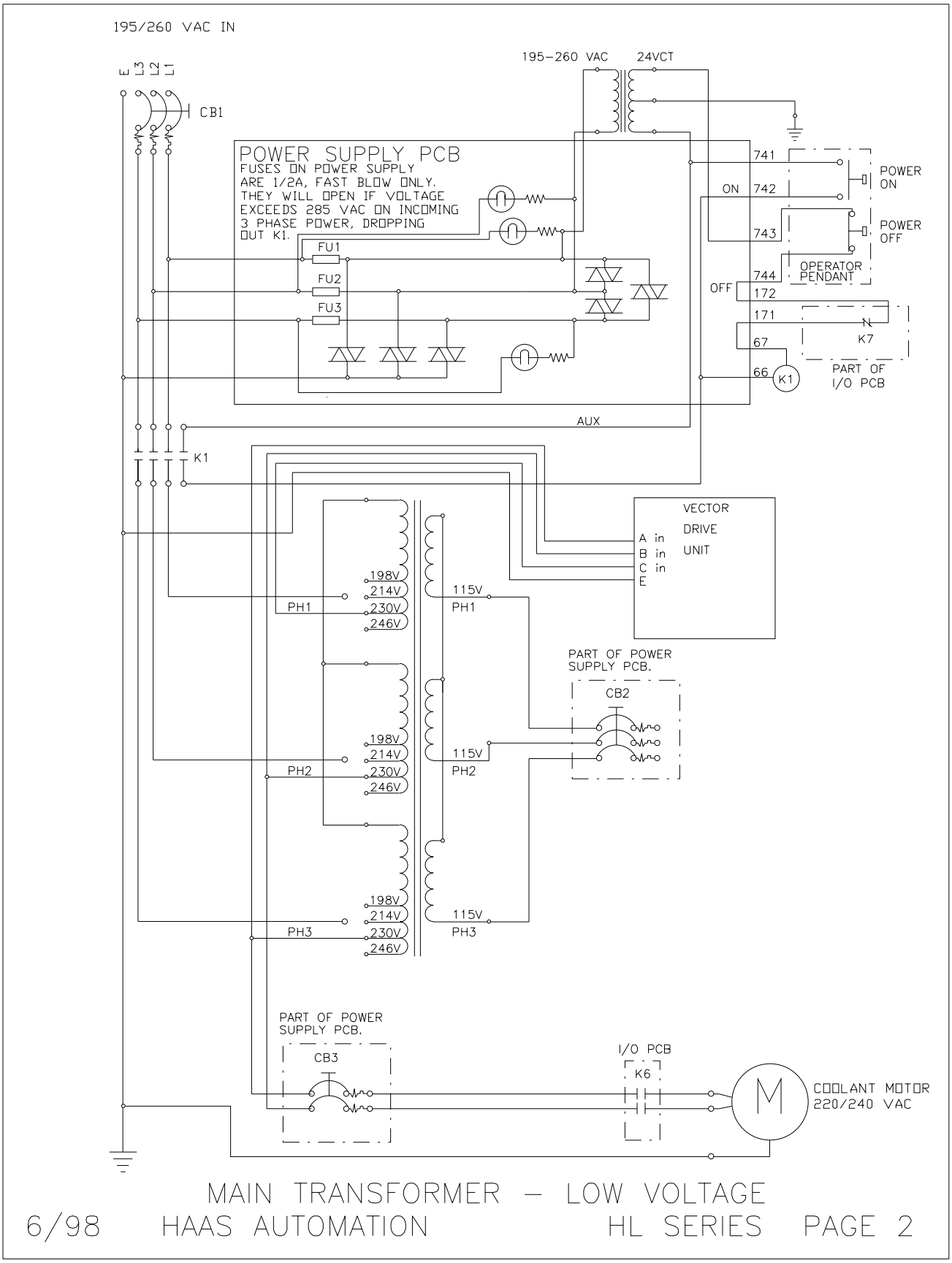


CABLE INTERCONNECT DIAGRAM – HL SERIES (BRUSHLESS)



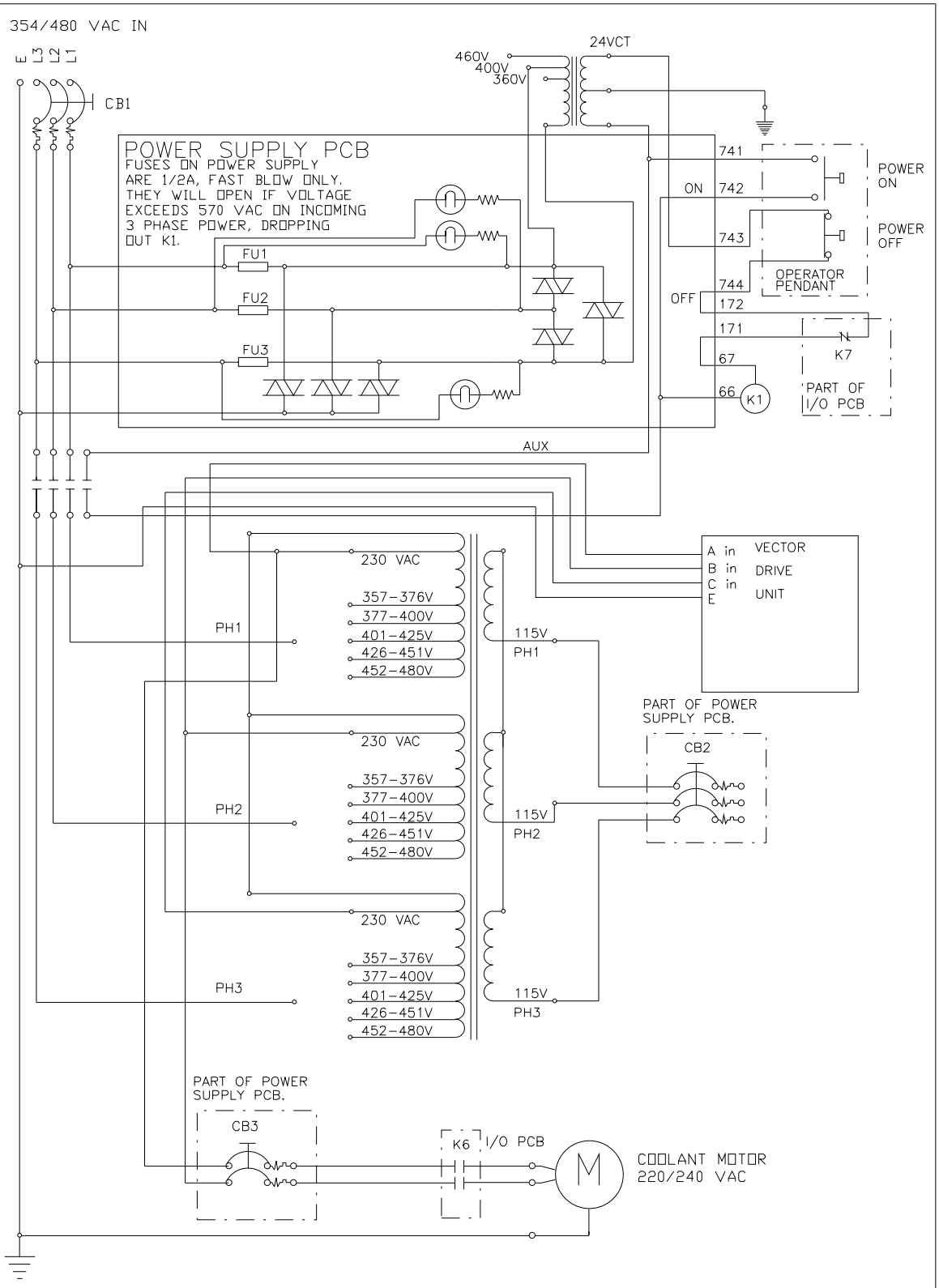
SERVO SYSTEM

6/98 HAAS AUTOMATION HL SERIES PAGE 1



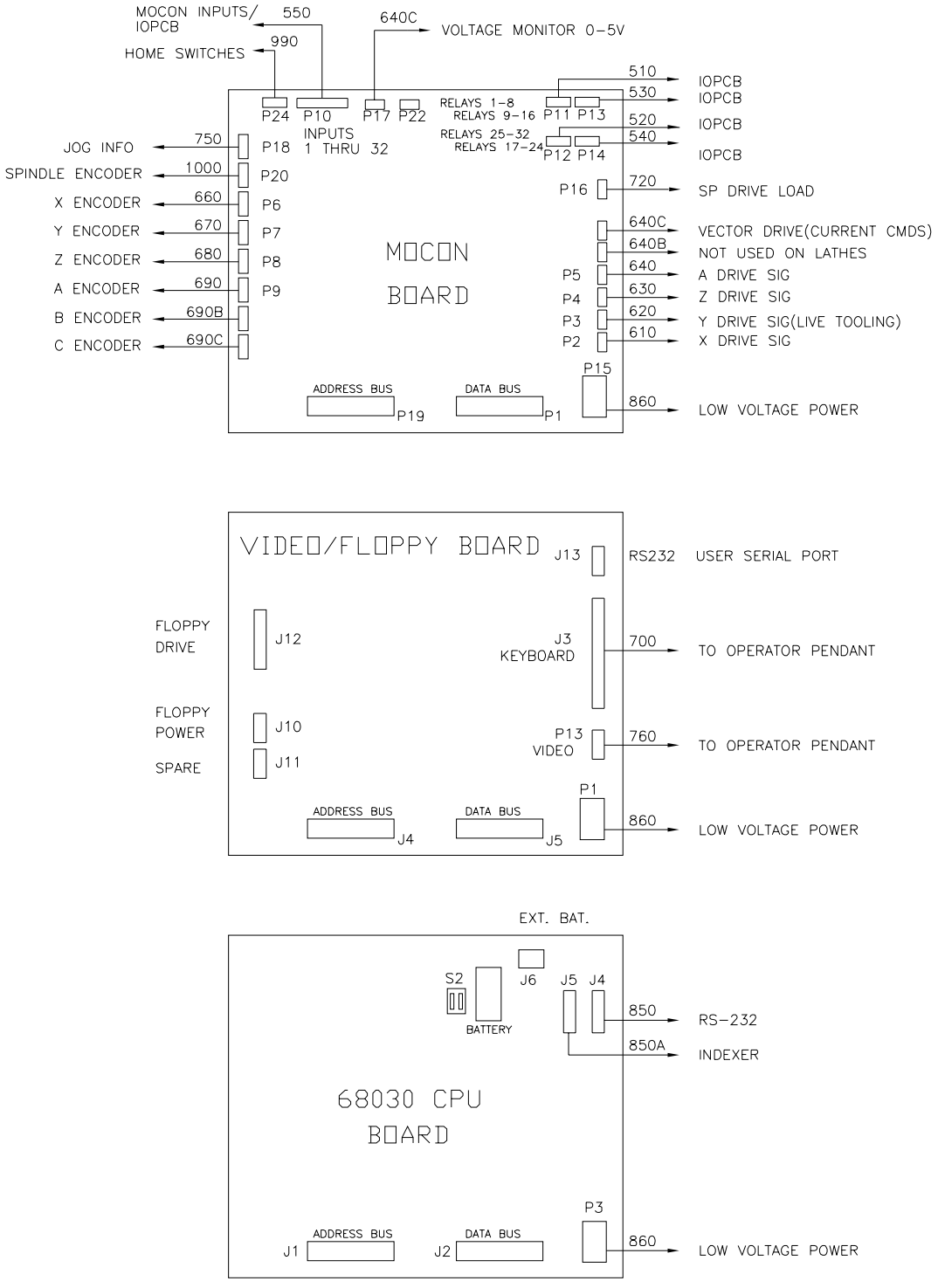
MAIN TRANSFORMER – LOW VOLTAGE

6/98 HAAS AUTOMATION HL SERIES PAGE 2



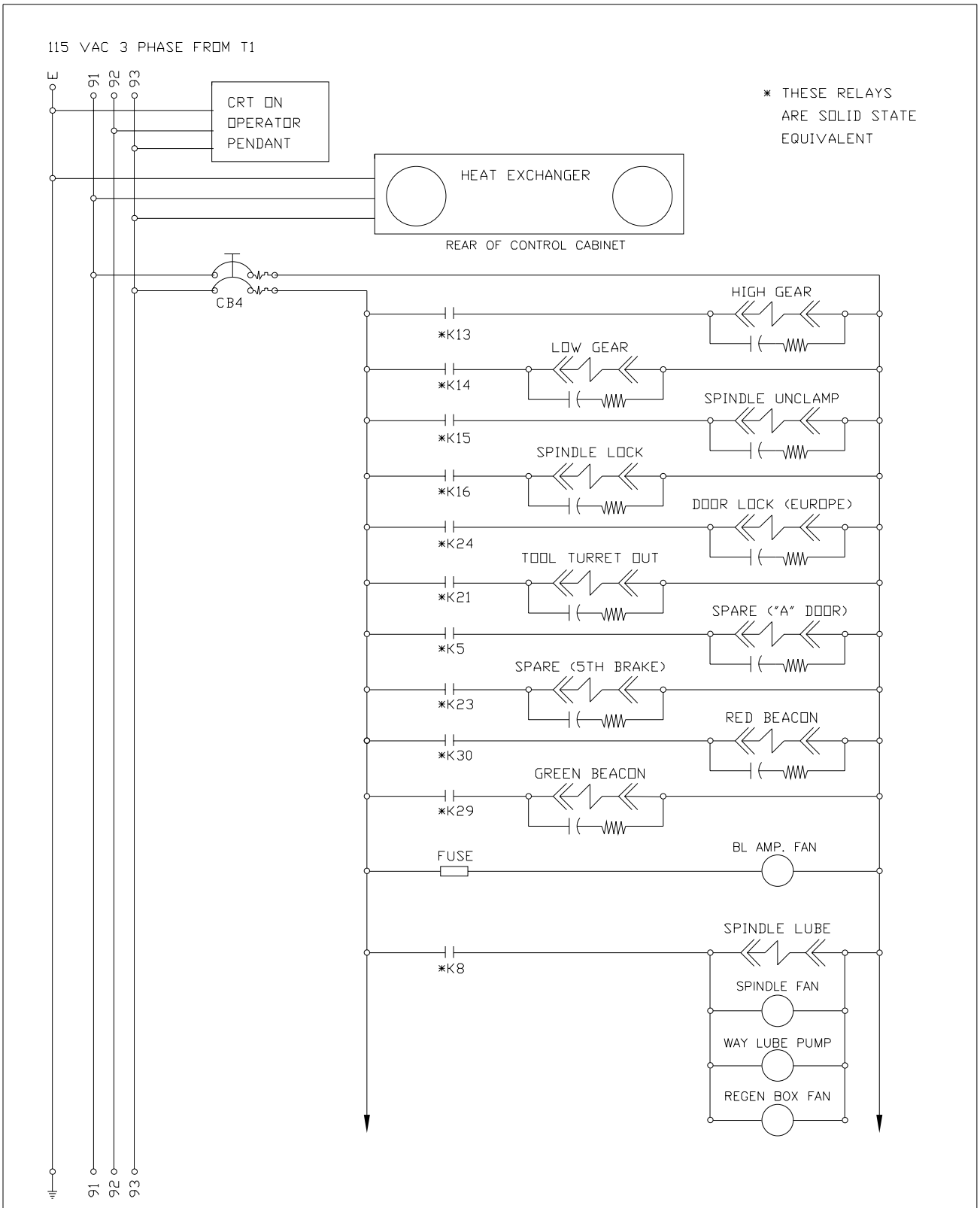
MAIN TRANSFORMER – HIGH VOLTAGE

6/98 HAAS AUTOMATION HL SERIES PAGE 3



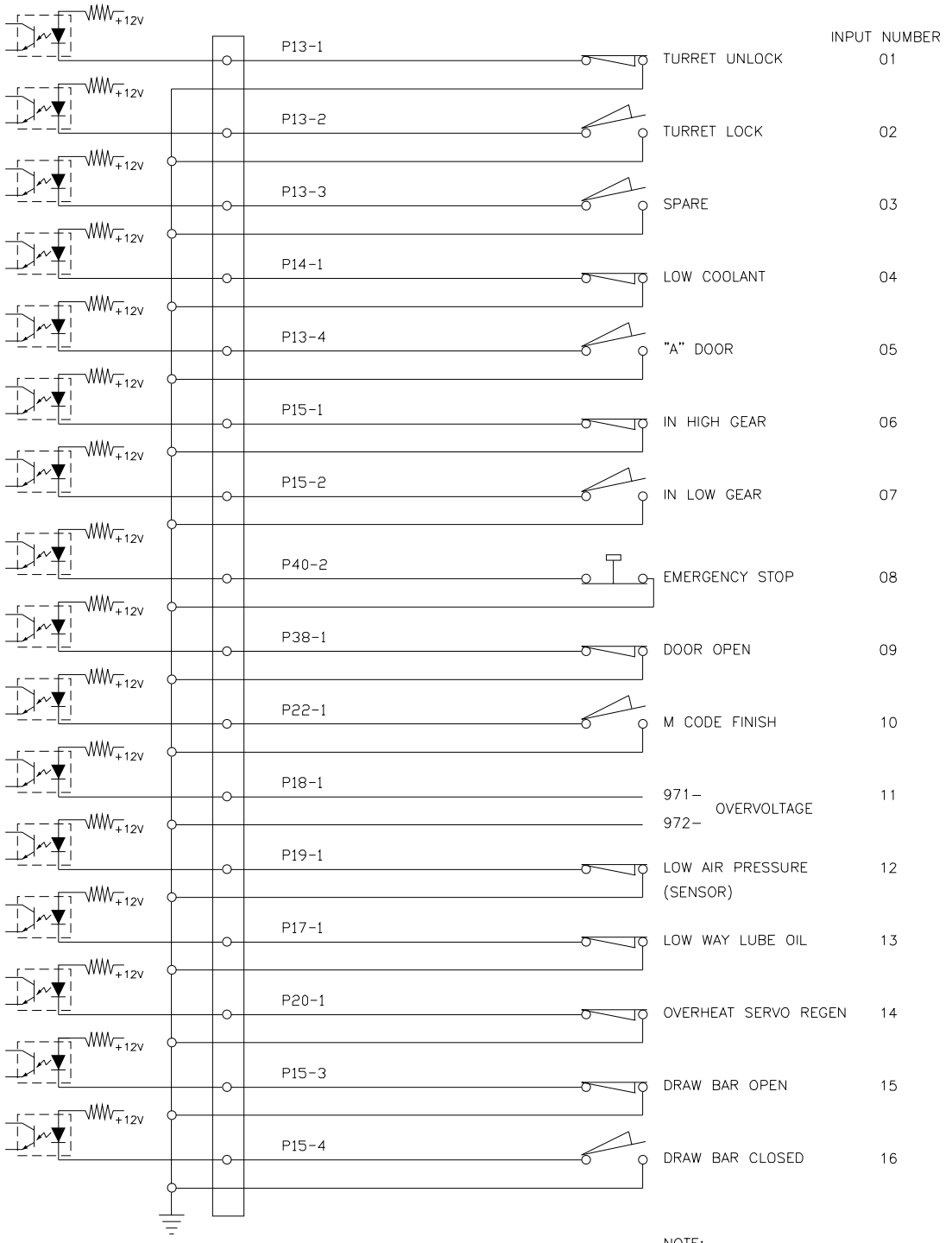
CNC UNIT

6/98 HAAS AUTOMATION HL SERIES PAGE 4



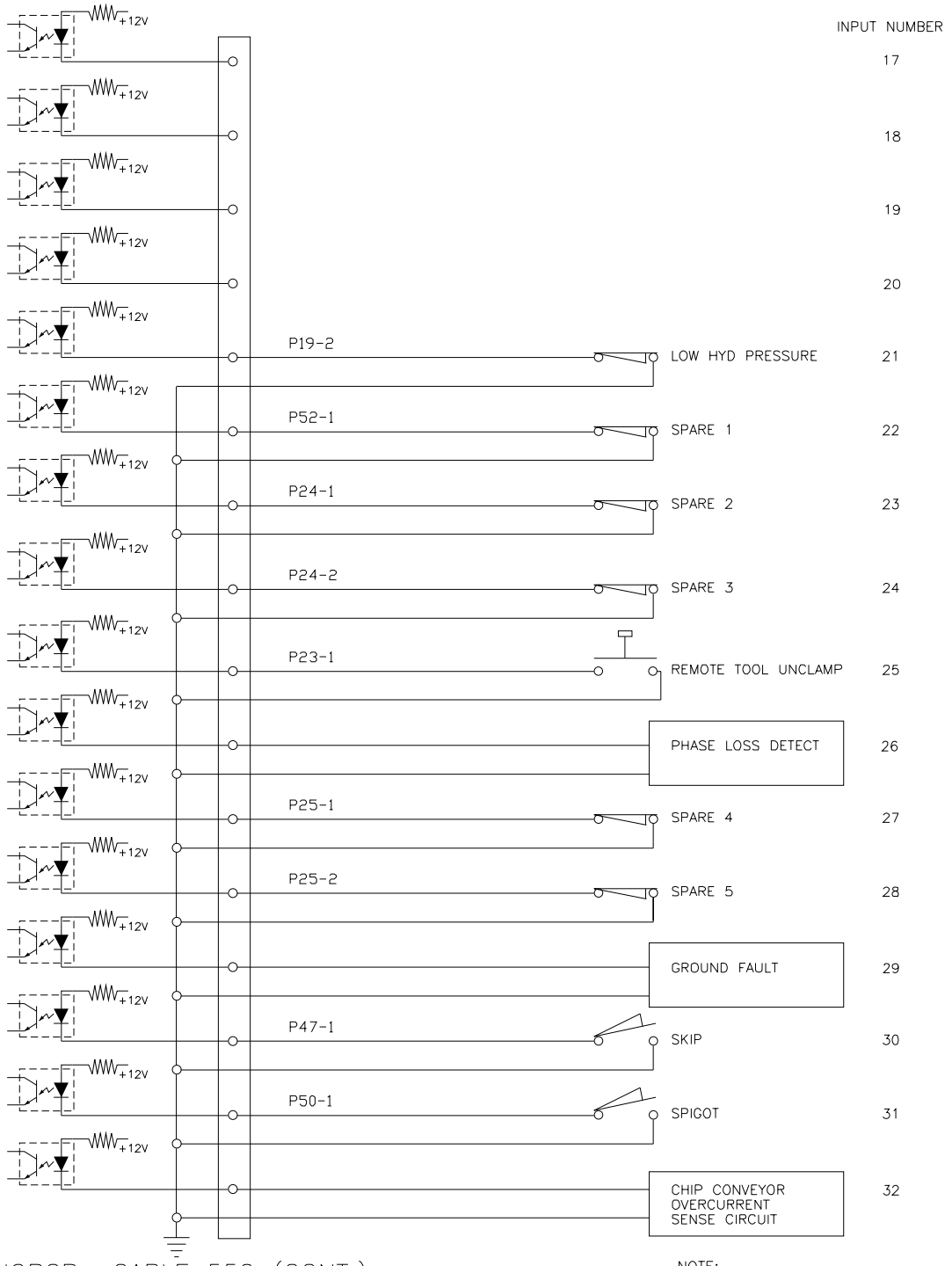
115 VAC CIRCUITS

6/98 HAAS AUTOMATION HL SERIES PAGE 5



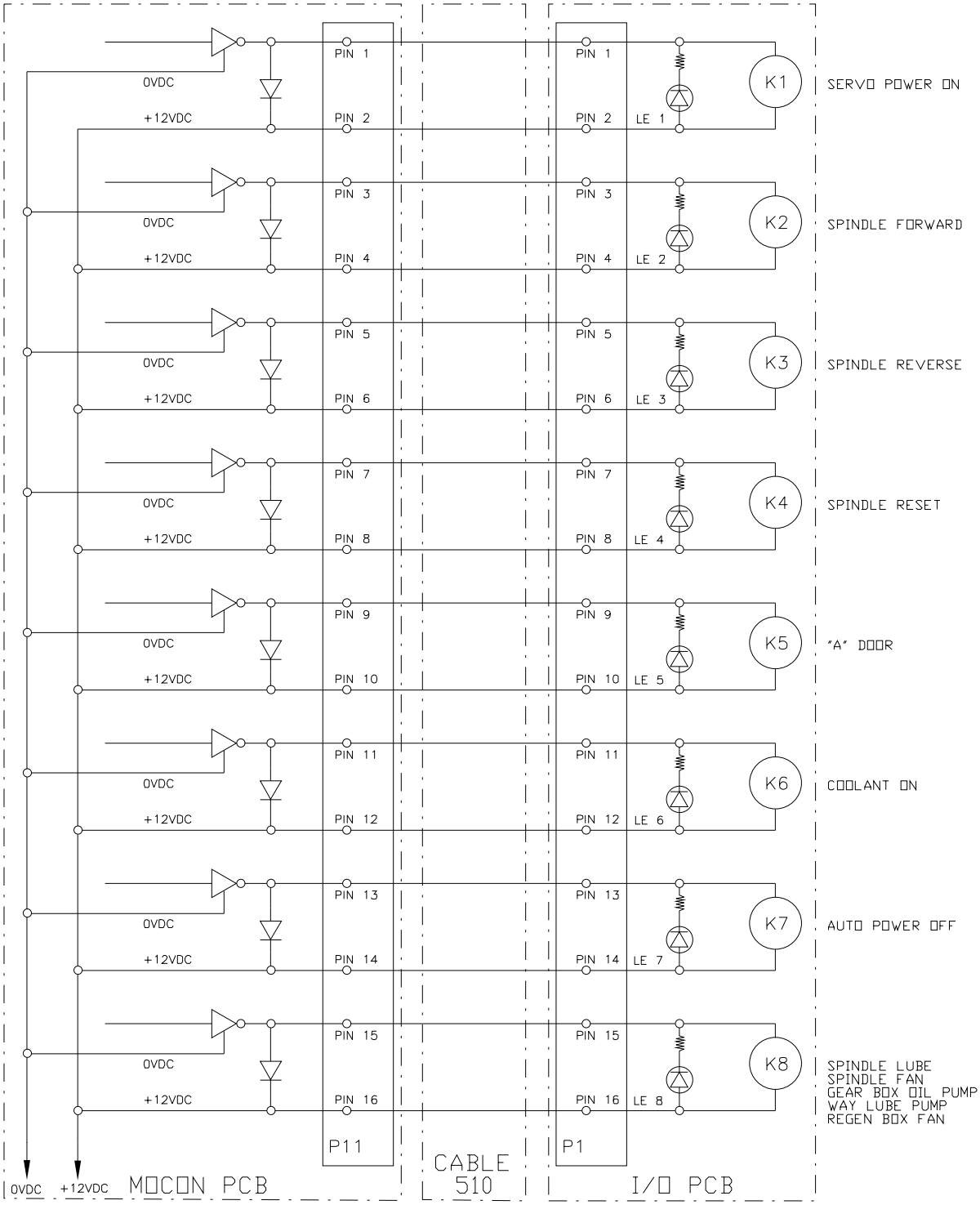
DISCRETE INPUTS 1 THROUGH 16

6/98 HAAS AUTOMATION HL SERIES PAGE 6



DISCRETE INPUTS 17 THROUGH 32

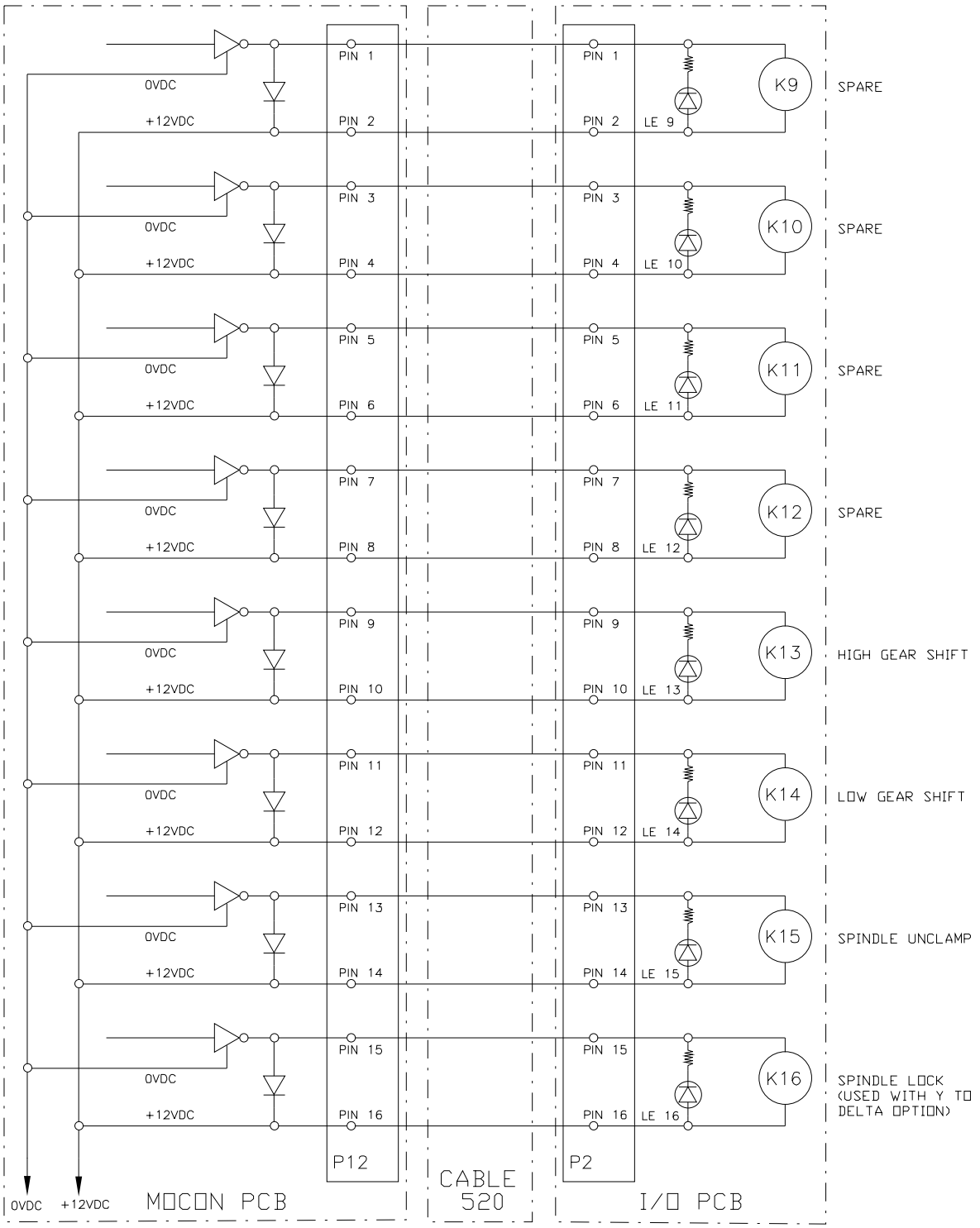
6/98 HAAS AUTOMATION HL SERIES PAGE 7



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

RELAY COIL DRIVERS, K1 THROUGH K8

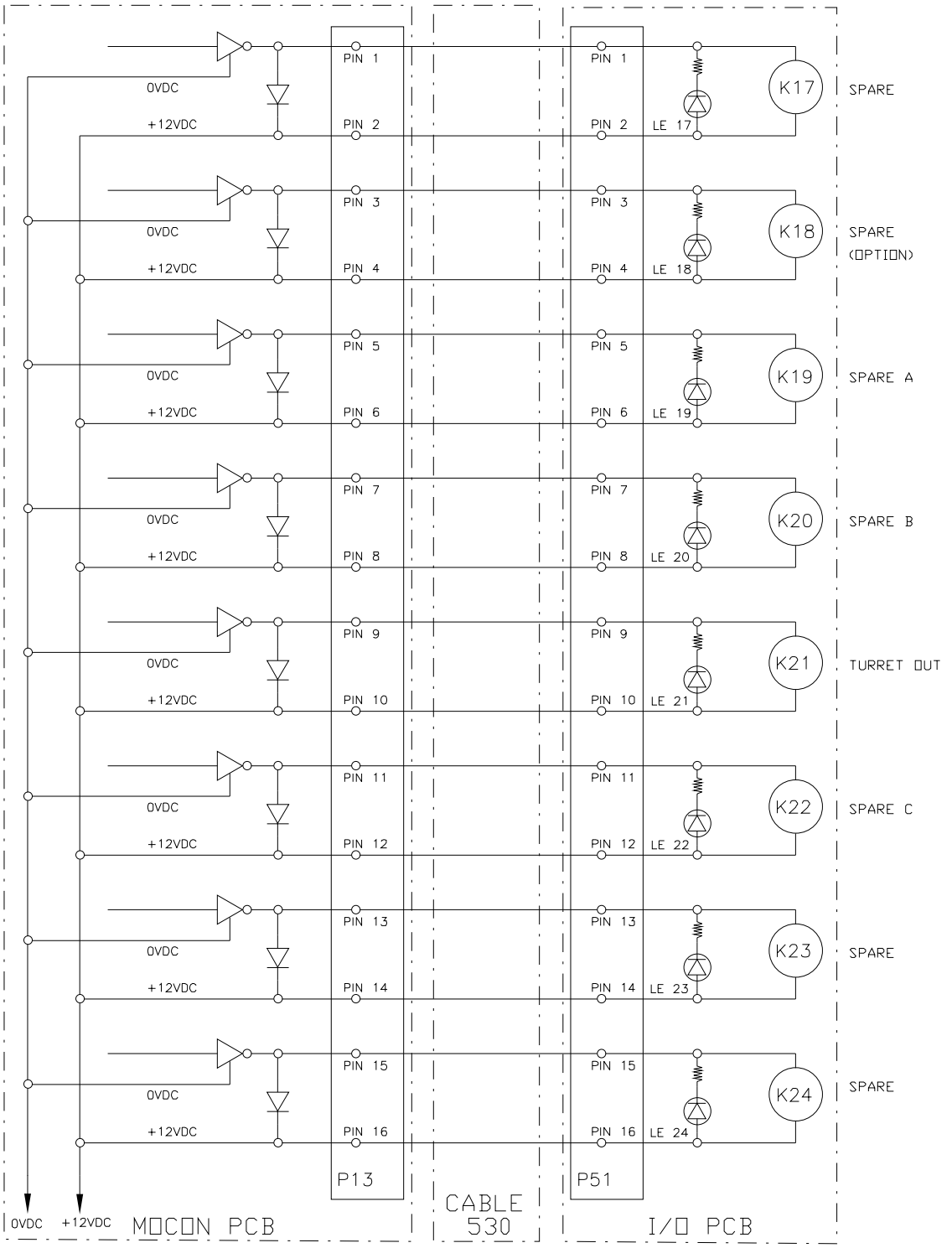
6/98 HAAS AUTOMATION HL SERIES PAGE 8



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

RELAY COIL DRIVERS, K9 THROUGH K16

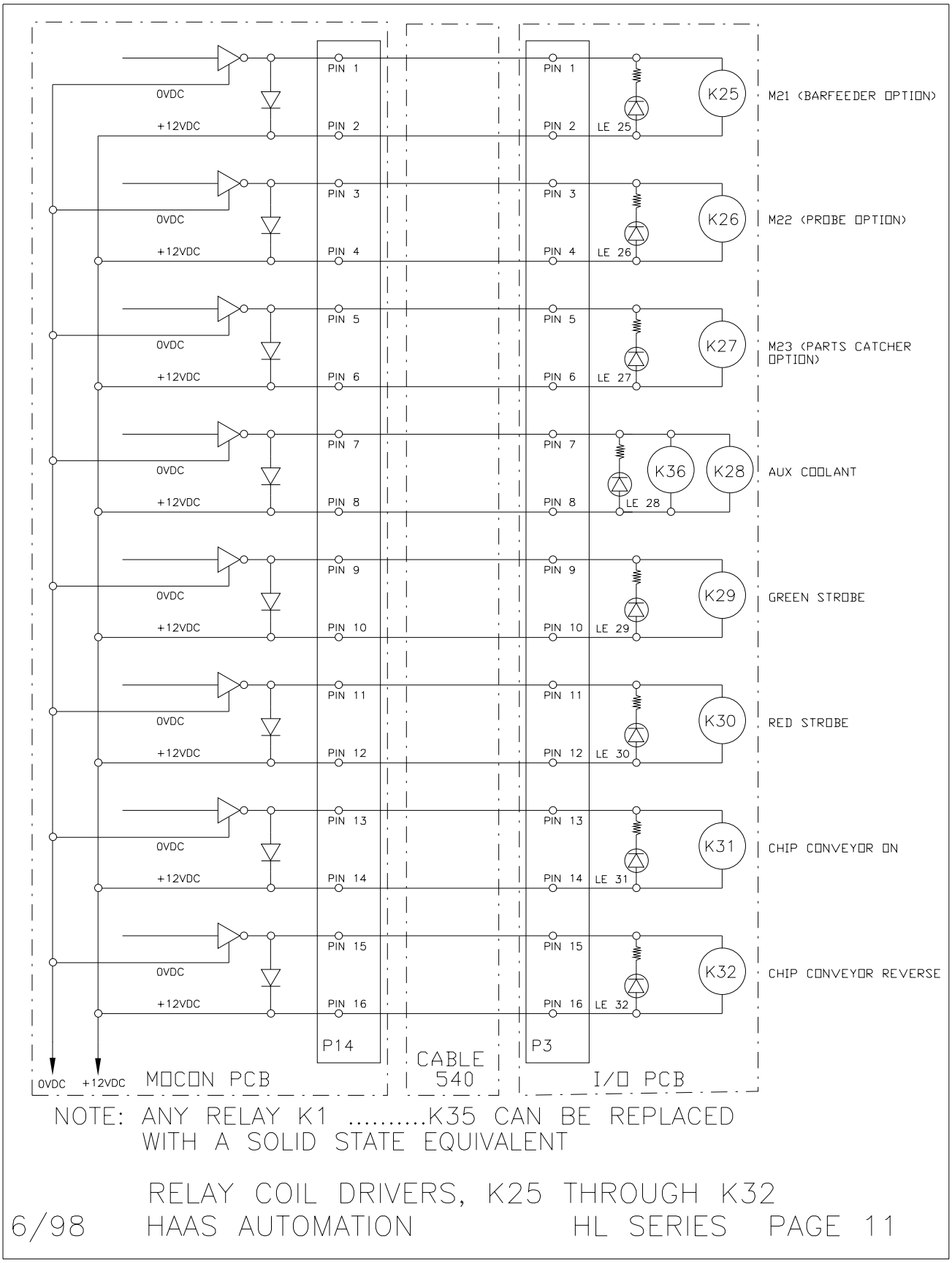
6/98 HAAS AUTOMATION HL SERIES PAGE 9



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

RELAY COIL DRIVERS, K17 THROUGH K24

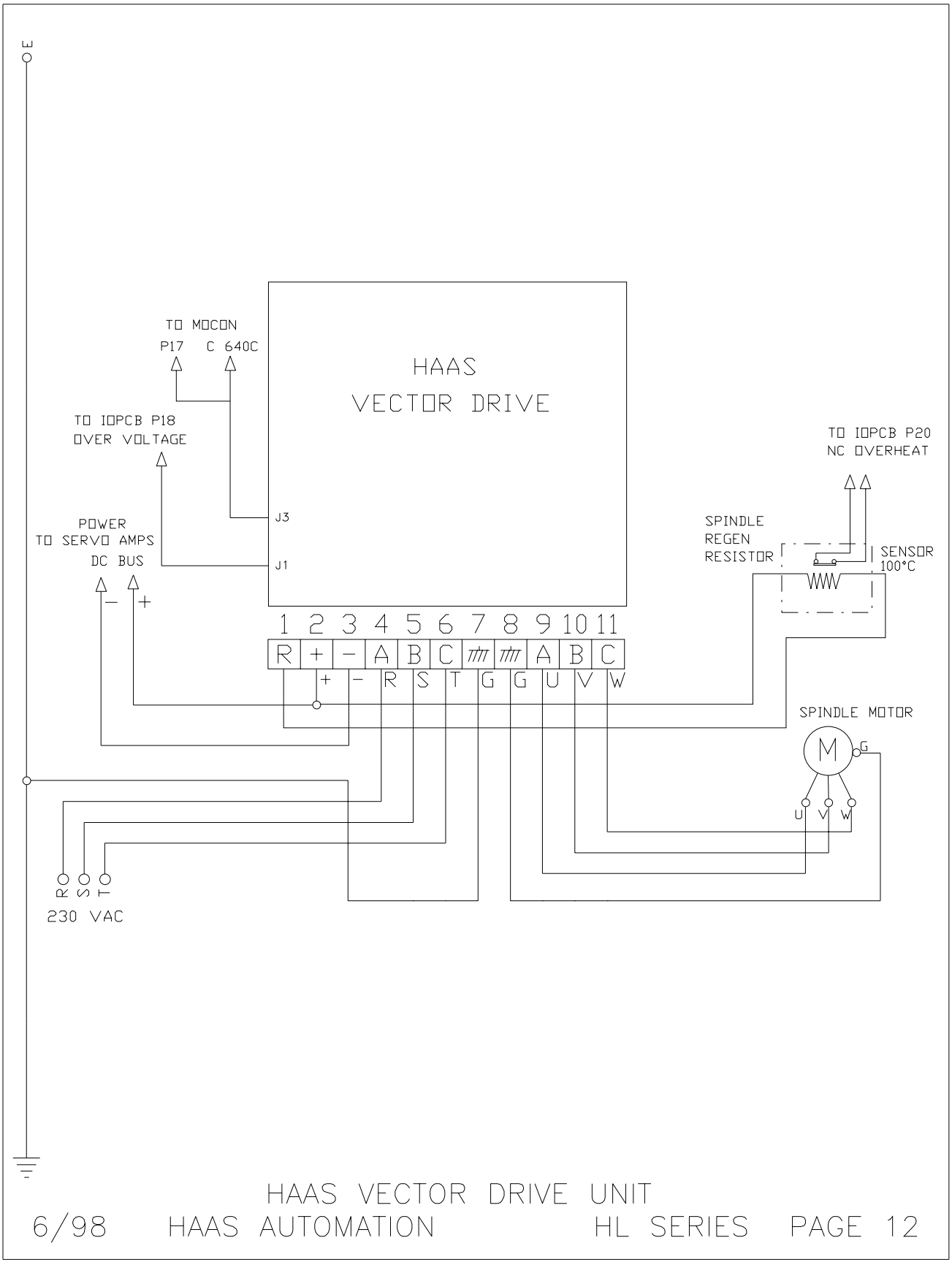
6/98 HAAS AUTOMATION HL SERIES PAGE 10

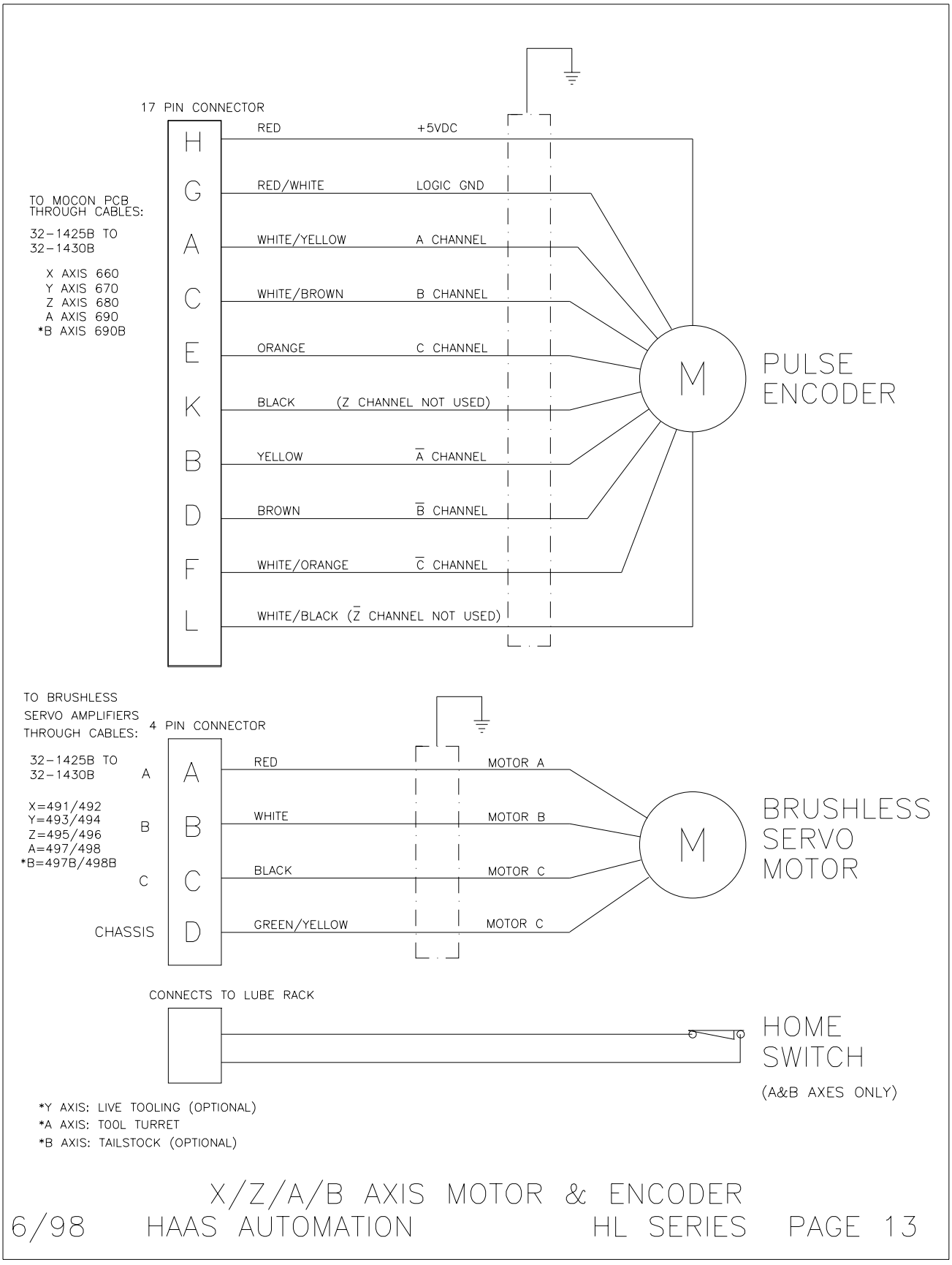


NOTE: ANY RELAY K1 .....K35 CAN BE REPLACED WITH A SOLID STATE EQUIVALENT

RELAY COIL DRIVERS, K25 THROUGH K32

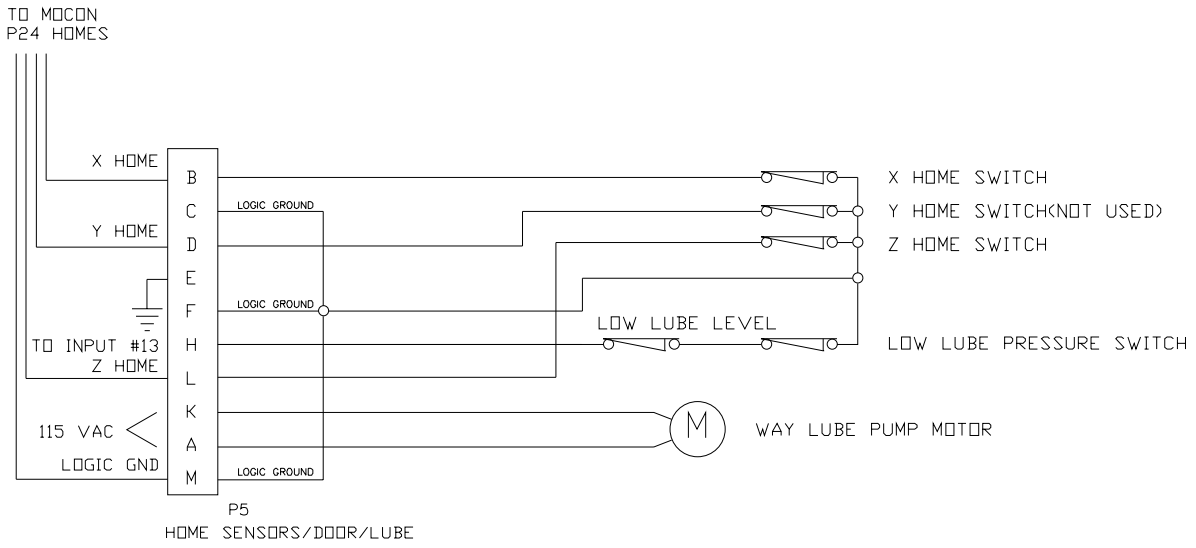
6/98 HAAS AUTOMATION HL SERIES PAGE 11

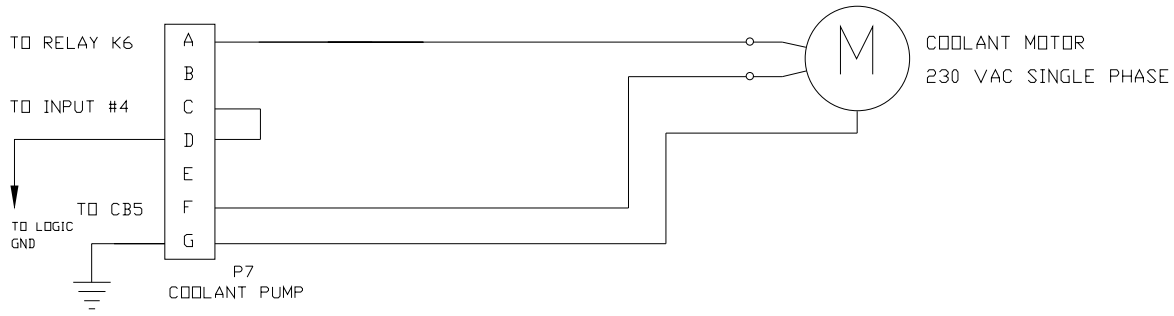

E
TO MOCON
P17 C 640C
HAAS
VECTOR DRIVE
TO IOPCB P18
OVER VOLTAGE
TO IOPCB P20
NC OVERHEAT
POWER
TO SERVO AMPS
DC BUS
J3
J1
SPINDLE
REGEN
RESISTOR
SENSOR
100°C
1 2 3 4 5 6 7 8 9 10 11
R + − A B C A B C
+ − R S T G G U V W
SPINDLE MOTOR
M
G
U V W
R S T
230 VAC
HAAS VECTOR DRIVE UNIT
6/98 HAAS AUTOMATION HL SERIES PAGE 12



X/Z/A/B AXIS MOTOR & ENCODER

6/98 HAAS AUTOMATION HL SERIES PAGE 13

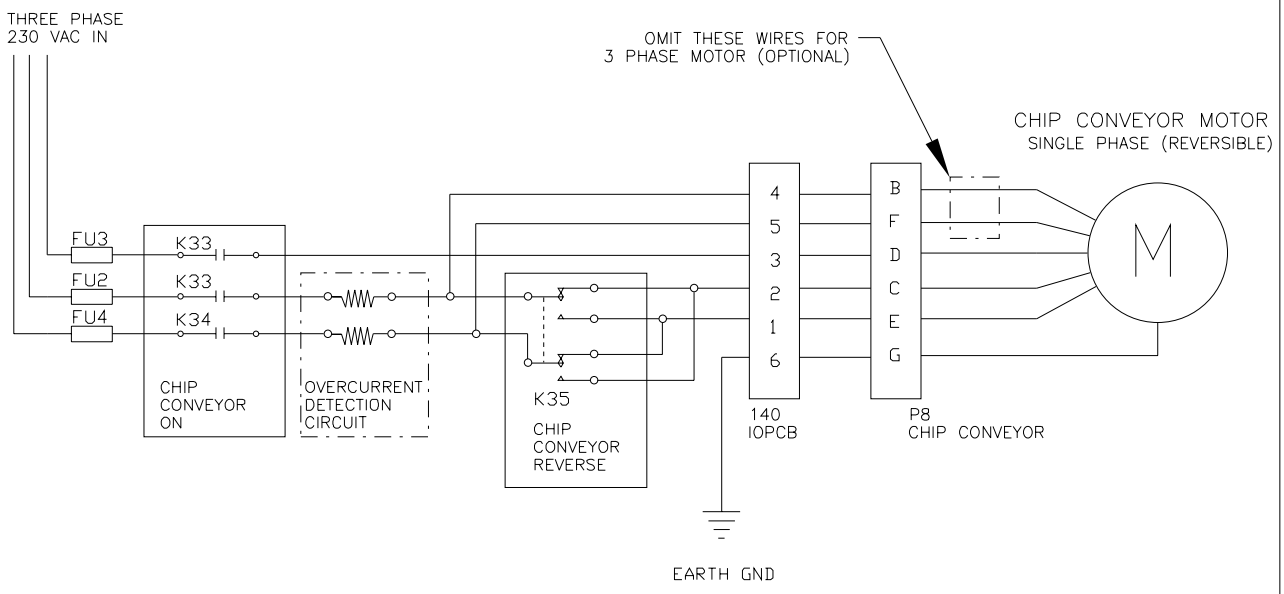




NOTE: CONNECTORS ARE LOCATED ON SIDE OF CONTROL CABINET.

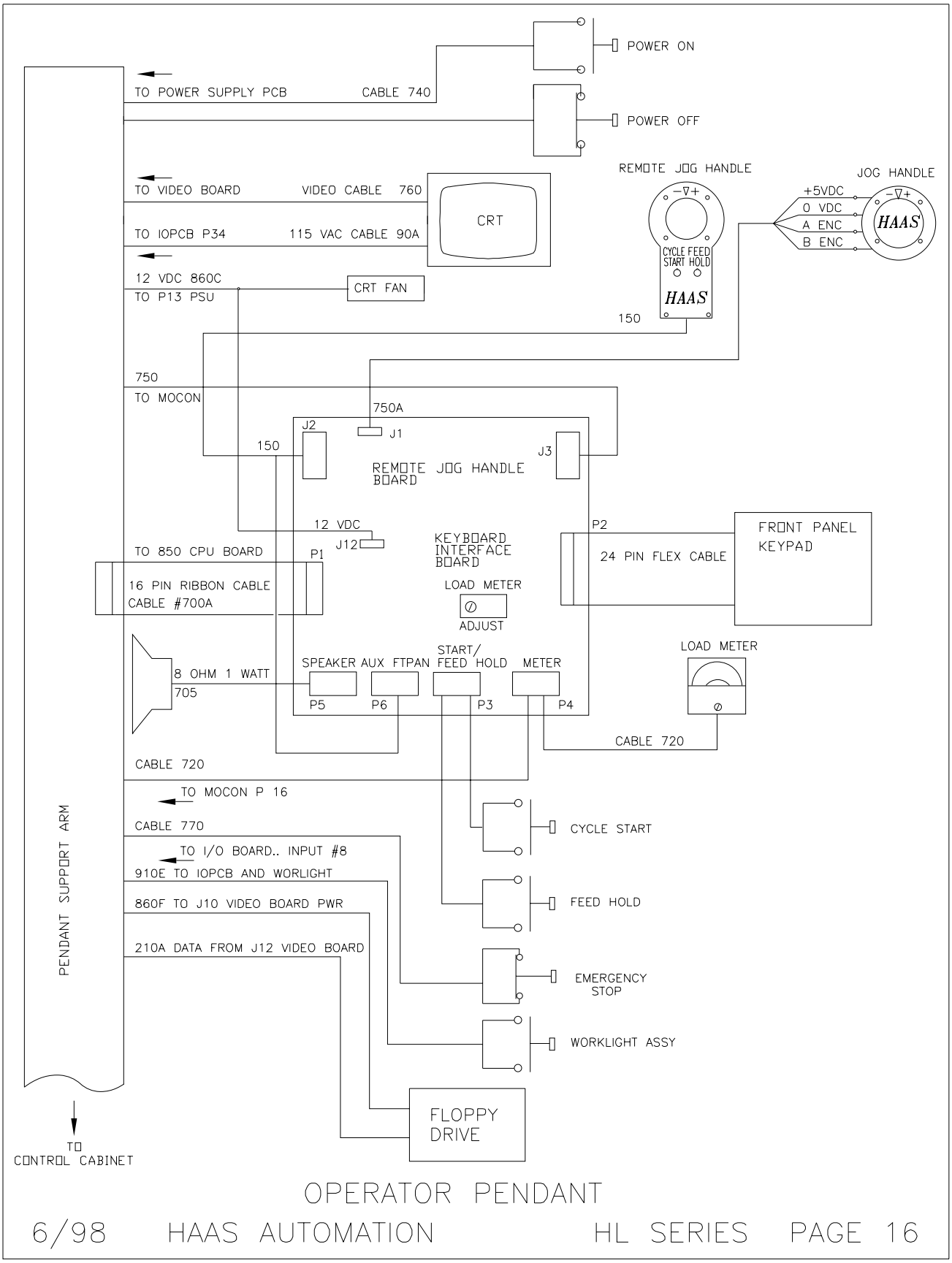
CABINET CONNECTORS

6/98 HAAS AUTOMATION HL SERIES PAGE 14



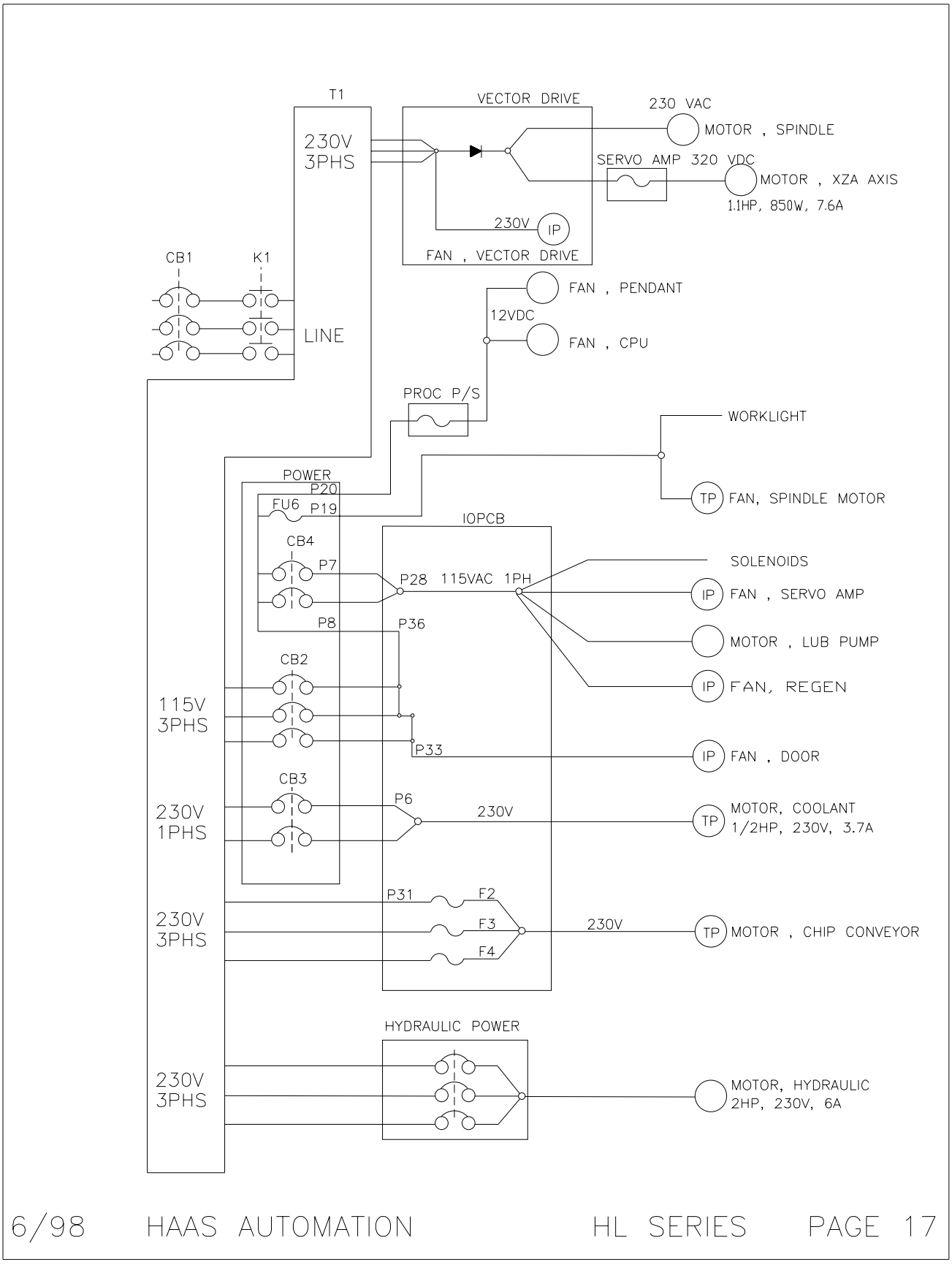
CHIP CONVEYOR MOTOR

6/98 HAAS AUTOMATION HL SERIES PAGE 15



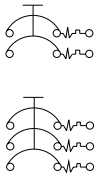
OPERATOR PENDANT

6/98 HAAS AUTOMATION HL SERIES PAGE 16

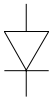


6/98 HAAS AUTOMATION HL SERIES PAGE 17

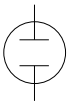

CIRCUIT BREAKER (SINGLE)

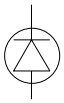

CIRCUIT BREAKER (MULTI)

COIL


DIODE


GROUND

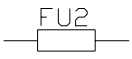

LAMP (FLOURESCENT)


LED (LIGHT EMITTING DIODE)


LIMIT SWITCH (CLOSED)


LIMIT SWITCH (OPEN)

MOTOR



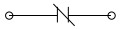
FUSE

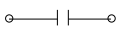

VARISTOR

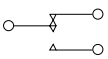

NEON BULB (W/ RESISTOR)


PUSH BUTTON SWITCH (NORMALLY CLOSED)

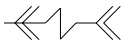

PUSH BUTTON SWITCH (NORMALLY OPEN)


RELAY (CLOSED)

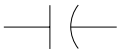

RELAY (OPEN)

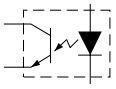

RELAY (SINGLE POLE DOUBLE THROW)


RESISTOR


SOLENOID


TRANSFORMER

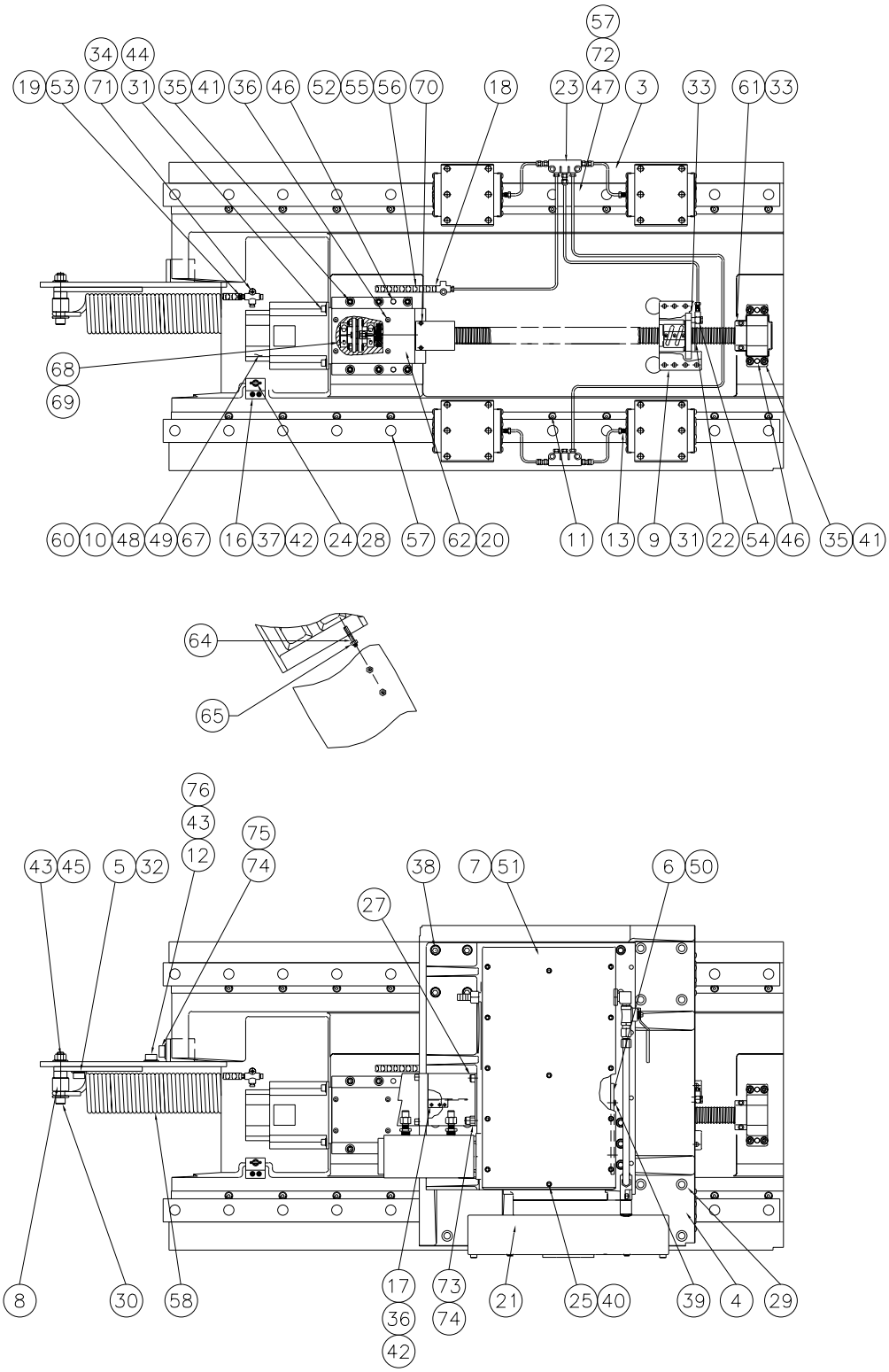

CAPACITOR


OPTO–ISOLATOR

ELECTRICAL SYMBOLS

6/98 HAAS AUTOMATION HL SERIES PAGE 18

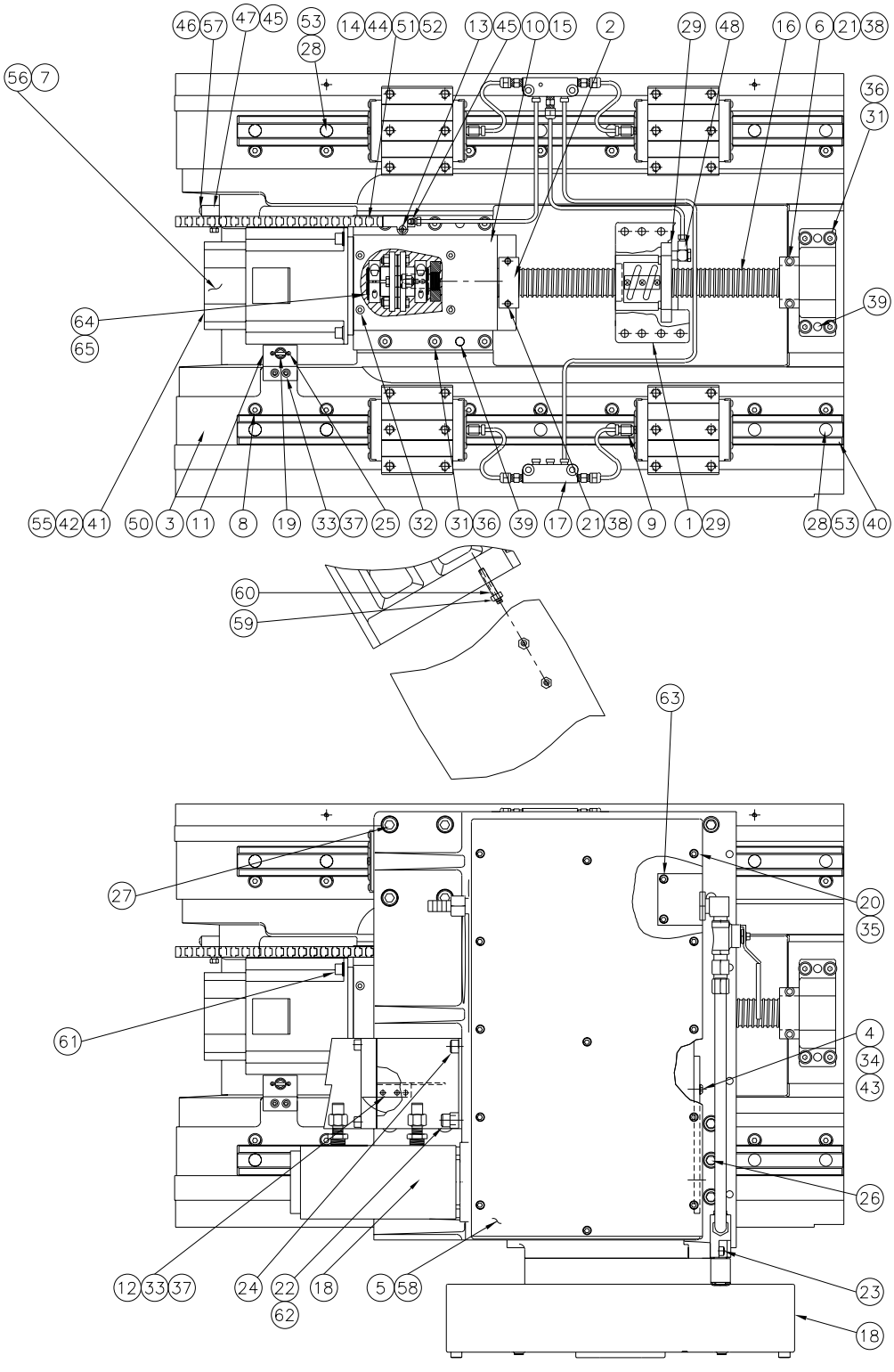
ASSEMBLY DRAWINGS



HL-5/6 Wedge Assembly

30-0058 WEDGE ASSY, HL-5,6

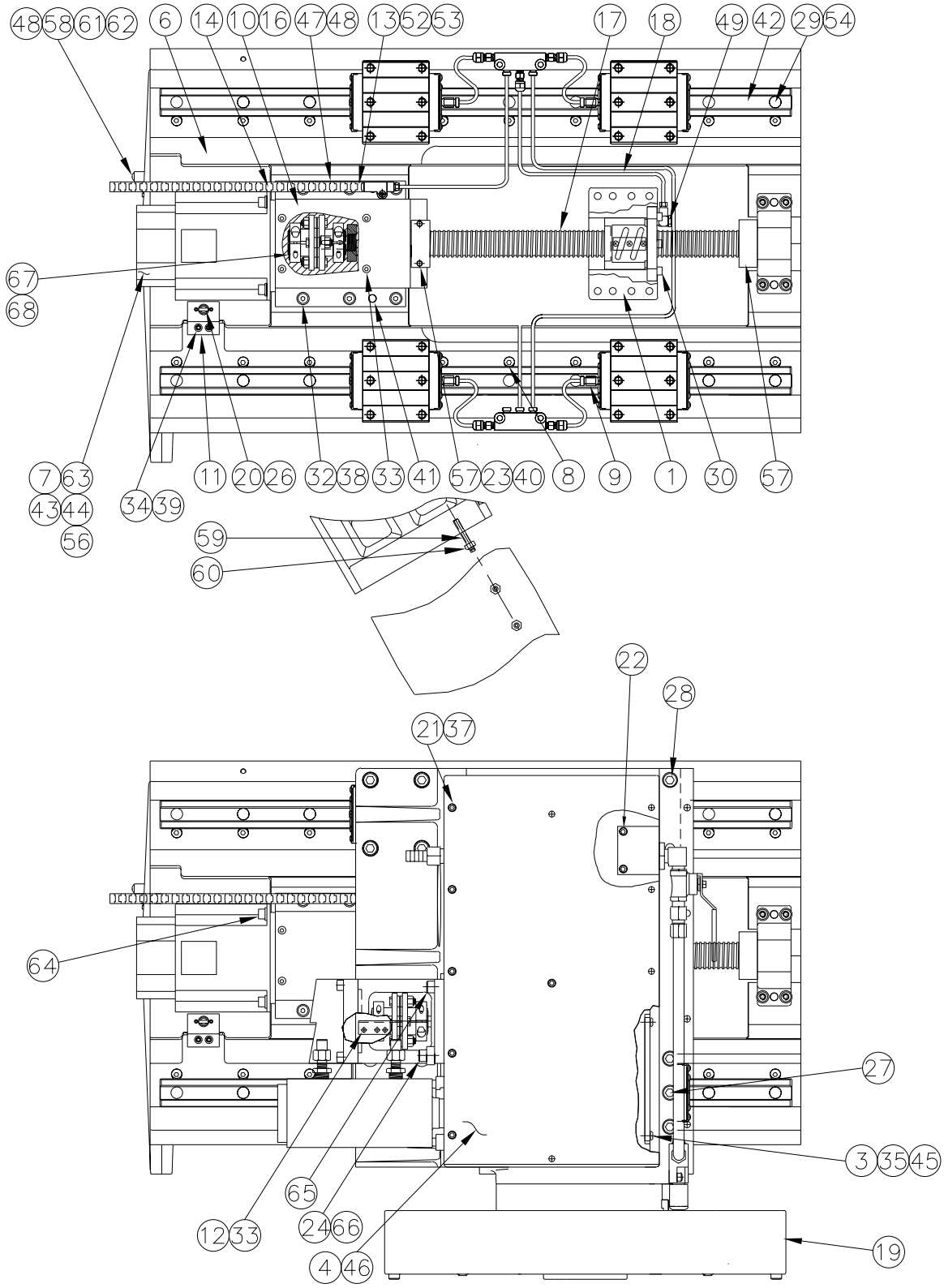
ITEM	QTY	PART NO.	TITLE
1	*	20-7185	-REMOVED- BUMPER
2	*	20-7186	-REMOVED- BUMPER
3	1	20-8202	CARRIAGE MACHINED, HL-5,-6
4	1	20-8204	X-RISER, MACHINED
5	2	20-8289	LINK ROTATING SPRING, T/C
6	1	20-8535	PLATE, ACCESS, T/C
7	1	20-8545	COVER, HOUSING, T/C
8	2	20-8721	BUSHING, SWING ARM, SPRING
9	1	20-9007	NUT HOUSING
10	1	22-2629	KEY .1875/.1870 SQUARE
11	22	22-7458	CAM, LINEAR GUIDE
12	1	22-8280	BRACKET, SPRING, T/C
13	4	24-7325	STR FIT-METRIC, LINEAR GUIDE
14	*	25-7042	-REMOVED- COVER PLATE / LEAD SCREW
15	*	25-7080	-REMOVED- BUMPER BRACKET
16	1	25-7267	Y AXIS MOUNTING BRACKET (USED ON X-LIMIT SWITCH)
17	1	25-7459	TRIP BRACKET, TABLE
18	1	25-7485	BRACKET, OIL LINE CARRIER, LFT
19	1	25-7486	BRACKET, OIL LINE CARRIER, RGT
20	1	26-7233A	GASKET, DEFLECTOR SHIELD
21	1	30-0057	TOOL CHANGER ASSEMBLY
22	1	30-0118	BL LEAD SCREW ASSEMBLY
23	1	30-8330	X-AXIS OIL LINE ASSEMBLY
24	1	32-2063	LIMIT SWITCH X HOME
25	13	40-1610	SHCS, 1/4-20 x 1"
26	*	40-1632	-REMOVED- SHCS, 1/4-20 x 1/2"
27	3	40-1639	SHCS, 3/8-16 x 1"
28	2	40-16413	MSHCS, M3 x 5
29	16	40-16548	MSHCS, M12 x 50
30	2	40-16627	SHCS, 1/2-13 x 3 1/2"
31	8	40-1500	SHCS, 5/16-18 x 1"
32	2	43-16011	HHB, 1/2-13 x 1"
33	7	40-1697	SHCS, 1/4-20 x 3/4"
34	5	40-1705	FHCS, 10-32 x 1
35	20	40-1715	SHCS, 5/16-18 x 1 1/2
36	6	40-1750	BHCS, 10-32 x 3/8
37	2	40-1850	SHCS, 10-32 x 3/8
38	18	40-1960	SHCS, 3/8-16 x 1 3/4
39	4	40-1976	BHCS, 1/4-20 x 3/4
40	13	45-0040	WASHER, BLK HARD, 1/4 A325
41	10	45-1600	WASHER, SPLIT LOCK, 5/16 MED.
42	2	45-1620	WASHER, SPLIT LOCK, #10 MED.
43	20	45-1740	WASHER, BLK HARD, 1/2
44	*	45-1800	-REMOVED- WASHER, SPLIT LOCK, 1/4 MED.
45	2	46-1720	NUT, HEX, 1/2-13, PLATED
46	4	48-0045	PIN, PULL, 3/8 x 1 1/2
47	2	50-9011	LINEAR GUIDE
48	1	57-0075	O-RING, 2-021 BUNA
49	1	57-0080	O-RING, 2-023 BUNA
50	1	57-8546	GASKET, PLATE ACCESS, T/C
51	1	57-8576	GASKET, COVER, T/C
52	1.5FT	58-2010	NYLON TUBING, 5/32 IN CL
53	2	58-2130	SLEEVE, COMP NYLON TUBING
54	1	58-3031	BANJO ELBOW, 5/16 F x M6 M
55	2	59-6150A	PLASTIC CARRIER SEALED
56	2	59-6153	PLASTIC CARRIER ENDS
57	22	59-6655	RUBBER PLUG, GUIDE RAIL
58	2	59-8220	SPRING, CROSS SLIDE
59	*	62-0013	-REMOVED- SERVO MOTOR, YASKAWA
60	0.05	99-4521	ELECTRICAL GREASE, 3 OZ TUBE
61	2	20-7474	BUMPER X-AXIS BLUE VF-2
62	1	25-7042A	SNAP LOCK MTR MNT CVR PLT
63	1	40-1643	SHCS 3/8-16 X 2 1/2 BLK. OX.
64	4	44-1717	SSS CUP PT. 1/4-20 X 1 3/4
65	4	46-1625	NUT HEX BLK OX 1/4-20
66	*	46-1730	-REMOVED- NUT HEX 3/8-16
67	1	62-0014	YASKAWA SIGMA MOTOR 09
68	1	30-1220A	COUPLING ASSEMBLY, SERVO DRIVE
69	1	22-2629	KEY SUB SHAFT/WORM SHAFT
70	1	20-0141	SNAP LOCK RING BUMPER 4"
71	1	58-2763	3-WAY JUNCTION
72	22	40-1660	SHCS 1/2-13 X 1 1/2"
73	1	20-8364	SPACER
74	5	40-1636	SHCS 3/8-16 X 1 1/4"
75	2	45-1730	WASHER, 3/8 BLACK ANODIZE X 1/8 THK.
76	2	40-1654	SHCS 1/2-13 X 1"



HL-1/2 Wedge Assembly

30-2610A WEDGE ASSY

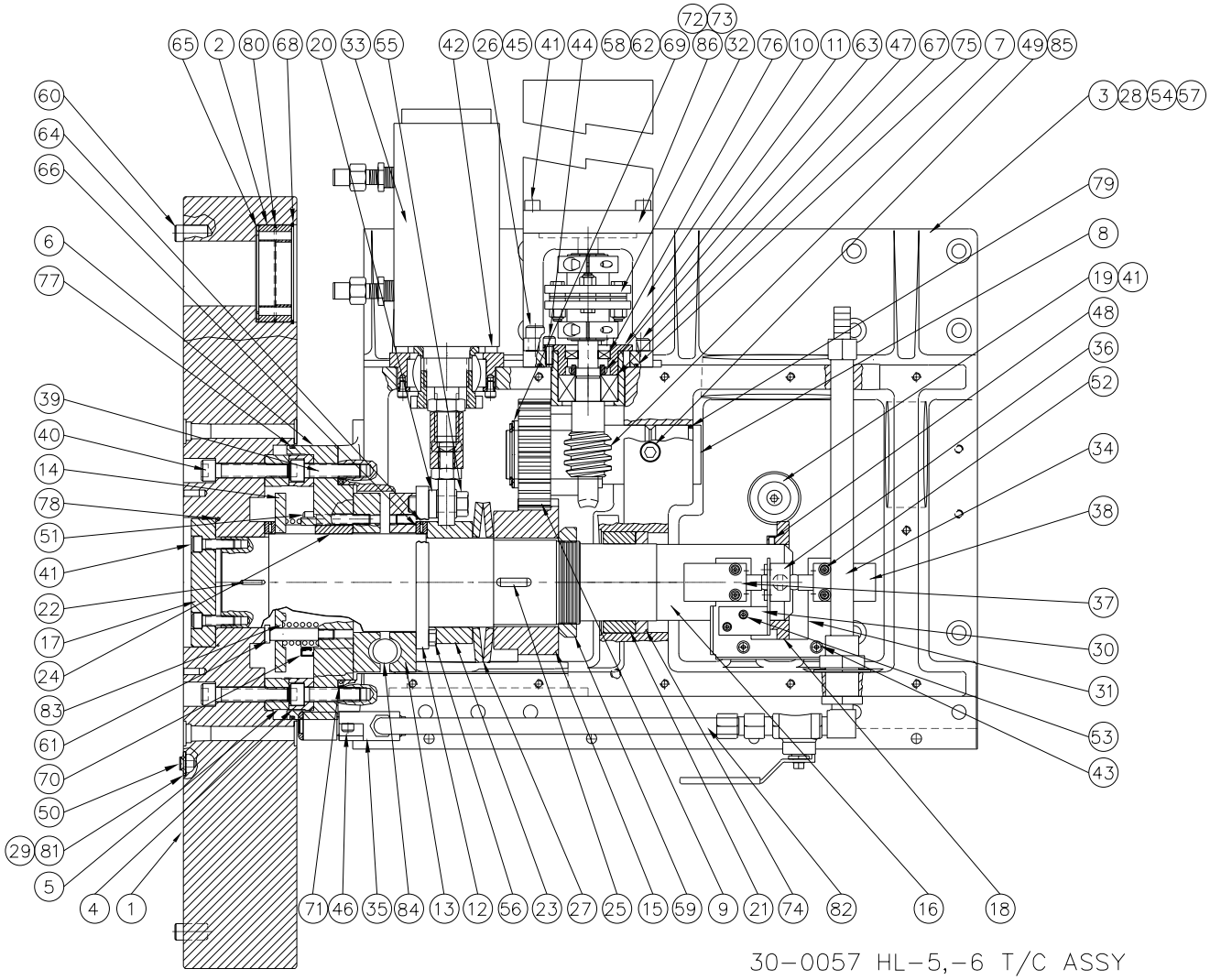
ITEM	QTY	PART NO.	TITLE
1	1	20-7008F	NUT HOUSING, LD SCREW ASSY
2	1	20-7185	BUMPER, Z AXIS, MTR END
3	1	20-8502	CARRIAGE MACHINED
4	1	20-8535	PLATE, ACCESS, T/C
5	1	20-8545	COVER, HOUSING, T/C
6	1	20-8723	BUMPER, SUPPORT END, X-AXIS
7	1	22-2629	KEY, 0.1875/0.1870 SQ.
8	18	22-7458	CAM SCREW, LINEAR GUIDE
9	4	24-7325	STR FIT METRIC, LINEAR GUIDE
10	1	25-7042	COVER PLATE/LD SCREW
11	1	25-7266	X AXIS MOUNT BRACKET
12	1	25-7459	TRIP BRACKET, TABLE
13	1	25-7485	BRACKET, OIL LINE CARRIER, LEFT
14	1	25-7486	BRACKET, OIL LINE CARRIER, RIGH
15	1	26-7233A	GASKET, DEFLECTOR SHEILD
16	1	30-1290A	LEAD SCREW ASSY
17	1	30-8716	X AXIS OIL LINE ASSEMBLY
18	1	30-9700	TOOL CHANGER ASSEMBLY
19	1	32-2051	LIMIT SWITCH X HOME
20		40-1610	SHCS, 1/4-20 x 1"
21		40-1632	SHCS, 1/4-20 x 1/2"
22	1	40-1636	SHCS, 3/8-16 x 1 1/4"
23		40-16385	SHCS, 5/16-18 x 3/4"
24	3	40-1639	SHCS, 3/8-16 x 1"
25		40-16413	MSHCS, M3 x 5
26		40-16582	SHCS, M10 x 35
27		40-16583	SHCS, M10 x 45
28		40-1667	SHCS, 5/16-18 x 1 1/4"
29		40-1697	SHCS, 1/4-20 x 3/4"
30	*	40-1705	-REMOVED- FHCS, 10-32 x 1"
31		40-1715	SHCS, 5/16-18 x 1 1/2"
32		40-1750	BHCS, 10-32 x 3/8"
33		40-1850	SHCS, 10-32 x 3/8"
34		40-1976	BHCS, 1/4-20 x 3/4"
35		45-0040	WASHER, BLK HARD 1/4
36		45-1600	WASHER, SPLIT LOCK, 5/16 MED
37		45-1620	WASHER, SPLIT LOCK #10 MED
38		45-1800	WASHER, SPLIT LOCK, 1/4" MED
39	4	48-0045	PIN PULL, 3/8 x 1 1/2"
40	2	50-8549	LINEAR GUIDE
41	1	57-0075	O-RING, 2-021 BUNA
42	1	57-0080	O-RING, 2-023 BUNA
43	1	57-8546	GASKET, PLATE ACCESS
44	1.2'	58-2010	NYLON TUBING, 5/32 IN
45	2	58-2110	SLEEVE NUTS LUBE ASSY
46	2	58-2130	SLEEVE COMP NYLON TUBING
47	1	58-2763	3-WAY JUNCTION
48	1	58-3031	BANJO ELBOW, 5/16 F x M6 M
49	*	58-3105	-REMOVED- PIPE PLUG, 1/4 NPT
50	*	58-8663	-REMOVED-TUBING, TRANS Z- X
51	0.8'	59-6150A	PLASTIC CARRIER 0130.06
52	2	59-6153	PLASTIC CARRIER ENDS
53	18	59-6600	PLUG, GUIDE RAIL
54	*	62-0013	-REMOVED- SERVO MOTOR YASKAWA
55	0.05	99-4521	ELECTRICAL GREASE 3 OZ TUBE
56	1	62-0014	YASKAWA SIGMA MOTOR 09
57	1	40-16091	BHCS 10-32 x 1"
58	1	57-8576	GASKET COVER T/C
59	4	46-1625	NUT HEX BLACK OXIDE 1/4-20
60	4	44-1717	SSS CUP PT. 1/4-20 X 1 3/4"
61	4	40-1500	SHCS, 5/16-18 X 1"
62	1	20-8364	SPACER
63	2	40-1631	SHCS, 1/4-20 x 3/8"
64	1	30-1220A	COUPLING ASSEMBLY, SERVO DRIVE
65	1	22-2629	KEY SUB SHAFT/WORM SHAFT



HL-3/4 Wedge Assembly

30-2620A WEDGE ASSEMBLY

IT	QTY	PART NO.	TITLE
1	1	20-7008F	NUT HOUSING, LD SCREW ASSY
2	*	20-7185	-REMOVED- BUMPER, Z AXIS, MTR END
3	1	20-8535	PLATE, ACCESS, T/C
4	1	20-8545	COVER, HOUSING, T/C
5	*	20-8723	-REMOVED- BUMPER, SUPPORT END
6	1	20-8752	CARRIAGE
7	1	22-2629	KEY, 0.1875/0.1870 SQ.
8	20	22-7458	CAM SCREW, LINEAR GUIDE
9	4	24-7325	STR FIT METRIC, LINEAR GUIDE
10	1	25-7042	COVER PLATE/LD SCREW
11	1	25-7266	X AXIS MOUNT BRACKET
12	1	25-7459	TRIP BRACKET, TABLE
13	1	25-7485	BRACKET, OIL LINE CARRIER, LEFT
14	1	25-7486	BRACKET, OIL LINE CARRIER, RIGHT
15	*	25-8620	-REMOVED-CONNECTOR PLATE, T/C
16	1	26-7233A	GASKET, DEFLECTOR SHIELD
17	1	30-1295A	LEAD SCREW ASSY
18	1	30-8716	X-AXIS OIL LINE ASSY
19	1	30-9700	BL TOOL CHANGER ASSY, HL-3,-4
20	1	32-2051	LIMIT SWITCH X HOME
21	6	40-1610	SHCS, 1/4-20 x 1"
22	2	40-1631	SHCS, 1/4-20 x 3/8"
23	4	40-1632	SHCS, 1/4-20 x 1/2"
24	1	40-1636	SHCS, 3/8-16 x 1 1/4"
25	3	40-16385	SHCS, 5/16-18 x 3/4"
26	2	40-16413	MSHCS, M3 x 5
27	2	40-16582	SHCS, M10 x 35
28	17	40-16583	SHCS, M10 x 45
29	22	40-1667	SHCS, 5/16-18 x 1 1/4"
30	5	40-1697	SHCS, 1/4-20 x 3/4"
31	*	40-1705	-REMOVED- FHCS, 10-32 x 1"
32	10	40-1715	SHCS, 5/16-18 x 1 1/2"
33	4	40-1750	BHCS, 10-32 x 3/8"
34	4	40-1850	SHCS, 10-32 x 3/8"
35	2	40-1976	BHCS, 1/4-20 x 3/4"
36	2	40-1978	BHCS, 1/4-20 x 1 1/2"
37	4	45-0040	WASHER, BLK HARD 1/4
38	14	45-1600	WASHER, SPLIT LOCK, 5/16 MED
39	4	45-1620	WASHER, SPLIT LOCK #10 MED
40	2	45-1800	WASHER, SPLIT LOCK, 1/4" MED
41	1	48-0045	PIN PULL, 3/8 x 1 1/2"
42	2	50-8766	LINEAR GUIDE
43	1	57-0075	O-RING, 2-021 BUNA
44	1	57-0080	O-RING, 2-023 BUNA
45	2	57-8546	GASKET, PLATE ACCESS
46	1	57-8576	GASKET, COVER, T/C
47	1.5FT	58-2010	NYLON TUBING, 5/32"
48	2	58-2130	SLEEVE COMP NYLON TUBING
49	1	58-3031	BANJO ELBOW, 5/16 F x M6 M
50	*	58-3105	-REMOVED- PIPE PLUG, 1/4 NPT
51	*	58-8663	-REMOVED- TUBING, TRANS Z- X
52	2.0FT	59-6150A	PLASTIC CARRIER 0130.06
53	2	59-6153	PLASTIC CARRIER ENDS
54	20	59-6600	PLUG, GUIDE RAIL
55	*	62-0013	-REMOVED- SERVO MOTOR, YASKAWA
56	0.05	99-4521	ELECTRICAL GREASE 3 OZ. TUBE
57	2	20-7474	BUMPER X-AXIS BLUE VF-2
58	1	40-16091	BHCS 10-32 x 1"
59	4	44-1717	SSS CUP PT. 1/4-20 X 1 3/4"
60	4	46-1625	NUT HEX BLACK OXIDE 1/4-20
61	1	58-2110	SLEEVE NUTS LUBE ASSY
62	1	58-2763	3-WAY JUNCTION
63	1	62-0014	YASKAWA SIGMA MOTOR 09
64	4	40-1500	SHCS, 5/16-18 x 1"
65	3	40-1639	SHCS, 3/8-16 x 1"
66	1	20-8364	SPACER
67	1	30-1220A	COUPLING ASSEMBLY, SERVO DRIVE
68	1	22-2629	KEY SUB SHAFT/WORM SHAFT

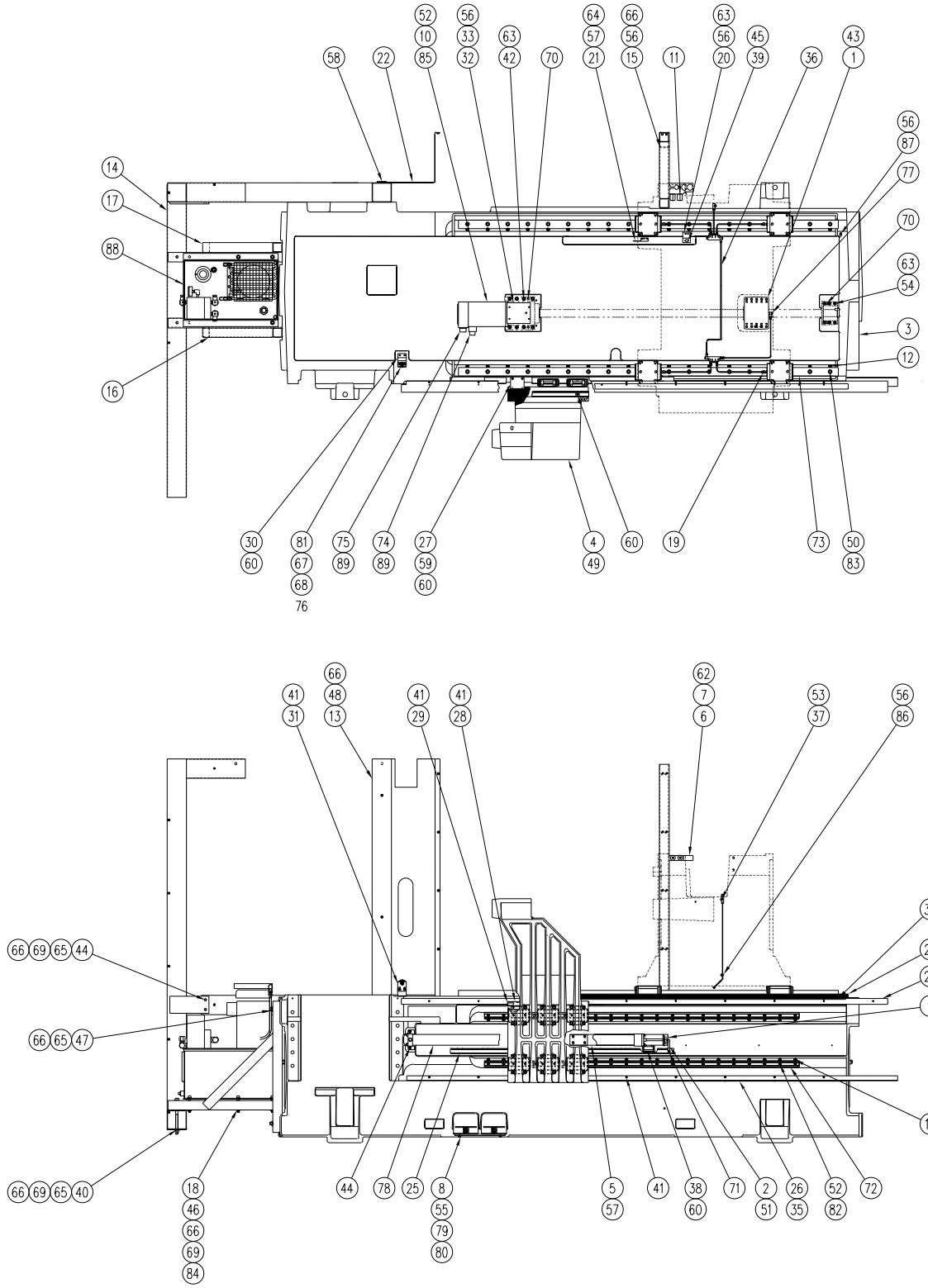


HL-5/6 Tool Changer

30-0057 TOOL CHANGER ASSY, HL-1, 2

ITEM	QTY	DWG_NUMBER	TITLE
1	1	20-8221	TURRET, T/C
2	10	20-8321	NUT, TOOL HOLDER
3	1	20-8503A	TOOL CHANGER HOUSING, MACHINED
4	1	20-8505A	COUPLING, TURRET FEMALE
5	1	20-8506A	COUPLING, TURRET MALE
6	1	20-8507A	MOUNT, COUPLING TURRET
7	1	20-8509	WORM, TOOL CHANGER
8	1	20-8510	SHAFT, TRANSFER T/C
9	1	20-8511A	GEAR, CLUSTER, T/C
10	1	20-8512A	WORM HOUSING, T/C
11	1	20-8515	CLAMP, BEARING, WORM, T/C
12	1	20-8516	LEVER CAM
13	2	20-8517	CAM, TURRET, T/C
14	1	20-8518	RETAINER, SPRINGS, T/C
15	1	20-8522A	GEAR, SPUR, T/C
16	1	20-8530	SHAFT, TURRET, T/C
17	1	20-8532	RETAINER TURRET, T/C
18	1	20-8533	RING, SWITCH, T/C
19	1	20-8537	RETAINER, SPRING, T/C
20	1	20-8538	SPACER, ROD END, T/C
21	1	20-8539	BEARING, REAR, T/C
22	1	20-8543	KEY, TURRET, T/C
23	1	20-8550	SPACER BELLEVILLE
24	1	20-8557	BUSHING FRONT, TURRET
25	1	20-8544	KEY, GEAR SPUR, T/C
26	1	22-9673	SPACER
27	2	24-4010	BELLEVILLE WASHER
28	1	25-7459	TRIP BRACKET, TABLE
29	10	25-8286	PLATE, COOLANT, TURRET
30	1	25-8534	BRACKET, HOME SWITCH
31	1	25-8536	BRACKET, LIMIT SWITCH, T/C
32	1	30-1220A	COUPLING ASSEMBLY
33	1	30-3650	AIR CYLINDER ASSY
34	1	30-3655	XFER COOLANT LINE ASSY
35	1	30-3660	XFER COOLANT TIP ASSY
36	1	32-2010	TELEMECH. 24 IN CABLE ASSY
37	1	32-2161	REED SWITCH, UNCLAMP
38	1	32-2162	REED SWITCH, CLAMP
39	10	40-0014	SHCS, 7/16-14 x 1 3/4”
40	10	40-0015	SHCS, 7/16-14 x 2 1/4”
41	10	40-1500	SHCS, 5/16-18 x 1
42	4	40-1610	SHCS, 1/4-20 x 1"
43	2	40-1631	SHCS, 1/4-20 x 3/8"
44	3	40-1632	SHCS, 1/4-20 x 1/2"
45	1	40-16372	SHCS, 3/8-16 x 1 1/2”
46	2	40-16385	SHCS, 5/16-18 x 3/4"
47	3	40-1639	SHCS, 3/8-16 x 1"
48	2	40-16403	SSS, CUP PT 10-32 x 1/4"
49	1	40-1643	SHCS, 3/8-16 x 2 1/2"
50	20	40-1703	FHCS, 10-32 x 1/2"

ITEM	QTY	DWG_NUMBER	TITLE
51	4	40-1716	SHCS, 5/16-18 x 1 3/4"
52	6	40-1800	SHCS, 8-32 x 3/4"
53	2	40-1801	SHCS, 8-32 x 3/8"
54	2	40-1850	SHCS, 10-32 x 3/8"
55	1	43-1614	HHB, 1/2-20 x 1 1/2"
56	2	43-7006	HHB, 5/16-18 x 1"
57	2	45-1620	WASHER, SPLIT LOCK #10 MEDIUM
58	2	45-2001	WASHER, ARBOR
59	1	46-7016	BEARING NUT, N-13
60	12	48-0049	PIN, PULL 1/2 x 1"
61	4	49-1010	SHOULDER BOLT, 3/8 x 1 1/2"
62	1	49-4115	WASHER, STEEL
63	1	51-2042	BEARING LOCK NUT, BH-04
64	4	51-2983	THRUST WASHER
65	10	51-2984	THRUST WASHER
66	2	51-3001	BEARING, THRUST NEEDLE ASSY
67	1	51-7001	BALL BEARING
68	10	56-2090	RETAIN RING, RR-300
69	1	56-9057	RETAIN RING, N5100-150
70	1	57-0029	SEAL, CR 29841
71	1	57-0030	O-RING, BUNA 2-258
72	1	57-0075	O-RING, 2-021 BUNA
73	1	57-0080	O-RING, 2-023 BUNA
74	1	57-1045	SEAL, TURRET SHAFT
75	1	57-2022	O-RING, 2-150 BUNA
76	1	57-2129	SEAL, WORM SHAFT
77	1	57-2150	O-RING, 2-172 PARKER
78	1	57-2154	O-RING, #240 ALL SEALS
79	1	57-2831	O-RING, 2-130 BUNA
80	10	57-2994	O'RING, 2-039N525-60 PRKR
81	10	57-8283	GASKET PLATE, COOLANT T/H
82	1	58-8657	TUBING, COOLANT FRONT
83	4	59-0035	DIE SPRING
84	3	59-2056	3/4 STEEL BALLS
85	1	59-2057	5/16 STEEL BALL
86	1	62-0013	SERVO MOTOR YASKAWA
87	0.05	99-4521	ELECTRICAL GREESE 3 OZ. TUBE

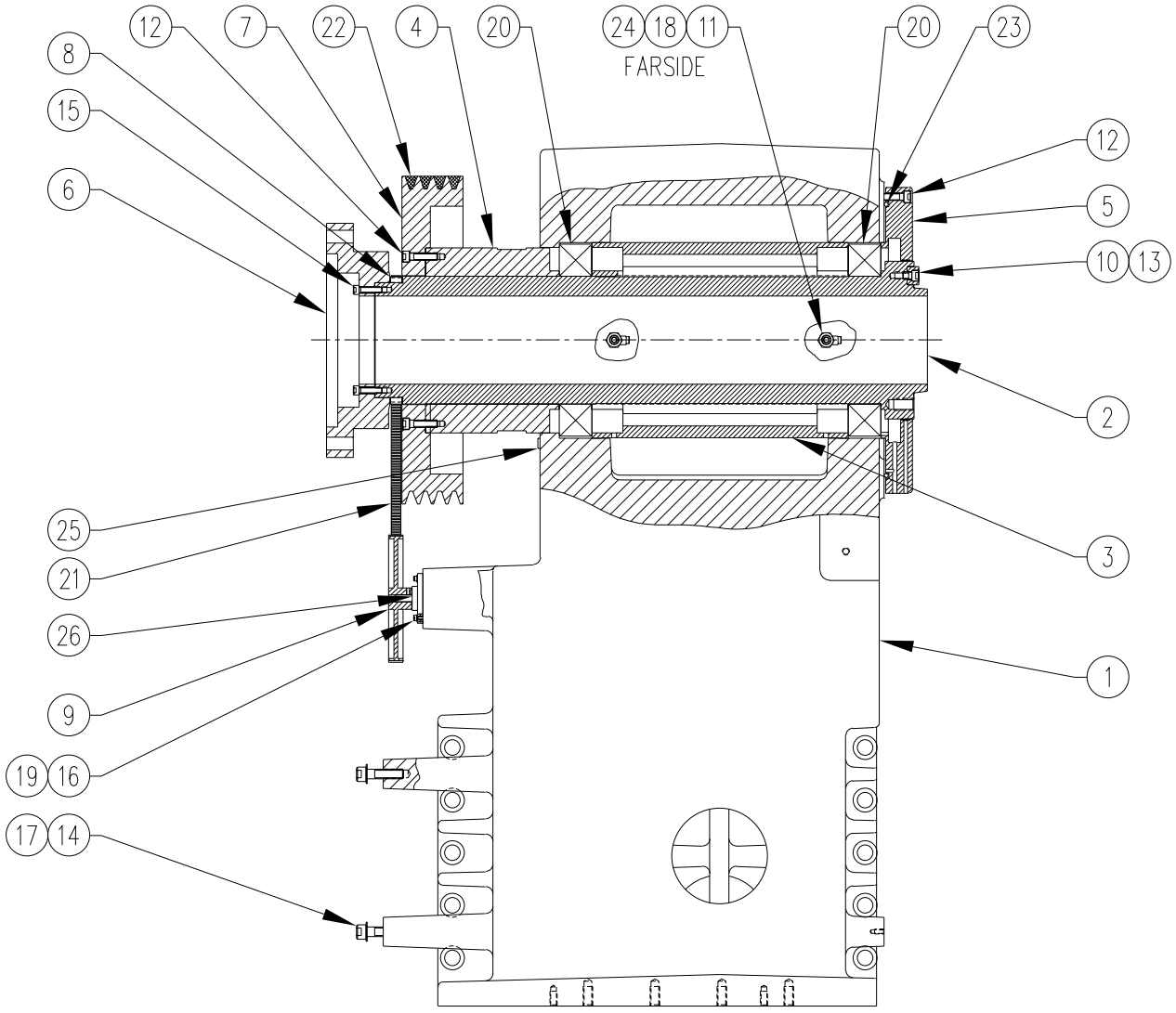


HL-6 Casting Assembly

30-0059 MACHINE CAST ASSY HL-6

ITEM	PART. NO.	DESCRIPTION	QTY.
1	20-0150	NUT HSNG 40/50MM BS MACH Y	1
2	20-8035	TS ENCDR STRIP ATTCH BRKT	1
3	20-8200	BASE MACHINED HL-5/6	1
4	20-8203	TAILSTOCK MACHINED HL-6	1
5	20-8228	MOUNT HYD CYL T/S	1
6	20-8617	CONDUIT STRAIN RELIEF,FRT	1
7	20-8618	CONDUIT STRAIN RELIEF, RR	1
8	20-8894	PLATE T/S DBL FOOT PEDAL	1
9	20-8988A	TAILSTOCK CYL ATTACH BRKT	1
10	22-2629	KEY STUB SHAFT/WORM SHAFT	1
11	22-7423	STANDOFF	2
12	22-7458	CAM LINEAR GUIDE	80
13	22-8233	SUPPORT CONTROL BOX	1
14	22-8236	SUPPORT LEFT	1
15	22-8238	SUPPORT REAR 5/6	1
16	22-8239	SUPPORT HYD FRONT 5/6	1
17	22-8240	SUPPORT HYD REAR 5/6	1
18	22-8877	BUSHING ISOLATOR HYD	6
19	24-7325	STR FIT-METRIC LINEAR GDE	4
20	25-7267	Y-AXIS MOUNTING BRACKET	1
21	25-7459	TRIP BRACKET TABLE	1
22	25-8284	SUPPORT CONTROL/BACK	1
23	25-8296	GUIDE Z WAYCOVER BOTTOM	1
24	25-8297	RAIL/GUIDE WAYCOVER T/S	1
25	25-8300	STRIP ENCODER T/S	1
26	25-8302	RAIL T/S WAYCOVER LOWER	1
27	25-8303	MOUNT STRIP ENCODER	1
28	25-8305	RAIL DRIP T/S	1
29	25-8306	COVER RAIL DRIP T/S	1
30	25-8653	BRACKET, SUPPORT ROLLER	1
31	25-8656	EXT.BRCKT, SUPPORT ROLLER	1
32	25-9203	COVER PLATE MTR MOUNT	1
33	26-7233A	GASKET DEFLECTOR SHIELD	1
34	26-8319	STRIP SLIDE Z WAYCOVER	1
35	26-8324	LONG COOLANT TANK SEAL	1
36	30-8325	Z-AXIS OIL LINE ASSY	1
37	30-8335	X/Z-AXIS OIL LINE ASSY	1
38	32-0017	ENCODER READ HEAD ASSY	1
39	32-2040	TELEMECH 85 IN Z-AXIS	1
40	40-0021	.HCS 3/8-16 X 7	
41	40-1632	SHCS 1/4-20 X 1/2	
42	40-16372	SHCS, 3/8-16 X 1 1/2	
43	40-16385	SHCS 5/16-18 X 3/4	
44	40-1639	SHCS, 3/8-16 X 1	
45	40-16413	MSHCS, M3 X 5	
46	40-16435	SHCS, 3/8-16 X 3 BLK OX	
47	40-16437	SHCS, 3/8-16 X 3 1/4	
48	40-16439	SHCS, 3/8-16 X 5	
49	40-16585	SHCS, M10 X 100	
50	40-1660	SHCS, 1/2-13 X 1 1/2	
51	40-1663	SHCS, 1/2-13 X 1 3/4	

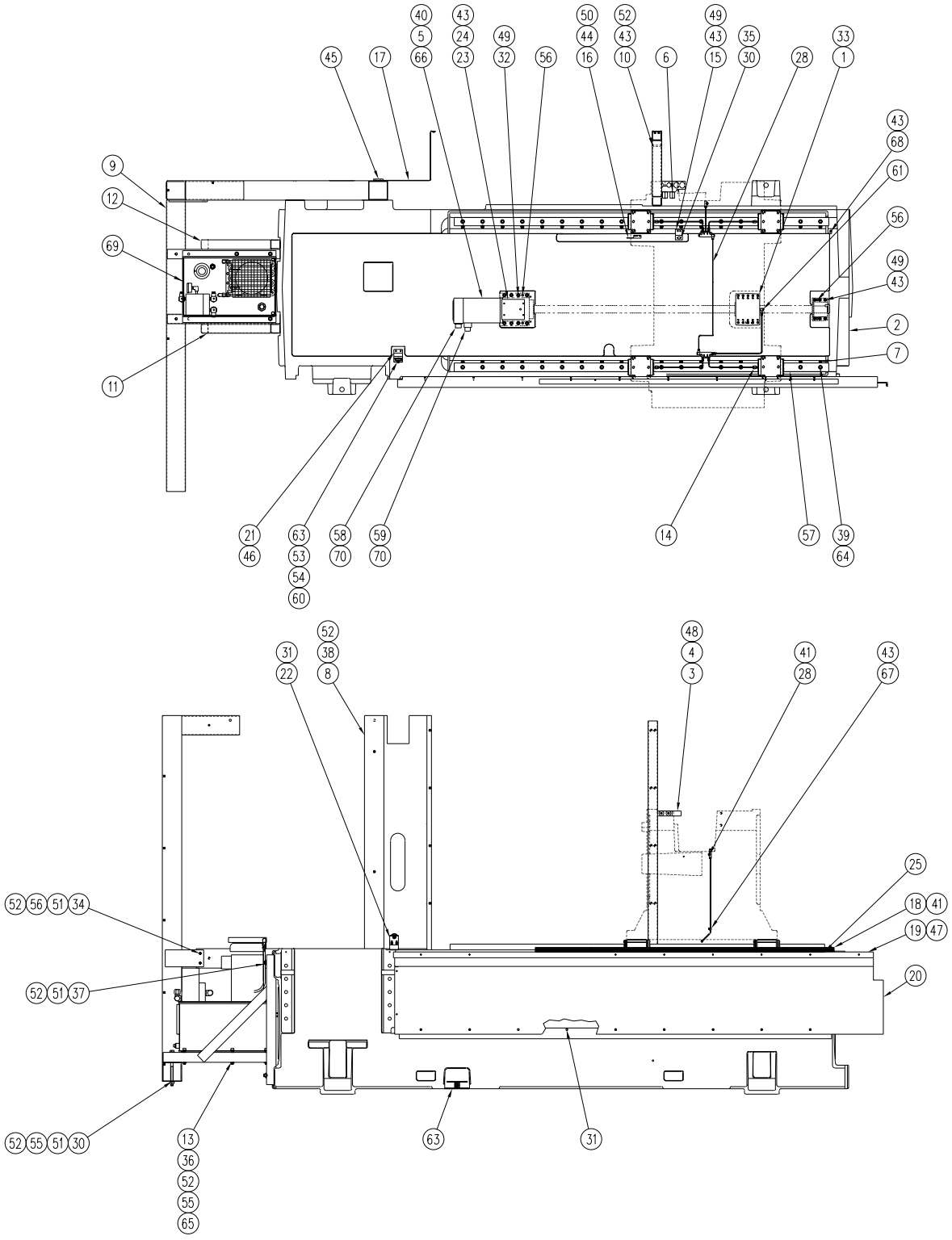
ITEM	PART. NO.	DESCRIPTION	QTY.
52	40-1667	SHCS, 5/16-18 X 1 1/4	
53	40-1705	FHCS, 10-32 X 1	
54	40-1715	SHCS, 5/16-18 X 1 1/2	
55	40-1800	SHCS 8-32 X 3/4	
56	40-1850	SHCS 10-32 X 3/8	
57	40-1963	SHCS, 3/8-16 X 2 1/4	
58	40-1976	BHCS, 1/4-20 X 3/4	
59	40-1980	BHCS, 1/4-20 X 1/2	
60	40-1981	FBHCS 1/4-20 X 1/2	
61	40-2028	SHCS 10-32 X 1 1/4	
62	43-7011	HHB, 5/16-18 X 4	
63	45-1600	WASHER SPLIT LOCK 5/16MED	
64	45-1620	WASHER,SPLIT LOCK #10 MED	
65	45-1681	WASHER,SPLIT LOCK 3/8 MED	
66	45-1730	WASHER, BLK HARD 3/8	
67	45-1860	PTHS, 1/4-20 X 3/4 BLK OX	
68	46-1625	NUT HEX BLK OX 1/4-20	
69	46-1730	NUT, HEX 3/8-16	
70	48-0045	PIN, PULL 3/8 X 1 1/2	4
71	49-0007	SPACER 1/4 ID X 1 LONG	1
72	50-8205	GUIDE LINEAR TAILSTOCK	2
73	50-9305	LINEAR GUIDE, X-AXIS VF-4	2
74	57-0075	O-RING 2-021 BUNA	1
75	57-0080	O-RING 2-023 BUNA	1
76	57-0100	O-RING, 2-318 BUNA	1
77	58-3031	BANJO ELBOW,5/16 F X M6 M	1
78	59-0034	HYDRAULIC CYLINDER	1
79	59-1041	LEGS, CONTROL	4
80	59-1064	FOOT SWITCH W/CONDUIT	2
81	59-6400	GUIDE WHEEL	1
82	59-6600	PLUG, GUIDE RAIL	42
83	59-6655	RUBBER PLUG, GUIDE RAIL	38
84	59-7201	GROMMET RUBBER #330	6
85	62-0013	SERVO MOTOR YASKAWA	1
86	63-1030	CABLE CLAMP 3/16	1
87	63-1031	CABLE CLAMP 1/4	3
88	90-7000B	HPU WITH T/S EXT GUAGE	1
89	99-4521	ELECTRICAL GREASE 3OZ TUBE	0.05



HL-5/6 Spindle Assembly

30-0061A SPINDLE ASS'Y

ITEM	QTY	PART NO.	TITLE
1.	1	20-8201	SPINDLE HOUSING, MACHINE
2.	1	20-8222	SHAFT, SPINDLE
3.	1	20-8223	SPACER BEARING, SPINDLE
4.	1	20-8224	RING CLAMP, BEARING
5.	1	20-8225	RING RETAINER, SPINDLE
6.	1	20-8226	ADAPTER, CYL., HYD.
7.	1	20-8227	PULLEY, DRIVE SPINDLE
8.	1	20-8229	PULLEY TIMING SPINDLE
9.	1	20-8230	PULLEY TIMING, ENCODER
10.	1	20-8290	BUTTON DRIVE, A8
11.	2	20-8314	NOZZLE OIL MIST
12.	16	40-16372	SHCS, 3/8-16 X 1 1/2
13.	1	40-16391	SHCS, 3/8-16 X 1/2
14.	4	40-1661	SHCS, 1/2-13 X 2
15.	8	40-1667	SHCS, 5/16-18 X 1 1/4
16.	4	40-1805	SHCS, 8-32 X 5/8
17.	4	45-1740	WASHER, BLK. HARD 1/2
18.	2	46-1720	NUT, HEX 1/2-13, PLATED
19.	4	49-4110	WASHER, #8 SEALING S.S.
20.	1	51-0016	BALL BEARING 170MM I.D.
21.	1	51-0009	TIMING BELT 480L
22.	4	54-0011	V-BELT, 5VX900
23.	1	57-0035	O-RING #383 BUNA
24.	2	58-3050	ELBOW, 1/4 NYLON TUBING
25.	1	58-3105	PIPE PLUG, 1/4 NPT
26.	1	60-1820	SHAFT, ENCODER 5000 LINE



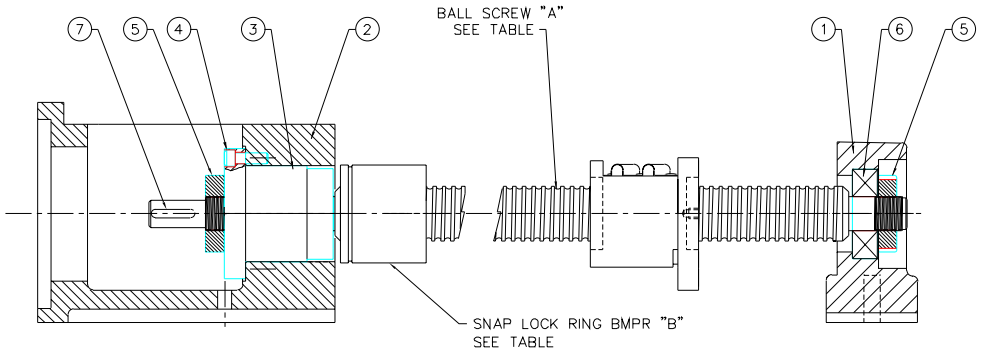
HL-5 Casting Assembly

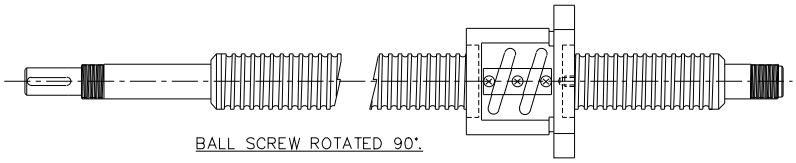
30-0080 MACHINE CAST ASSY HL-5

ITEM	PART. NO.	DESCRIPTION	QTY.
1	20-0150	NUT HSNG 40/50MM BS MACH	1
2	20-8200	BASE MACHINED HL-5/6	1
3	20-8617	CONDUIT STRAIN RELIEF,FRT	1
4	20-8618	CONDUIT STRAIN RELIEF, RR	1
5	22-2629	KEY STUB SHAFT/WORM SHAFT	1
6	22-7423	STANDOFF	2
7	22-7458	CAM LINEAR GUIDE	38
8	22-8233	SUPPORT CONTROL BOX	1
9	22-8236	SUPPORT LEFT	1
10	22-8238	SUPPORT REAR 5/6	1
11	22-8239	SUPPORT HYD FRONT 5/6	1
12	22-8240	SUPPORT HYD REAR 5/6	1
13	22-8877	BUSHING ISOLATOR HYD	6
14	24-7325	STR FIT-METRIC LINEAR GDE	4
15	25-7267	Y-AXIS MOUNTING BRACKET	1
16	25-7459	TRIP BRACKET TABLE	1
17	25-8284	SUPPORT CONTROL/BACK	1
18	25-8296	GUIDE Z WAYCOVER BOTTOM	1
19	25-8297	RAIL/GUIDE WAYCOVER T/S	1
20	25-8307	COVER, BASE	1
21	25-8653	BRACKET, SUPPORT ROLLER	1
22	25-8656	EXT.BRCKT, SUPPORT ROLLER	1
23	25-9203	COVER PLATE MTR MOUNT	1
24	26-7233A	GASKET DEFLECTOR SHIELD	1
25	26-8319	STRIP SLIDE Z WAYCOVER	1
26	26-8324	LONG COOLANT TANK SEAL	1
27	30-8325	Z-AXIS OIL LINE ASSY	1
28	30-8335	X/Z-AXIS OIL LINE ASSY	1
29	32-2040	TELEMECH 85 IN Z-AXIS	1
30	40-0021	.HCS 3/8-16 X 7	2
31	40-1632	SHCS 1/4-20 X 1/2	16
32	40-16372	SHCS, 3/8-16 X 1 1/2	8
33	40-16385	SHCS 5/16-18 X 3/4	5
34	40-1639	SHCS, 3/8-16 X 1	4
35	40-16413	MSHCS, M3 X 5	2
36	40-16435	SHCS, 3/8-16 X 3 BLK OX	6
37	40-16437	SHCS, 3/8-16 X 3 1/4	6
38	40-16439	SHCS, 3/8-16 X 5	4
39	40-16585	SHCS, M10 X 100	24
40	40-1660	SHCS, 1/2-13 X 1 1/2	39
41	40-1667	SHCS, 5/16-18 X 1 1/4	48
42	40-1705	FHCS, 10-32 X 1	10
43	40-1715	SHCS, 5/16-18 X 1 1/2	6
44	40-1850	SHCS 10-32 X 3/8	4
45	40-1963	SHCS, 3/8-16 X 2 1/4	14
46	40-1976	BHCS, 1/4-20 X 3/4	2
47	40-1981	FBHCS 1/4-20 X 1/2	8
48	40-2028	SHCS 10-32 X 1 1/4	6
49	43-7011	HHB, 5/16-18 X 4	2

30-0080 MACHINE CAST ASSY HL-5

ITEM	PART. NO.	DESCRIPTION	QTY.
50	45-1600	WASHER SPLIT LOCK 5/16MED	14
51	45-1620	WASHER,SPLIT LOCK #10 MED	2
52	45-1681	WASHER,SPLIT LOCK 3/8 MED	16
53	45-1730	WASHER, BLK HARD 3/8	24
54	45-1860	PTHS, 1/4-20 X 3/4 BLK OX	1
55	46-1625	NUT HEX BLK OX 1/4-20	1
56	46-1730	NUT, HEX 3/8-16	10
57	48-0045	PIN, PULL 3/8 X 1 1/2	4
58	50-9305	LINEAR GUIDE, X-AXIS VF-4	2
59	57-0075	O-RING 2-021 BUNA	1
60	57-0080	O-RING 2-023 BUNA	1
61	57-0100	O-RING, 2-318 BUNA	1
62	58-3031	BANJO ELBOW,5/16 F X M6 M	1
63	59-1064	FOOT SWITCH W/CONDUIT	2
64	59-6400	GUIDE WHEEL	1
65	59-6655	RUBBER PLUG, GUIDE RAIL	38
66	59-7201	GROMMET RUBBER #330	6
67	62-0013	SERVO MOTOR YASKAWA	1
68	63-1030	CABLE CLAMP 3/16	1
69	63-1031	CABLE CLAMP 1/4	3
70	90-7000B	HPU WITH T/S EXT GUAGE	1
71	99-4521	ELECTRICAL GREASE 3OZ TUBE	0.05





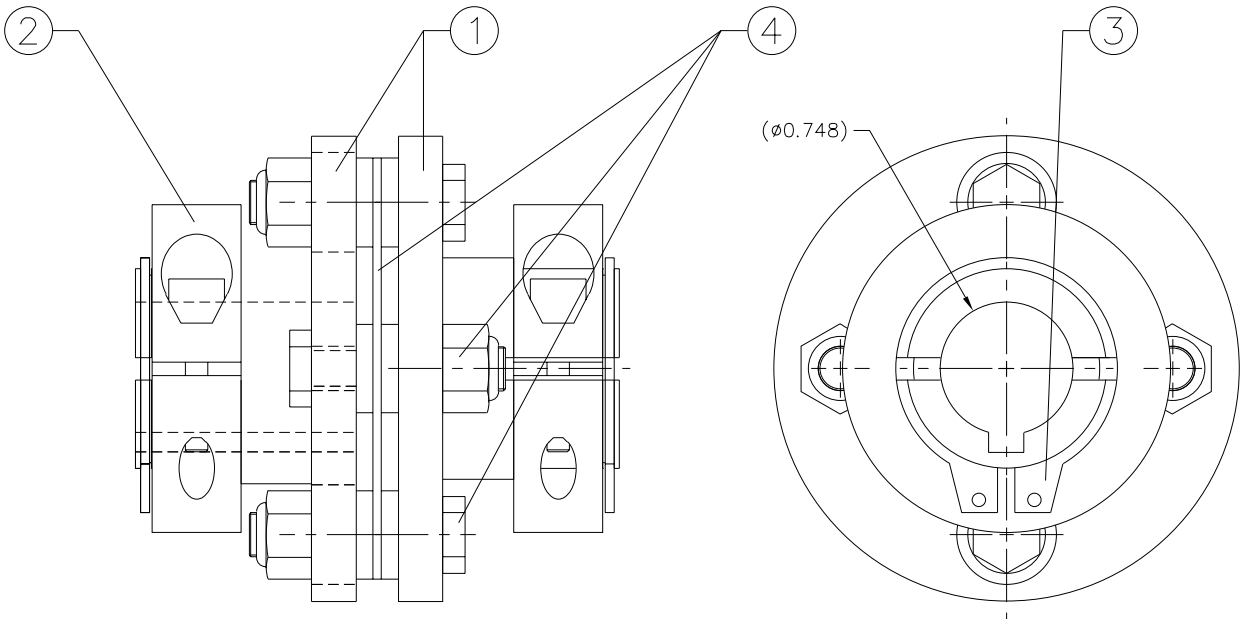
30-1100A BALL SCREW ASSEMBLY 32mm

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)

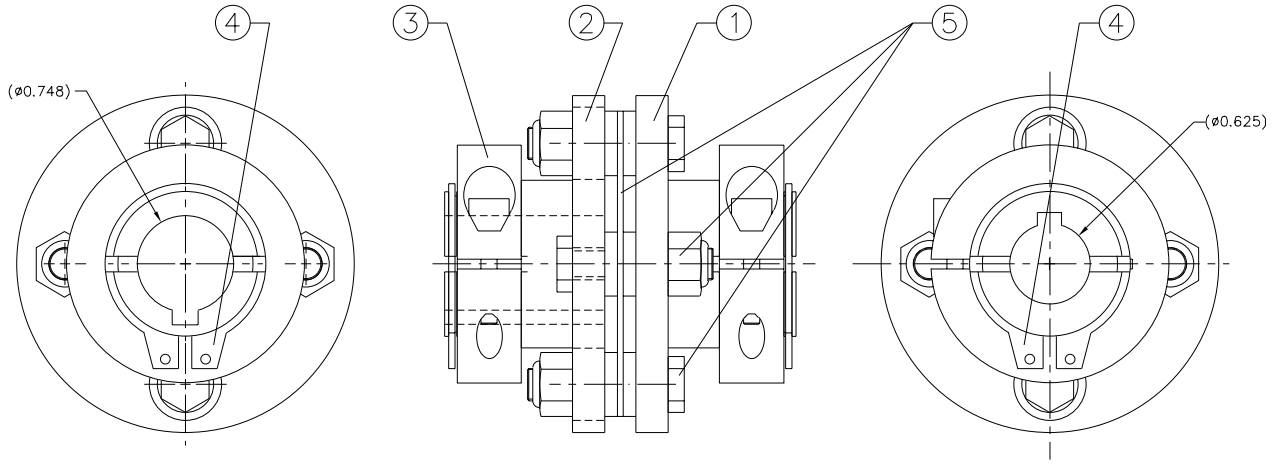
30-1100A Ball Screw Assembly



30-1219 COUPLING ASSEMBLY

ITEM	QTY	PART No.	TITLE
1	2	20-7615	COUPLER, SERVO DRIVE BRUSHLESS
2	2	51-2014	BEARING LOCKNUT, CL18F
3	2	56-0065	SNAP RING, (5100-112)
4	1	59-2060	FLEXPAK FOR AJ05

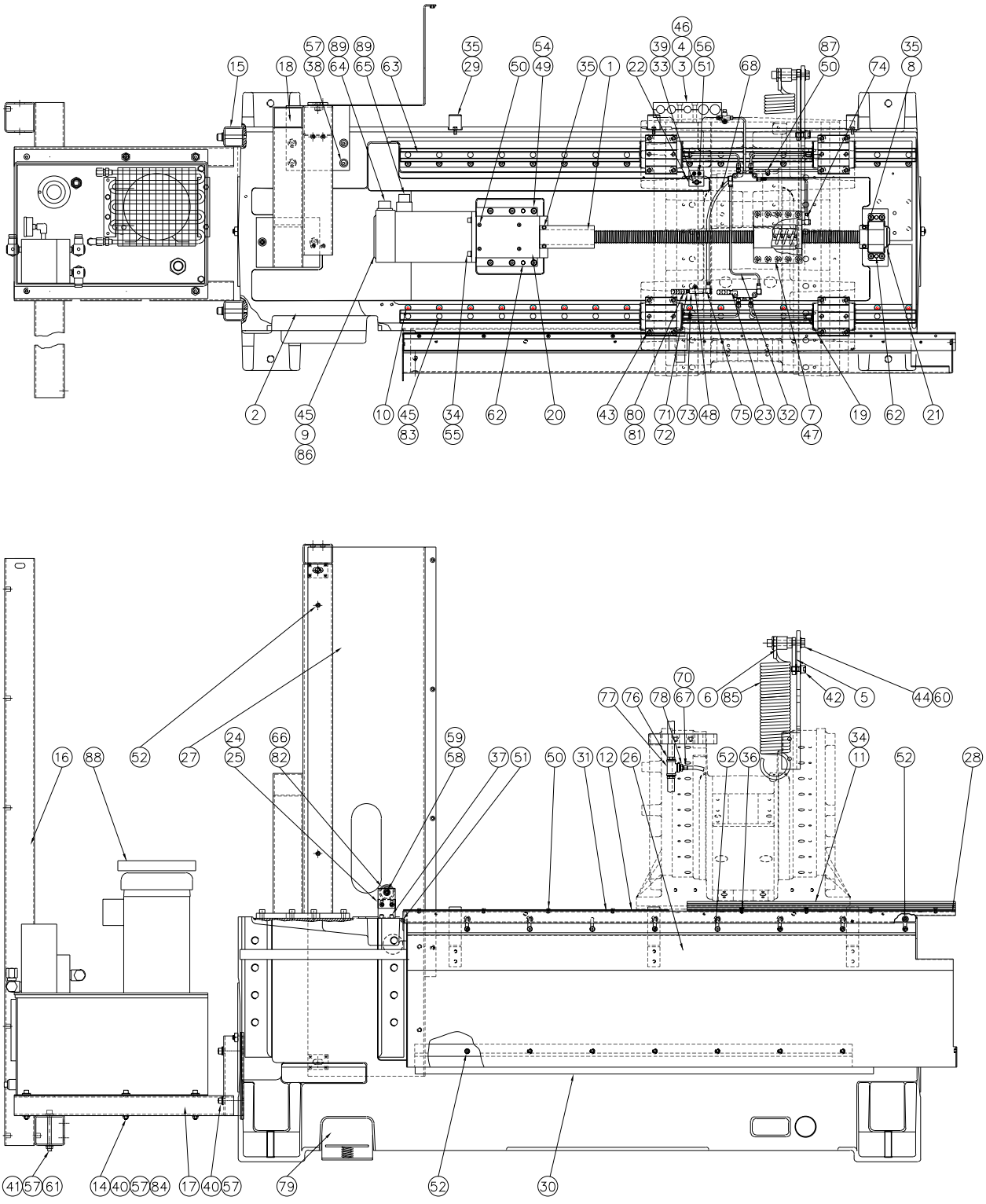
WHERE USED	APPLICATION
30-0018A BS ASSY ø40mm(1.57) x 71.94	VF-6B, 8B (X)
30-0053 BS ASSY ø40mm(1.57) x 57.90	HL-5, 6 (Z)
30-1211A BS ASSY ø40mm(1.57) x 90.86	VF-7B, 9B (X)
30-1212A BS ASSY ø40mm(1.57) x 47.71	VF-6B, 7B, 8B, 9B, 10B, 11B & VR-11B (Y) (Z)
30-0302 BS ASSY ø40mm(1.57) x 32.70	VF-5/50 (Y) (Z)
30-0303 BS ASSY ø40mm(1.57) x 57.90	VF-5/50 (X)



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



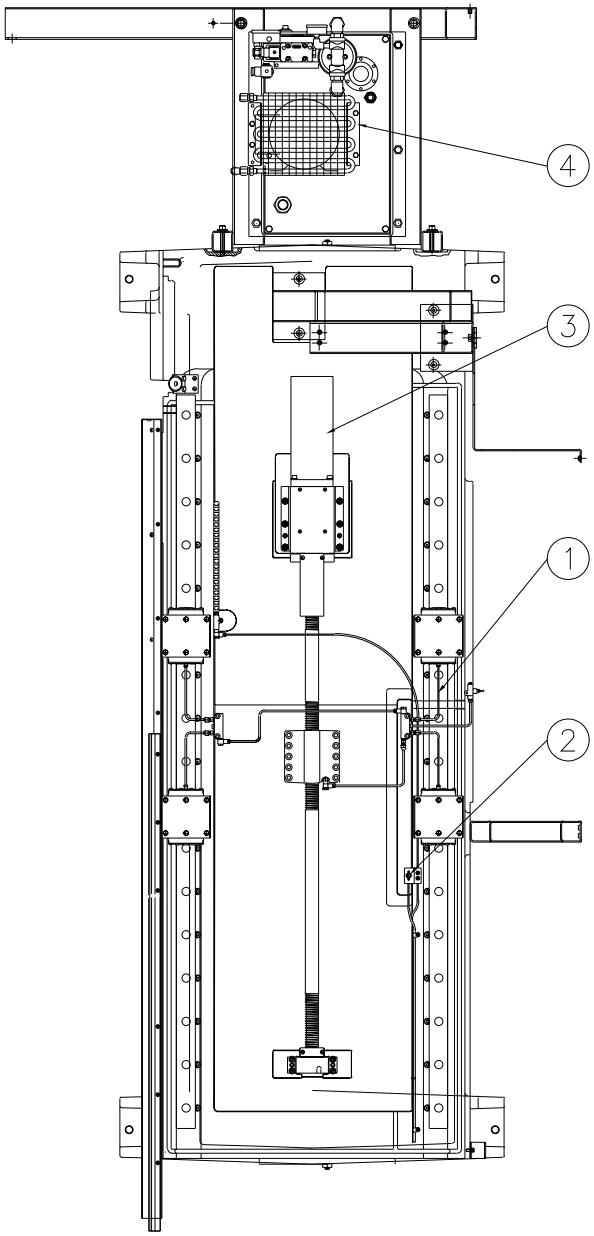
HL-1 Casting Assembly

30-1600A MACHINE CASTING ASSEMBLY, HL-1

ITEM	QTY	DWG_NUM	TITLE
1	1	20-7185	BUMPER, Z-AXIS, MOTOR END
2	1	20-8500	BASE, MACHINED
3	1	20-8617	CONDUIT STRAIN RELIEF
4	1	20-8618	CONDUIT STRAIN RELIEF
5	1	20-8720	SWING ARM SPRING
6	1	20-8721	BUSHING, SWING ARM SPRING
7	1	20-9007	NUT HOUSING, MACHINED
8	1	20-9096	BUMPER, Y AXIS
9	1	22-2629	KEY, .1875/.1870 SQUARE
10	64	22-7458	CAM, LINEAR GUIDE
11	1	22-8052	GUIDE Z WAYCOVER BOTTOM
12	1	22-8624	SEAL, RAIL, BACKING BAR
13	1	22-8722	BRACKET, SPRING, T/C
14	6	22-8877	BUSHING ISOLATOR HYD.
15	1	22-8901	SUPPORT, LEFT, MIDDLE
16	1	22-8902	SUPPORT, LEFT, REAR
17	1	22-8904	SUPPORT, LEFT, FRONT
18	1	22-8905	SUPPORT, CONTROL BOX
19	4	24-7325	STR FIT - METRIC, LINEAR GUIDE
20	1	25-7042	COVER PLATE/LEAD SCREW
21	1	25-7080	BUMPER BRACKET
22	1	25-7266	X AXIS MOUNTING BRACKET
23	2	25-7485	BRACKET, OIL LINE CARRIER (L)
24	1	25-8653	BRACKET, SUPPORT ROLLER
25	1	25-8656	EXT BRACKET, SUPPORT ROLLER
26	1	25-8923	BASE COVER
27	1	25-8925	SUPPORT BACK COVER
28	1	25-8950A	RAIL INTERFACE
29	3	25-9746	CABLE CLAMP, BASE
30	1	26-8010	LONG COOLANT TANK SEAL
31	1	26-8623	SEAL RAIL WIPER
32	1	30-8717	Z AXIS LUBE LINE ASSY
33	1	32-2040	TELEMECHANIQUE, 85 IN Z AXIS
34	8	40-1500	SHCS, 5/16-18 x 1"
35	4	40-1609	BHCS, 10-32 X 1/2
36	4	40-16091	BHCS, 10-32 X 1”
37	11	40-1632	SHCS, 1/4-20 x 1/2"
38	6	40-1639	SHCS, 3/8-16 X 1”
39	2	40-16413	MSHCS, M3 x 5
40	10	40-16435	SHCS, 3/8-16 x 3"
41	2	40-16438	SHCS, 3/8-16 x 4"
42	1	40-1654	SHCS, 1/2-13 X 1”
43	16	40-16583	SHCS, M10 x 45
44	1	40-16627	SHCS, 1/2-13 X 3 1/2
45	36	40-1667	SHCS, 5/16-18 x 1 1/4"
46	2	40-1675	SHCS, 5/16-18 X 2 1/4
47	11	40-1697	SHCS, 1/4-20 x 3/4"

30-1600A MACHINE CASTING ASSEMBLY, HL-1

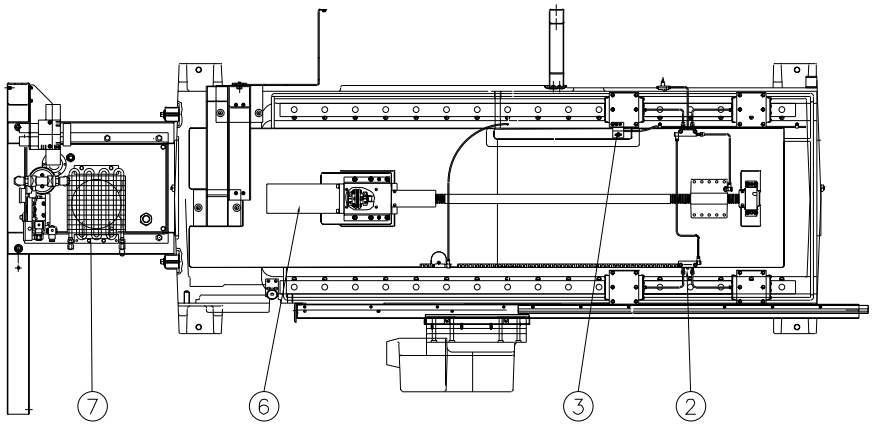
ITEM	QTY	DWG_NUM	TITLE
48	6	40-1705	FHCS, 10-32 x 1"
49	10	40-1715	SHCS, 5/16-18 x 1 1/2"
50	9	40-1750	BHCS, 10-32 x 3/8"
51	8	40-1850	SHCS, 10-32 x 3/8"
52	23	40-1981	FBHCS, 1/4-20 x 1/2"
53	2	43-7011	HHB, 5/16-18 X 4”
54	12	45-0008	WASHER, 5/16" USS STANDARD
55	4	45-1600	WASHER, SPLIT LOCK 5/16" MED
56	8	45-1620	WASHER, SPLIT LOCK , #10 MED
57	6	45-1730	WASHER, BLK HARD, 3/8"
58	1	45-1860	PTHS, 1/4-20 x 3/4 BLK OX
59	1	46-1625	NUT, HEX BLK OX 1/4-20
60	1	46-1720	NUT, HEX 1/2-13, PLATED
61	6	46-1730	NUT, HEX, 3/8-16
62	4	48-0045	PIN, PULL, 3/8 X 1 1/2
63	2	50-3400	LINEAR GUIDE
64	1	57-0075	O-RING 2-021 BUNA
65	1	57-0080	O-RING 2-023 BUNA
66	1	57-0100	O-RING, 2-318 BUNA
67	1	58-1550	1/8 NPT CONN.
68	10	58-2000	NYLON TUBING, 1/4 IN CL
69	18’	58-2010	NYLON TUBING, 5/32”
70	2	58-2100	SLEEVE LUBE ASSEMBLY
71	2	58-2110	SLEEVE NUTS LUBE ASSEMBLY
72	8	58-2130	SLEEVE COMP. NYLON TUBING
73	1	58-2760	FITTING, MANIFOLD, 2 WAY
74	1	58-3031	BANJO ELBOW, 5/16 F x M6 M
75	1	58-3045	ELBOW, 5/16-24 TO 5/16-24
76	2	58-3048	HOSE BARB 1/2 X 3/8 NPT MALE
77	1	58-3084	TEE, 3/8 FPT X 38 FPT X 1/4 FPT
78	1	58-3670	1/4 NPT MALE - 1/8 FEMALE REDUCER
79	2	59-1054	FOOT SWITCH W/FLEX COND
80	0.916	59-6150A	PLASTIC CARRIER SEALED
81	2	59-6153	PLASTIC CARRIER ENDS
82	1	59-6400	GUIDE WHEEL
83	68	59-6600	PLUG, GUIDE RAIL
84	6	59-7201	GROMMET RUBBER #330
85	1	59-8508	SPRING CROSS SLIDE HL-1,2
86	1	62-0013	SERVO MOTOR YASKAWA
87	4	63-1031	CABLE CLAMP, 1/4"
88	1	90-7001A	HPU NO T/S EXT GUAGE
89	0.05	99-4521	ELECTRICAL GREASE 3 OZ TUBE

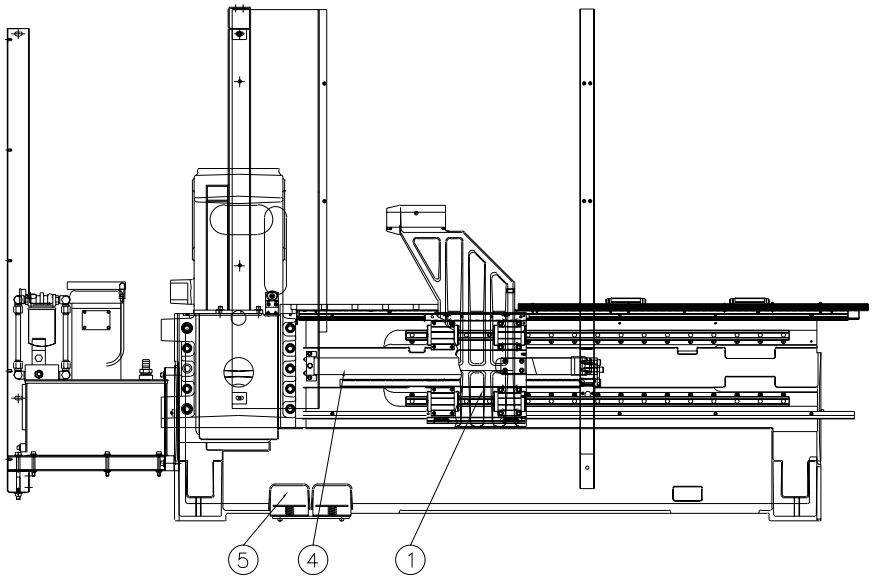


1 – 30–8863 – OIL LINE ASSEMBLY
2 – 30–2040 – TELEMECH. SWITCH ASSEMBLY
3 – 62–0013 – SERVO MOTOR YASKAWA
4 – 90–7000 – HYDRAULIC POWER UNIT

30–1630A HL–3 MACH CAST ASSY

HL-3 Casting Assembly

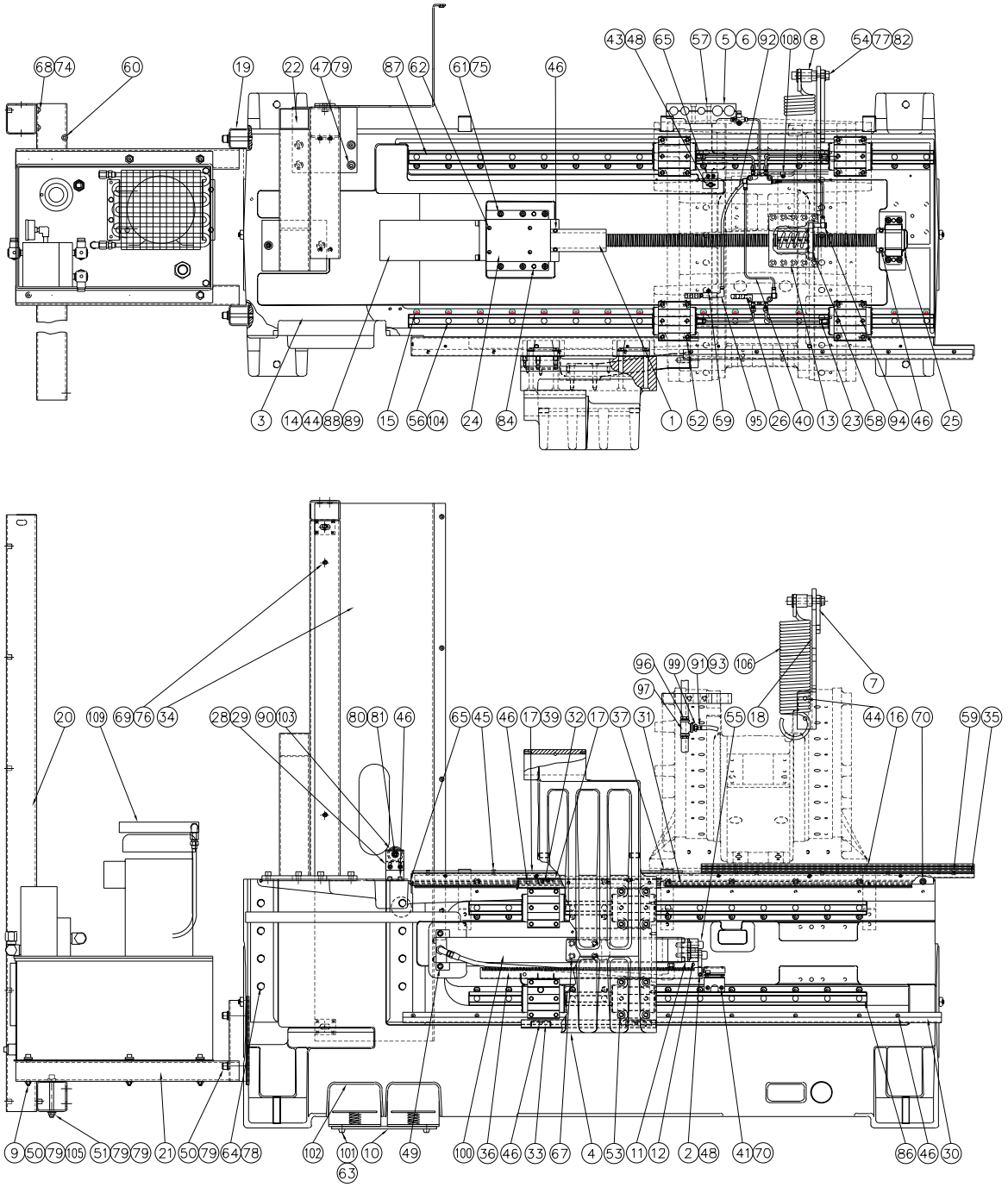




1 – 20–8753 – TAILSTOCK
2 – 30–8663 – OIL LINE ASSEMBLY
3 – 32–2040 – TELEMECH. SWITCH ASSEMBLY
4 – 59–0013 – HYDRAULIC CYLINDER
5 – 59–1054 – FOOT SWITCH
6 – 62–0013 – SERVO MOTOR YASKAWA
7 – 90–7000 – HYDRAULIC POWER UNIT

30–1640A HL–4 MACH CAST ASSY

HL-4 Casting Assembly

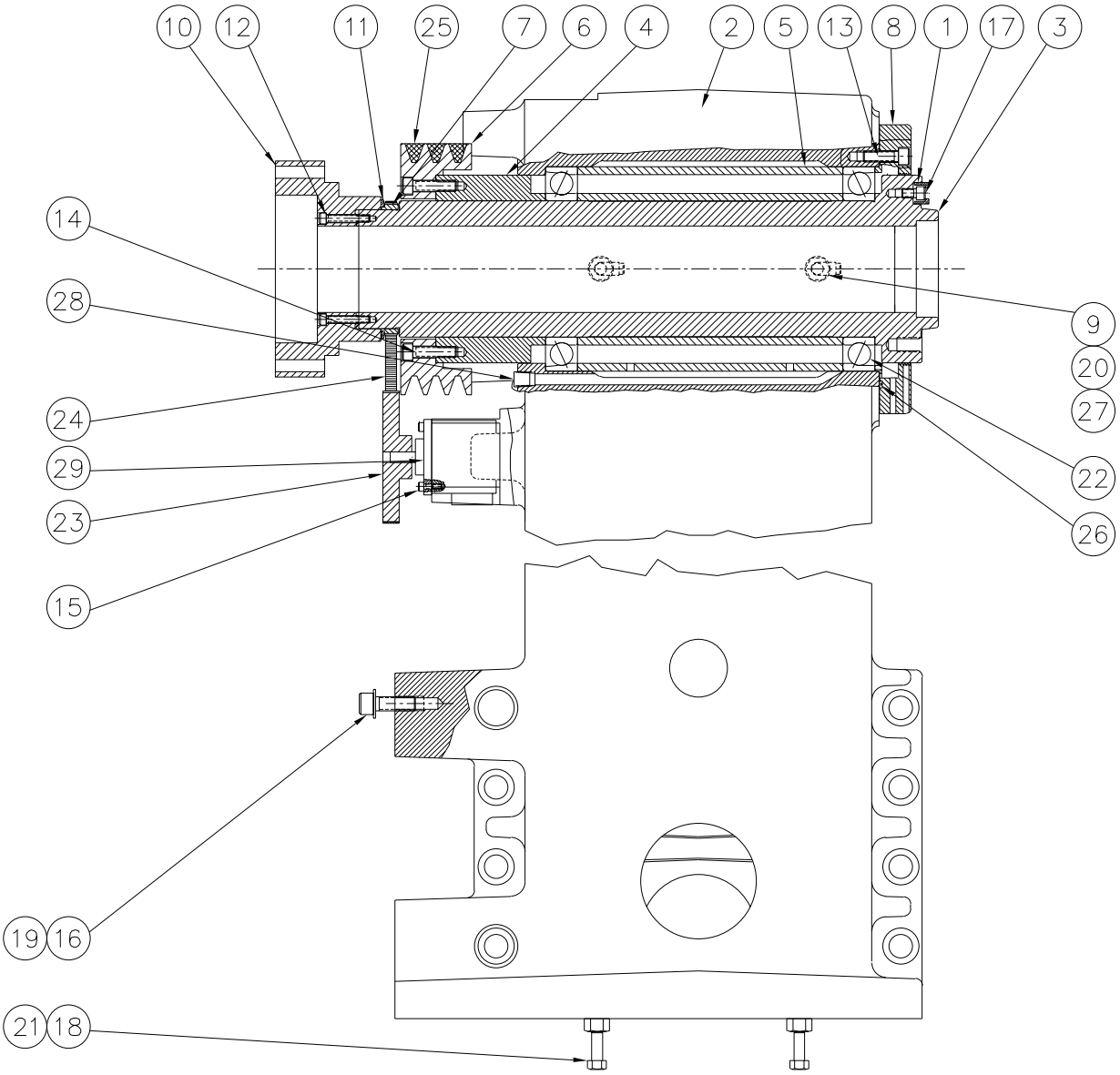


HL-2 Casting Assembly

ITEM	QTY	PART NO.	TITLE
1	1	20-7185	BUMPER, Z-AXIS, MOTOR END
2	1	20-8035	TS ENCODER STRIP ATTCH BRKT
3	1	20-8500	BASE, MACHINED
4	1	20-8504	TAIL STOCK, MACHINED
5	1	20-8617	CONDUIT STRAIN RELIEF, FRT
6	1	20-8618	CONDUIT STRAIN RELIEF, RR
7	1	20-8720	SWING ARM, SPRING
8	1	20-8721	BUSHING, SWING ARM SPRING
9	6	22-8877	BUSHING ISOLATOR HYD.
10	1	20-8894	PLATE T/S DLBL FT PEDAL
11	1	20-8987	ARM TAILSTOCK CYLINDER
12	1	20-8988A	TAILSTOCK CYL ATTACH BRKT
13	1	20-9007	NUT HOUSING, MACHINED
14	1	22-2629	KEY, .1875/.1870 SQUARE
15	64	22-7458	CAM, LINEAR GUIDE
16	1	22-8052	GUIDE Z WAYCOVER BOTTOM
17	1	22-8624	SEAL, RAIL, BACKING BAR
18	1	22-8722	BRACKET, SPRING, T/C
19	1	22-8901	SUPPORT, LEFT, MIDDLE
20	1	22-8902	SUPPORT, LEFT, REAR
21	1	22-8904	SUPPORT, LEFT, FRONT
22	1	22-8905	SUPPORT, CONTROL BOX
23	4	24-7325	STR FIT - METRIC, LINEAR GUIDE
24	1	25-7042	COVER PLATE/LEAD SCREW
25	1	25-7080	BUMPER BRACKET
26	2	25-7485	BRACKET, OIL LINE CARRIER (L)
27	1	25-8050	TAILSTOCK CHIP TRAY
28	1	25-8653	BRACKET, SUPPORT ROLLER
29	1	25-8656	EXT BRACKET, SUPPORT ROLLER
30	1	25-8673B	GUIDE WAYCOVER, T/S BOTTOM
31	1	25-8675A	GUIDE WAYCOVER, T/S BOTTOM
32	1	25-8678B	CHANNEL DRIP TAILSTOCK
33	1	25-8873	SHIELD CHIP, T/S
34	1	25-8925	SUPPORT BACK COVER
35	1	25-8950A	RAIL INTERFACE
36	1	25-8999A	TAILSTOCK ENCODER STRIP
37	3	25-9746	CABLE CLAMP, BASE
38	1	26-8010	LONG COOLANT TANK SEAL
39	1	26-8623	SEAL RAIL WIPER
40	1	30-8717	Z AXIS LUBE LINE ASSY
41	1	32-0400A	ENCODER READ HEAD ASSY
41	1	32-2011	TELEMECHANIQUE 30 IN CABLE AS
43	1	32-2040	TELEMECHANIQUE, 85 IN Z AXIS
44	2	40-1500	SHCS, 5/16-18 x 1"
45	4	40-1609	BHCS, 10-32 x 1/2"
46	22	40-1632	SHCS, 1/4-20 x 1/2"
47	6	40-1639	SHCS, 3/8-16 x 1"
48	2	40-16413	MSHCS, M3 x 5
49	4	40-1643	SHCS, 3/8-16 x 2 1/2"
50	8	40-16435	SHCS, 3/8-16 x 3"
51	2	40-16438	SHCS, 3/8-16 x 4"
52	16	40-16583	SHCS, M10 x 45

ITEM	QTY	PART NO.	TITLE
53	16	40-16585	SHCS, M10 x 100
54	1	40-16627	SHCS, 1/2-13 x 3 1/2"
55	2	40-1663	SHCS, 1/2-13 x 1 3/4"
56	72	40-1667	SHCS, 5/16-18 x 1 1/4"
57	2	40-1675	SHCS, 5/16-18 x 2 1/4"
58	11	40-1697	SHCS, 1/4-20 x 3/4"
59	5	40-1705	FHCS, 10-32 x 1"
60	2	40-1712	SHCS, 5/16-18 x 1/2"
61	4	40-1715	SHCS, 5/16-18 x 1 1/2"
62	7	40-1750	BHCS, 10-32 x 3/8"
63	4	40-1800	SHCS, 8-32 x 3/4"
64	8	40-1810	SHCS, 3/4-10 x 3 1/4"
65	4	40-1850	SHCS, 10-32 x 3/8"
66	4	40-1961	SHCS, 3/8-16 x 2"
67	4	40-1963	SHCS, 3/8-16 x 2 1/4"
68	2	40-1976	BHCS, 1/4-20 x 3/4"
69	2	40-1980	BHCS, 1/4-20 x 1/2"
70	29	40-1981	FBHCS, 1/4-20 x 1/2"
71	5	40-2030	SHCS, 3/8-16 x 3/4"
72	4	43-1602	HHB, 1/2-13 x 3"
73	12	45-0008	WASHER, 5/16" USS STANDARD
74	3	45-0040	WASHER, BLK HARD 1/4"
75	4	45-1600	WASHER, SPLIT LOCK 5/16" MED
76	20	45-16390	WASHER, 1/4 ID x 5/8 OD
77	4	45-1666	WASHER, FLAT 1/2 ID
78	8	45-1720	WASHER, SPLIT LOCK 3/4" MED
79	6	45-1730	WASHER, BLK HARD, 3/8"
80	1	45-1860	PTHS, 1/4-20 x 3/4 BLK OX
81	1	46-1625	NUT, HEX BLK OX 1/4-20
82	1	46-1720	NUT, HEX 1/2-13, PLATED
83	6	46-1730	NUT, HEX, 3/8-16
84	2	48-0045	PIN, PULL 3/8 x 1 1/2"
85	1	49-2015	PTHS, 1/4-20 x 7/8" BLK OX
86	2	50-3300	LINEAR GUIDE
87	2	50-3400	LINEAR GUIDE
88	1	57-0075	O-RING, 2-021 BUNA
89	1	57-0080	O-RING, 2-023 BUNA
90	1	57-0100	O-RING, 2-318 BUNA
91	1	58-1550	1/8 NPT CONNECTOR
92	10	58-2000	NYLON TUBING, 1/4 IN CL
93	2	58-2100	SLEEVE, LUBE ASSY
94	1	58-2748	ADAPTER, BANJO, 5/16-24 F TO M
95	1	58-3045	ELBOW, 5/16-24 TO 5/16-24
96	2	58-3048	HOSE BARB, 1/2 x 3/8 NPT MALE
97	1	58-3084	TEE 3/8 FPT x 3/8 FPT x 1/4 FPT
98	1	58-3665	1/4 NPT FEMALE TO 3/8 MALE
99	1	58-3670	1/4 NPT M - 1/8 F REDUCER
100	1	59-0012	CYLINDER HYDRAULIC
101	4	59-1041	LEGS, CONTROL
102	2	59-1054	FOOT SWITCH W/FLEX COND
103	1	59-6400	GUIDE WHEEL
104	68	59-6600	PLUG, GUIDE RAIL

ITEM	QTY	PART NO.	TITLE
105	6	59-7201	GROMMET RUBBER #330
106	1	59-8508	SPRING CROSS SLIDE
107	1	62-0013	SERVO MOTOR YASKAVA
108	4	63-1031	CABLE CLAMP, 1/4"
109	1	90-7000B	HPU W/ T/S EXT GAUGE
110	0.05	99-4521	ELECTRICAL GREASE 3 OZ TUBE

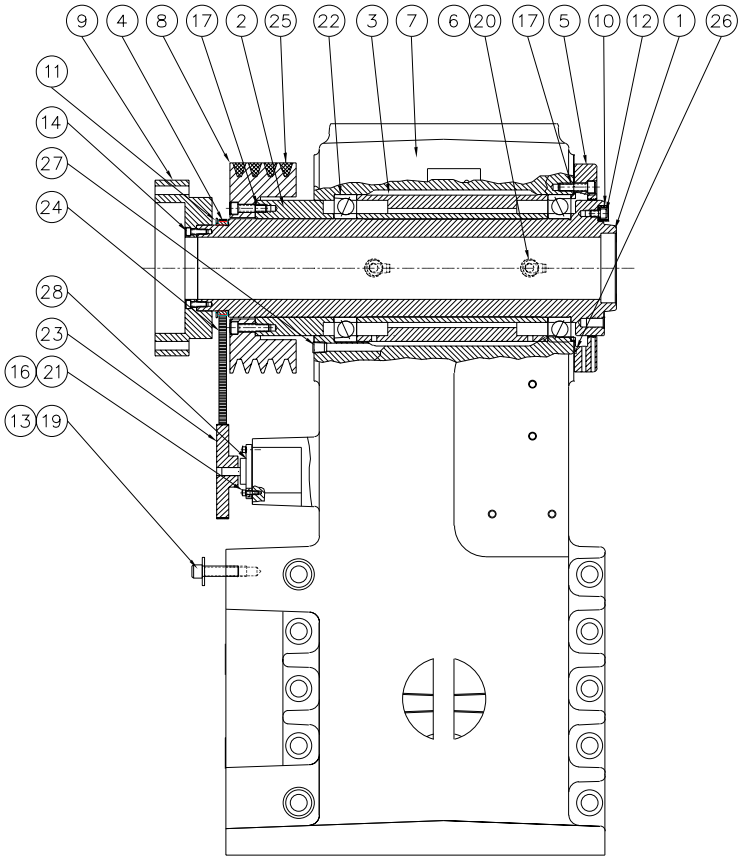


30–3600 SPINDLE ASSY, LATHE

HL-1/2 Spindle

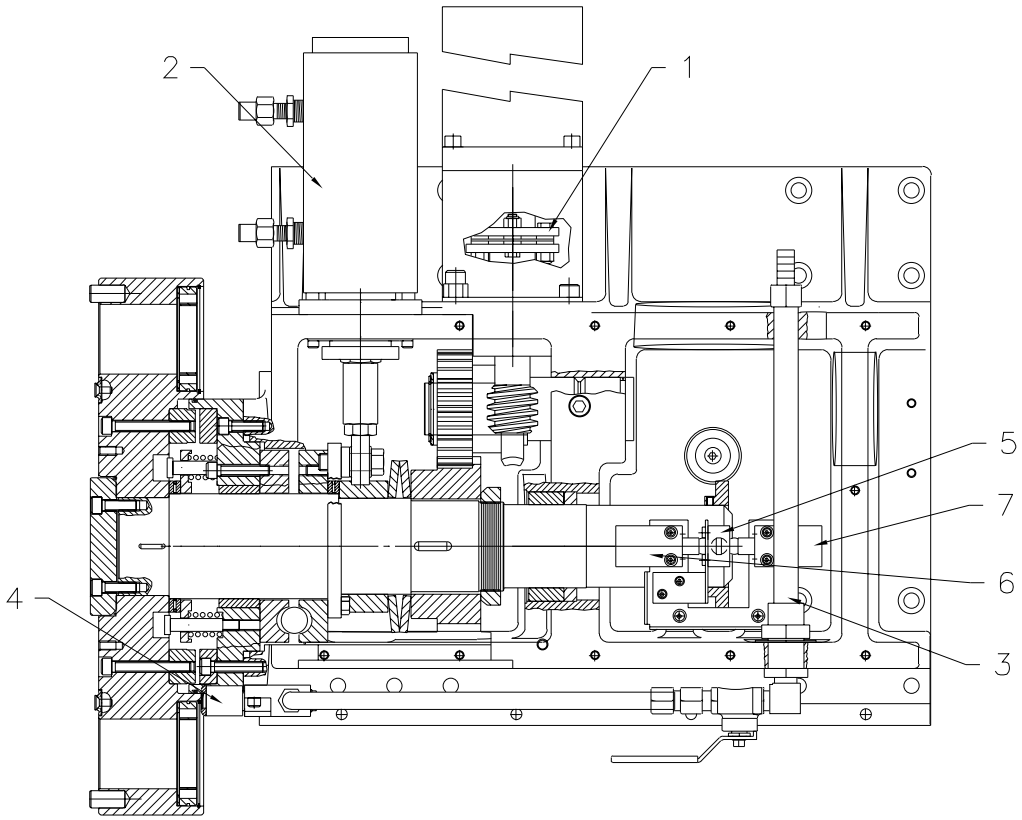
30-3600 SPINDLE ASSY, LATHE

ITEM	QTY	P/N	DESCRIPTION
1	1	22-2717	LOCATING PIN, SRT
2	1	20-8501A	SPINDLE HOUSING MACHINED
3	1	20-8563B	SHAFT, SPINDLE
4	1	20-8564B	RING, CLAMP
5	1	20-8565A	SPACER, BEARING
6	1	20-8566B	SHEAVE, DRIVE
7	1	20-8567B	PULLEY
8	1	20-8568	RING RETAINER
9	2	22-8572	NOZZLE, OIL MIST SPINDLE
10	1	20-8707B	ADAPTER, CYLINDER, DRAWTUBE
11	1	22-8562B	FLANGE, PULLEY
12	8	40-1615	SHCS, 1/4-20 X 1 1/2
13	6	40-1636	SHCS, 3/8-16 X 1 1/4
14	6	40-16372	SHCS, 3/8-16 X 1 1/2
15	4	40-1645	SHCS, 10-32 X 5/8
16	4	40-1660	SHCS, 1/2-13 X 1 1/2
17	1	40-1712	SHCS, 5 1/6-18 X 1/2
18	2	43-1010	HHB 3/8-16 X 2 1/4
19	4	45-1740	WASHER BLK HRD 1/2
20	2	46-1720	NUT, HEX, 1/2-13
21	2	46-1730	NUT, HEX 3/8-16
22	1	51-7100	BALL BEARING
23	1	54-3090	TIMING PULLEY, 3/8 BORE
24	1	54-3100	TIMING BELT, 3/ WIDE
25	3	54-7131	DRIVE BELT, V-BELT
26	1	57-2989	O-RING, #265 N 70
27	2	58-3050	ELBOW, 1/4 NYLON TUBING
28	1	58-3105	PIPE PLUG, 1/4 NPT
29	1	60-1810a	ENCODER, 2000 LINE
30	2	40-16385	SHCS 5/16-18 X 3/4
31	2	45-1683	WASHER FLT 3/8X1 1/4X 3/32



ITEM	QTY	P/N	DESCRIPTION
1	1	20-8563B	SHAFT, SPINDLE
2	1	20-8564B	RING, CLAMP, INNER, SPINDLE
3	1	20-8565A	SPACER, BEARING
4	1	20-8567B	PULLEY, TIMING, SPINDLE
5	1	20-8568	RING, RETAINER, SPINDLE
6	2	20-8572	NOZZLE, OIL MIST
7	1	20-8751	SPINDLE HOUSING
8	1	20-8800	PULLEY, DRIVE, SPINDLE
9	1	20-8804	9ADAPTER, CYL DRAWTUBE
10	1	22-2717	LOCATING PIN
11	1	22-8562B	FLANGE, PULLEY, TIMING
12	1	40-16391	SHCS, 3/8-16 x 1/2"
13	4	40-1663	SHCS, 1/2-13 x 1 3/4"
14	8	40-1697	SHCS, 1/4-20 x 3/4"
15	2	40-1712	SHCS, 5/16-18 x 1/2
16	4	40-1805	SHCS, 8-32 x 5/8"
17	12	40-1959	SHCS, 3/8-16 x 1 3/8
18	2	45-1599	WASHER, FLAT 5/16 I.D.
19	4	45-1656	FLAT WASHER, 1/2" SAE
20	2	46-1720	NUT, HEX 1/2-13
21	4	49-4110	WASHER, #8 SEALING
22	1	51-7100	BALL BEARING, 120 mm I.D.
23	1	54-3090	TIMING PULLEY
24	1	54-3101	TIMING BELT, #340XL037-1/5P
25	4	54-3110	V-BELT, #5VX670
26	1	57-2989	O-RING, #265 N 70
27	1	58-3105	PIPE PLUG, 1/4 NPT
28	1	60-1810	ENCODER, 2000 LINE

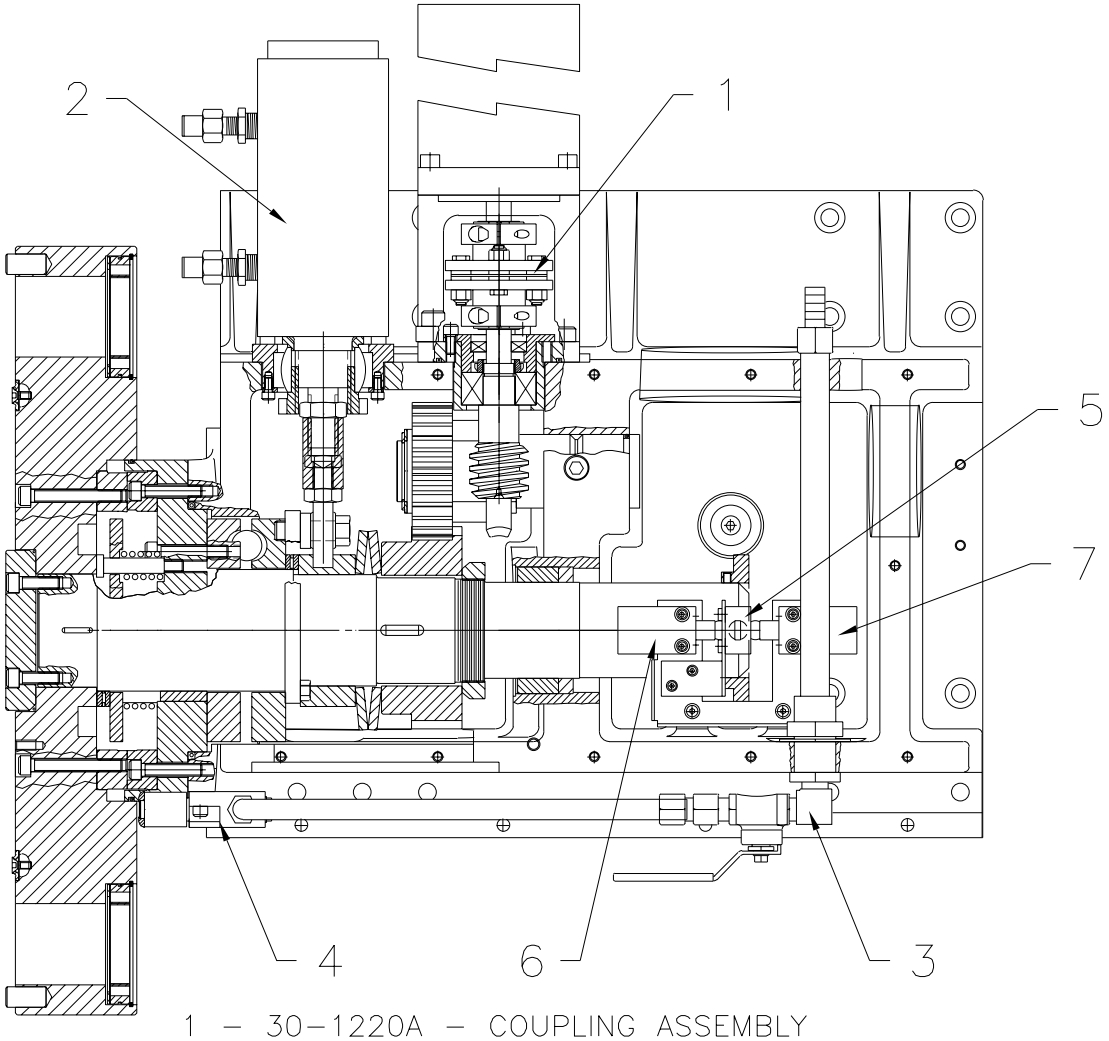
HL-3/4 Spindle



30-9700 TOOL CHANGER ASSEMBLY

1. 30-1220A COUPLING ASSEMBLY
2. 30-3650 AIR CYLINDER ASSEMBLY
3. 30-3655 XFER COOLANT ASSEMBLY
4. 30-3660 XFER COOLANT TIP ASSEMBLY
5. 32-2010 TELEMECHANIQUE SWITCH ASSEMBLY
6. 32-2153 LIMIT SWITCH ASSEMBLY
7. 32-2154 LIMIT SWITCH ASSEMBLY

HL-1/2 Tool Changer



1 – 30–1220A – COUPLING ASSEMBLY
2 – 30–3650 – AIR CYLINDER ASSEMBLY
3 – 30–3655 – XFER COOLANT LINE ASSEMBLY
4 – 30–3660 – XFER COOLANT TIP ASSEMBLY
5 – 32–2011 – TELEMECHANIQUE SWITCH ASSEMBLY
6 – 32–2153 – LIMIT SWITCH, UNCLAMP/CLAMP
7 – 32–2154 – LIMIT SWITCH, CLAMP

HL-3/4 Turret Assembly