HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

SL Series Service Manual 96-8710G RevG English June 2003

- 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.

COMMON ABBREVIATIONS USED IN HAAS MACHINES

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

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

1. TROUBLESHOOTING

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

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

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

BEFORE YOU BEGIN:

USE COMMON SENSE

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

FIND THE PROBLEM FIRST

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

DON'T TINKER WITH THE MACHINE

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

1.1 General Machine Operation

Machine Not Running

Machine cannot be powered on.

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

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

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

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

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

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

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

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 housing and observe the reading of the indicator. A reading of more than .001 would indicate excessive vibration. The two common sources of noise are the spindle and axis drives. Most complaints about vibration, accuracy, and finish can be attributed to incorrect machining practices such as poor quality or damaged tooling, incorrect speeds or feeds, or poor fixturing. Before concluding that the machine is not working properly, ensure that good machining practices are being observed. These symptoms will not occur individually (Ex. A machine with backlash may vibrate heavily, yielding a bad finish). Put all of the symptoms together to arrive at an accurate picture of the problem.

Machine vibrates while 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. Any cutter will vibrate if pushed beyond its tensile strength. In order to eliminate the machine as the source of the problem, you need to check the spindle and the backlash of the axes as described in the following sections. Once machining practices have been eliminated as the source of vibration, observe the machine in both operation and “cutting air.” Move the axes (individually) without the spindle turning and then turn the spindle without moving the axes. Isolate whether the vibration comes from the spindle head or from an axis.

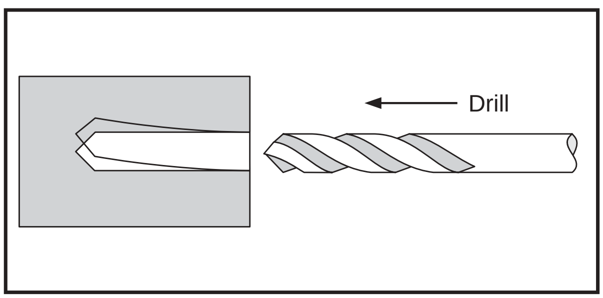
ACCURACY

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

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

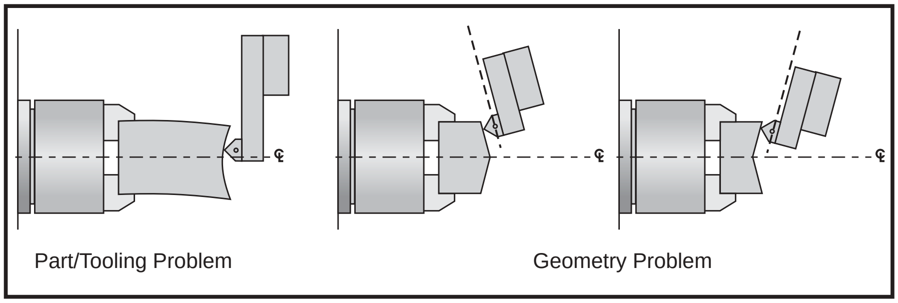
- Ensure the tool probe is set up correctly (settings, etc.)
- Ensure tool offsets are coorect. Note that the coordinate system (FANUC, YASNAC, HAAS) must be selected *before* setting tools.
- Ensure Parameter 254, Spindle Center, is set correctly.
- Check for thermal growth of the X-axis ballscrew (see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

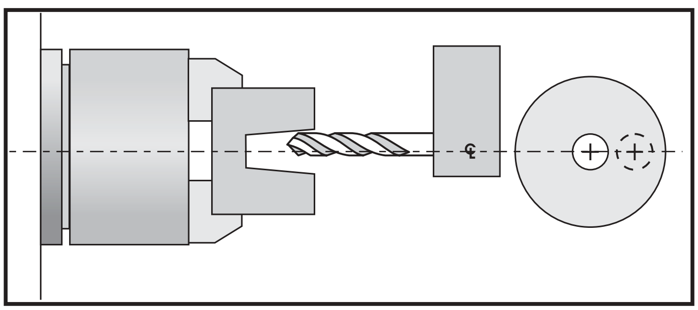
Part faces are conical

- 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 ballscrews (see Thermal Growth" section).



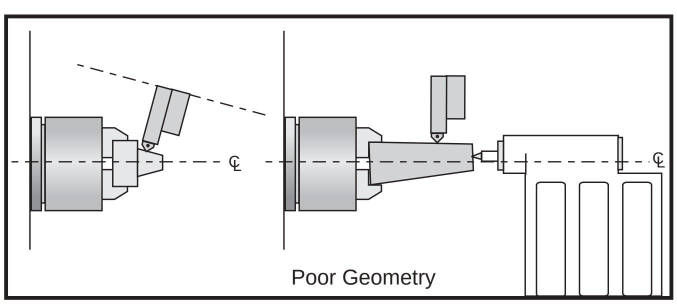
Bores are tapered

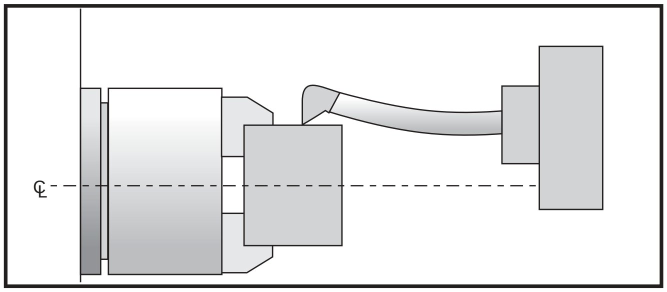
- Check that tooling and machining practices are correct. Bores will be tapered if the tooling is inappropriate, the speeds and feeds are incorrect, or coolant is not getting to the cutting tool when required.
- Although it is rare, the spindle may be out of alignment due to a crash
- Check that the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

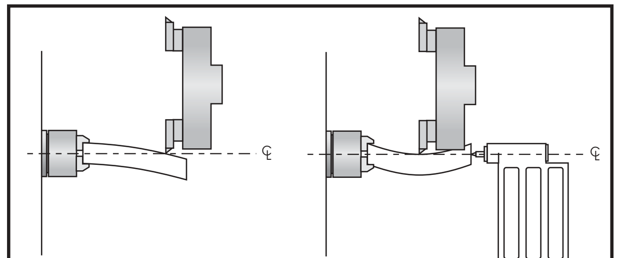


Outside diameter (O.D.) is tapered

- 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.
- Spindle to Z-axis may be out of alignment (not parallel).
- Program around it. Reduce depth of final rough cut and finish pass to reduce part deflection.

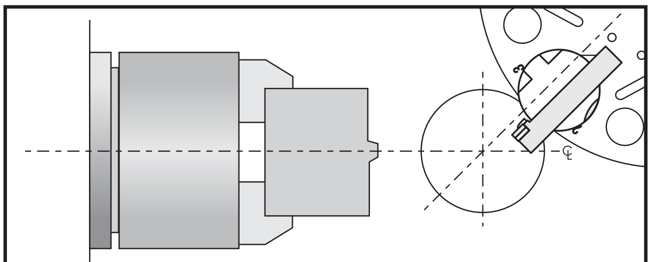





Poor Technique

Material left after facing a part

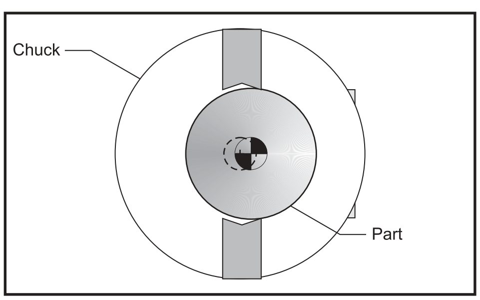
- Ensure tooling is correct.
- Ensure turret is aligned to X-axis travel.
- Ensure Parameter 254, Spindle Center, is set correctly.


Material Left After Facing Part

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 ballscrews. As the machine warms up, the ballscrews 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.

Verify Thermal Growth

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

1. Home the machine. In MDI mode, press POSIT and PAGE DOWN to the OPER page.
2. Jog to an offset location. 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 X) 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 its 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 beginning of its 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. Error 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 ballscrews to warm up to the correct temperature and stabilize. Once the machine is at temperature, the ballscrews won't expand any further, unless they are 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 is still not turning, replace MOCON PCB.
- Disconnect the drive belt. If the spindle will not turn, it is seized and must be replaced.

For Brush machines only:

- 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 the air cylinder style.
- Check the wiring of analog speed command from MOTIF PCB to spindle drive (cable 720).
- 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 noise 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.

Vector Drive

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.3 Transmission (SL 30 and 40)

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, Mechanical 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, Mechanical 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 be approximately +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 / Ballscrews

Not Operating

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

Servo motor is not functioning.

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

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

Noise

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

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

Servo motor noise.

- Disconnect the servo motor from the ball screw and rotate by hand. If the noise persists, replace the motor assembly ("Axis Motor Removal/Installation" section).
- If motor noise is caused by motor bearings, replace motor.

Ball screw noise.

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

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

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

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

Accuracy / Backlash

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

Poor Z-axis accuracy.

- Check for a loose encoder on the servo motor. Also, ensure the key in the motor or the ball screw is in place and the coupling is tight (Brush motors only).
- Check parameters for that axis.
- Check for backlash in the ball 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. 1.4-1

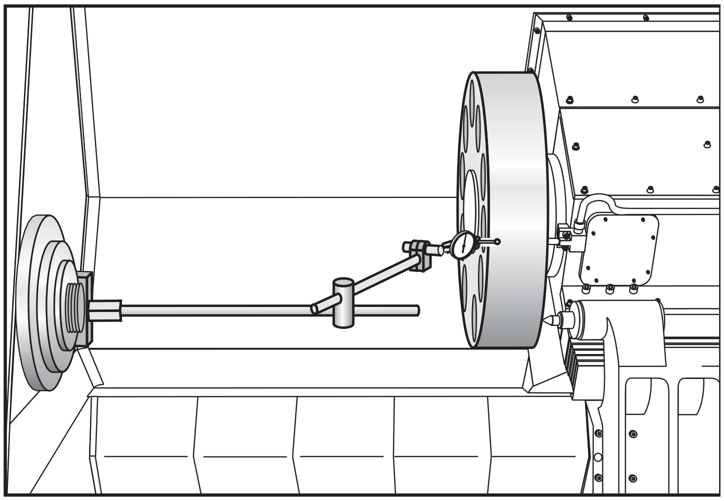


Fig. 1.4-1 Dial indicator in position to check X-axis.

2. Set dial indicator and the “Distance to go” display in 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. 1.4-2.

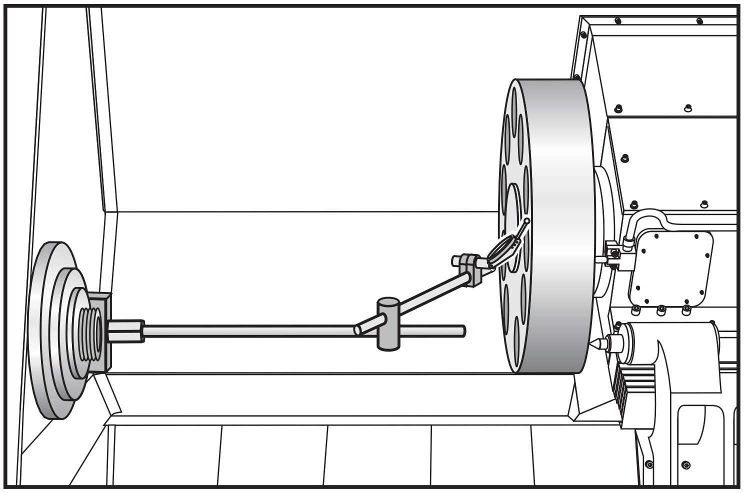


Fig. 1.4-2 Dial indicator in position to check Z-axis

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 (0) ± .001.
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.
- A bad motor can cause vibration if there is an open or short in the motor. A short would normally cause a GROUND FAULT or OVERCURRENT alarm; check the ALARMS. An ohmmeter applied to the motor leads should show between 1 and 3 ohms between leads, and over 1 megohm from leads to chassis. If the motor is open or shorted, replace.

Overheating

Servo motor overheating.

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

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 ball screw.

Ball Screws - Visual Inspection

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

Wear of the nut balls and the screw threads is generally not an issue under proper operating conditions.

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

Loss of Lubrication:

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

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

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

Contamination:

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

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

1. If the lube is wet and clean, this indicates a properly functioning lube system.
2. If the lube is thick and dark, but free of metal chips, the lube itself is old and must be changed out. The entire system should be cleaned of the old lube.
3. If the lube is wet and black, the lube system has been contaminated by metal particles. Inspect the Ball Screws for wear.

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

Machine Crash:

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

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

Cleaning

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

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

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

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

1.5 Turret Clamp / Unlcamp

Alarm 113 and 114

1) Check the tool changer solenoid.
   A) Does the solenoid appear to be activating.?
      I) If no, check power to the solenoid during a tool change. If there is voltage replace the solenoid.
      II) If yes, go on.
   B) Are the exhaust mufflers dirty?
      I) If yes, remove the muffler and do a tool change. If the alarm goes away then replace the muffler
      II) If no, proceed to the next step.
   C) Is there water in the airlines?
      I) If yes, insure that the air is now dry and replace the solenoid.
      II) If no, proceed to the next step.

2) Check air pressure.
   A) Is the main regulator set to a minimum 85 psi?
   B) Does the air pressure drop more than 10 psi during a tool change?
      I) If no, go to the next check.
      II) If yes, the lathe has an insufficient volume of air. Must have a supply of 100 psi at 4 sfm at the regulator. A small diameter air supply hose, hose length, and fitting size may restrict the volume of air going to the machine.

3) Remove the top toolchanger cover. Confirm that the air cylinder is fully clamping (114 alarm) or fully unclamping (113 alarm).
   A) If yes, go to the next check,.
   B) If no, try to push the air cylinder into position.
      I) If the air cylinder will not fully clamp or unclamp disconnect the air cylinder from the cam lever and retry. If the air cylinder still does not fully clamp or unclamp, replace the air cylinder.
      II) If the air cylinder fully clamps and unclamps then:
         1) Cam balls fell out of time with each other. This would be more common on the original style cams. This design does not have a cage. Fully clamping the air cylinder by hand should position the 3 balls correctly.
         2) If this problem persists then the cams might be damaged. Replace with part numbers 93-8138 “cam upgrade kit”. This is a cam assembly with the cage. It is compatible with all lathes.

4) Clamp switch or unclamp switch is failing or is out of adjustment. (Reed style or telemecanique switches).
   A) Switch identification and adjustment.

      I) Reed style switches- these types of clamp/unclamp switches are mounted on the air cylinder to detect the clamp and unclamp position of the turret. The air cylinder has a magnetic piston, which activates the switch when the magnetic piston is under it. This style detects the movement of the piston, not the turret shaft.

         1) Adjust the switch by first confirming that the air cylinder is fully clamped. While observing the diagnostic data for the control, slide the switch in one direction until the bit changes from a “1” to a “0”. Mark the position with a pen then do the same while sliding the switch in the other direction. Position the switch between the two markings and tighten the clamp.

2) If the alarm still persists then the switch might be failing. Change the clamp switch with the unclamp switch at the air cylinder and at the lube panel. If the problem goes away or changes to an unclamp alarm then replace the switch.

II) Telemecanique clamp/unclamp switches at the rear of the turret shaft- these types of switches detect the position of the turret shaft during a tool change, these switches are installed on the same bracket which supports the turret home switch, also called the a-axis home switch.

The amount of shaft movement or turret pop out is very important with this style of switch. The switches are a direct indication of the position of the shaft. If the turret in/out travel is not adjusted correctly or the switch bracket is holding the switches too far apart then alarms during a tool change will occur.

1.6 Hydraulic System

Hydraulic Pressure

"Low hydraulic pressure" alarm (143).

- 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.
- Make sure the filter has been replaced within the last 6 months.
- If pressure drops below 40 PSI during activation of chuck or tailstock, an alarm will occur.

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.
- Remove, clean, and reinstall adjustment valves.

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.

1.7 Electrical Troubleshooting

CAUTION!	Before working on any electrical components, power off the machine and wait approximately 10 minutes. This will allow the highvoltage 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, It is 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. Adjust voltage to correct specifications or replace the power supply.
  Overvoltage could occur if regen load is not coming on, but this does not usually happen. The problem could also be the axis motor itself, with leads either shorted to each other or to ground, which is very rare.

Axis Overload

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

Phasing Error

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

Servo Error Too Large

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

Axis Z Fault or Z Channel Missing

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

Axis Cable Fault

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

Alarm 101, "MOCON Comm. Failure"

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

Alarm 157, "MOCON Watchdog Fault"

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

Alarm 354 - Aux Axis Disconnected

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

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

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

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

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

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

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

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

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

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

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

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

Processor Stack Diagnostic

(DISCONNECT CABLES FROM A NORMAL OPERATING SYSTEM)

Remove low voltage cable from the Video & Keyboard PCB

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

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

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

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

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

KEYBOARD DIAGNOSTIC

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

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

KEYBOARD GRID

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

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

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

Example

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

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

ETHERNET

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

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

To fix this error first verify the following:

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

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

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

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

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

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

Lathe code will not work

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

CRT Test Pattern

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

1.8 Barfeeder Troubleshooting

Push finger works but the pushrod will not load (during initial installation), ensure there are relays installed in the top two tool changer locations on the IOPCB. (K9 and K10). This can occur when installing a barfeeder on an older machine.

Problem with accuracy or incorrect pushes: Try doing a new set up as G105 Q2, Q4 or Q5 may have inadvertently been changed. Once the barfeeder is installed and running the set up procedures should not have to be repeated unless the bar feeder is moved or the the collet or chuck is is changed.

The End of Bar switch at the right of the transfer tray has a switch paddle that can stick in the down position. This will cause erroneous bar lengths and other problems. The switch paddle can be formed slightly to assure clearance in the opening in the transfer tray.

There is a small ampount of play in between the ball screw and the ball nut. This can set up a small amount of vibration when very fast spindle speeds are used. This is **normal** operation and will not affect finished part.

Any time the transport assembly on the bar feeder is disassembled or changed, parameters 240, 1st Aux Max Travel, and 244, 1st Aux Min Travel, may be affected. If these parameters are not correctly set, malfunctioning of the pushrod can occur and in some instances the barfeeder can crash. These parameters can be checked by the following procedure:

1. Zero the bar feeder.

2. In handle jog mode, jog in the minus direction, until the V position on the screen matches parameter 244.

3. Push down on the control arm positioner on the right side of the pushrod to ensure the rotation control arm moves smoothly in and out of the notch on the left end. Loosen the two screws on the fork activator and adjust if necessary.

4. On the left end of the pushrod control arm is a pin that drops onto a notch when the pushrod is loaded. This pin shopuld be just far enough to the left to clear the lobe in the notch. If this pin is not in the correct position, use the jog handle to adjust it and enter the new number from the screen into parameter 244.

5. To adjust parameter 240 ensure the pushrod is unloaded and jog the push finger all the way to the right. Paramter 240 should be set such that the carriage comes within about 3/8" of the ball screw support end without hitting it. If not, adjust it using the jog handle and enter the V position from the CRT into parameter 240.

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 one of them is possibly bad. Check cable connections and boards. This alarm could also be caused by a memory fault, which was detected on the MOCON.
102	Servos Off	Indicates that the servo motors are off, the tool changer is disabled, the coolant pump is off, and the spindle motor is stopped. Caused by EMERGENCY STOP, motor faults, tool changer problems, or power fail.
103	X Servo Error Too Large	Too much load or speed on X-axis motor. The difference between the motor position and the commanded position has exceeded a parameter. The servos will be turned off and a RESET must be done to restart. This alarm can be caused by problems with the driver, motor, or the slide being run into the mechanical stops. The motor may also be stalled, disconnected, or the driver failed.
104	Y Servo Error Too Large	Same as alarm 103.
105	Z Servo Error Too Large	Same as alarm 103.
106	A Servo Error Too Large	Same as alarm 103.
107	Emergency Off	EMERGENCY STOP button was pressed. 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 is large enough to exceed the continuous rating of the motor over a period of several seconds or even minutes. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops 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 alarm 108.
110	Z Servo Overload	Same as alarm 108.
111	A Servo Overload	Same as alarm 108.
112	No Interrupt	Electronics fault. Call your dealer.
113	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 adjustment, or there is a mechanical problem.
115	Turret Rotate Fault	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 delays and orient spindle speed. 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 delays. Check circuit breaker CB4, the circuit breaker for the air pressure solenoids and the spindle drive.
118	Spindle Low Gear Fault	Gearbox did not shift into low gear. During a change to low gear, the low gear sensor was not detected in time. Parameters 67, 70 and 75 can adjust the delays. Check the solenoid's circuit breaker CB4, and the spindle drive.
119	Over Voltage	Incoming line voltage is above maximum. The tool changer, and coolant pump will stop. If this condition persists, an automatic shutdown will begin after the time specified by parameter 296.
120	Low Air Pressure	Air pressure dropped below 80 PSI for a period 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 is overheating. This alarm will turn off the spindle drive, coolant pump, and tool changer. One common cause of this overheat condition is an input line voltage too high. If this condition persists, an automatic shutdown will begin after the interval specified by parameter 297. It can also be caused by a high start/stop duty cycle of the spindle.

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 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	Transmission is out of position when a command is given to start a program or rotate the spindle. This means that the two speed transmission is not in either high or low gear but is somewhere in between. Check the air pressure, the solenoid's circuit breaker CB4, and the spindle drive. Use the POWER UP/RESTART button to correct the problem.
127	Door Fault	The control failed to detect a low signal at the Door Switch input after the door was commanded and the Door Switch input was not received after the door was commanded to close and the time set in parameter #251 has elapsed.
129	M Fin Fault	M-code relays were active at power on. Check the wiring to your **M** code interfaces. This test is only performed at power-on.
130	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.
131	Tool Not Clamped	When clamping or powering up the machine, the Tool Release Piston is not Home. This is a possible fault in the air solenoids, relays on the I/O Assembly, the drawbar assembly, or wiring.
132	Power Down Failure	Machine did not turn off when an automatic power-down was commanded. Check wiring to the Power Interface card on power supply assembly, relays on the IO assembly, and the main contactor K1.
133	Spindle Brake Engaged	The brake is engaged. It must be released before the spindle can turn.
134	Low Hydraulic	Hydraulic pressure is sensed to be low. Check pump pressure and Pressure hydraulic tank oil level. Verify proper pump and machine phasing.
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 axes at the stops for several minutes.
136	Y Motor Over Heat	Same as alarm 135.
137	Z Motor Over Heat	Same as alarm 135.
138	A Motor Over Heat	Same as alarm 135.
139	X Motor Z Fault	Encoder pulse count failure. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at P1-P4.

140	Y Motor Z Fault	Same as alarm 139.
141	Z Motor Z Fault	Same as alarm 139.
142	A Motor Z Fault	Same as alarm 139.
143	Spindle Not Locked	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. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.
146	Y Limit Switch	Same as alarm 145.
147	Z Limit Switch	Same as alarm 145.
148	A Limit Switch	Normally disabled for rotary axis.
149	Spindle Turning	Spindle not at zero speed for tool change. A signal from 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	Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.
151	HPC LOW PRESSURE	A low coolant pressure condition has been detected. To disable this alarm, set parameter 209 Common Switch 2 DSBL CLNT IN to 1.
152	Self Test Fail	Control has detected an electronics fault. All motors and solenoids are shut down. This is most likely caused by a fault of the processors. Call your dealer.
153	X-axis Z Ch Missing	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 alarm 153.
155	Z-axis Z Ch Missing	Same as alarm 153.
156	A-axis Z Ch Missing	Same as alarm 153.
157	MOCON Watchdog Fault	The self-test of the MOCON has failed. Call your dealer.
158	Video/Keyboard PCB Failure	Internal circuit board problem. This could also be caused by a short in the front panel membrane keypad. Call your dealer.
159	Keyboard Failure	Keyboard shorted or button pressed at power on. A power-on test of the membrane keypad has found a shorted button. It can also be caused by a short in the cable from the main cabinet or by holding a button 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 into a mechanical stop. It can also be caused by a short in the motor or a short of one motor leads to ground.
162	Y-Axis Drive Fault	Same as alarm 161.
163	Z-Axis Drive Fault	Same as alarm 161.
164	A-Axis Drive Fault	Same as alarm 161.
165	X Zero Ret Margin Too Small	This alarm indicates that the zero return position may not be consistent from one zero return to the next. The encoder **Z** channel signal must occur between 1/8 and 7/8 revolution of where the home switch releases. This will not turn the servos off but will stop the zero return operation. This alarm can occur if the home/limit switches are moved or misadjusted.
166	Y Zero Ret Margin Too Small	Same as alarm 165.
167	Z Zero Ret Margin Too Small	Same as alarm 165.
168	A Zero Ret Margin Too Small	Same as alarm 165.
169	Spindle Direction Fault	Problem with rigid tapping hardware. The spindle started turning in the wrong direction.
170	Phase Loss	Problem with incoming line voltage between legs L1 and L2. This usually indicates that there was a transient loss of input power to the machine.
171	Rpm Too High To Unclamp	The spindle speed exceeded the max speed allowed in parameter 248 to unclamp.
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 longer than the interval specified by parameter 297 and caused an automatic shutdown.
177	Over Voltage Shutdown	An overvoltage condition persisted longer than the interval specified by parameter 296 and caused an automatic shutdown.
178	Divide by Zero!	There are some parameters that are used as a divisor and therefore must never be set to zero. If the problem cannot be corrected by parameters, cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.
181	Macro not completed-spindle disabled	Macro code operating Haas optional equipment (bar feeder, etc.) was not completed for some reason (ESTOP, RESET, Power Down, etc.). Check optional equipment and run recovery procedure.
182	X Cable Fault	Cable from X-axis encoder does not have valid differential signals.

183	Y Cable Fault	Same as alarm 182.
184	Z Cable Fault	Same as alarm 82.
185	A Cable Fault	Same as alarm 182.
186	Spindle Not Turning	Trying to feed while spindle is in the stopped position.
187	B Servo Error Too Large	Same as alarm 103.
188	B Servo Overload	Same as alarm 108.
189	B Motor Overheat	Same as alarm 135.
190	B Motor Z Fault	Same as alarm 139.
191	B Limit Switch	Same as alarm 145.
192	B Axis Z Ch Missing	Same as alarm 153.
193	B Axis Drive Fault	Same as alarm 161.
194	B Zero Ret Margin Too Small	Same as alarm 165.
195	B Cable Fault	Same as 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	Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.
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	Ball Screw CRC Error	Ball screw compensation tables lost maybe by low battery. Check for Cyclic Redundancy Check 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 disk, delete all, then reload. Check for a low battery and low battery alarm.
207	Queue Advance Error	Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.
208	Queue Allocation Error	Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.
209	Queue Cutter Comp Error	Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

210	Insufficient Memory	Not enough memory to store users program. Check the space available in the LIST PROG mode and possibly gain space by saving programs on disk.
211	Odd Prog Block	Possible corrupted program. Save all programs to disk, delete all, then reload.
212	Program Integrity Error	Possible corrupted program. Save all programs to disk, delete all, then reload. Check for a low battery and low battery alarm.
213	Program RAM CRC Error	Electronics fault; 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 alarm 217.
219	Z Axis Phasing Error	Same as alarm 217.
220	A Axis Phasing Error	Same as alarm 217.
221	B Axis Phasing Error	Same as alarm 217.
222	C Axis Phasing Error	Same as alarm 217.
223	Door Lock Failure	In machines equipped with safety interlocks, this alarm occurs when the control senses the door is open but it is locked. Check the door lock circuit.
224	X Transition Fault	Illegal transition of encoder counts 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 and MOTIF PCBs.
225	Y Transition Fault	Same as alarm 224.
226	Z Transition Fault	Same as alarm 224.
227	A Transition Fault	Same as alarm 224.
228	B Transition Fault	Same as alarm 224.
229	C Transition Fault	Same as alarm 224.
230	Door Open	The spindle RPM has exceeded the max value in parameter 586 while the door is open. Stop the spindle, close the door, or lower your spindle rpm to a value less than or equal to the value of parameter 586.
231	Jog Handle Transition Fault	Illegal transition of encoder counts in jog handle encoder. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors.

232	Spindle Transition Fault	Illegal transition of encoder counts in spindle encoder. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON.
233	Jog Handle Cable Fault	Cable from jog handle encoder does not have valid differential signals.
234	Spindle Enc. Cable Fault	Cable from spindle encoder does not have valid differential signals.
235	Spindle Z Fault	Same as alarm 139.
236	Spindle Motor Overload	This Spindle motor is overloaded.
237	Spindle Following Error	The error between the commanded spindle speed and the actual speed has exceeded the maximum allowable (as set in Parameter 184).
239	Unknown MOCON Alarm1	Mocon has reported an alarm to the current software. See mocon software release notes for additional diagnostics.
240	Empty Prog or No EOB	DNC program not found, or no end of program found.
241	Invalid Code	RS-232 load bad. Data was stored as comment. Check the program being received.
242	Number Format Error or Too Long	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	Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.
248	Number Range Error	Number entry is out of range.
249	Prog Data Begins Odd	Possible corrupted program. Save all programs to disk, delete all, then reload.
250	Program Data Error	Same as alarm 249.
251	Prog Data Struct Error	Same as alarm 249.
252	Memory Overflow	Same as alarm 249.
253	Electronics Overheat	This alarm is generated if the control cabinet temperature exceeds 135°F. This can be caused by an electronics problem, high ambient temperature, or clogged air filter.
254	Spindle Motor Overheat	the motor driving the spindle is too hot. This alarm is only generated in machines with a Haas vector drive. The spindle motor temperature sensor sensed a high temperature for greater than 1.5 seconds.
257	Program Data Error	Same as alarm 249.
258	Invalid DPRNT Format	Macro DPRNT statement not structured properly.

259	Language Version	Problem with language files. Please reload foreign language files.
260	Language CRC	FLASH memory has been corrupted or damaged. Please reload foreign language files.
261	Rotary CRC Error	Rotary table saved parameters (used by Settings 30, 78) have a Cyclic Redundancy Check error.
262	Parameter CRC Missing	RS-232 or disk read of parameter had no Cyclic Redundancy Check when loading from disk or RS-232.
263	Ball Screw CRC Missing	Ball screw compensation tables have no Cyclic Redundancy Check when loading from disk or RS-232.
264	Rotary CRC Missing	Rotary table parameters have no Cyclic Redundancy Check when loading from disk 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 when 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 alarm 103.
271	C Servo Overload	Same as alarm 108.
272	C Motor Overheat	Same as alarm 135.
273	C Motor Z Fault	Same as alarm 139.
274	C Limit Switch	Same as alarm 145.
275	C Axis Z Ch Missing	Same as alarm 153.
276	C Axis Drive Fault	Same as alarm 161.
277	C Zero Ret Margin Too Small	Same as alarm 165.
278	C Cable Fault	Same as alarm 182.
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	The command after the block commanded with chamfering, corner R is not Chamfering, Corner R 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	Consecutive blocks commanded with chamfering, corner R (i.e., G01 Xb Kk; with Chamfering G01 Zb Ii). After each chamfering block, there must be a single move perpendicular to the one with chamfering, corner R amount.
297	320V Power Supply Fault	320 Volt P.S. fault has occurred. This alarm will be generated when overvoltage, undervoltage, short circuit, over temperature, or shorted regen fault occurs. Check hexadecimal LED display on Power Supply for fault conditions.

302	Invalid R in G02 or G03	Check your geometry. **R** must be greater than or equal to half the distance from start to end.
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 0.001 inches (0.01 mm.)
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 sub-routine.
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 alarm 316.
318	Z Over Travel Range	Same as alarm 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	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). This alarm can also be generated by entering an invalid M95 time format.
325	Queue Full	Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.
326	G04 Without P Code	Put a **Pn.n** for seconds or a **Pn** for milliseconds.
327	No Loop For M Code Except M97, 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	Parameter has disabled this axis.
334	Y-Axis Disabled	Same as alarm 333.
335	Z-Axis Disabled	Same as alarm 333.
336	A-Axis Disabled	An attempt was made to program the A-axis while it was disabled (DISABLED bit in Parameter 43 set to 1).
337	GOTO or P line Not Found	Subprogram is not in memory, or **P** code is incorrect. or P's not found.
338	Invalid IJK and XYZ in G02 or G03	There is a problem with circle definition; check your geometry.
339	Multiple Codes	Only one **M, X, Y, Z, A , Q,** etc. allowed in any block or 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	Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.
344	Cutter Comp With G18 and G19	Cutter comp only allowed in XY plane (G17).
345	Invalid R Value in M19 or G105	R value must be positive.
346	Illegal M Code	There was an M85 or M86 commanded. These commands are not allowed while Setting 51 DOOR HOLD OVERRIDE is OFF. Also check Setting 131 for AUTO DOOR and Parameter 57 for DOOR STOP SP.
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.
359	Invalid I, J Or K In G12 Or G13	Check your geometry.
360	Tool Changer Disabled	Check Parameter 57. Not a normal condition for 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.
365	P Definition Error	P value not defined, or P value out of range. An M59 or M69 must have a P value between the range of 1100 and 1155.
366	Cutter Comp Interference	G01 cannot be done with tool size.
367	Cutter Comp Interference	G01 cannot be done with tool size.
368	Groove Too Small	Tool too big to enter cut.
369	Tool Too Big	Use a smaller tool for cut.
370	Tailstock Excessive Drift	The tailstock position has changed even though it has not been commanded to do so. Check for hydraulic leaks.
372	Tool Change in Canned Cycle	Tool change not allowed while canned cycle is active.
373	Invalid Code in DNC	A code found in a DNC program could not be interpreted because of DNC restrictions.
374	Missing 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.
380	X,B,A Or G49 Not Allowed In G37	G37 may only specify Z-axis and must have tool offset defined.
381	G43,G44 Not Allowed In G36 Or G136	Auto work offset probing must be done without tool offset.

382	D Code Required In G35	A Dnn code is required in G35 in order to store the measured tool diameter.
383	Inch Is Not Selected	G20 was specified but settings have selected metric input.
384	Metric Is Not Selected	G21 was specified but settings have selected inches.
385	Invalid L, P, or R Code in G10	G10 was used to changes offsets but **L**, **P**, or **R** code is missing or invalid.
386	Invalid Address Format	An address A..Z was used improperly.
387	Cutter Comp Not Allowed With G103	If block buffering has been limited, Cutter 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 alarm 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 its 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 **Onnnnn** and must be at beginning of a block.
406	RS-232 Missing Code	A receive found bad data. Check your program. The program will be stored but the bad data is turned into a comment.
407	RS-232 Invalid Code	Check your program. The program will be stored but the bad data is turned into a comment.

408	RS-232 Number Range Error	Check your program. The program will be stored but the bad data is turned into a comment.
409	RS-232 Invalid N Code	Bad Parameter or Setting data. User was loading settings or parameters and something was wrong with the data.
410	RS-232 Invalid V Code	Bad parameter or setting data. User was loading settings or parameters and something was wrong with the data.
411	RS-232 Empty Program	Check your program. Between **%** and **%** there was no program found.
412	RS-232 Unexpected End of Input	Check Your Program. An ASCII EOF code was found in the input data before the complete program was completely received. This is a decimal code 26.
413	RS-232 Load Insufficient Memory	Program received does not fit. Check the space available in the LIST PROG mode and possibly delete some programs.
414	RS-232 Buffer Overflow	Data sent too fast to CNC. Computer sending data may not respond to X-OFF
415	RS-232 Overrun	Data sent too fast to CNC.
416	RS-232 Parity Error	Data received by CNC has bad parity. Check parity settings, number of data bits and speed. Also check your cables.
417	RS-232 Framing Error	Data received was garbled and proper framing bits were not found. One or more characters of the data will be lost. Check parity settings, number of data bits and speed.
418	RS-232 Break	Break condition while receiving. The sending device set the line to a break condition. This might also be caused by a simple break in the cable.
419	Invalid Function For DNC	A code found on input of a DNC program could not be interpreted.
420	Program Number Mismatch	The **O** code in the program being loaded did not match the **O** code entered at the keyboard. Warning only.
423	Servo Bar Eob Switch Position Unknown	Place 12 inch standard bar in charging position and run G105 Q5 to set End of Bar Switch Position.
424	Servo Bar Metric Unsupported	Metric mode is currently unsupported. Change setting 9 to inch.
425	Servo Bar Length Unknown	Both the bar length and reference position are unknown. Unload bar, Run G105 Q4 followed by G105 Q2 or Q3.
426	Servo Bar Illegal Code	G105 (feed bar) commanded with an illegal code on block. Legal codes are I,J,K,P,Q,R
428	Servo Bar Switch Failure	One of the switches controlling the Servo Bar failed.
429	Disk Dir Insufficient Memory	Disk memory was almost full when an attempt was made to read the disk directory.
430	Disk Unexpected	Check your program. An ASCII EOF code was found in the input data End of Input before the complete program was received. This is a decimal code 26.
431	Disk No Prog	Need name in programs when receiving ALL; otherwise has no way to store them.

432	Disk Illegal Prog Name	Check files being loaded. Program must be **Onnnnn** and must be at the beginning of a block.
433	Disk Empty Prog Name	Check your program. Between % and % there was no program found.
434	Disk Load Insufficient Memory	Program received does not fit. Check the space available in the LIST PROG mode and possibly delete some programs.
435	Disk Abort	Could not read disk.
436	Disk File Not Found	Could not find disk file.
437	TS Under Shoot	The tailstock did not reach its 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.
440	Servo Bar Max Parts Reached	Job Complete. Reset Current # Parts Run on Servo Bar current commands page.
441	Servo Bar Max Bars Reached	Job Complete. Reset Current # Bars Run on Servo Bar current commands page.
442	Servo Bar Max Length Reached	Job Complete. Reset Current Length Run on Servo Bar current commands page.
443	Servo Bar Already Nested	An Illegal G105 Pnnn was found in cutoff subprogram.
445	Servo Bar Fault	SERVO BAR program error.
446	Servo Bar Bar Too Long	The Bar that was just loaded is longer than the Length of Longest Bar as displayed on the Servo Bar current commands page. The system was unable to accurately measure it.
447	Servo Bar Bar In Way	The end of bar switch was depressed and a load or unload bar was commanded. Remove the bar.
448	Servo Bar Out Of Bars	Add more Bars.
449	Servo Bar Cutter Comp Not Allowed	G105 cannot be executed while cutter compensation is invoked.
450	Bar Feeder Fault	This means that discrete input 1027 (BFSPLK) is too high. See parameter 278 bit 20 CK BF status.
451	Bar Feeder Spindle Interlock	This means that discrete input 1030 (BF FLT) is high. See parameter 278 bit 21 CK BF SP ILK.
452	Servo Bar Gearmotor Timeout	The motor which loads bars and the Push rod did not complete its motion in the allowed time. Check for jammed bars.
453	C Axis Engaged	A spindle command (M14, M41, M42, G05 or G77) was given with the C axis drive engaged. The C axis motormust be disengaged with M155 before a spindle brake or gear change.
454	C-Axis Not Engaged	A command was given to the C-axis without the C-axis engaged. The C-axis drive must be engaged with M154 before commanding the C-axis.

455	G112 Block Ends W/O Cancel Cutter Comp	An X/Y cutter compensation exit move is required before a G113 is issued to cancel the G112 block.
456	Parameter Conflict	There is a conflict between two or more of the AXIS MOCON CHANNEL parameters.
459	APL Door Fault	Door was not completely open while APL was inside CNC. Or parameter 315 bit 5 was set to zero.
460	APL Illegal Code	Internal software error; call your dealer.
461	APL Gripper Timeout	The gripper failed to reach its target position within the allowed time.
462	U Over Travel Range	Commanded U-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user's program or improper offsets.
463	V Over Travel Range	Commanded V-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user's program or improper offsets.
464	W Over Travel Range	Commanded W-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user's program or improper offsets.
465	U Axis Disabled	Parameter has disabled this axis.
466	V Axis Disabled	Parameter has disabled this axis.
467	W Axis Disabled	Parameter has disabled this axis.
468	U Lmiit Switch	Axis hit limit switch or switch disconnected. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.
469	V Lmiit Switch	Axis hit limit switch or switch disconnected. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.
470	W Lmiit Switch	Axis hit limit switch or switch disconnected. The stored stroke limits should stop the slides before they hit the limit switches. Verify the value of parameter Grid Offset and check the wiring to the limit switch and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.
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 Brackets In Expression	Unbalanced brackets, “[“ or “]”, were found in an expression. Add or delete a bracket.
505	Value Stack Error	The macro expression value stack pointer is in error. Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.
506	Operand Stack Error	The macro expression operand stack pointer is in error. Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.
507	Too Few Operands On Stack	An expression operand found too few operands on the expression stack. Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.
508	Division By Zero	A division in a macro expression attempted to divide by zero. Re-configure expression.
509	Illegal Macro Variable Use	See "MACROS" section for valid variables.
510	Illegal Operator or Function Use	See "MACROS" section for valid operators.
511	Unbalanced Right Brackets	Number of right brackets not equal to the number of left brackets.
512	Illegal Assignment Use	Attempted to write to a read-only macro variable.
513	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	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.
541	Macro Alarm	This alarm was generated by a macro command in a program.
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 its 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	This alarm is caused by an axis moving into the tailstock restricted zone during program execution. To eliminate the problem, change the program to avoid the restricted zone or change Setting 93 or Setting 94 to adjust the restricted zone. To recover, go to jog mode, press RESET twice to clear the alarm, then jog away from 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	While cutter comp was in effect, a geometry was encountered whose Offsets in CC 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.
617	Missing Address	This alarm is generated if an address code is missing. This alarm supports G77.
618	INVALID ADDRESS	This alarm is generated if an address code is being used incorrectly. For example, a negative value is being used for an address code that should be positive.

619	Stroke Exceeds Start Position	This alarm is generated by an incorrect G71 or G72 type 2 command. It refers to a stroke in the PQ path of a G71 or G72 type 2 canned cycle has passed the starting point. Try adjusting the starting point in the block before the G71 or G72.
620	C Axis Disabled	Same as alarm 333.
621	C Over Travel Range	Same as alarm 316.
623	Invalid Code In G112	Only G00 to G03 and G17 are used in G112. G113 cancels G112. No incremental axes are used in G112. G18 cancels G17. G41 and G42 tool nose compensation are permitted.
629	Exceeded Max Feed Per Rev	This alarm supports G77 and G5. If the alarm is received during a G77, reduce diameter of part or change geometry. If the alarm is received during a G5, reduce X or Z travel.
664	U Axis Disabled	Parameter has disabled this axis.
665	V Axis Disabled	Parameter has disabled this axis.
666	W Axis Disabled	Parameter has disabled this axis.
701	U Servo Error Too Large MOCON2	Same as alarm 103.
702	V Servo Error Too Large Mocon2	Same as alarm 103.
703	W Servo Error Too Large Mocon2	Same as alarm 103.
704	C Servo Error Too Large Mocon2	Same as alarm 103.
705	Tt Servo Error Too Large Mocon2	Same as alarm 103.
706	Ss Servo Error Too Large Mocon2	Same as alarm 103.
707	J Servo Error Too Large Mocon2	Same as alarm 103.
708	S Servo Error Too Large Mocon2	Same as alarm 103.
711	U Servo Overload Mocon2	Same as alarm 108.
712	V Servo Overload Mocon2	Same as alarm 108.
713	W Servo Overload Mocon2	Same as alarm 108.
714	A Servo Overload Mocon2	Same as alarm 108.
715	B Servo Overload Mocon2	Same as alarm 108.
716	C Servo Overload Mocon2	Same as alarm 108.
717	J Servo Overload Mocon2	Same as alarm 108.
718	S Servo Overload Mocon2	Same as alarm 108.
721	U Motor Over Heat Mocon2	Same as alarm 135.
722	V Motor Over Heat Mocon2	Same as alarm 135.
723	W Motor Over Heat Mocon2	Same as alarm 135.
724	A Motor Over Heat Mocon2	Same as alarm 135.

725	B Motor Over Heat Mocon2	Same as alarm 135.
726	C Motor Over Heat Mocon2	Same as alarm 135.
727	J Motor Over Heat Mocon2	Same as alarm 135.
728	S Motor Over Heat Mocon2	Same as alarm 135.
731	U Motor Z Fault Mocon2	Same as alarm 139.
732	V Motor Z Fault Mocon2	Same as alarm 139.
733	W Motor Z Fault Mocon2	Same as alarm 139.
734	A Motor Z Fault Mocon2	Same as alarm 139.
735	B Motor Z Fault Mocon2	Same as alarm 139.
736	C Motor Z Fault Mocon2	Same as alarm 139.
737	J Motor Z Fault Mocon2	Same as alarm 139.
738	S Motor Z Fault Mocon2	Same as alarm 139.
741	U Axis Z Ch Missing Mocon2	Same as alarm 153.
742	V Axis Z Ch Missing Mocon2	Same as alarm 153.
743	W Axis Z Ch Missing Mocon2	Same as alarm 153.
744	A Axis Z Ch Missing Mocon2	Same as alarm 153.
745	B Axis Z Ch Missing Mocon2	Same as alarm 153.
746	C Axis Z Ch Missing Mocon2	Same as alarm 153.
747	J Axis Z Ch Missing Mocon2	Same as alarm 153.
748	S Axis Z Ch Missing Mocon2	Same as alarm 153.
751	U Axis Drive Fault Mocon2	Same as alarm 161.
752	V Axis Drive Fault Mocon2	Same as alarm 161.
753	W Axis Drive Fault Mocon2	Same as alarm 161.
754	A Axis Drive Fault Mocon2	Same as alarm 161.
755	B Axis Drive Fault Mocon2	Same as alarm 161.
756	C Axis Drive Fault Mocon2	Same as alarm 161.
757	J Axis Drive Fault Mocon2	Same as alarm 161.
758	S Axis Drive Fault Mocon2	Same as alarm 161.
761	U Cable Fault Mocon2	Same as alarm 182.
762	V Cable Fault Mocon2	Same as alarm 182.
763	W Cable Fault Mocon2	Same as alarm 182.

764	A Cable Fault Mocon2	Same as alarm 182.
765	B Cable Fault Mocon2	Same as alarm 182.
766	C Cable Fault Mocon2	Same as alarm 182.
767	J Cable Fault Mocon2	Same as alarm 182.
768	S Cable Fault Mocon2	Same as alarm 182.
771	U Phasing Error Mocon2	Same as alarm 217.
772	V Phasing Error Mocon2	Same as alarm 217.
773	W Phasing Error Mocon2	Same as alarm 217.
774	A Phasing Error Mocon2	Same as alarm 217.
775	B Phasing Error Mocon2	Same as alarm 217.
776	C Phasing Error Mocon2	Same as alarm 217.
777	J Phasing Error Mocon2	Same as alarm 217.
778	S Phasing Error Mocon2	Same as alarm 217.
781	U Transition Fault Mocon2	Same as alarm 224.
782	V Transition Fault Mocon2	Same as alarm 224.
783	W Transition Fault Mocon2	Same as alarm 224.
784	A Transition Fault Mocon2	Same as alarm 224.
785	B Transition Fault Mocon2	Same as alarm 224.
786	C Transition Fault Mocon2	Same as alarm 224.
787	J Transition Fault Mocon2	Same as alarm 224.
788	S Transition Fault Mocon2	Same as alarm 224.
791	Comm. Failure With Mocon2	Same as alarm 101.
792	MOCON2 Watchdog Fault	Same as alarm 157.
796	Sub Spindle Not Turning	Same as alarm 186.
797	Sub 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. This can be caused by a trip of circuit breaker CB4, a lack of air pressure, or too much friction with the orientation pin.
900	Manual Parameter Changes	When the operator alters the value of a parameter, alarm 900 “PAR NO xxx HAS CHANGED. OLD VALUE WAS xxx.” will be added to the alarm history. When the alarm history is displayed, the operator will be able to see the parameter number and the old value along with the date and time the change was made. Note that this is not a re-settable alarm, it is for information purposes only.

901 Parameter Changes Via Disk Load	This is a new feature. When a parameter file has been loaded from disk, alarm 901 PARAMETERS HAVE BEEN LOADED BY DISK will be added to the alarm history along with the date and time. Note that this alarm is not a re-settable alarm, it is for information purposes only.
902 Parameter Changes Via RS-232 Load	When a parameter file has been loaded via RS-232, alarm 902 PARAMETERS HAVE BEEN LOADED BY RS-232 will be added to the alarm history along with the date and time.

Note that this alarm is not a re-settable alarm, it is for information purposes only.

903 Machine Power Up	When the machine is powered up, alarm 903 CNC MACHINE POWERED UP will be added to the alarm history along with the date and time. Note that this alarm is not a re-settable alarm, it is for information purposes only.
923 Low Oil Pressure	This alarm to supports the VTC-48. Oil Pump for platter gear has no pressure. Check that pump is pumping oil through lines. Check to make sure filter next to pump is not plugged. PARAMETER 618 determines delay to check pressure after start.
924 SS Low Lube Or Low Pressure	This alarm supports the VTC-48. Way lube is low or empty or there is no lube pressure or too high a pressure. Check tank at rear of mill and below control cabinet. Also check connector on the side of the control cabinet. Check that the lube lines are not blocked. PARAM-ETER 616 determines cycle time.
932 Bar 100- Zero Value	A non zero value must be entered for #3100 Part Length + Cutoff, #3102 Min Clamping Length and #3109 Length of Bar stock on the Bar 100 Commands page.
933 Bar 100- Maximum Parts Completed	Job Completed. To Continue, reset #3103 Max # Parts and/or #3106 Current # Parts Run on the Bar 100 Commands page.
934 Bar 100- Current Bar Finished	Load a new bar. Reset Alarm and press Cycle Start to continue.
935 Bar 100 Fault	Bar 100 program error. Cycle power on the machine. If the alarm reoccurs, call your dealer and report the sequence of events that lead to the alarm.

End Of List

NOTE: Alarms 1000-1999 are user defined.

The following alarms are for the VTC:

1001 SMTC FLT-Tool Not Found	Specified tool not found in tool table.
1002 SMTC Pocket Up Timeout	Pocket did not reach UP position within time limit.
1003 SMTC FLT MS Tool One SW	Carousel not on tool one when expected or when on tool one and not expected.
1004 SMTC FLT TC Mark Timeout	Carousel did not come off mark switch or did not reach next mark switch within time limits.
1007 Gear Fault	Machine did not reach specified gear within time limit.
1008 DB Clamp/Uncl Flt	Drawbar did not reach open or closed position within time limit.

1009 SMTC Fault Not Found	Errors in macro, call your dealer.
1010 TSC Fault	Through the tool coolant pressure not reached or not stabilized within time limit. Another cause coulbe that pressure is still present at completion of purge.
1012 SMTC ATC MTR Timeout	Arm did not reach destination within time specified.
1013 SMTC MIS Origin SW	Arm not at origin at start of tool change, start of carousel motion, or at the completion of arm motion.
1014 SMTC MIS Clamp SW	Arm not at the clamp/unclamp position at completion of motion.
1015 SMTC-Pocket DWN Timeout	Pocket did not reach the down position within time limit.
1017 SMTC Too HI Tool#	Specified tool exceeds max limit. Maximum number of tools is 26.
1018 SMTC SP Not In Gear	Live tooling spindle not in gear at start of tool change.
1021 No Depth of Cut Defined	Missing value on command line that is needed for canned cycle.
1022 No Depth of Hole Defined	Missing value on command line that is needed for canned cycle.
1023 No Feed Rate	Missing value on command line that is needed for canned cycle.
1024 No Peck Amount Defined	Missing value on command line that is needed for canned cycle.
1025 No R Plane Defined	Missing value on command line that is needed for canned cycle.
1026 No Start Diameter Defined	Missing value on command line that is needed for canned cycle.

3. MECHANICAL SERVICE

RECOMMENDED TORQUE VALUES FOR MACHINE FASTENERS

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

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

3.1 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.

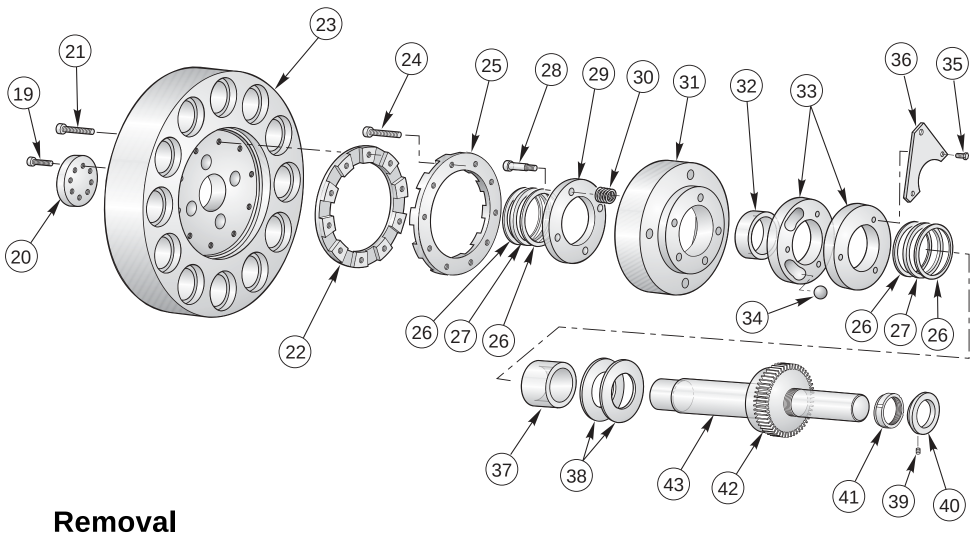
3. Press PRGRM/CNVRS, then the MDI key. Type “M43” into MDI and press CYCLE START. This will unlock the turret by pushing it in the Z-direction.
4. Press the HANDLE JOG key, and then the POSIT key to get into the Position Display and Jog mode. The A axis should be displayed below the X and Z axes.
5. 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)
2. Spindle alignment verification
3. Turret alignment verification (Spindle)

Turret Removal and Replacement



Parts List

19	SHCS 5/16-18 x 1
20	Turret retaining cap
21	SHCS 7/16-14 x 2-1/4
22	Turret male coupling
23	Turret
24	SHCS 7/16-14 x 2-1/4
25	Female turret coupling
26	Thrust washer
27	Thust needle bearing
28	Shoulder bolt
29	Spring retainer
30	Die spring
31	Coupling mount
32	Coupling mount bushing (bronze)
33	Turret cam
34	15/16 steel ball
35	HHB 5/16-18 x 1
36	Lever cam
37	Belleville spacer
38	Belleville washers
39	Key
40	Ring switch
41	Lock nut
42	Spur gear
43	Turret shaft

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 may fall and have to be replaced before the turret can be reassembled.

6. 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.

7. Remove the turret from the shaft.

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

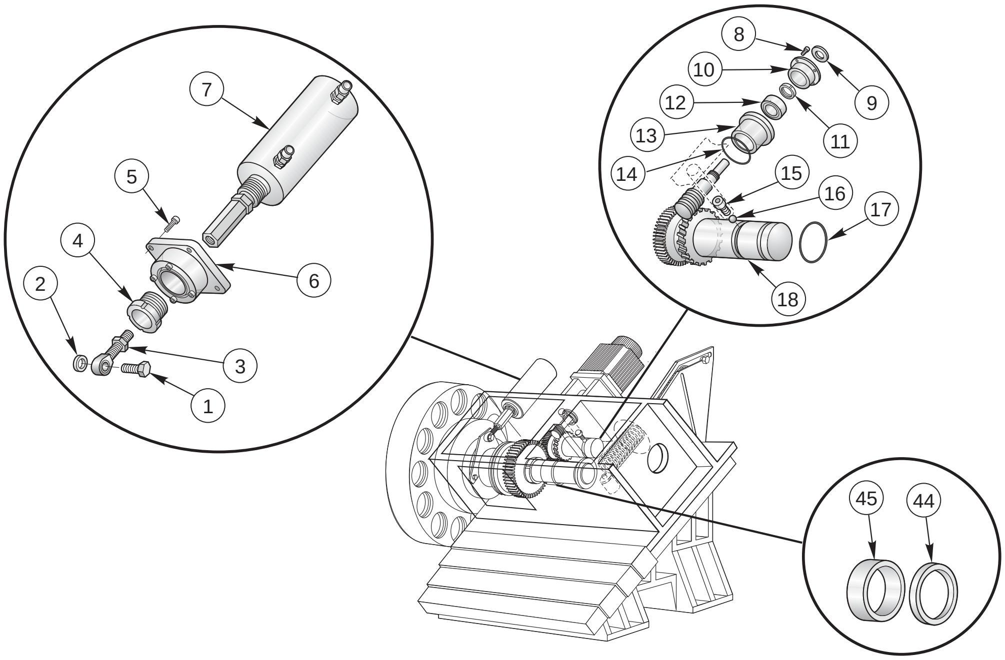
12. Connect the air. The turret should clamp.

13. Change Parameter 76 back to 500.

14. Exercise the tool changer to verify proper operation.

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

Turret Shaft Removal and Replacement



Parts List	
1	HHB 1/2-20 x 1-1/2
2	Rod end spacer
3	1/2 Rod end male
4	Air cylinder nut
5	SHCS 1/4-20 x 1
6	Air cylinder housing
7	Air cylinder
8	SHCS 1/4-20 x 3/4
9	1/4 flat washer
10	Bearing retainer
11	Locknut
12	Bearing
13	Worm housing
14	O-ring
15	SHCS 3/8-16 x 2-1/2
16	5/16 Steel ball
17	O-ring
18	Cluster Gear Shaft
44	Rear turret shaft seal
45	Rear bearing (bronze bushing)

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

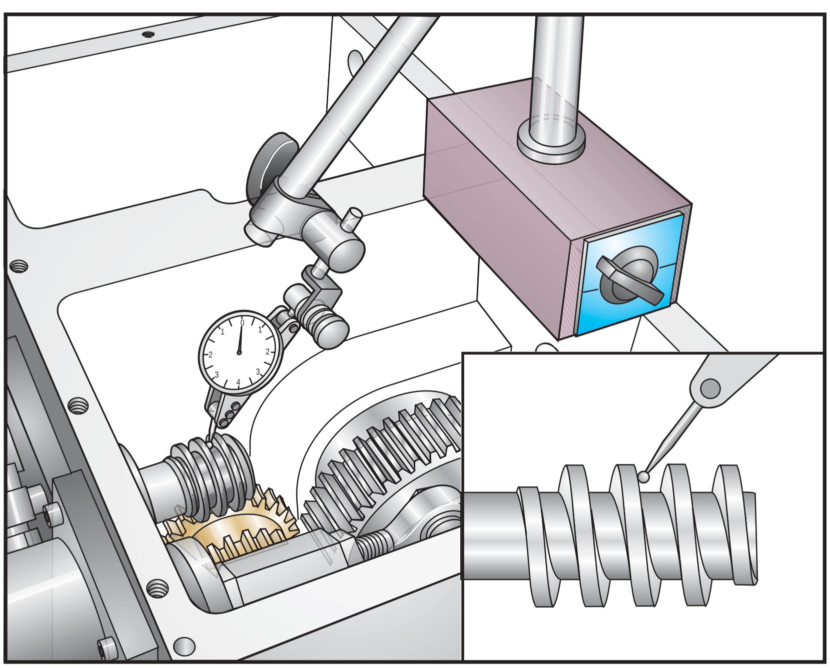
1. Apply grease to the ball bearing areas of the cam.
2. Install coupling mount (cams and bearing) using the installation tool, and line up key way with the bolt that is equidistant between the springs (or previous marked alignment).

3. Install turret shaft assembly (align mark on retaining ring with the mark on the casting).
4. Align keyway 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 10 cups (2400 ml).
14. Install turret as described in previous section.

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

Adjusting Turret Backlash

1. Affix the magnetic base and indicator on a clean surface and check rigidity.
2. Set the indicator pointer on the worm gear. Pointer should be in line with the lead angle on the center thread of the worm gear. See figure.



3. Rotate the worm gear to the end of rotational travel in the counterclockwise direction. Zero your indicator.

4. Rotate the worm gear to the end of rotational travel in the clockwise direction. Record your reading.

5. Rotate the worm gear to exactly half the value of your recorded reading; this is the position to now clamp your coupler. Coupler torque value is 16 ft./lbs.

Example: Rotate the coupler and observe the indicated reading. The force used to rotate the coupler should be great enough so that when the force is removed you will see the indicated reading lesson; i.e. with little force T.I.R. is noted at .006 with more force T.I.R. is .012 (see note).

NOTE: While holding the coupler at its maximum rotational movement release the pressure and note that the backlash reading will fall to a lesser value. By experimenting with this method you will find a “spongy” area. This spongy area is the end play in the worm and cluster gear.

NOTE: Excessive backlash can come from the coupler or bearing retainer.

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

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

3. Loosen the turret motor coupling clamp screw closest to the motor. (Refer to Figure 3.1-1)

4. 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.

5. With the servos on, move the turret motor coupling back and forth to find the center of its backlash, and torque 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 its backlash area. If it gets tighter when it is turned, STOP; this is the wrong direction.

6. Change Parameter 43, “Z CH ONLY” back to “0” (zero).

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

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

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

10. Replace the sliding tool changer cover.

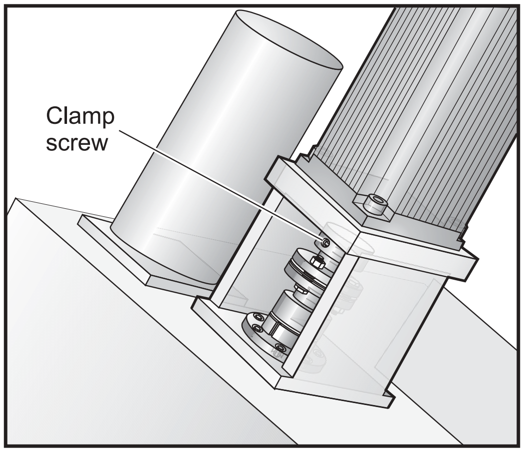


Figure 3.1-1. Turret motor adjustment.

Turret Alignment Verification (X-Axis)

TOOLS REQUIRED:

- **MAGNETIC INDICATOR BASE** • **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 3.1-2.
4. Jog the X axis so the indicator is at one end of its travel then zero the indicator.
5. Jog the X-axis to the other end of its 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.

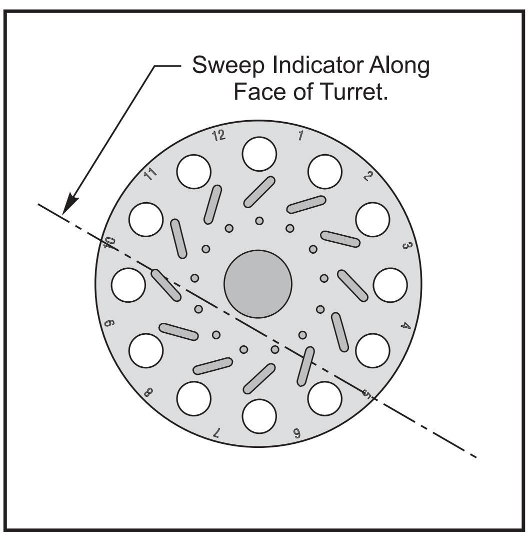


Figure 3.1-2. Turret alignment verification (X-axis)

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.

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 “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:

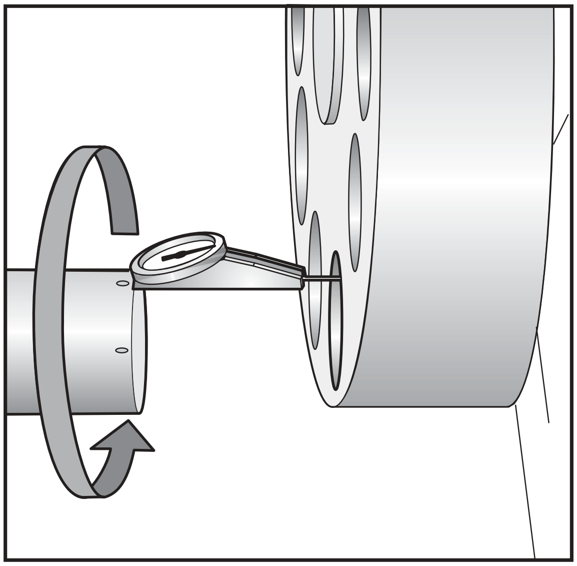
- SPINDLE ALIGNMENT TOOL
- DIAL INDICATOR (0.0005" OR LESS RESOLUTION)

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 3.1-3.
4. Jog the X axis to the spindle center line. This is the value stored in Parameter 254, found on the "Position Raw Data" page (this page is entered through Debug mode).
5. Position the indicator tip just inside pocket #1 so that it is almost parallel to the X- axis. Zero the indicator, then rotate the spindle 180°, 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.

NOTE: If the reading is within specifications, but the X axis position is different from parameter 254, enter the new number in parameter 254.



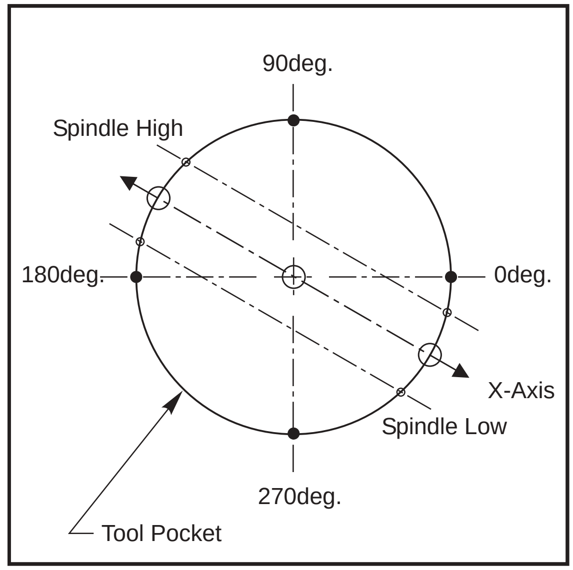


Figure 3.1-3. Turret Pocket Alignment

Turret Alignment Verification (Parallelism of X-Axis)

TOOLS REQUIRED:

- **MAGNETIC INDICATOR BASE**
- **DIAL INDICATOR (0.0005" OR LESS RESOLUTION)**
- **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. 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.
4. Place the 12" x 4" x 1" bar across the small diameter of the two tool holders (ground side down).

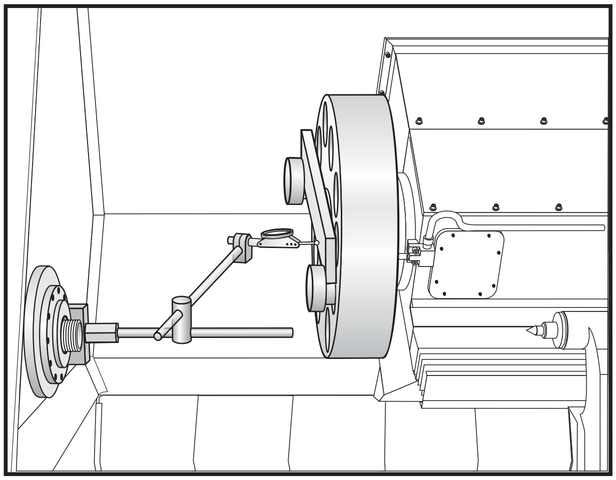


Figure 3.1-4. Turret Bar Sweep.

5. Jog the X axis to the center of its travel.
6. Mount the indicator to the spindle retainer ring. Position the indicator tip at the bottom edge of the bar.
7. Jog the X axis so the indicator is at one end of the bar, and zero the indicator.
8. Jog the X axis to the other end of the bar, and check your reading (tolerance is 0.0003" TIR).
9. If the reading is not within tolerance, loosen all (10) turret bolts with the turret in the clamped position
10. Rotate the turret 180 degrees and check for .0003" TIR or less with the indicator.
11. Tap on the turret until the readings are within tolerance.
12. Retighten all (ten) turret bolts.

- If the reading is within tolerance, proceed to, 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 in 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.
5. Loosen the 10 bolts on the inner coupling and center the coupling to the bolt holes. Retighten them 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. 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.
8. Return to Step 1 of the "Turret Alignment Verification" section and verify your readings.

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.

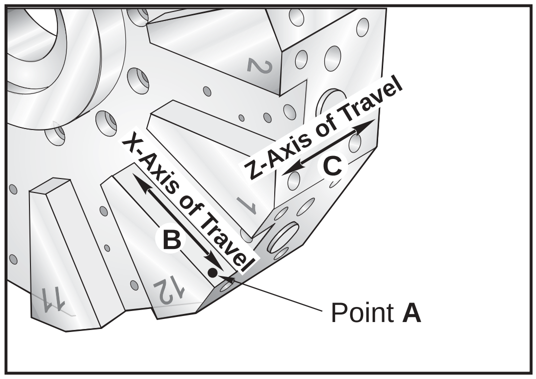
1. Remove the 1/4" brass plug to gain access to the rear coupling.
2. Loosen, then lightly snug all the inner coupling bolts by doing a tool change to each station.
3. Using a toolholder placed in the turret, move the turret in the necessary direction with a rubber or plastic mallet to align the spindle.
4. 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.

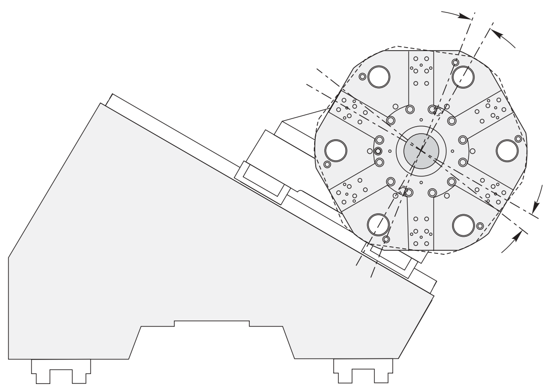
NOTE: All alignments done could change spindle centerline. Verify and enter new spindle centerline position in Parameter 254.

Bolt On Turret Alignment

1. Clean the turret thoroughly before beginning alignment.
2. Index tool position #1 into the cutting position.
3. If the machine has a tailstock, move the turret and tailstock head next to each other and use the tailstock head as a secure mounting point for the indicator. If there is no tailstock, move the turret as close the fixed spindle bulkhead as possible. Assemble a short and rigid indicator mount as possible on the spindle retaining cap. A rigid setup is critical for proper turret indication.
4. Select four (4) equally spaced SHCS that secure the turret to the coupler and mark them with a felt pen. Loosen all the remaining bolts.

5. Place the indicator tip at the outside edge of the turret, point A in the following figure. Sweep the indicator along this edge by jogging the X-axis, direction B. This edge should be parallel to the X-axis within 0.0002” along its entire length and should as close to zero as possible.





Hybrid Turret Shown

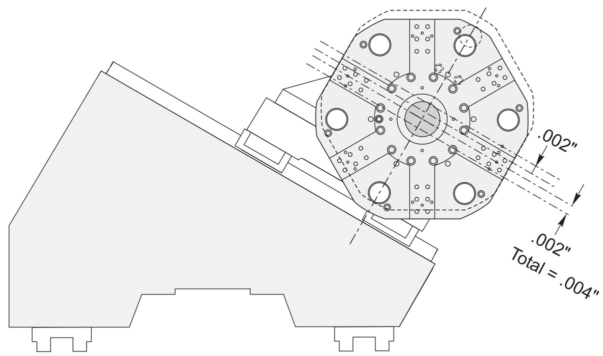
The previous illustrations shows a turret that is twisted about the coupler along direction “B” as described in step five. The turret flats should be parallel to the X-axis with in 0.0002”.

6. If the reading is not within specification install a boring bar tool onto the top of the turret. Slightly loosen the four (4) marked SHCS and tap on the side of tool holder to twist the turret about the coupler. The clearance between the SHCS that secure the turret to the coupler allows for this adjustment. This step is to remove the twist between the turret tool positions and the center of rotation of the coupler. See the previous figure.

7. Place the indicator tip back at point A and set the indicator dial at zero (0). Jog the turret away from the indicator along the Z-axis (Direction C). Index the turret 180° so that tool position #7, on SL-10 and SL-30, or tool position #6 on SL-20 and SL-40, is in the cutting position.

8. Jog the turret back into position along the Z-axis relative to the indicator tip. This reading not to exceed 0.001”. If the reading is out of specification, then the turret is not yet on the same center of rotation as the coupler. If the indicator is showing the turret is lower at this position, index the turret 180 degrees to bring tool position #1 back into the cutting position. Ensure that the turret is above the coupler center of rotation so that when the turret is moved onto center, gravity does not work against you.

9. Loosen the four (4) marked SHCS and tap on the turret perpendicular to the X-axis. Move the turret half of the distance indicated. This will place this half of the turret on the center of rotation of the coupler. See the following figure.



The above example illustrates a turret that is off center from the coupler center of rotation. The reading taken at point "A" in step seven, indicates how far off center the turret is. It must be moved half of this value to place it on to the coupler center of rotation. This must also be performed 90° from the first position.

10. Recheck that the turret did not become twisted by repeating step #5.

11. Index the turret so that tool position #4, on SL-10 and SL-30 or tool position #3 on SL-20 and SL-40, is in the cutting position.

12. Place the indicator at point A on the flat for this tool position. Repeat steps #7 through #10. This will move the turret on to the center of rotation of the coupler for the other half of the turret. See the previous figure.

13. If the turret is moved relative to the coupler again, twist and on-center, in both directions, must be measured again to ensure they are within specifications.

14. The tool positions of the turret are now on center with the coupler. Torque all of the SHCS and recheck readings.

15. Index tool position #1 into the cutting position.

16. Install the appropriate alignment bar onto the spindle and remove all runout from the alignment bar. Install a test indicator in the end of the spindle alignment bar.

17. On SL-10s there is not enough travel in the X-axis to reach the indication hole on the turret, so a good tool holder must be used. Install the tool holder in tool position #1. Ensure that the tool is seated completely against the turret and the front edge is pushed back against the turret face. Check with shim stock that the tool is completely seated against the turret.

18. Jog the X-axis to the centerline position listed in parameter 254. If the 3/16" pin hole is used for centerline verification, the turret must be moved 3.0000" (SL-20/SL-30; 3.5200 for SL-40) further away form the home position to place the pin hole in line with the spindle.

19. Place the indicator tip into the 3/16" indication hole in the turret or the tool holder. Sweep the hole 360 degrees. TIR not to exceed 0.002" for tool position #1.

20. Sweep all other tool positions in the same manner. All other positions TIR not to exceed 0.006"

21. After the turret is indicated into position, sweep the flats of the turret that are parallel to the Z-axis. They are to be parallel to the Z-axis within 0.001" along their length. Direction C. If they are out of specification, the turret gearbox may have to be re-squared on the X-axis.

Converting Spindle Centerline to Encoder Step

1. Jog the X-axis to the spindle center.
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. Press ALARMS, enter "DEBUG," press WRITE. Or simply turn the power off and back on. This deactivates debug mode.

Turret In / Out Adjustment

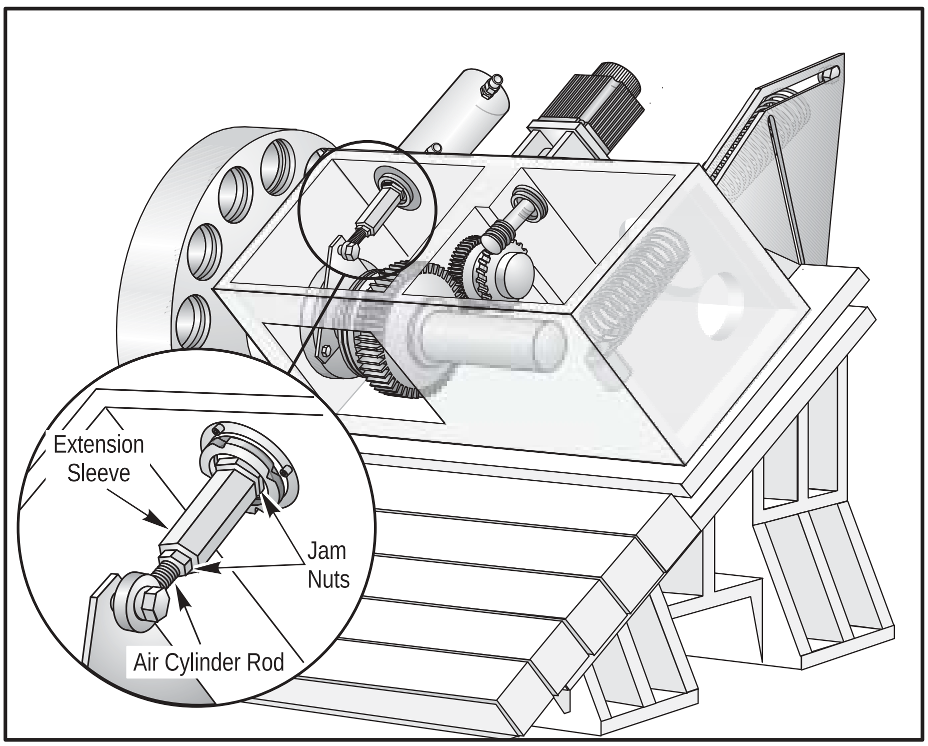


Figure 3.1-5. Turret travel adjustment components.

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. 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.

2. 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

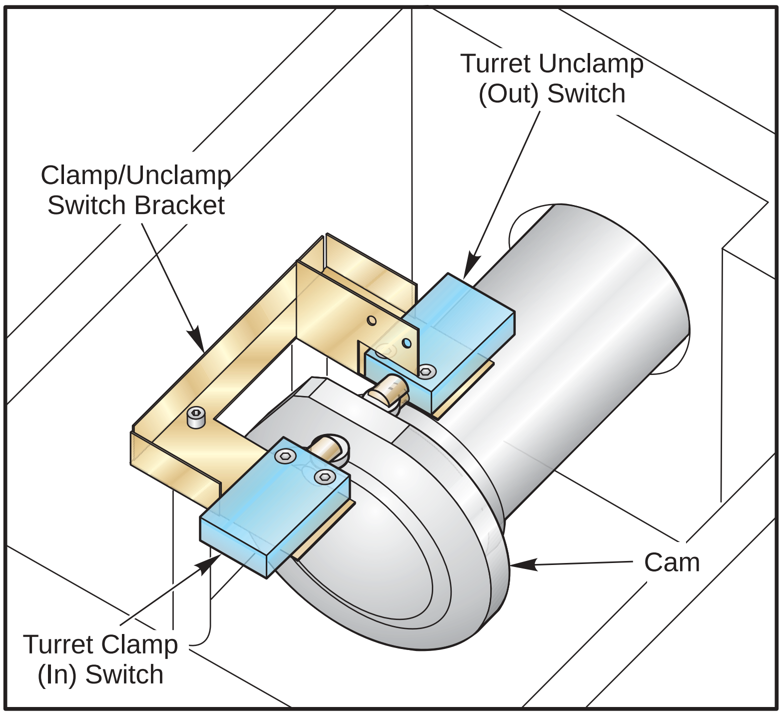


Figure 3.1-6. Turret Clamp/Unclamp switches.

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.

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 3.1-6.

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 lower air cylinder mounted reed switch needs to be adjusted by loosening the worm drive clamp retaining the sensor and moving it until the input reads “1”. Mark the location. Move the sensor slowly in both directions until the input reads “0” and mark the location. Place the sensor in between the marks and tighten the worm-drive clamp. Retighten sensor. When the turret is in any other position than Unlock Turret, the discrete input should read "0."

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 upper air cylinder mounted reed switch needs to be adjusted by loosening the worm drive clamp retaining the sensor and moving it until the input reads “1”. Mark the location. Move the sensor slowly in both directions until the input reads “0” and mark the location. Place the sensor in between the marks and tighten the worm-drive clamp. Retighten sensor. When the turret is in any other position than Lock Turret, the discrete input should read "0."

3.2 Spindle

Spindle Alignment Verification

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

TOOLS REQUIRED:

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

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

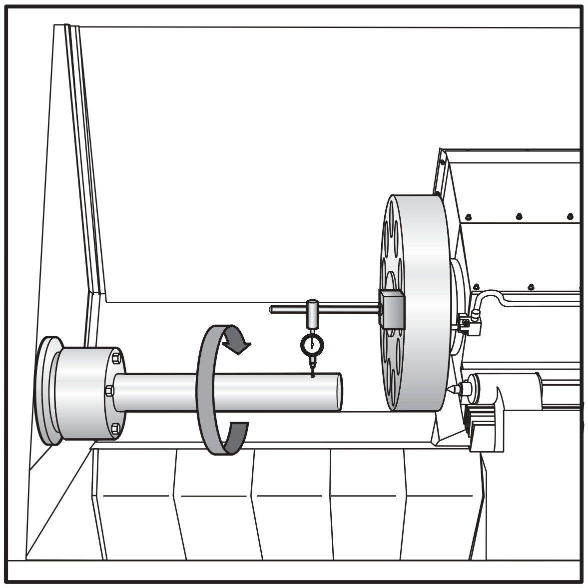


Figure 3.2-1. Checking runout.

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"

NOTE: 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 0.0001".

NOTE: If the reading is greater than 0.0001" 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")

NOTE: •If the measurement is greater than the allowable tolerance then the spindlehead casting must be realigned. Before realigning the spindlehead, perform a Turret Alignment Verification (Parallelism of X-axis).
•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".

NOTE: •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 from Hydraulic Cylinder 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.

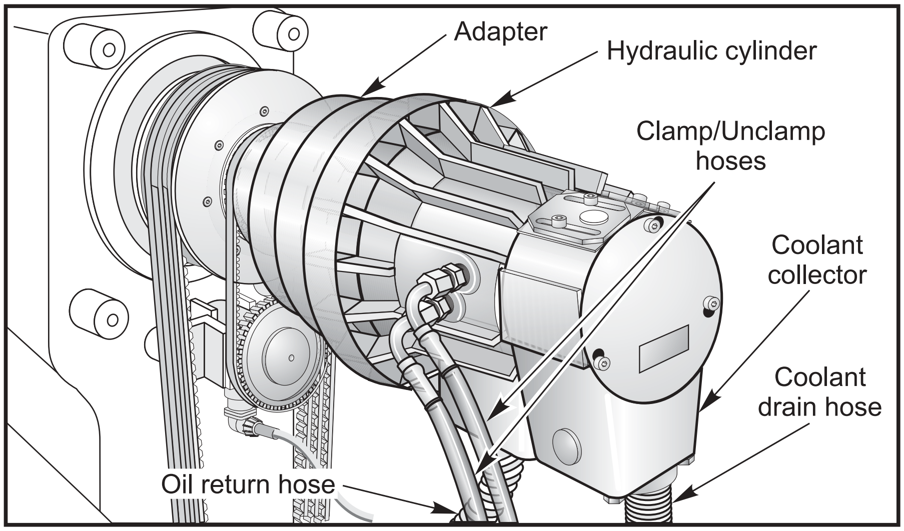


Figure 3.2-2. Hydraulic cylinder.

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 SL-40 spindle removal, contact HAAS Service for removal tool)

SL-10 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 from Hydraulic Cylinder 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 SHCS on the inside of adapter and detach from spindle shaft.

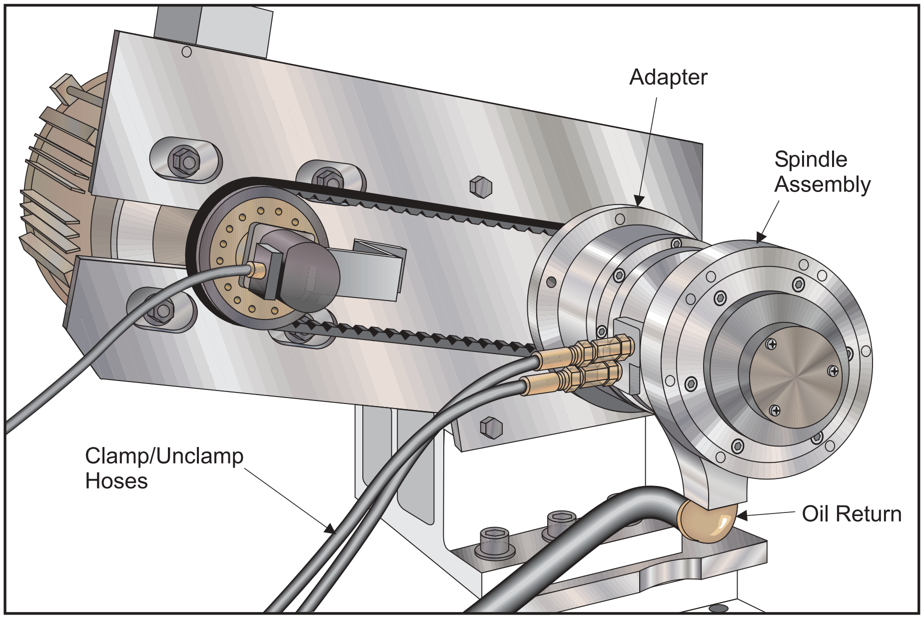
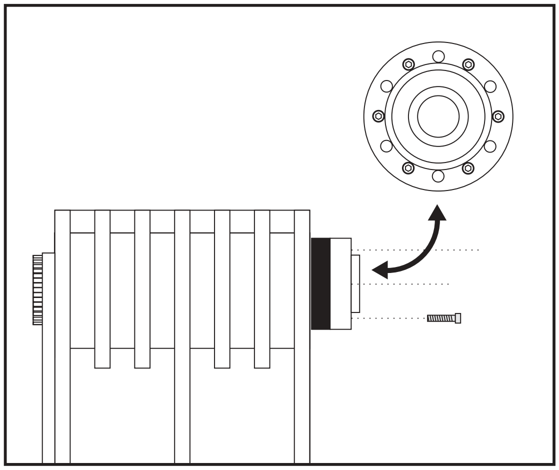


Figure 3.2-2. Hydraulic cylinder (Coolant Collector not shown)

6. Unplug the encoder.
7. Loosen the four SHCS holding the spindle motor. Slide the motor towards the spindle to remove tension from the belts. Slide the belts off of the spindle drive pulley.
8. 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.
9. Unscrew the SHCS holding the spindle retaining ring and remove. Also remove the O-ring.
10. Remove Spindle Carefully.

Mini Lathe Spindle Removal and Replacement

1. Remove the door, the coolant collector, and left front and left side enclosure panels.
2. Disconnect the air/oil lube lines that supply the spindle and the air closer.
3. Remove the work holding device, air closer, adapter and drawtube.
4. Remove the belt from the driven pulley.
5. Attach the spindle drive sprocket removal tool as specified by the factory to the driven sprocket.
6. Using a hydraulic ram, pull the sprocket off the end of the spindle.
7. Remove the oil injection cover off the back of the spindle.
8. Remove the SHCS that secure the spindle front cap to the spindle housing. These are accessed via the through holes in the spindle nose itself.



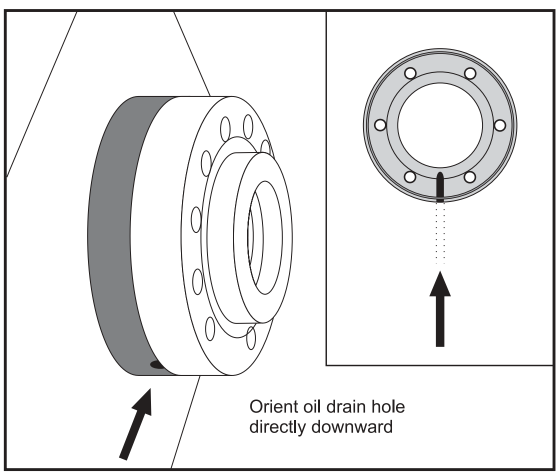
9. Remove the spindle cartridge from the spindle housing.

10. Thoroughly clean out the spindle cavity. Ensure that there are no particulates or other contaminates are removed. Clean thoroughly with alcohol.

11. Ensure that the spindle is also free from any contaminates before installing it into the spindle head housing.

12. Slide the spindle cartridge into the spindle head housing.

13. Orient the front cap such that the oil drain passage is pointed downwards. Also ensure that the O-ring is installed on the front cap and that it is cut at the oil passage point.



14. Once the spindle front cap is oriented properly, evenly torque the front cap bolts to 10 ft-lb.

15. Reinstall the oil injection cover.

16. Heat the drive sprocket on a hot plate at 450 degrees F for at least 5 minutes and then install onto the spindle shaft.

17. After the sprocket cools, reinstall the air closer, adapter, drawtube and work holding device.

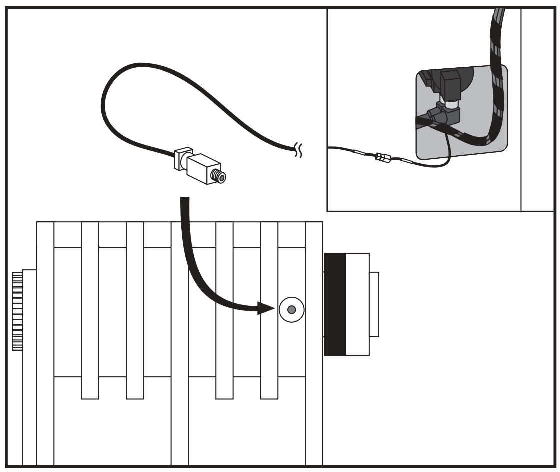
18. Reconnect the air/oil lube lines.

MINI LATHE SPINDLE BREAK-IN

1. Load the Mini Lathe spindle break in program, o02222, into the control. Ensure that Parameter 57, bit 22 is set to 1 so that the Macro feature is enabled. Parameter 266, bit 3 must also be set to 1 to ensure the control is reading the thermal probe.

2. Attach a thermal probe cable P/N 33-9022 to the side of the spindle head casting with a 1/4-20 x ¾" SSS. Ensure that the thermal probe is seated completely against the casting. This will ensure accurate readings.

3. From the control cabinet, there is a cable that normally plugs into the X-axis ball screw thermal probe cable (33-9022A). Disconnect them from each other and plug the spidle head thermal probe cable in place of the X-axis ball screw thermal probe cable.



4. Verify that the thermal probe is working by inputting the following code into MDI; #119 = #1092 / 65534 * 500; M99

5. Press 'Cycle Start' and then look at the macro page under the 'Current Commands' menu. Macro #119 should read some where around the ambient temperature. This verifies that both the probe and macros are functioning properly.

6. Double check that the spindle air/oil lines are attached and that the air regulator for the spindle air/ oil is set to 25 psi.

7. Run the program. It should take around 5 hours. If the spindle does not pass, the control will state this. Do not reset the program. There is important information in the macro page. Call the Factory.

8. Remove the thermal probe from the spindle. Reattach X-axis thermal probe and reinstall the sheet metal.

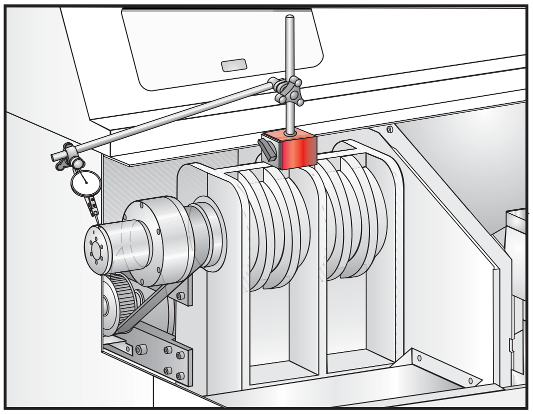
Mini Lathe Removal and Replacement of Air Closer

1. Install the air closer adapter onto the spindle drive sprocket.

2. Measure the runout of the O.D. of the adapter. Runout should not exceed .001.

3. Install the air closer onto the adapter.

4. Measure the radial runout of the non-rotating portion the air closer as close the end as possible. If the readings are high, reclock the air closer to remove the excess runout. Runout NTE .0005".

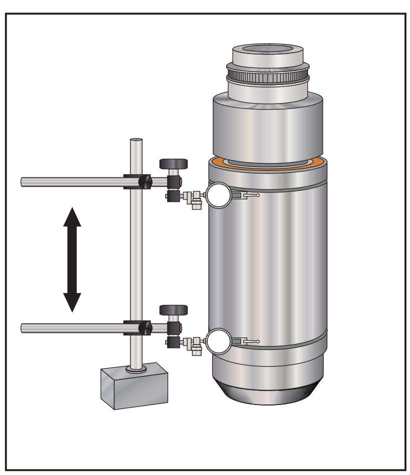


Spindle Installation

TOOLS REQUIRED:

- **Blue Loctite**
- **1/2" Torque Wrench (Up to 250 ft-lbs)**
- **HAAS Belt Tensioning Tool P/N# T1510 (SL 20), P/N# T1537 (SL 30 and 40)**

1. Inspect the new spindle once it is removed from the packaging. Check the alignment of the spacer between the two bearings. Use a dial indicator on the spacer and bearings to check the run-out. The run-out should be between .0005-.0015, adjust if necessary.



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

3. 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.

4. 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.

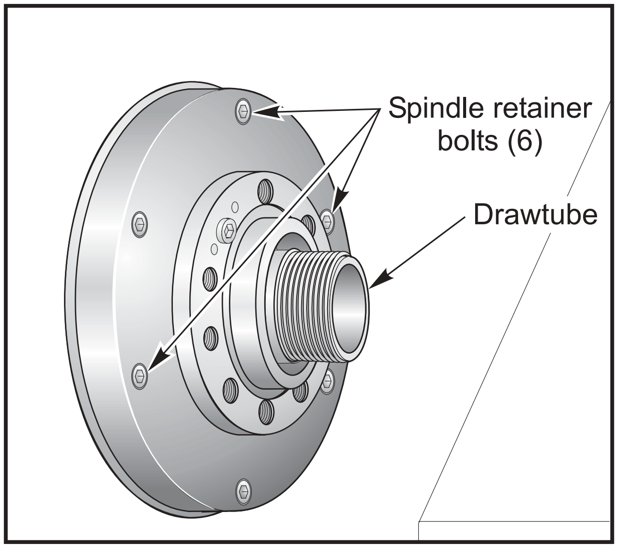


Figure 3.2-3. Spindle retaining bolts.

5. 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.

6. 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.

7. 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.

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

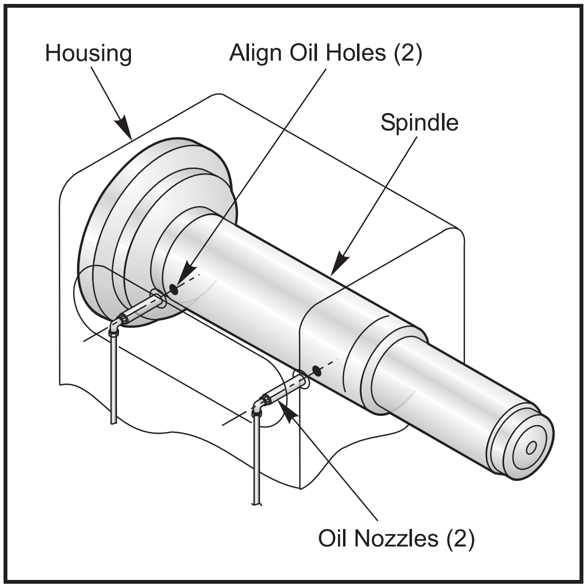
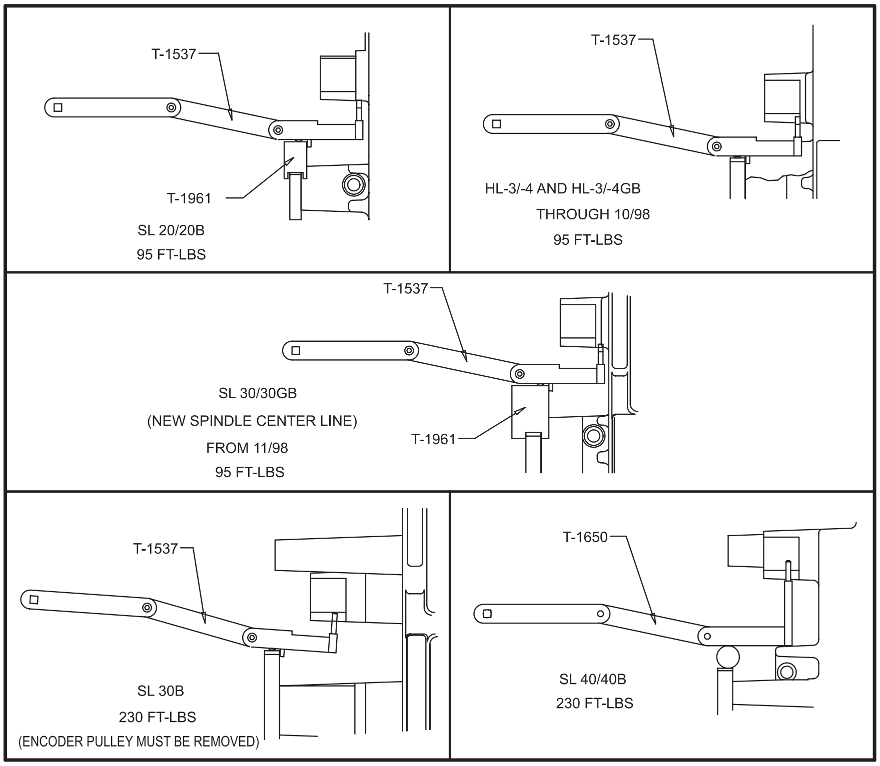


Figure 3.2-4. Alignment of oil mist holes.

9. Install the spindle drive pulley.

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

11. 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.



12. 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.

13. Mount the encoder onto the spindle housing below the spindle shaft with four mounting bolts.
14. Place the 3/8" timing belt on the spindle pulley, with the other end on the encoder pulley.
15. Align and attach the hydraulic cylinder adapter onto the spindle shaft with the mounting bolts. Tolerance on the face of the adapter plate perpendicular to centerline within .001". Check tolerance of large I.D. bore circular within .002".
16. Slide the hydraulic cylinder into spindle shaft. Insert and snug the mounting bolts.
17. Attach and clamp the oil drain hose and coolant drain hose onto hydraulic cylinder.
18. Attach and screw in clamp and unclamp hoses.
19. Set the magnetic base on top of the spindle housing with the indicator touching the top of the hydraulic cylinder.
20. Spin the hydraulic cylinder and verify that the runout is under 0.001 inches. If runout is over 0.001 inches, spin the hydraulic cylinder to its high point and tap cylinder with a rubber mallet. Tighten and torque the bolts.
21. Replace all previously removed sheet metal.

SPINDLE HEAD ALIGNMENT

TOOLS REQUIRED:
- **Dual Indicator Stand**

Depending on lathe model, the following sheet metal pieces may need to be removed:
- The front left panel
- The front bottom panel
- The drain rail
- 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, then screw them in to lower the spindle 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".

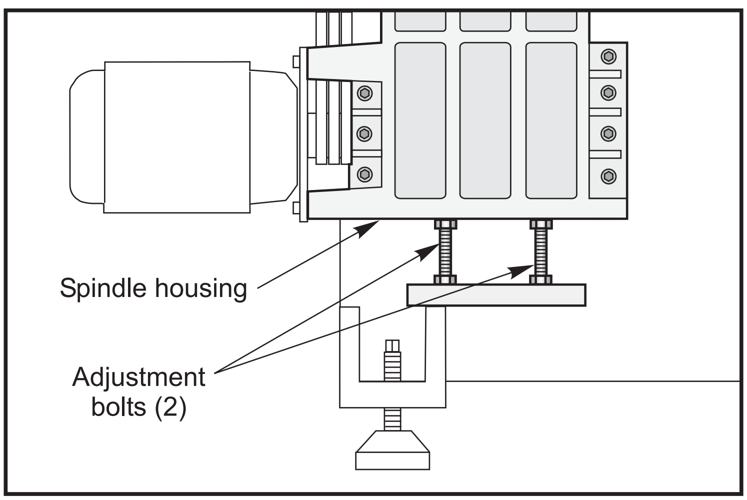


Figure 3.2-5. Adjustment bolts.

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 3.2-6.

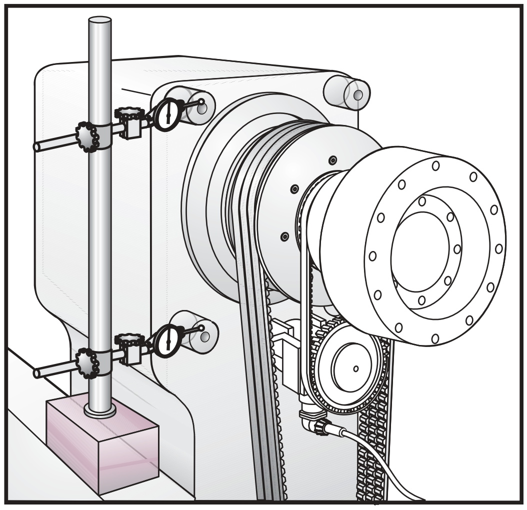


Figure 3.2-6. Indicator setup.

NOTE: 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: 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 180º along the axis. Refer to Figure 3.1-3.

NOTE: The tool holder alignment pins create a bump in the pocket that should be ignored.

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

NOTE: 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.
11. Rotate the spindle 180º 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 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: 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. Reinstall the following sheet metal pieces if removed:
    - •The front left panel
    - •The front bottom panel
    - •The drain rail
    - •The front door

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

SL-10 Spindle Head Alignment

1. Attach the spindle alignment bar to the spindle. Adjust the position of the alignment bar until the measured runout at both the base and end of the bar is less than 0.0001”. To adjust the position of the alignment bar, slightly loosen the mounting bolts and tap on the mounting end of the alignment bar.

2. Loosen the 8 SHCS mounting bolts for the spindle head.

3. Back out the two set-screws on the front side, lower edge of the spindle head.

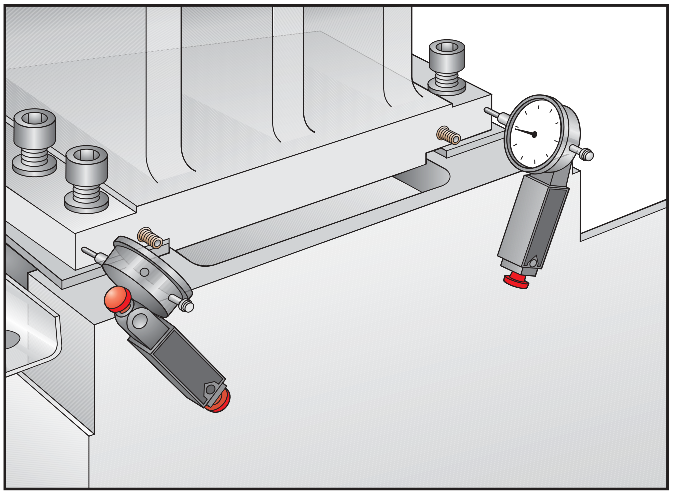
4. Attach a 0.0001” dial indicator to the turret.

5. Jog the X and Z-axes to position the dial indicator on the side of the alignment bar.

6. Sweep down the length of the alignment bar to measure the spindle head parallelism with the Z-axis.

7. Push the spindle head towards the back of the machine. Run in the set-screws on the front, lower edge of the spindle head until they contact the locating dowels underneath the spindle head. Adjust the spindle head parallelism with the Z-axis using these two set-screw. The spindle head should be parallel with the Z-axis with in 0.0004”/10”.

8. Mount two travel dial indicators onto the side of the base. Place the tips at the extreme ends of the spindle head casting. Zero the indicators.



9. Attach a 0.0001” dial indicator into the end of the alignment bar.

10. Install a boring bar tool holder into tool position #1. Ensure that the bore of the tool holder is clean and free of any burrs, chips or other contaminants. The tool holder must be seated completely against the turret.

11. Jog the X-axis down to the original spindle centerline.

12. Jog the Z-axis until the tip of the dial indicator can be placed on the inside of the bore in the tool holder. Sweep the bore to measure the concentricity of the spindle head to the tool position. The tool holder bore must be concentric with the spindle within 0.002” TIR.

13. Adjust the position of the spindle head by carefully screwing in the set-screws. Ensure that the spindle head parallelism to the Z-axis remains constant by moving the spindle equal amounts as indicated on the two travel dial indicators.

14. Once the runout is less than 0.002” TIR, verify that the spindle head parallelism to the Z-axis is within 0.0004”/10”.

15. Evenly torque the spindle head bolts to 300 ft. lbs and ensure that all SSS in the spindle head casting are bottomed out on the dowel pins.

Mini Lathe Spindle Head Alignment

1. The X and Z-axes must be perpendicular to each other prior to aligning the spindle head.

2. Remove the door, the left side and the end panel.

3. Install a spindle alignment bar (P/N T-2113) on the spindle.

4. Remove the run-out from the base and end of the alignment bar. NTE 0.0001” at each end.

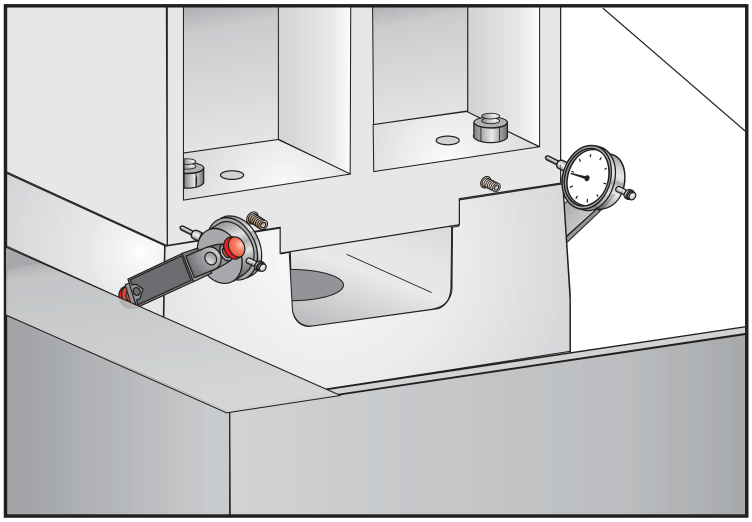
5. Place an indicator on the tool platter and run the indicator along the side alignment bar along the Z-axis. Alignment bar parallelism to the Z-axis NTE 0.0004” per 10” of travel.

6. Loosen the nuts that secure the spindle head to the base casting.

7. Using the ½”-13 SSS, adjust the position of the spindle head on the base casting until the parallelism of the alignment bar to the Z-axis is with in 0.0004” over 10” of travel. There are socket set screws (SSS) on both sides of the spindle head casting.

8. Once the alignment of the spindle is achieved, torque the nuts that secure the spindle head to the base casting to 250 ft-lb.

9. After torquing the nuts, ensure that all of the SSS are bottomed out on the dowels within the spindle head.



3.3 TL-Series Sub Spindle

Spindle Motor Replacement

1. Remove the sheet metal covering the sub spindle motor and the union.
2. Cut all plastic ties to the motor wiring. Disconnect the wiring from the motor.
3. **Remove the encoder:**
Loosen the set screw that holds the encoder to the motor shaft. Remove the screw that holds the encoder bracket to the motor.
4. Remove the four (4) bolts that mount the motor to the spindle head.

Caution! You may need to use a hoist to lift the sub spindle motor as it weights approx. 90 lbs.

5. Install the replacement motor in reverse steps for removal. Make sure the wiring is fed beneath the belt.

Sub Spindle Motor Belt Replacement

1. Remove all sheet metal covering the sub spindle motor.
2. Remove the chuck and unhook the hoses to the union.
3. Disconnect the electrical wiring to the encoder.
4. Loosen the set screw that holds the encoder to the motor shaft.
5. Remove the screw that holds the encoder bracket to the motor.
6. Loosen but do not remove the four (4) sub spindle motor mounting bolts.
7. Remove and replace the motor belt.
8. Reassemble in reverse steps for removal. Make sure the wiring

Sub Spindle Head Alignment

1. Insure that the main spindle is aligned. Following standard alignment procedures in the lathe service manual.
2. Mount the spindle alignment bar **(Part # T-2113)** to sub spindle face. Before installing the test bar, insure that both mating surfaces are cleaned thoroughly.

3. Mount a magnetic base and a .0001” indicator on the turret face. Rest the indicator tip on the top surface nearest the sub-spindle face and manually rotate the sub-spindle. Tap on the alignment bar flange and indicate it to zero runout. Jog the indicator in the Z-axis direction to the end of the alignment bar and set the indicator to read zero. Rotate the sub spindle to check runout. runout should not exceed .0002. If the runout exceeds .0002, then use different tension on the test bar mount bolts to adjust. (See figure 3.3-1.)

NOTE: Test bar should be indicated to .0 runout before checking alignment of sub-spindle

4. Rest indicator tip on the top surface. Using the “Z” axis jog the indicator tip over eight inches of the test bar to check spindle flatness, max tolerance is .0003”.

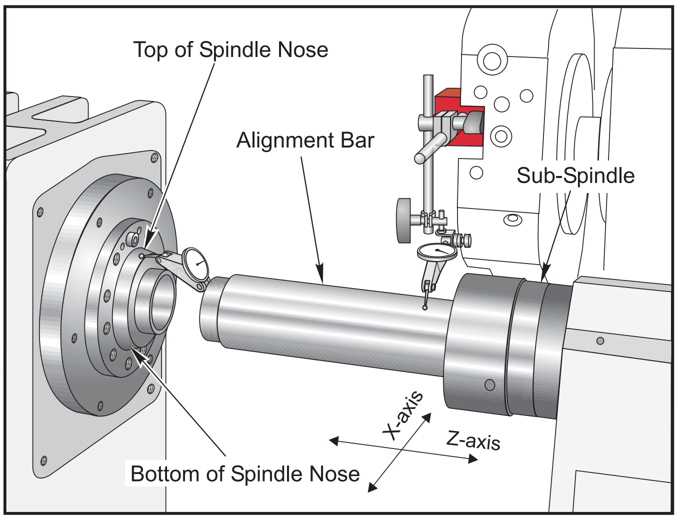


Figure 3.3-1

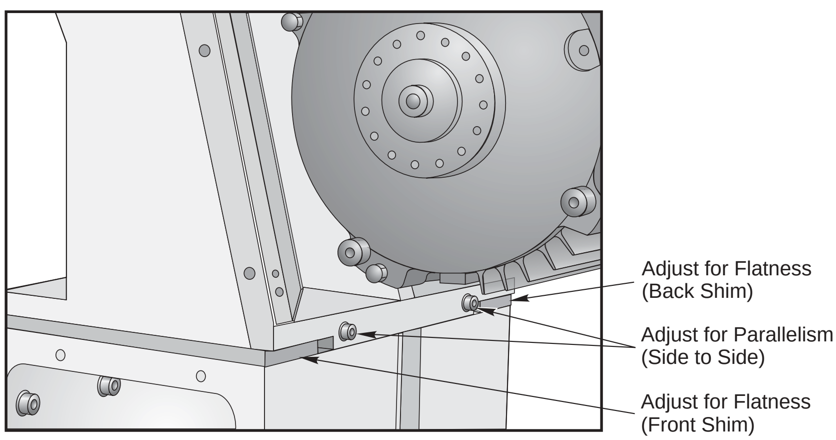
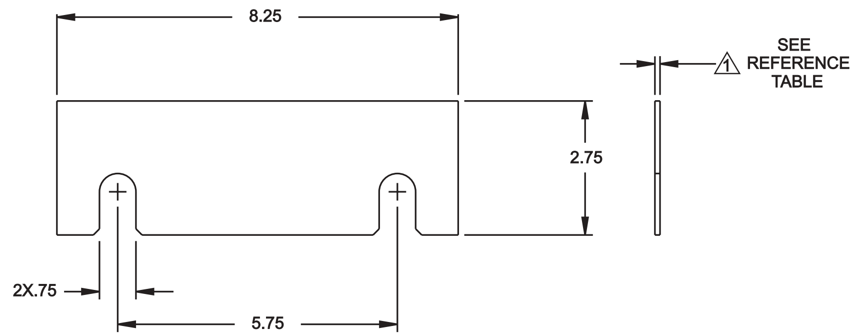


Figure 3.3-2

5. If the sub-spindle is out of tolerance then shimming is necessary. See figure 3,3-3 for shim stock information and figure 3.3-2 for the location of where the shim stock will be inserted.



THICKNESS TABLE

PART NO.	1 REF DIM TOL: ±0.0010	'SIZE'
20-6460	0.1040	NOMINAL
20-6461	0.0840	-0.0200
20-6462	0.0890	-0.0150
20-6463	0.0940	-0.0100
20-6464	0.0990	-0.0050
20-6465	0.1090	+0.0050
20-6466	0.1140	+0.0100
20-6467	0.1190	+0.0150
20-6468	0.1240	+0.0200

THICKNESS TABLE

PART NO.	1 REF DIM TOL: ±0.00015
20-8812	0.2300
20-8813	0.2275
20-8814	0.2280
20-8815	0.2290
20-8816	0.2295
20-8817	0.2305
20-8818	0.2310
20-8819	0.2320
20-8820	0.2325

Figure 3.3-3

Repeat steps 4 and 5 until the flatness is within specifications.

6. With the indicator on the nose of the test bar, place the indicator tip on the top of the beveled lip of the main spindle and set it to zero. (See figure 3.3-1)

7. Rotate the bar 360° and check the concentricity of the sub spindle to the main spindle. The tolerance is .002" TIR. Adjust side to side using set screws (Figure 3.3-2)

8. If the height is out of tolerance you need to change the front and back sub-spindles shims by the amount of correction necessary, and still maintain flatness.

9. Repeat steps 5 –9 until the **Flatness** and Top to Bottom **Centerline** tolerance are within specifications.

10. Rest the indicator tip that is riding on the top of the test bar to run along the side of the test bar. Use the "Z" axis to jog the indicator tip over eight inches of the test bar to check the sub-spindle parallelism, max tolerance is .0003" (see figure 3.3-1).

11. If the sub-spindle is out of tolerance adjust the parallelism adjusting screws to bring it in (see figure 3.3-2).

Repeat steps 10 and 11 until parallelism is within specifications.

12. With the indicator on the nose of the test bar place the indicator tip on the side (90° position) of the beveled lip of the main spindle and zero (see figure 3.3-1).

13. Rotate the bar 360° and check the concentricity of the sub to main spindle. The tolerance is .002" TIR.

3.4 Tailstock Alignment

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

There are two different tailstocks, a one-piece original design and the newer two-piece design. If the tailstock needs to be aligned, follow the procedure for that type of tailstock

One- Piece 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 .0001 indicator to the end of the alignment 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 indicator 360^0. Max. tolerance is .001" from centerline.
5. Jog the tailstock back and measure the runout at the end of the tailstock test bar.

NOTE: •If these measurements are out of tolerance from top to bottom (0^0 and 180^0), then proceed to the Tailstock Leveling Procedure.
•If this measurement is out of tolerance from side to side (90^0 and 270^0), then the insert needs to be replaced and realigned as described in the Tailstock Insert Removal and Installation section.

TAILSTOCK LEVELING PROCEDURE

This procedure should only be performed after the Tailstock Alignment has been checked.

TOOLS REQUIRED:
•Tenths Indicator
•Tailstock Alignment Tool (Test Bar P/N# T-1416)
•Tailstock Leveling Assembly (Leveling Stand P/N# 93-6001)
•Spindle Alignment Test Bar (P/N T-1312)

1. 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 3.4-1)

2. 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.

3. Sweep the diameter of the Test Bar and note the vertical runout. Refer to Figure 3.4-1.

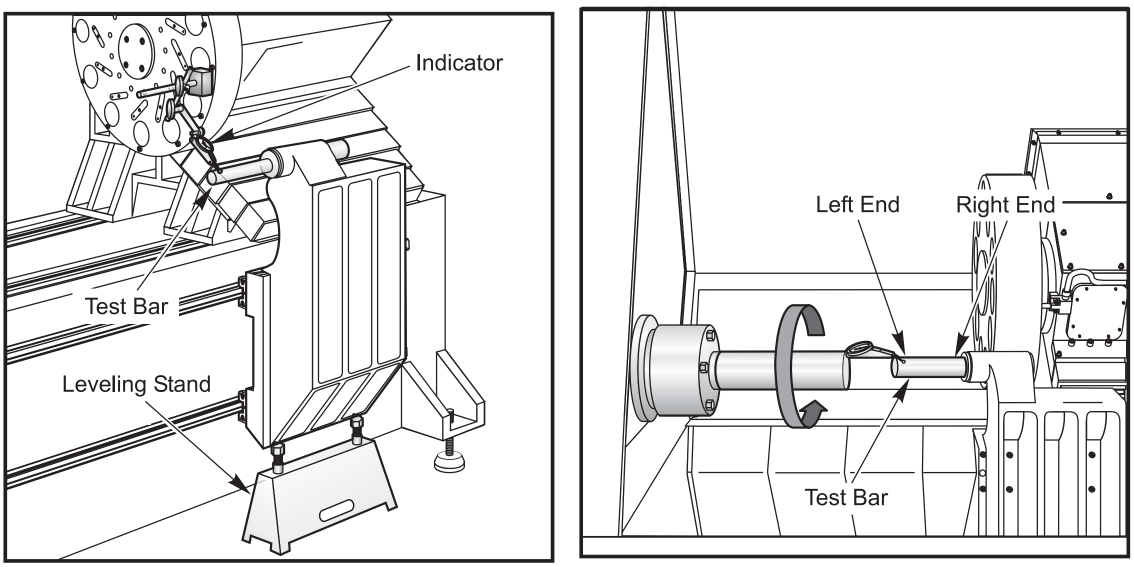


Figure 3.4-1. Tailstock leveling indicator setup.

4. 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.

5. 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".

6. 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.

Two-Piece Tailstock Alignment

1. Using a spindle alignment tool and a Morse taper tool, indicate from spindle to tailstock. Measure flatness and TIR (total indicated run-out). Determine which direction the tailstock is out of alignment (Figure 3.4-2).

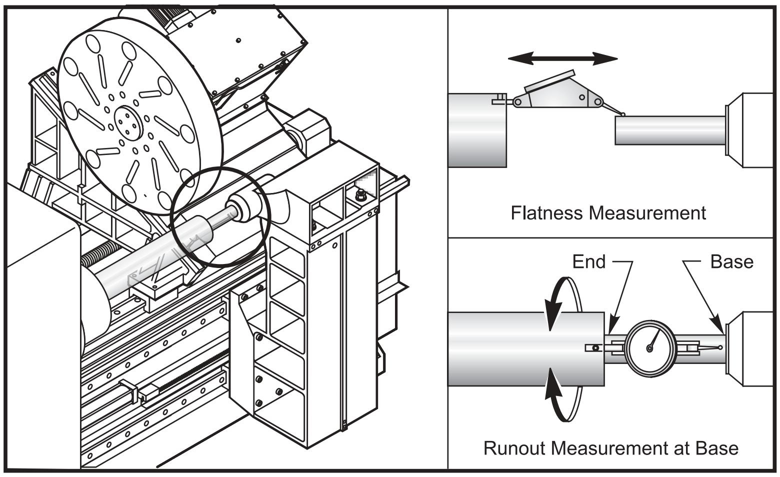


Figure 3.4-2

2. If the tailstock is out of alignment in both flatness and parallelism, remove the head from the tailstock base. Mark the shims so they can be installed in the same order, and inspect them. If the tailstock is only out of parallel alignment go to step 6.

3. Check the top surface of the tailstock base for parallelism to the Z axis. Check for dents and lightly stone the top mating surface of the tailstock. Indicate from the turret to the top of the tailstock base. Readings must be no more than +/- .0004" for 10 inches of travel.

4. Install the shims, lightly stone and clean the shims before installing

5. Install the head of the tailstock and snug the four retaining nuts.

6. Rotate the spindle and measure parallelism. Tap the head into place using a mallet. If flatness is within tolerance, proceed to step 8.

7. Measure flatness from base to end of tailstock. Add or remove shims if necessary using the tailstock head alignment tool. To adjust the number of shims, bolt on alignment tool, snug alignment bolts against the tailstock head, then remove the tool (Figure 3.4-3). Loosen either the front or rear pair of tailstock retaining nuts and add or remove shims as necessary. This will keep parallelism. Re-tighten the nuts. If necessary loosen the other end to add or remove shims as well. To re-align, install the alignment tool and position the tailstock against the adjustment bolts of the alignment tool. Snug the tailstock nuts and remove the tool.

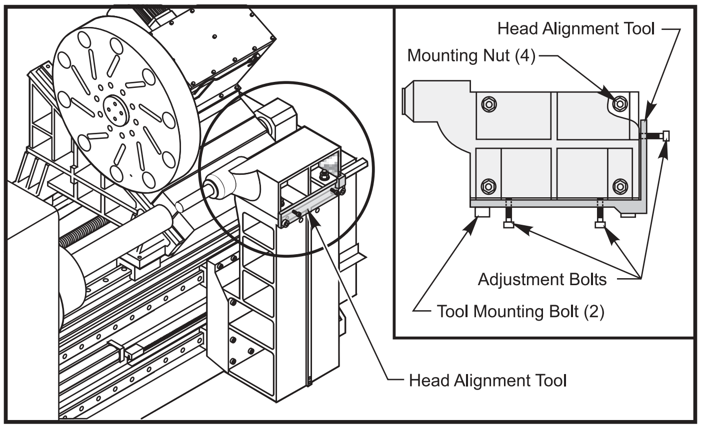


Figure 3.4-3

8. Rotate the spindle and measure run-out at the base and the end of the tailstock. Tap into place using a mallet. Tolerance is less than .001 TIR.

9. Torque the tailstock head retaining nuts.

SL-10 Tailstock Alignment

1. Insert the Tailstock Alignment Bar into the tailstock quill.

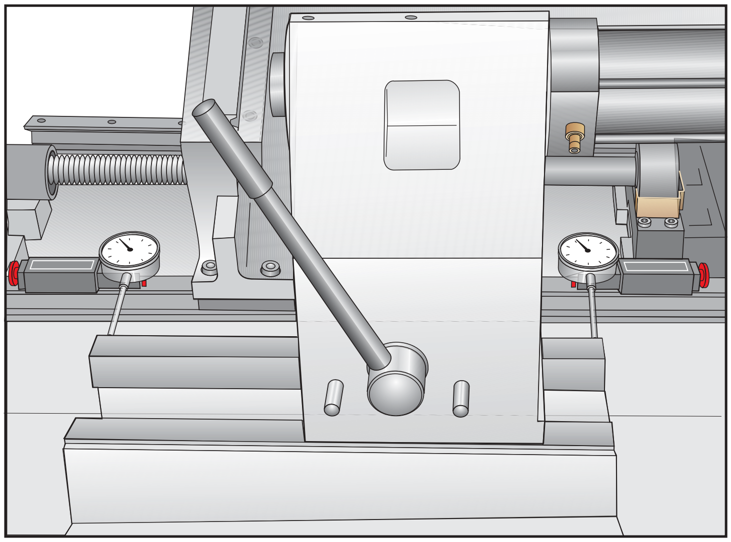
2. Place a 0.0001" indicator onto the turret. Position the X-axis so that the flatness and parallelism of the alignment bar can be measured.

3. Place the indicator stylus onto the side of the alignment bar and sweep along the Z-axis. The tailstock should be parallel with the Z-axis within 0.0004" over the length of the tailstock alignment bar. If the Z-axis parallelism is not within 0.0004", then the tailstock foot will need to be adjusted.

4. Loosen the four SHCS that attach the tailstock foot to the lathe base and back out the set screws at the base of the foot. Push the tailstock foot as close to the turret as possible. Place the indicator stylus onto the machined surface along the backside of the tailstock foot. Jog the Z-axis to sweep along this surface. Adjust the position of the tailstock foot until the runout along this machined surface is less than 0.0001" along the entire length.

5. Install the spindle alignment bar onto the end of the spindle. Install a 0.0001" dial indicator into the end of the spindle.

6. Set up two travel dial indicators at the extreme ends of the tailstock foot.



7. Measure the side to side runout of the concentricity of the spindle to the tailstock quill. The total side to side runout cannot exceed 0.0005".

8. Using the set screws in the tailstock base, move the entire tailstock assembly until the total side to side runout does not exceed 0.0005". Maintain the parallelism with the Z-axis by insuring that the travel indicators move an equal amount.

9. Torque the SHCS that attach the foot to the lathe base in an even and gradual pattern to 200 ft-lb. Verify that the runout has been maintained after the tailstock foot is torqued.

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).

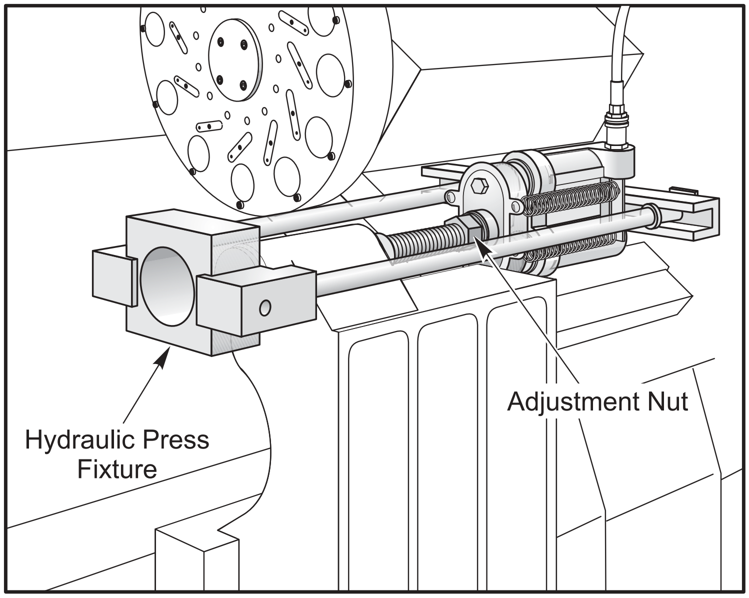


Figure 3.4-4 Tailstock insert press.

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 onto the spindle.
3. Then mount a tenths indicator to the nose of the test bar.
4. Make sure the fill hole at the back of the tailstock casting is not clogged
5. Install the tailstock insert and three mounting screws.
6. Insert the tailstock taper alignment bar.
7. Position the indicator tip at the base of the tailstock test bar.
8. Adjust the insert until the runout at the base of the test bar is less than .0003" TIR. Then tighten all three screws.
9. Install the rear insert plate. Tighten the three 1/4 x 20 bolts but leave the three 10 x 32 bolts loose.
10. Position the indicator at the end (far left) of the tailstock taper alignment bar.
11. Insert a pry bar into the rear of insert and adjust the runout at the end of the shaft until the reading is .001" or less from centerline. Then tighten the remaining screws.
12. 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.

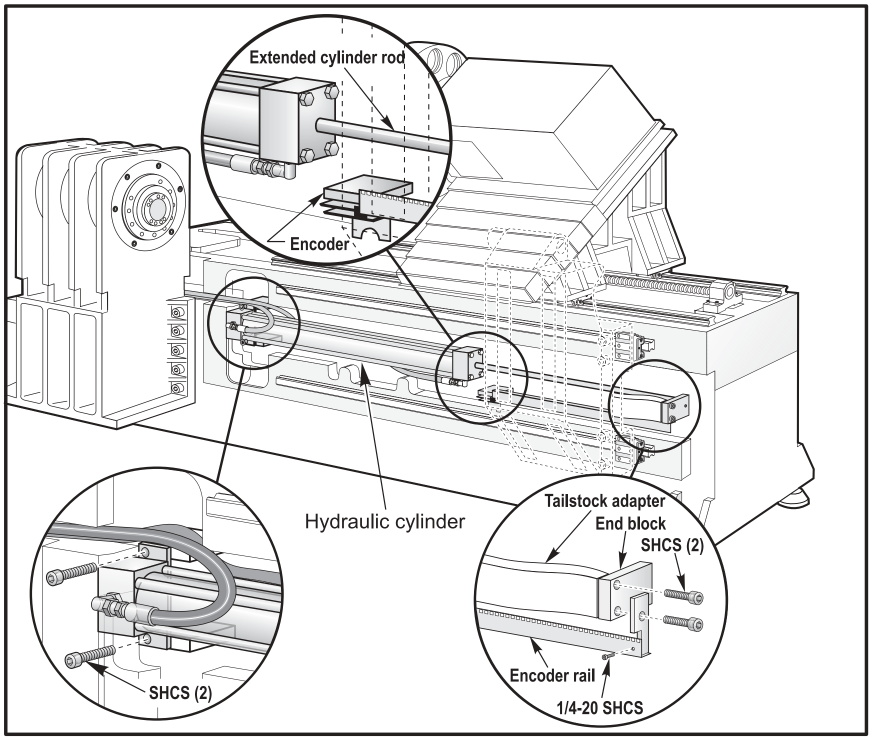


Figure 3.4-5. Hydraulic cylinder replacement.

2. Move to mid travel before disconnecting
3. 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.

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. 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.
7. Remove the (2) SHCS that mount the hydraulic cylinder body to the base casting.
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. Install the (2) SHCS that mount the cylinder body to the base casting. Before tightening move the tailstock to the front end of travel.
13. Thread the end block onto the end of the cylinder rod and tighten.
14. Install the (2) SHCS that attach the end block.
15. Install the 1/4 - 20 SHCS that hold the encoder rail to the bottom of the mounting block.
16. Attach the hydraulic lines to both the front and rear of the cylinder. Check for leaks.
17. Reinstall waycovers.
18. Check the fluid level at the hydraulic tank to determine how much fluid needs to be added.

3.5 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 does not 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.

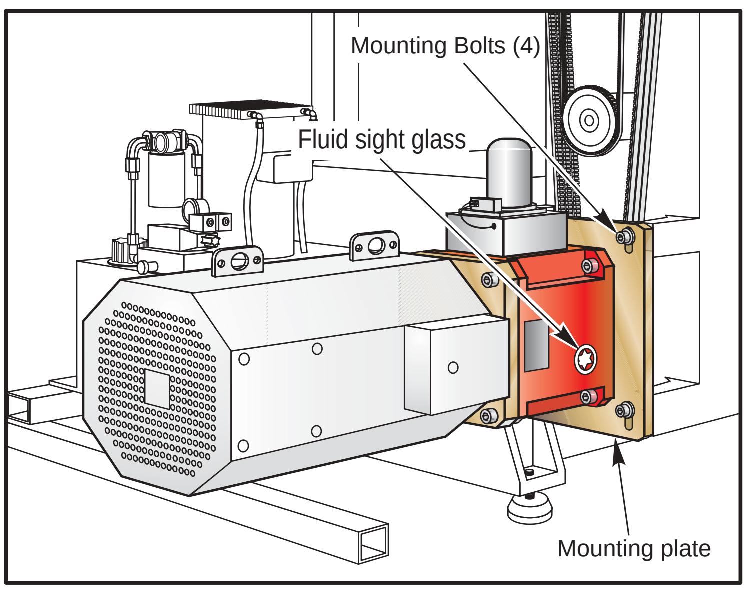


Figure 3.5-1. Lathe transmission mounting plate.

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.

3.6 Grid Offset Calculation

Please read this section in its entirety before attempting to set the grid offset.

GUIDELINES -

The encoder Z channel signal must occur between 1/8 and 7/8 revolution from where the home switch is released. If DISTANCE TO GO is less than 1/8 (.0295) or greater than 7/8 (.2065) of a revolution, it will alarm to "Zero Return Margin Too Small".

In ZERO RETURN mode, the DISTANCE TO GO is the amount the encoder rotated from when the switch was released until it found the Z channel signal. The ideal amount for the DISTANCE TO GO is ½ of a revolution of the encoder. These values are: X-axis =.236, Z-axis=.118, B-axis (TL-15) = .118. Older HL series machines with ball screw tailstocks will have the grid offset set to .050.

Note: Machines with non hydraulic tailstock machines have no grid offset to set.

SETTING THE OFFSET -

1. Set the grid offset to zero. (Parameter 125 or 127 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 B).

3. Calculate the grid offset using the following formula, and write the result in Parameter 125 (X-axis), 127 (Z-axis), or 170 (B-axis), depending on the axis being set.

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

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

4. ZERO RET the axis again to use this offset.

NOTE: If X-axis grid offset is reset, Parameter 254 should be checked and adjusted accordingly.

A-axis (tool changer) grid offset always must be set to zero.

Setting the Offset using the <u>Grid</u> Feature

The control will calculate grid offset parameters (125, 126, 127, and so on) using the 'GRID' command. It is recommended that the GRID command be used on each axis separately as follows:

1) Turn the machine off and back on. This will un-zero all the axes.

2) Select the ALARMS screen and enter DEBUG mode.

3) Perform a ZERO SINGLE AXIS on each of the desired axes individually. Ignore any ZERO RET MARGIN TOO SMALL alarms. Note: if a SERVO ERROR TOO LARGE alarm was generated, this indicates that a GRID OFFSET parameter is out of range (make sure it is -138718 to +138718.)

4) Select the Positions screen, enter GRID and press ENTER. The message GRID OFSET DONE should appear and the GRID OFFSET parameters for the homed axes will have been updated. If the message "NO ZERO" appears, this indicates that none of the axes had been zeroed.

5) Perform AUTO ALL AXIS and verify that the DIST TO GO value for each of the selected axes is now close to 0.118". Note that on a lathe with a C axis (such as a TL-15), the C axis does not have a home switch. Consequently the GRID command will not alter parameter 517 C axis GRID OFFSET. The grid offset for the C axis must continue to be calculated my hand.

3.7 Lube Air Panel

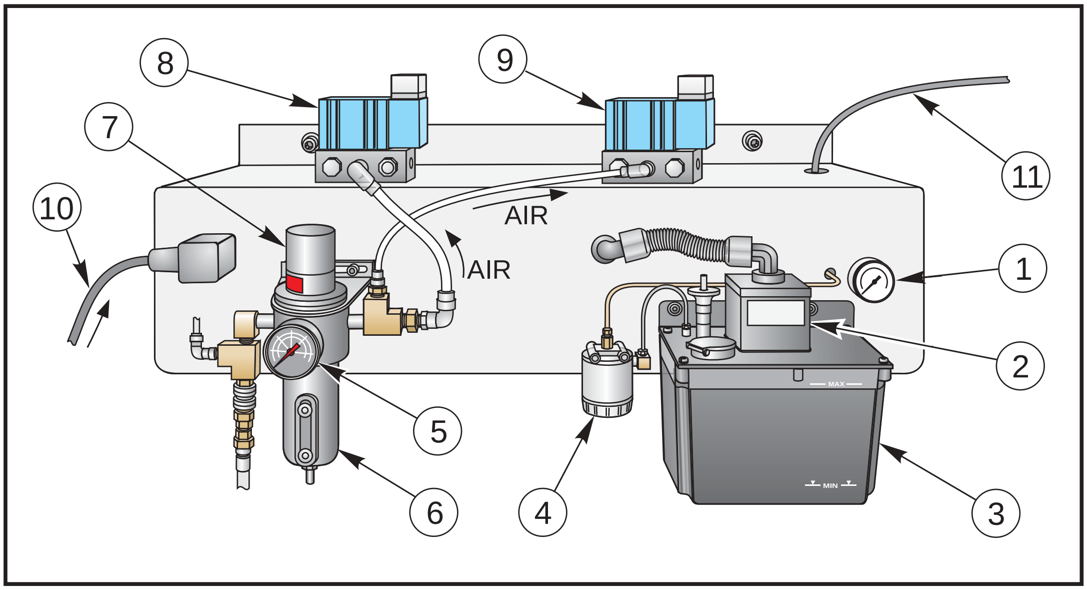


Figure 3.7-1. Lube Air Panel (Front View).

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 approximately 3cc of oil (at approximately 20 psi).
3. **Oil Reservoir** - Stores the oil (Vactra #2) that is used for lubrication in the linear guides and ball 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 and removes moisture 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 parts catcher air cylinder. This assembly is only on machines equipped with a part catcher.
10. **Power Cable** - Supplies power to the Lube Air Panel from the main control box and carries signals from switches to control box.
11. **Foot Pedal Cable** - Connects chuck actuator foot pedal to the lube air panel.

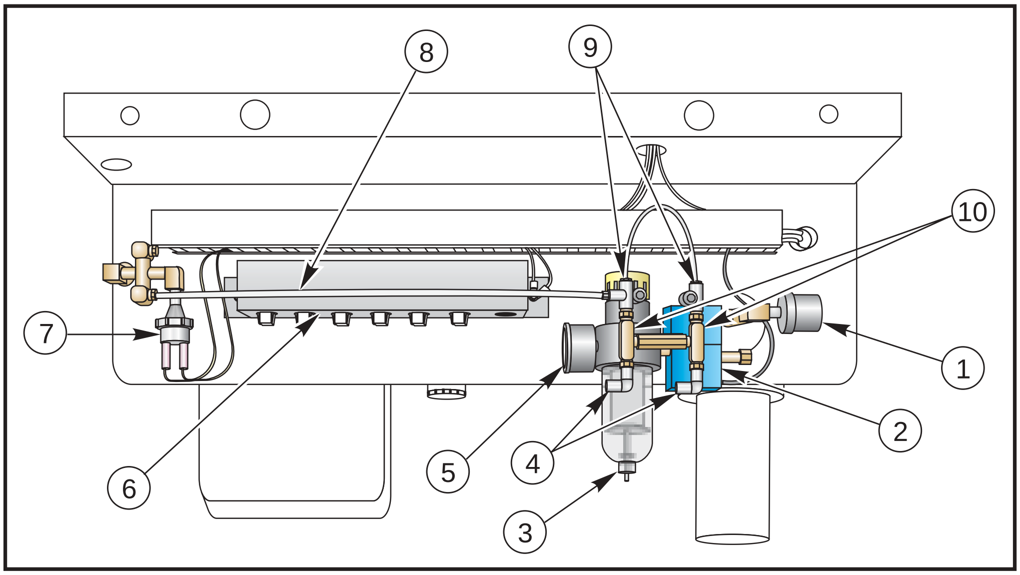


Figure 3.7-2. Lube Air Panel (Rear View).

The following is a list of the Lube Air Panel Assembly components on the rear of the panel, each with a description of its 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 (10-12 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 ball screws, linear guides, and spindle bearings.
9. **Oil Ports** - Connect to nylon tubing that carries the oil to the ball 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

CAUTION! Power off the machine before performing the following procedure.

1. Remove the rear panel.
2. Disconnect the main air line.
3. Disconnect limit switches from lube panel.
4. Disconnect spindle air lines.
5. Disconnect oil line at lube panel.

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

6. Remove all conduits.
7. Disconnect main oil line.
8. Remove the mounting screws located at the top of the lube panel.

3.8 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. Drain the hydraulic fluid.
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.

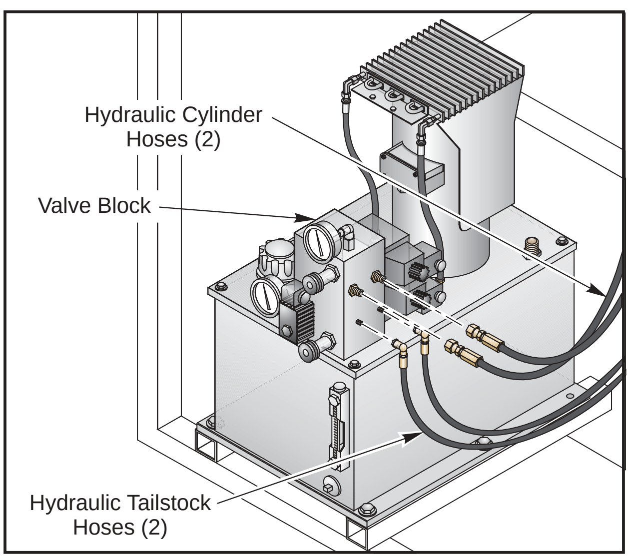


Figure 3.8-1. Hydraulic power unit.

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. Connect tailstock 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. Fill the hydaulic unit with DTE25 to the top of the sight glass.
7. Replace any panels that were removed to access the hydraulic unit.

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.

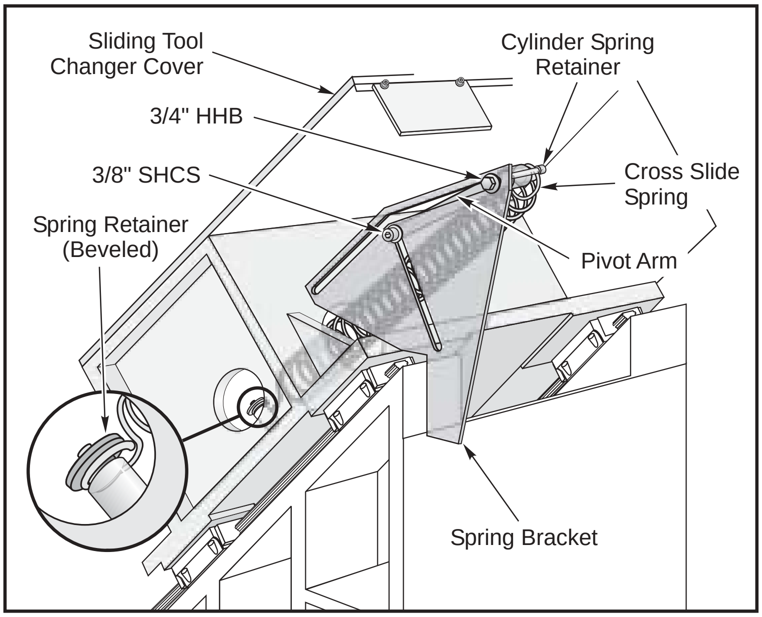


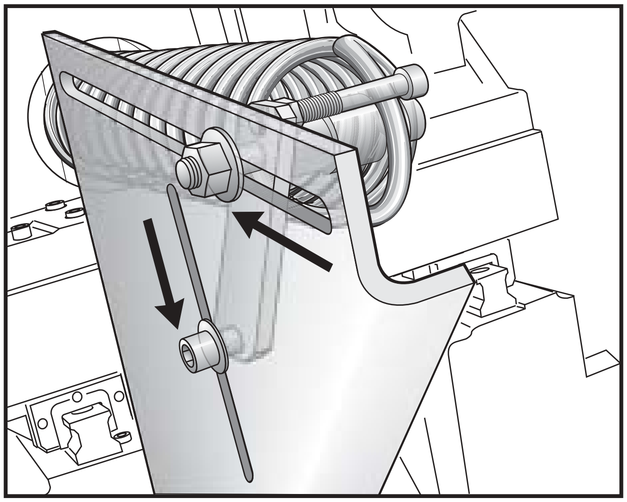
Figure 3.9-1. Cross-slide spring components.

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.

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 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 a wrench with a cheater bar for leverage when relieving spring tension.

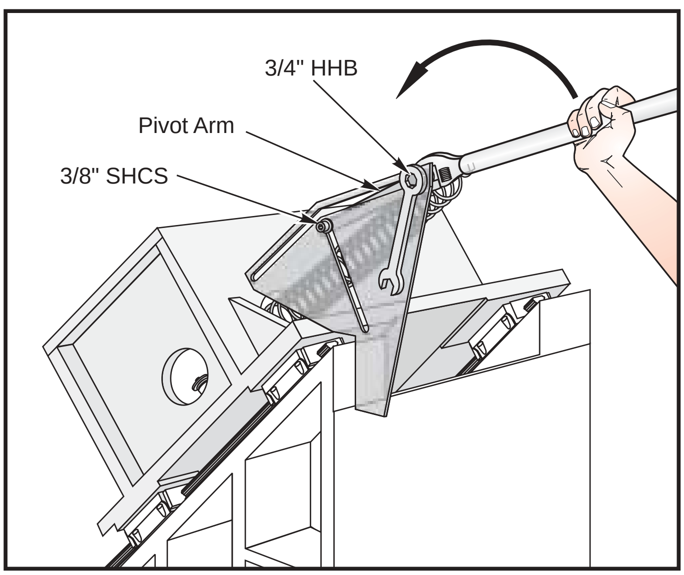
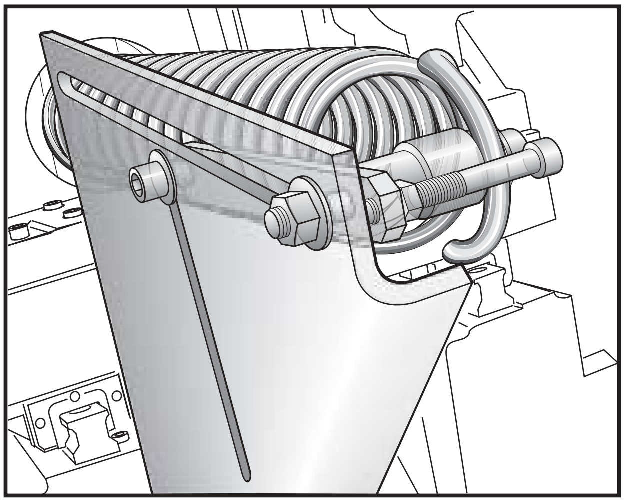


Figure 3.9-2. Spring tension relief.

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 a 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 nut of upper pivot arm on spring bracket.
10. Remove the wood safety block.
11. Re-attach the X-axis way cover.
12. Install sliding tool changer 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.

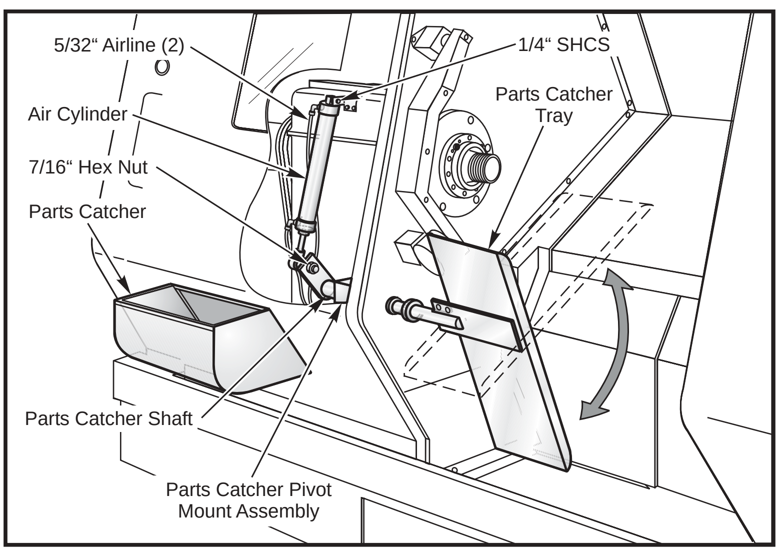


Figure 3.10-1. Front view of parts catcher/tray

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.

Lathe Tool Presetter Setup

This procedure measures probe faces and sets parameters based on the actual distances. If a diameter difference greater than the tolerence of +/- 0.002 is noticed, preforming this procedure will correct the setup without any mechanical changes.

1. Parameter 254, spindle center distance must be set correctly before setting LTP.
2. Install 1" diameter axial reference tool in position 1.
3. Select YASNAC for SETTING #33 coordinate system.

4. Offset G54 must be set X=0, Z=0.

5. Tool wear #1 must be set to 0.

6. Handle jog to a position for clear X travel

7. In OFFSET page, use F2 to set tool 1 work shift to centerline.

8. Enter this program in MDI:

```
G54
G50 T5100
X0
```

9. Run MDI program, the Tool will move to spindle center

10. Select handle jog mode, Distance to go will read X=0.0000, Z=0.0000

11. Manually jog in Z to a position clear of the LTP arm, **don't move the X.**

12. Lower the LTP arm, the display will switch to OFFSETS,

13. Select POSITION display again in order to view DISTANCE TO GO Display.

14. Manually jog to probe tip and "probe" the 1"dia reference tool in the -X direction (move down) using 0.0001 feed rate.

15. Record the X distance to go. (e.g.; 4.9993)

16. Subtract 1" from the number in step 15 (e.g.; 4.9993 - 1.0000 = 3.9993).

17. Enter the number from step 16 in SETTING #59 (**X+ DISTANCE**).

18. Manually jog the tool and "probe" the 1" reference tool in the X+ direction (move up) using 0.0001 feed rate.

19. Record the X distance to go for this position. (e.g. 2.2309).

20. Add 1" to the number in step 19. (e.g. 2.2309 + 1.0000 = 3.2309).

21. Enter the number from step 20 in SETTING #60 (**X- DISTANCE**).

22. Subtract the number in SETTING #60 from SETTING #59 (e.g. 3.9993 - 3.2309 = 0.7684).

23. Divide the number in step 22 by 2 (e.g. 0.7684 / 2 = 0.3842).
(This is the effective width of the probe head, recall the actual width is 10mm or 0.3937)

24. Enter the number from step 23 (effective probe width) in SETTING #62 and SETTING #63.

VERIFICATION

(Method assumes cut geometry is smaller than Tool Probe setting diameters.)

O.D.

25. Using Handle jog and an OD turning tool, OD turn a diameter. Set DISTANCE TO GO to X=0.000.
26. Measure the diameter. (e.g. 2.125)
27. Jog away in Z direction and lower the tool presetter.
28. Jog to probe the OD tool in the X- direction using the 0.0001 feed rate.
29. Record the X DISTANCE TO GO number. (e.g. 1.8743)
30. Add the number from step 29 to the measured diameter in step 26. (e.g. 2.125 + 1.8743 = 3.9993)
31. The SUM from step 30 should equal the number in SETTING #59 (**X+ DISTANCE**) +/- 0.0020).

I.D.

32. Using Handle jog and an ID boring tool, ID bore a diameter. Set DISTANCE TO GO to X=0.000.
33. Jog away in Z direction and lower the tool presetter.
34. Measure the bore diameter. (e.g. 1.750)
35. Jog to probe the ID tool in the X+ direction using the 0.0001 feed rate.
36. Record the X DISTANCE TO GO number. (e.g. 1.4809)
37. Add the number from step 36 to the measured diameter in step 34. (e.g. 2.125 + 1.4809 = 3.2309)
38. The SUM from step 37 should equal the number in SETTING #60 (**X- DISTANCE**) +/- 0.0020.
39. If verifying tool setter arm settings with cut diameters larger than tool probe setting diameter, subtract the X DISTANCE TO GO from the measured diameter and compare result to the appropriate X +/- setting (#59 or #60).

3.12 Ball Screw Replacement

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

TOOLS REQUIRED:

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

Z-Axis Ball 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 ball screw.
3. Remove the cover from the motor housing. Disconnect the oil line from the ball screw nut.

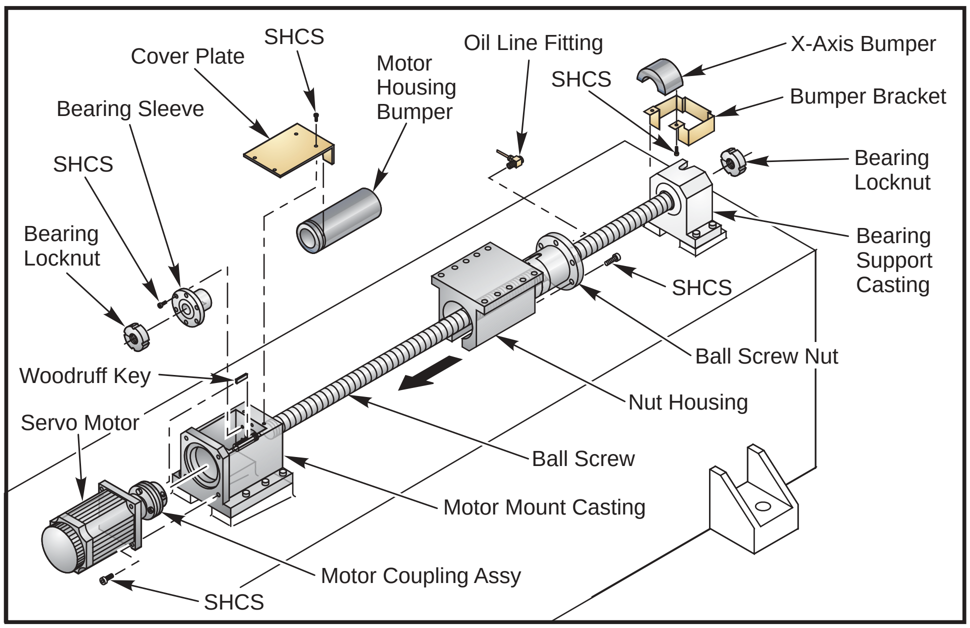


Figure 3.12-1

For 32mm Ball Screw:

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

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

c. In the motor housing, loosen the lock nut screw, attach the spanner wrench to the clamp nut and remove the nut from the ball 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 all the way towards the motor end. Underneath the wedge, remove the SHCS that attach the ball screw nut to the nut housing. Pull the ball screw forward to clear the nut from the housing and angle the ball screw towards the right of the bearing support. Carefully remove ball screw.

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

40mm Ball Screws:

a. At the bearing support side, loosen the lock 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 ball screw side of the coupling. Remove the four motor SHCS and the motor. Remove the Woodruff key from the key way on the ball screw. In the motor housing, loosen the lock nut screw and attach the spanner wrench. Remove the clamp nut.

c. Disconnect the oil line.

d. Underneath the wedge, remove the SHCS from the ball screw nut and push the wedge towards the motor housing.

e. 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 ball screw in place and remove the bearing support. Pull forward on the ball screw and carefully remove.

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

Z-Axis Ball Screw Installation

Ensure all mating surfaces on the bearing sleeve, motor housing, nut housing and the ball 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 Ball Screw:

1. Reinsert the ball screw, with the motor housing bumper on it, from the right hand side of the bearing support into the motor housing. Align the ball screw with the bearing support end and insert the ball screw. Prevent contact with the screw threads, to avoid any possible damage.

2. Hold the ball screw level on the motor side. Slide the bearing sleeve onto the ball 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 ball screw:

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

   b. At the motor side of the ball screw, attach lock nut.

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

   d. Torque 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 lock nut against the bearing to **4 IN-LBS.** Retighten the clamp nut screw and mark with yellow paint.

   f. Align the ball screw nut to the nut housing on the wedge, check oil line fitting is in the correct position. Apply a drop of blue Loctite to the five SHCS and fasten the nut to the housing. Torque the ball screw nut SHCS to **15 FT-LBS**.

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

   h. Install the motor with the coupling attached check condition of the coupler 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 ball screw and torque to **15 FT-LBS**. Attach bumper, and replace motor housing cover.

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

6. Replace the bearing support end hardstops and reconnect oil line to the ball screw nut.

7. Zero return Z axis and set grid offset.

For 40mm Ball Screw:

1. Reinsert the ball screw with bumpers into the bearing sleeve in the motor housing. (Make sure the ball screw nut will be able to slide in to the wedge nut housing). Support the ball 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. Fasten to the base casting using the six bearing support housing SHCS, lock washers and Loctite.

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

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

---

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

   c. Place a spanner wrench on the lock 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 lock nut screw and mark with yellow paint.

   e. At the bearing support end, remove the shaft lock.

   f. Align the ball 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 ball screw nut SHCS to **30 FT-LBS**.

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

   h. Install the motor with the coupling attached to the ball 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. Move turret to support housing end, taking care to stop before hitting the support housing.

6. Torque the bearing support housing SHCS to **30 FT-LBS**. Prevent contact with the ball screw threads, to avoid any possible damage.

7. Loosen the lock nut screw. Tighten the lock nut against the bearing to **4 IN-LBS**. Retighten the clamp screw and mark with yellow paint.

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

9. Replace the ball screw hardstops and reconnect oil line to the ball screw nut.

10. Zero return Z axis and set grid offset according to section 3.5.

Mini Lathe Z-axis Ballscrew Alignment

1. Move the Z-axis Ballscrew nut to the middle of the ballscrew. With all the bolts loose, take a “before” torque reading on the ballscrew.

2. Screw down (do not torque) the SHCS on the face of the nut.

3. Torque down the SHCS that fasten the nut housing to the side.

4. Now loosen the SHCS on the face of the nut. Run the Z-axis fully each way, then return the nut to the middle of the ballscrew.

5. Torque the SHCS on the face of the nut. Run the ballscrew nut to the motor end of the ballscrew. screw down the SHCS (do not torque) the bearing support.

6. Run the ballscrew nut to the bearing end of the ballscrew. Run the ballscrew nut back to the motor end and torque the SHCS.

7. Run the ballscrew nut back to the bearing nd and torque the SHCS. Take three ballscrew torque readings. One approximately 1” from each end, then one reading at the middle. Readings NTE 3 in-lb of each other.

3.13 SL-10 THRU SL-40 X-AXIS BALL SCREW REPLACEMENT

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

SPECIAL TOOLS REQUIRED:

- Torque Wrench
- Spanner wrench (32mm)
- Lock collar Nut Wrench P/N T-1601
- Straight Nose Snap Ring Tool
- Coupler Installation Tool (Haas part number T-1451)

X-AXIS BALL SCREW REMOVAL

1. Turn the machine on. Zero return all axes and put the machine in handle jog mode.
2. Remove all sheet metal necessary to gain access to the X-axis ball screw, servo motor, and coupler. Remove the way cover.
3. Handle jog the turret down the X-axis until there is access to the motor housing cover.

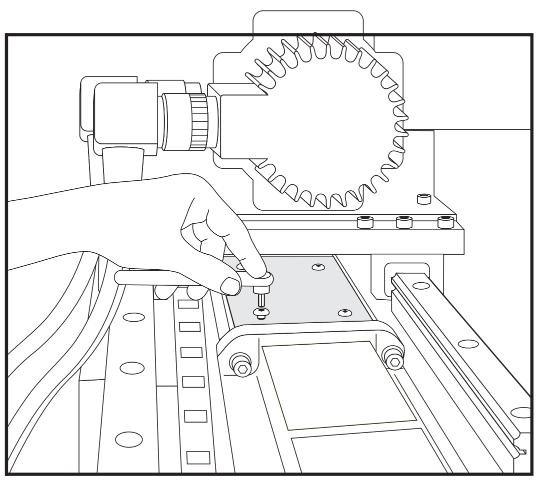


Figure 3.12-2

4. Remove the motor housing cover. (See figure 3.12-2.)
5. Loosen the clamp collar that ties the X-axis motor coupler to the ball screw.
6. Jog the X-axis to the home position. Remove the temperature sensor and oil line. Remove all but one of the SHCS that secure the ball nut to the nut mount. Loosen the remaining SHCS to hand tight. (See figure 3.12-3.)

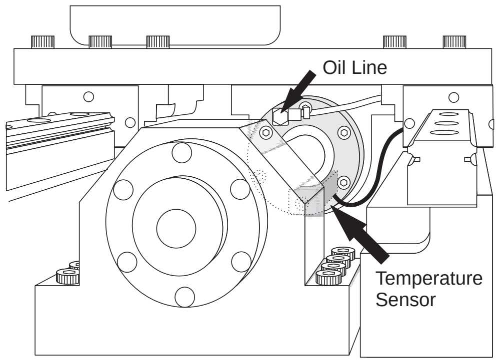


Figure 3.12-3

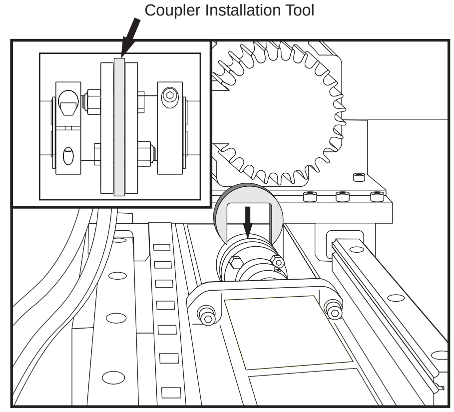


Figure 3.12-4

7. Carefully handle jog the X-axis until there is just enough room to install the coupler installation tool (P/N T-1451). Install the coupler installation tool into the coupler to prevent damage to the coupler when the motor is removed. (See figure 3.12-4)

8. Brace the gearbox casting to prevent it from movement when disconnected from the nut. Use a block of wood or other such material that will not cause damage. (See figure 3.12-5.)

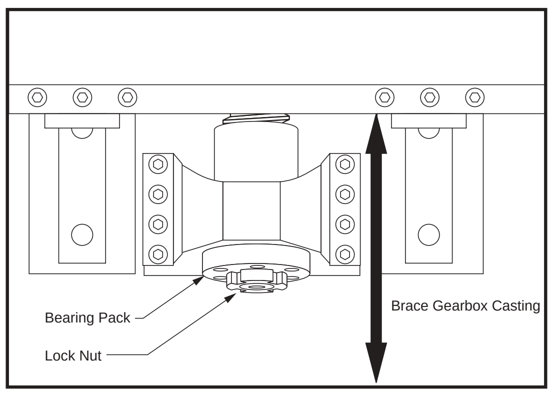


Figure 3.12-5

9. Disconnect the motor cables. Remove the four (4) SHCS that secure the axis motor to the motor housing. Pull the motor away from the casting, this will slide the coupler off of the ball screw, leaving it attached to the motor output shaft.

10. Remove the bearing locknut and the bearing housing from the bearing support end of the ball screw.

11. Remove the ball screw retaining ring from the motor end of the ball screw.

12. Ball screw removal for the (SL-10):

    a. Remove the last SHCS from the ball nut.

    b. Slide the ball screw down through the bearing support casting.

    c. Thread the ball nut up the ball screw towards the motor end, as you feed the ball screw down through the bearing support casting.

    d. Thread the nut up the ball screw until the ball screw can be swung down through the opening in the wedge casting.

e. Remove the ball screw through the back side of the wedge casting.

f. Take extreme care not to damage the ball screw while pulling it through the castings.

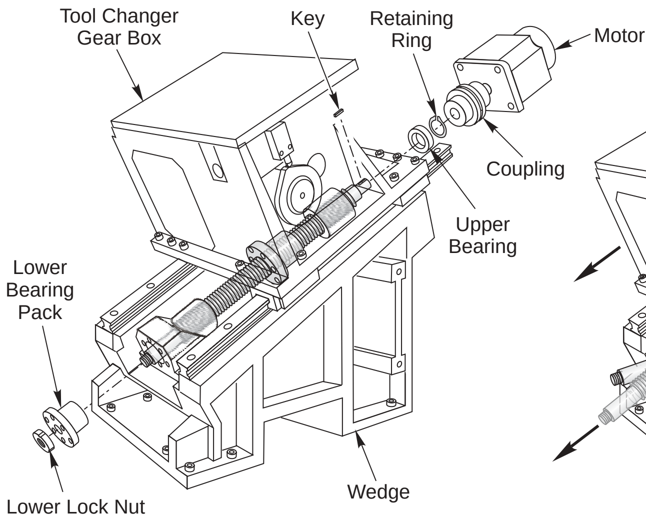


Figure 3.12-6a

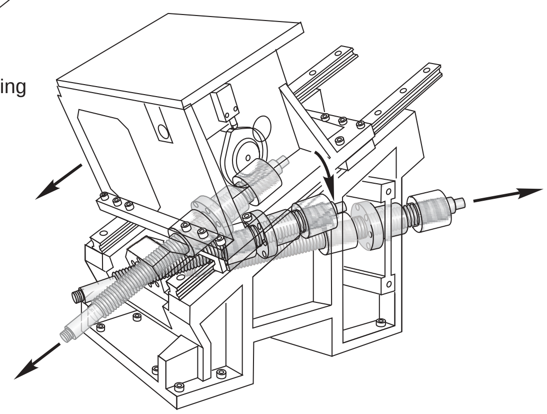


Figure 3.12-6b

Ball screw removal for (SL-20, SL-30, and SL-40):

a. Loosen the counterbalance spring nut at the motor end of the ball screw. Using a crescent wrench, hold swing arm and loosen upper hex bolt to slowly release the spring tension.

b. Remove the last SHCS from the ball nut.

c. Guide the ball screw out of the front of the machine

Reinstalling the X-axis Ball screw (SL-10)

1. Reinstall the bumpers onto the ball screw.

2. Replace the ball screw into the wedge casting in the reverse order by which it was removed:

   a. Thread the ball nut up the ball screw towards the motor end until there is clearance to install the ball screw through the wedge casting.

   b. Slide the bearing support end of the ball screw through the bearing support casting.

   c. Swing the ball screw up through the hole in the wedge casting.

   d. Thread the ball nut down the ball screw, towards the bearing support end, until the ball screw can be reinserted into the motor end bearing.

3. Ensure that the upper bearing is properly seated and then install the retaining ring.

4. Reinstall the bearing support cartridge into the bearing support casting and over the ball screw. Secure with the SHCS and torque in a crisscross pattern to **15 ft-lbs.**

5. Reinstall the lock nut onto the bearing support end of the lead screw. Torque the lock nut to 50 ft-lbs and then torque the SHCS in the lock nut to 15 in-lbs.

6. Thread the ball nut up the lead screw until the nut is back in alignment with the nut housing. Torque the SHCS to 15 ft-lbs.

7. Reinstall the oil line and the temperature sensor.

8. Check for binding in the beginning, middle and end of travel. Check for backlash or noisy operation.

Reinstalling the X-axis Ball screw (SL-20,30,40)

1. Reinstall the bumpers onto the ball screw.

2. Replace the ball screw into the wedge casting in the reverse order by which it was removed:

   a. Thread the ball nut up the ball screw towards the motor end until there is clearance to install the ball screw through the wedge casting.

   b. Slide the bearing support end of the ball screw through the bearing support casting.

   c. Thread the ball nut down the ball screw, towards the bearing support end, until the ball screw can be reinserted into the motor end bearing.

3. Ensure that the upper bearing is properly seated and then install the retaining ring.

4. Reinstall the bearing support cartridge into the bearing support casting and over the ball screw. Secure with the SHCS and torque in a crisscross pattern to **15 ft-lbs.**

5. Retighten the counterbalance spring: See the Turret Cross Slide Spring Replacement section of this manual.

6. Reinstall the lock nut onto the bearing support end of the lead screw. Torque the lock nut to 50 ft-lbs and then torque the SHCS in the lock nut to 15 in-lbs.

7. Thread the ball nut up the lead screw until the nut is back in alignment with the nut housing. Torque the SHCS to 15 ft-lbs.

8. Reinstall the oil line and the temperature sensor.

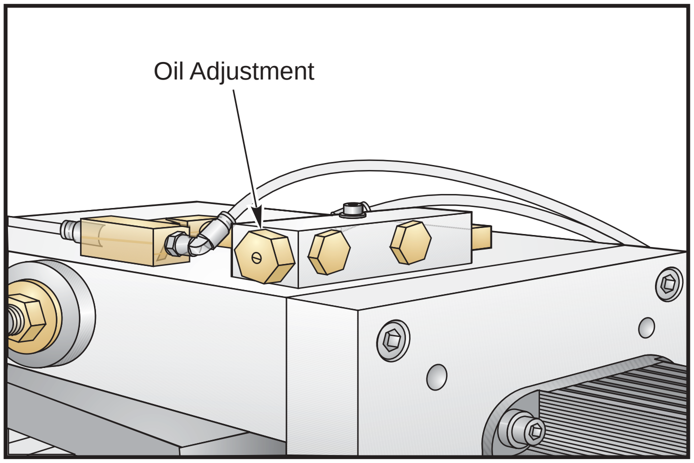
9. Check for binding in the beginning, middle and end of travel. Check for backlash or noisy operation.

3.14 C-Axis

NOTE: This option requires the use of a second MOCON PCB. Care should be taken when tracing signals to and from the MOCONs.

Lubrication

The C-Axis gears are automatically lubricated by the machine lube system. The gears are lubricated with one drop of oil every ten engagements. The amount of oil used is adjusted by a slotted screw on the side of the oiler block. Turn the screw in (clockwise) for less oil.



For a base line adjustment, turn the screw in completely, then back out 1/2 turn. Check lubrication frequency and adjust for approximately one drop every ten engagements.

Setting Grid Offset

NOTE: Grid Offset must be checked and reset if the drive gear or the "C" drive servo motor is replaced.

Enter MDI DNC mode. Enter the following program:

M19 P0 ;
G28 C0 ;
G04 P2.0 ;
M14

1. Press <SETNG GRAPH> and turn setting #7 off.
2. Press <ALARM MESGS>, Type DEBUG and press <ENTER>.
3. Press <POST>, use page up or down to find "Pos-Raw Dat 1 data page. Locate the "C" Axis actual column and record the value.
4. Disconnect the air supply to the C-Axis actuator block and install an in-line regulator with a cutoff valve. Set the pressure to 45psi.
5. Press <MDI DNC>. Press <CYCLE START>. Wait for the spindle to orient and the brake to apply.

6. Record current values for Parameter 356 U D GAIN and Parameter 357 U I GAIN. Reset Parameter 356 to 1000; reset Parameter 357 to 10. This will allow for low servo response so deviations in position can be read.

7. Engage C-Axis by turning on the air supply to the block (set at 45 psi).

8. Press <POST> raw data page and look at the C-Axis (actual) value. It should read less than 0.0050. Set to the lowest possible value by adjusting Parameter 373 U GRID OFFSET. Repeat steps 5 through 8 until the lowest value for the position raw data is reached.

NOTE: After changing Parameter 373, you must press <RESET> at least twice before zero-returning the C-Axis for the new value to enter into memory.

9. Exit debug mode. Press <ALARM MESGS> and type DEBUG. Press <ENTER>.

10. Enter the original values for Parameters 356 and 357, recorded in step 6.

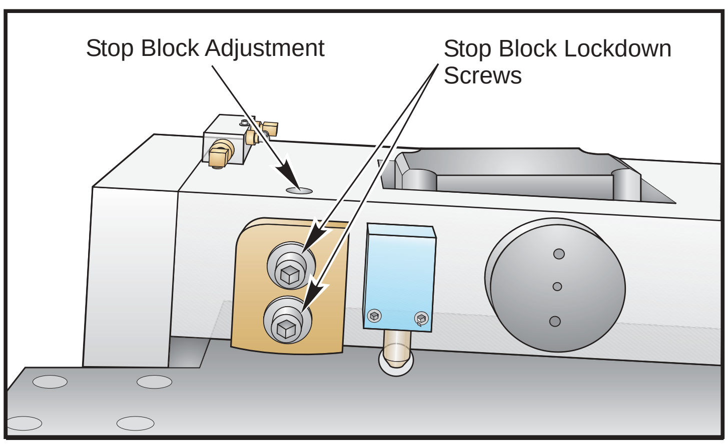
11. Record Parameter 373.

Setting Gear Mesh Contact Load

1. Disable the C-Axis (Parameter 354).

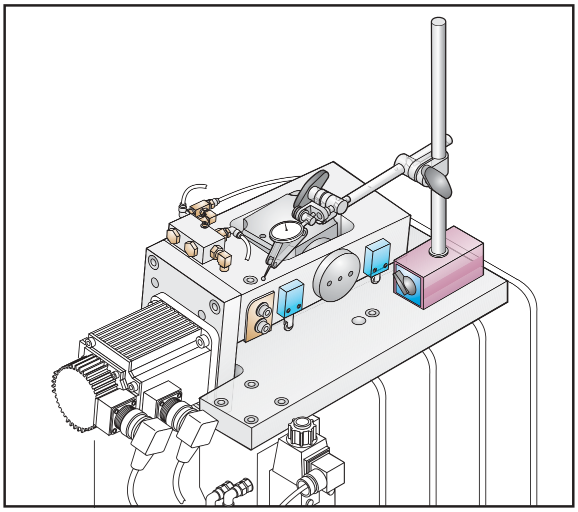
2. Activate the air supply to the C-Axis pivot block. Ensure the regulator is set to 45psi.

3. Loosen the two SHCS Stop Block Lockdown Screws, located on the side of the pivot stop block. Remove stop block adjustment set screw and apply one drop of Red Loctite to the threads.



4. Install the set screw, but do not put pressure on the stop block.

5. Place a magnetic base indicator on top of the spindle head and rest the indicator finger on top of the pivot block.



6. Rotate the spindle manually and observe the indicator. If runout is over .004” check the grid offset and/or servo motor installation. If the grid offset and servo motor installation are correct and the runout is still over .004” increase the air pressure to 50 psi and recheck.

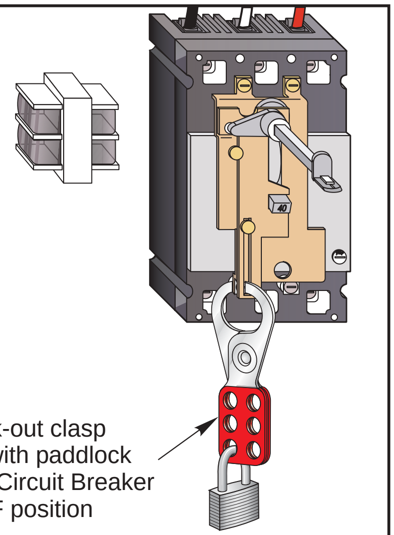
7. Once the proper runout is achieved set the indicator finger to zero at the lowest point of the runout.

8. Screw down the adjustment set screw until the pivot block is .0005” from the gear mesh contact point.

9. Tighten the two SHCS Stop Block Lockdown Screws, located on the side of the pivot stop block. Torque to 50 ft/lbs.

10. Reconnect the C-Axis air supply from the C-Axis solenoid.

4. ELECTRICAL SERVICE



Make sure the circuit breaker is locked in the off position before attemting any electrical work to avoid possible shock.

4.1 Solenoids

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

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.
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 it 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 section 3.6).
3. Disconnect exhaust lines.
4. Unplug the solenoid electrical lead in the wire channel (located on the rear of the lube air panel).
5. Remove the two SHCS holding the assembly to the bracket and remove the assembly.

INSTALLATION -

6. Replace the air solenoid assembly and attach to the bracket with the two SHCS. Tighten securely.
7. Reconnect the electrical connection to the solenoid at the switch bracket.
8. Reconnect the three air lines, ensuring that all connections are tight and do not leak.
9. Reconnect exhaust lines.
10. 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.

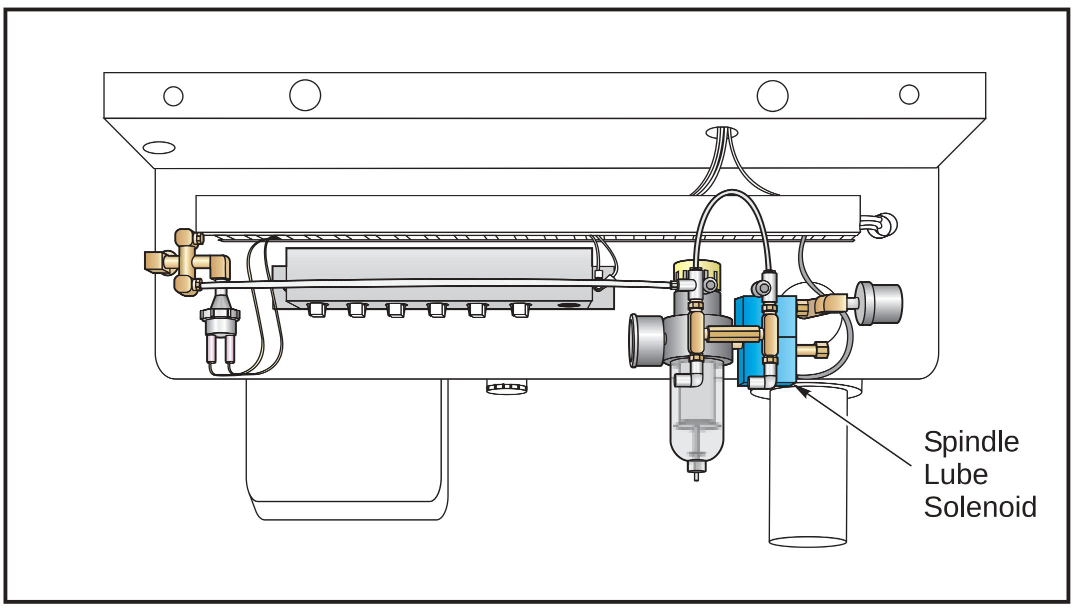


Figure 4.1-2. Rear view of lube/air panel.

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.

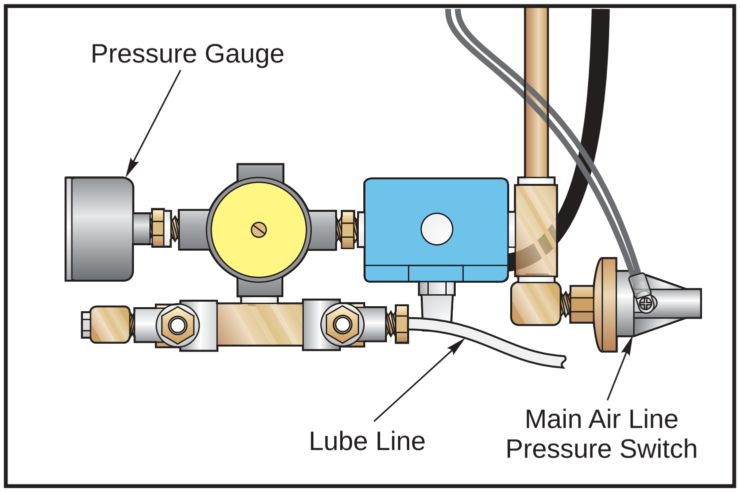


Figure 4.1-3. Top view of spindle lube/air solenoid assembly.

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

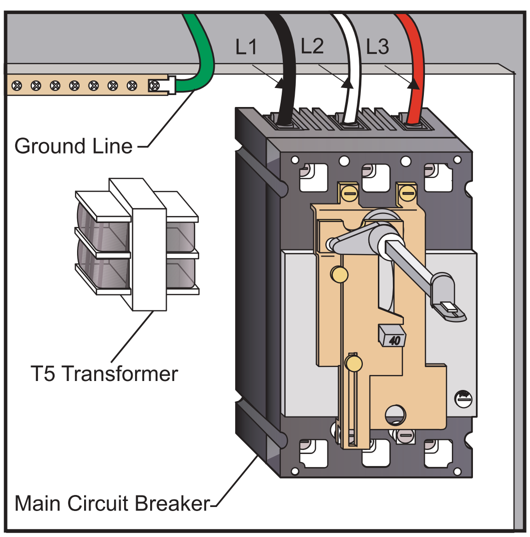
Electrical Connections

NOTE: The machine must have air pressure at the gauge or a “Low Air Pressure” alarm will be present on power up.

CAUTION! Working with the electrical services required for the SL can be extremely hazardous. The electrical power must be off and steps must be taken to ensure that it will not be turned on while you are working with it. In most cases this means turning off a circuit breaker in a panel and then locking the panel door. However, if your connection is different or you are not sure how to do this, check with the appropriate personnel in your organization or otherwise obtain the necessary help BEFORE you continue.

WARNING!

The electrical panel should be closed and the three latches on the door should be secured at all times except during installation and service. At those times, only qualified electricians should have access to the panel. When the main circuit breaker is on, there is high voltage throughout the electrical panel (including the circuit boards and logic circuits) and some components operate at high temperatures. Therefore, extreme caution is required.



1. Hook up the three power lines to the terminals on top of the main switch at upper right of electrical panel and the separate ground line to the ground bus to the left of the terminals.

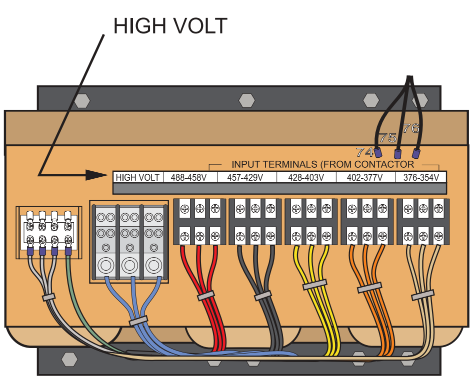
NOTE: Make sure that the service wires actually go into the terminal-block clamps. (It is easy to miss the clamp and tighten the screw. The connection looks fine but the machine runs intermittently or has other problems, such as servo overloads.) To check, simply pull on the wires after the screws are tightened.

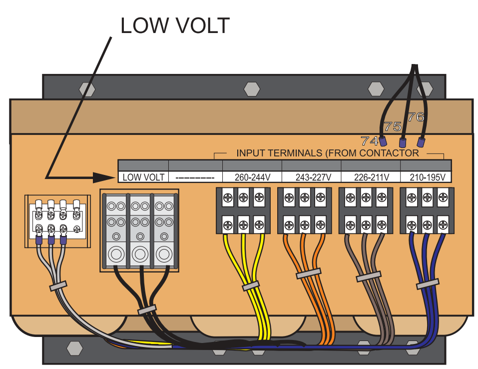
2. After the line voltage is connected to the machine, make sure that main circuit breaker (at top-right of rear cabinet) is OFF (rotate the shaft that connects to the breaker counterclockwise until it snaps OFF). Turn ON the power at the source. Using an accurate digital voltmeter and appropriate safety procedures, measure the voltage between all three pair phases at the main circuit breaker and write down the readings. The voltage must be between 195 and 260 volts (360 and 480 volts for high voltage option).

NOTE: Wide voltage fluctuations are common in many industrial areas; you need to know the minimum and maximum voltage which will be supplied to the machine while it is in operation. U.S. National Electrical Code specifies that machines should operate with a variation of +5% to -5% around an average supply voltage. If problems with the line voltage occur, or low line voltage is suspected, an external transformer may be required. If you suspect voltage problems, the voltage should be checked every hour or two during a typical day to make sure that it does not fluctuate more than +5% or -5% from an average.

CAUTION! Make sure that the main breaker is set to OFF and the power is off at your supply panel BEFORE you change the transformer connections. Make sure that all three black wires are moved to the correct terminal block and that they are tight.

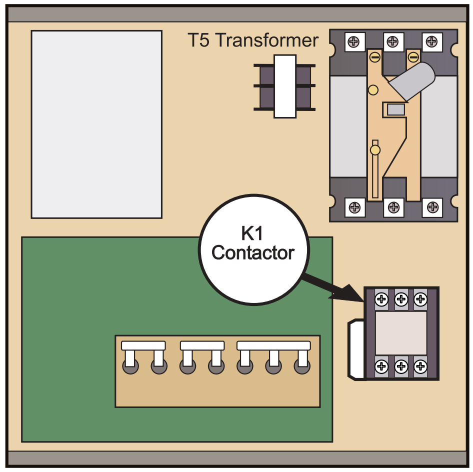
3. Check the connections on the transformer at the bottom-right corner of the rear cabinet. The three black wires labeled **74, 75,** and **76** must be moved to the terminal block triple which corresponds to the average voltage measured in **step 2** above. The labels showing the input voltage range for each terminal position are as shown in the following illustrations:





4. Transformer T5 supplies 24VAC used to power the main contactor. There are two versions of this transformer for use on 240 and 480V machines (32-0964B and 32-0965B, respectively). The 240V transformer has two input connectors located about two inches from the transformer, which allow it to be connected to either 240V or 200V. Users that have 220V-240V RMS input power should use the connector labeled 200V. Users with the External High Voltage Option should use the 240V connector if they have 420V-510V 60Hz power or the 200V connector if they have 50Hz power. Failure to use the correct input connector will result in either overheating of the main contactor or failure to reliably engage the main contactor.

5. Set the main switch to ON (rotate the shaft that engages the handle on the panel door clockwise until it snaps into the ON position). Check for evidence of problems, such as the smell of overheating components or smoke. If such problems are indicated, set the main switch to OFF immediately and call the factory before proceeding.



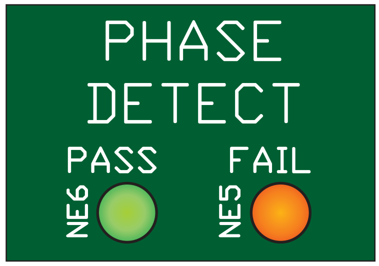
WARNING!

Through the Spindle Coolant (TSC) pump is a three phase pump and must be phased correctly! Improper phasing will cause damage to the TSC pump and void the warranty. Refer to the TSC start up section IF YOUR MACHINE IS EQUIPPED WITH TSC.

6. After the power is on, measure the voltage across the upper terminals on the contactor K1 (located below the main circuit breaker). It should be the same as the measurements where the input power connects to the main breaker. If there are any problems, check the wiring.

7. Apply power to the control by pressing the Power-On switch on the front panel. Check the high voltage buss on the Vector Drive (pin 2 with respect to pin 3 on the terminal bus at the bottom of the drive). It must be between 310 and 360 volts. If the voltage is outside these limits, turn off the power and recheck steps 2 and 3. If the voltage is still outside these limits, call the factory. Next, check the DC voltage displayed in the second page of the Diagnostic data on the CRT. It is labeled DC BUS. Verify that the displayed voltage matches the voltage measured at pins 2 and 3 of the Vector Drive +/- 7 VDC.

8. Electrical power must be phased properly to avoid damage to your equipment. The Power Supply Assembly PC board incorporates a "Phase Detect" circuit with neon indicators, shown below. When the orange neon is lit (NE5), the phasing is incorrect. If the green neon is lit (NE6), the phasing is correct. If both neon indicators are lit, then you have a loose wire. Adjust phasing by swapping L1 and L2 of the incoming power lines at the main circuit breaker.



WARNING!

ALL POWER MUST BE TURNED OFF AT THE SOURCE PRIOR TO ADJUSTING PHASING.

9. Turn off the power (rotate the shaft that engages the handle on the panel door counterclockwise until it snaps into the OFF position). Also, set the main switch handle on the panel door to OFF. (Both the handle and the switch must be set to OFF before the door can be closed). Close the door, lock the latches, and turn the power back on.

10. Remove the key from the control cabinet and give it to the shop manager.

Installation Procedure for External 480V Transformer

Introduction

The external transformer adds to overall machine reliability and performance, however it does require extra wiring and a place to locate it. The external transformer provides electrostatically shielded isolation. This type of transformer acts to isolate all common mode line transients and improve EMI conducted emissions.

The external transformer has a 45 KVA rating.

Installation

The transformer should be located as close to the machine as possible. The input and output wiring of the transformer should conform to the local electrical codes and should be performed by a licensed electrician. The following is for guidance only, and should not be construed to alter the requirements of local regulations.

The input wire should not be smaller than the 6AWG for the 45KVA transformer. Cable runs longer than 100” will require at least one size larger wire. The output wire size should be 4 AWG.

The transformer is 480V to 240V isolation transformers with delta wound primary and secondary windings. The primary windings offer 7 tap positions, 2 above and 4 below the nominal input voltage of 480V.

For domestic installations and all others using 60Hz power, the primary side should be wired as follows:

Input Voltage Range	Tap
493-510	1 (504)
481-492	2 (492)
469-480	3 (480)
457-468	4 (468)
445-456	5 (456)
433-444	6 (444)
420-432	7 (432)

This should produce a voltage on the secondary side of 234-243 V RMS L-L. Verify this and readjust the taps as required. At the machine, connect the cables at the input of the internal 230V transformer to the 227-243V taps. Apply power to the machine and verify that the DC voltage between pins 2 and 3 of the Vector Drive (2nd and 3rd pins from the left) is 329-345VDC. If not, return to the 480V isolation transformer and readjust the taps as required. Do not use the taps on the internal 230V transformer to adjust the voltage.

50Hz Installations

The external transformers are 60Hz rated, and cannot be used at 50Hz without derating the input voltage. For these applications, the internal 230V transformer should be tapped on the lowest setting (195-210V RMS). The external transformer should be tapped according to the table shown below. If these tap setting do not produce a DC bus voltage between pins 2 and 3 on the Vector Drive between 320 and 345VDC, readjust the taps on the external transformer as required. DO NOT move the taps on the internal transformer from the lowest position.

Input Voltage Range	Tap
423-440	1 (504)
412-422	2 (492)
401-411	3 (480)
391-400	4 (468)
381-390	5 (456)
371-380	6 (444)
355-370	7 (432)

4.3 Fuse Replacement

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

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 green POWER ON 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.

1. Turn machine power off.

2. Turn the main switch (upper right of electrical cabinet) to the off position.

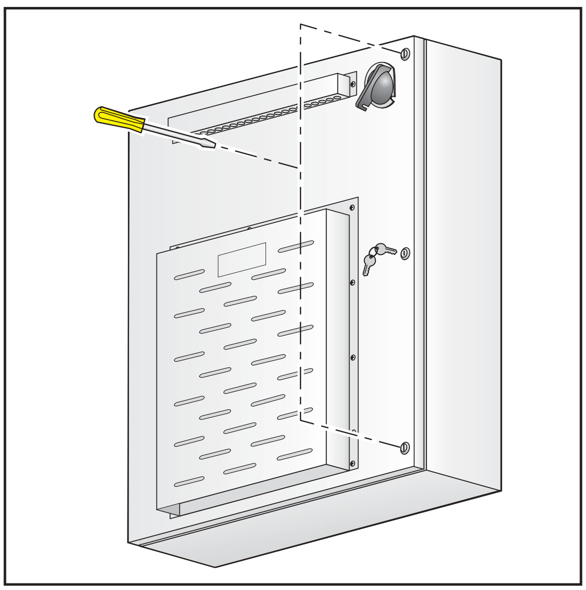


Figure 4.3-1. Unscrew the two screws to open the cabinet door. (Control cabinets require a key)

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 green POWER ON light on the servo amplifiers (servo drive assembly on brush machines) goes out before beginning any work inside the electrical cabinet.

4. On the POWER SUPPLY board there are three fuses located in a row at the upper right of the board; these are the overvoltage fuses. An orange light will be on to indicate the blown fuse(s).

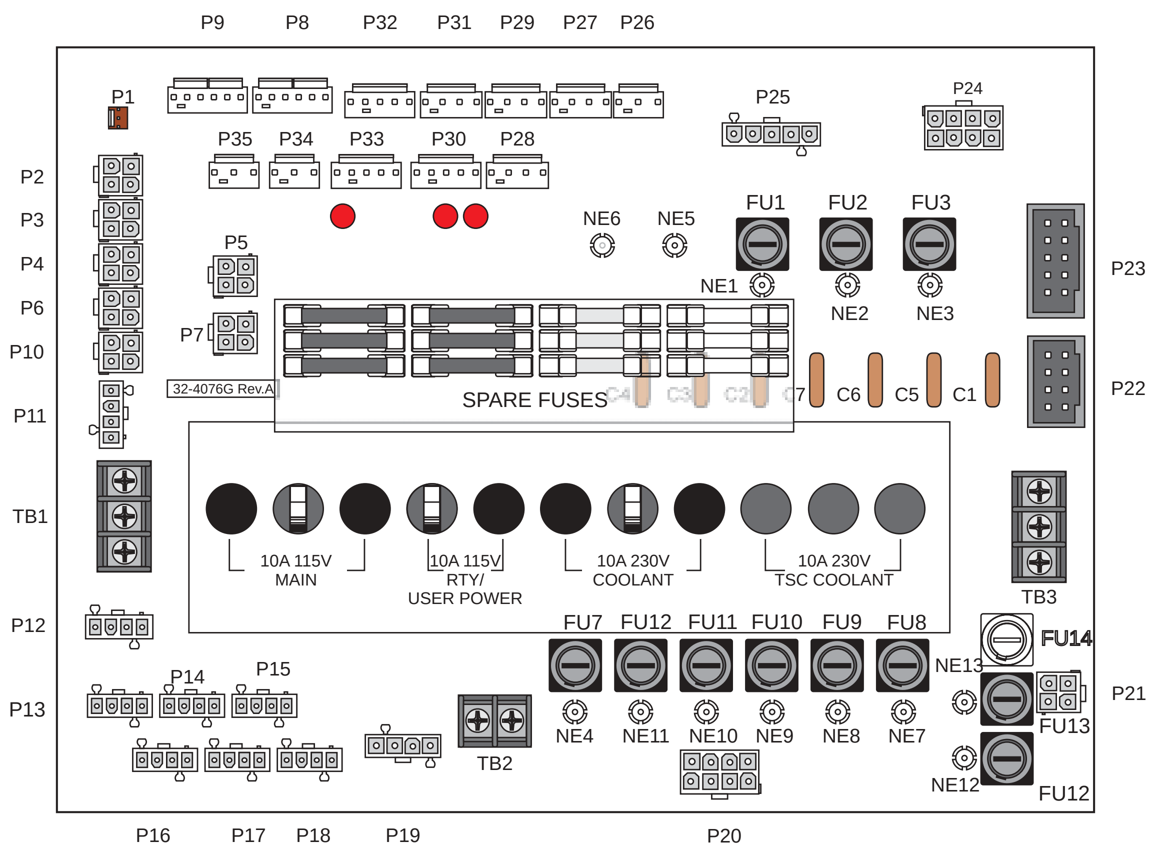


Figure 4.3-2. Power supply board; fuse locations.

5. Using a flat tip screwdriver, turn the fuse(s) counterclockwise to remove and replace the blown fuse(s) with ones having the same type and rating (½ amp, type AGC, 250V).

CAUTION! When the left fuse is blown, it is still possible to operate the machine, thereby making an overvoltage situation possible. VERIFY absolute voltage to the machine does not exceed 260 volts.

4.4 PCB Replacement

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

Microprocessor, MOCON (MOTIF), & Video / Keyboard

WARNING!

An anti-static strap should be worn when changing any PCB.

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 green POWER ON 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 green POWER ON 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. Refer to the Cable Locations section for illustrations showing 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.
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 steps 6 and 7.

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 - (Brush machines only)

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.

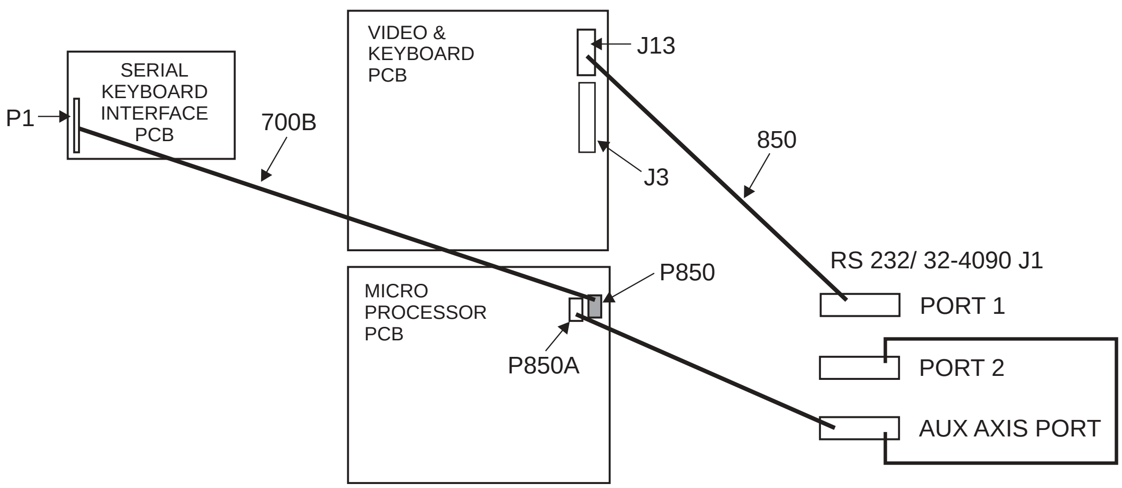
RS-232 PCB

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.

NOTE: It is suggested to make use of a step ladder high enough to allow you to work from the top of the electrical cabinet. It will be necessary, when replacing the RS-232 board, to work from the inside and outside of the cabinet at the same time.

4. On the left side of the cabinet, at the top of the side panel are two serial port connections labeled "SERIAL PORT #1" and "SERIAL PORT #2", SERIAL PORT #1 being the upper connection.



* Serial interface replaces cable 700 with cable 700B.

Figure 4.4-1. RS-232 wiring pictorial (with serial keyboard).

5. To remove the RS-232 board, unscrew the two hex screws (on the exterior of the cabinet) holding the connector to the cabinet. From the inside of the cabinet, pull the connector through the panel, and disconnect the cable.
6. Replace the RS-232 board by first connecting the appropriate cable to the board (850 to SERIAL PORT #1, 850A to SERIAL PORT #2, then inserting the board (cable side up) through the left side panel. Attach with the two hex screws previously removed. Ensure the board for Serial Port #1 is the upper connector and the board for Serial Port #2 is the lower connector.

RS-232 Serial Interface

There are two connectors used for the RS-232 interface. The RS-232 connector on the back of most PC's is a male DB-25, so only one type of cable is required for connection to the controller, or between controllers. This cable must be a DB-25 male on one end and a DB-25 female on the other. Pins 1, 2, 3, 4, 5, 6, 7, 8, and 20 must be wired one-to-one. It cannot be a Null Modem cable, which inverts pins 2 and 3. To check cable type, use a cable tester to check that communication lines are correct. The controller is DCE (Data Communication Equipment). This means that it transmits on the RXD line (pin 3) and receives on the TXD line (pin 2). The RS-232 connector on most PC's is wired for DTE (Data Terminal Equipment), so no special jumpers should be required.

The Down Line DB-25 connector is only used when more than one controller is to be used. The first controller's down line connector goes to the second controller's up line connector, etc.

The RS-232 interface sends and receives **seven data bits, even parity, and two stop bits**. The interface must be set correctly. The data rate can be between 110 and 19200 bits per second. When using RS-232, it is important to make sure that Parameters 26 (RS-232 Speed) and 33 (X-on/X-off Enable) are set to the same value in the controller and PC.

If Parameter 33 is set to **on**, the controller uses X-on and X-off codes to control reception, so be sure your computer is able to process these. It also drops CTS (pin 5) at the same time it sends X-off and restores CTS when is sends X-on. The RTS line (pin 4) can be used to start/stop transmission by the controller or the X-on/X-off codes can be used. The DSR line (pin 6) is activated at power-on of the controller and the DTR line (pin 20 from the PC) is not used. If Parameter 33 is 0, the CTS line can still be used to synchronize output.

When more than one HAAS controller is daisy-chained, data sent from the PC goes to all of the controllers at the same time. That is why an axis selection code (Parameter 21) is required. Data sent back to the PC from the controllers is OR'ed together so that, if more than one box is transmitting, the data will be garbled. Because of this, the axis selection code must be unique for each controller.

RS-232 Remote Command Mode

Parameter 21 must be non-zero for the remote command mode to operate as the controller looks for an axis select code defined by this parameter. The controller must also be in RUN mode to respond to the interface. Since the controller powers-on in RUN mode, remote unattended operation is thus possible.

RS-232 Line Noise

To minimize line noise on the serial port, reroute the cables; route them straight up the left-hand side of the control to the processor stack. Do not run them above the I/O PCB or up the center wire channel to the processor.

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

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

4.5 Front Panel

Please read this section in its entirety before attempting to replace any component of the control panel.

CRT Assembly Replacement

1. Turn the power off and disconnect power to the machine.
2. Remove the screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.
3. At this time, remove the end cap on the support arm and unplug the white cable and the black cable at the connection in the control panel. It may be necessary to cut straps off the black cable's connector to unplug.
4. Unscrew the four hex nuts on the bottom row of the CRT bracket and remove, along with the washers. Set aside in a safe place.
5. While holding up the CRT assembly, remove the four hex nuts on the top row of the CRT bracket, along with the washers.

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

6. CAREFULLY pull the CRT assembly out toward the rear until it is clear of the control panel and all wiring. Set CRT assembly down in a safe place so as not to damage.
7. Replace by sliding the new assembly onto the eight bolts (four each on top and bottom). Starting with the bottom right, place the washers and hex nuts on the bolts to hold in place. Refer to Fig. 4.5-1. Once all washers have been attached and nuts have been hand-tightened, tighten down completely with the socket.

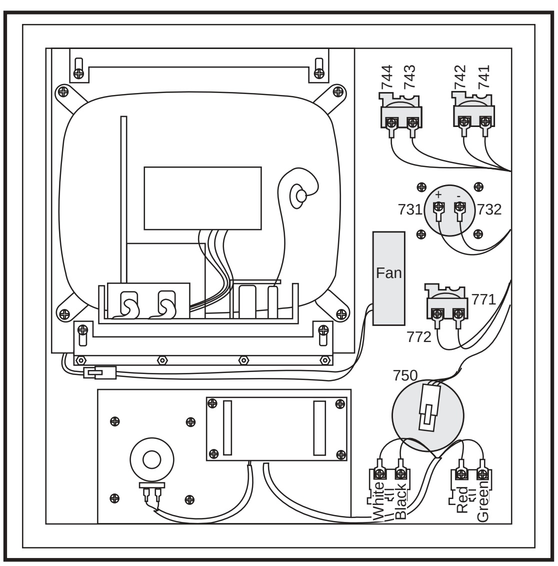


Figure 4.5-1. Interior of control panel (rear).

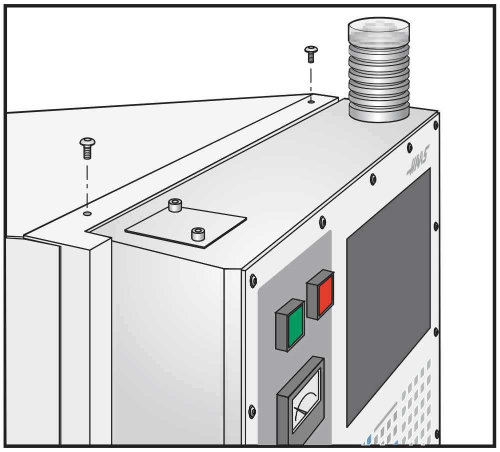
8. Plug the black cable and white cable into the matching cables. Feed the white cable through the opening in the top of the control panel.

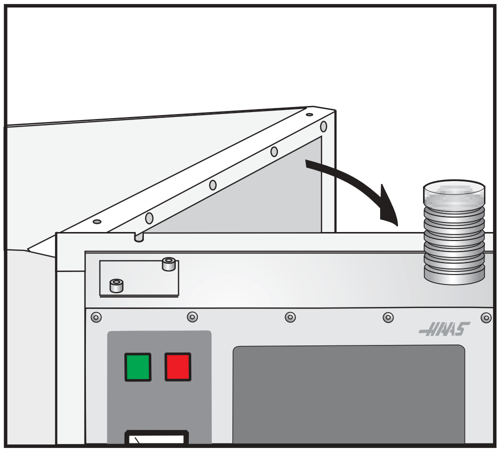
9. Replace the back cover panel and attach with the screws previously removed.

SL-10 Pendant Components Access

The SL-10 pendant door hinges on the left side. There are two (2) screws on top of the pendant that need to be removed so that the pendant door may pivot open.

Caution: when closing the door, be sure not to pinch the cable.





Jog Handle Replacement

The JOG handle is actually a 100-line-per-revolution encoder. We use 100 steps per revolution to move one of the servo axes. If no axis is selected for jogging, turning of the crank has no effect. When the axis being moved reaches its travel limits, the handle inputs will be ignored in the direction that would exceed the travel limits.

Parameter 57 can be used to reverse the direction of operation of the handle.

1. Turn the machine power off.

2. Remove the screws holding the cover panel on the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.

3. Unplug the cable leading to the jog handle encoder. **IMPORTANT!** The blank pin side of the connector must face as shown in Fig. 4.5-2 when reconnecting; otherwise, damage may occur to the machine.

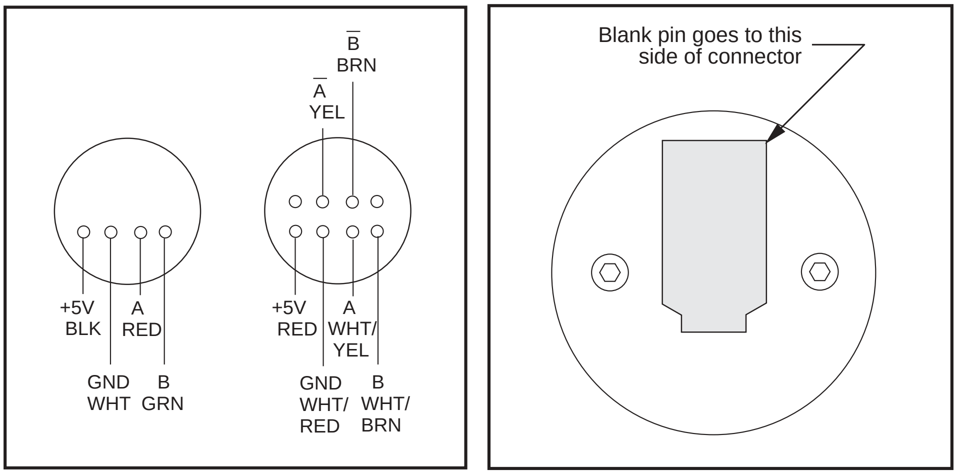


Figure 4.5-2. Jog handle encoder.

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

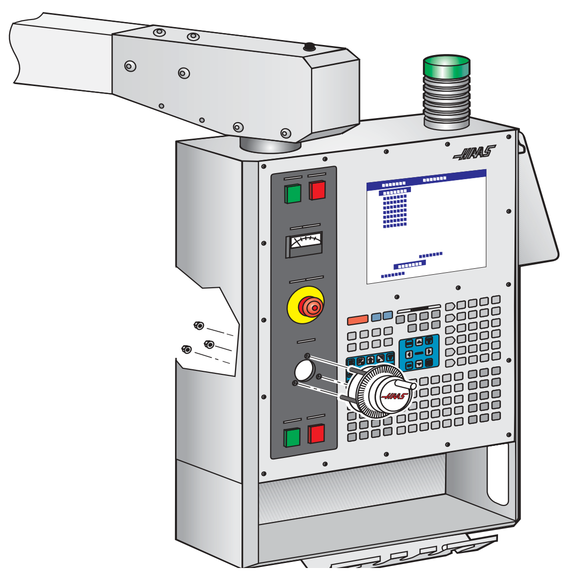


Figure 4.5-3. Jog handle removal.

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. 4.5-1 for proper locations.
4. Unscrew the two small set screws, one on top and one on the bottom, and turn the switch counterclock-wise 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 four screws holding the rear cover panel to the back of the control panel. Take care to hold the cover panel in place until all screws have been removed.
3. Unplug the keypad's 24-pin ribbon cable from the Keyboard Interface board.
4. Remove the screws from the front of the control panel. Take care to hold the front cover panel in place until all screws have been removed. Remove the pieces and set aside in a safe place.
5. Using a flat, blunt tool, such as putty knife, pry the keypad away from the control panel. Pull the ribbon cable through the opening in the control to remove.
6. To replace, first put the bezel spacer in place and fasten temporarily with screws in the top corners.

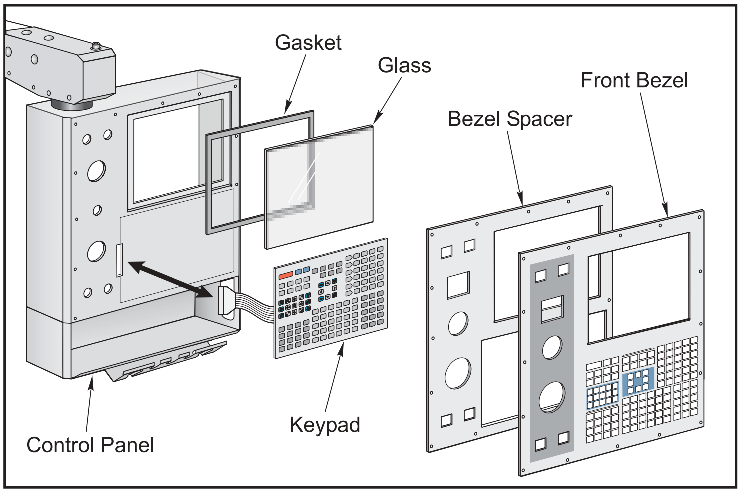


Figure 4.5-5. Keypad installation.

7. Insert the ribbon cable through the opening in the control panel. Expose the adhesive strip on the back of the keypad and press the keypad in place in the upper right corner of the keypad recess. Press to the control panel to mount. Plug the ribbon cable into the Keyboard Interface board, taking care to not bend the pins on the board.

8. Replace the front and rear cover panels and fasten with the screws that were previously removed.

Serial Keyboard Interface

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

1. Follow all precautions noted previously before working in the control cabinet (See warning at beginning of "Front Panel" section).

2. Turn the main switch (upper right of electrical cabinet) to the off position.

3. Remove the screws on the back of the control panel, 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.

8. Replace the Control Panel sheetmetal.

4.6 Spindle Encoder Replacement

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

REMOVAL -

1. Remove the left hand sheetmetal necessary to enable access to the Encoder.
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 -

1. Place the belt onto the pulley.
2. 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.

3. Replace the sheetmetal removed in **REMOVAL, Step 1.**

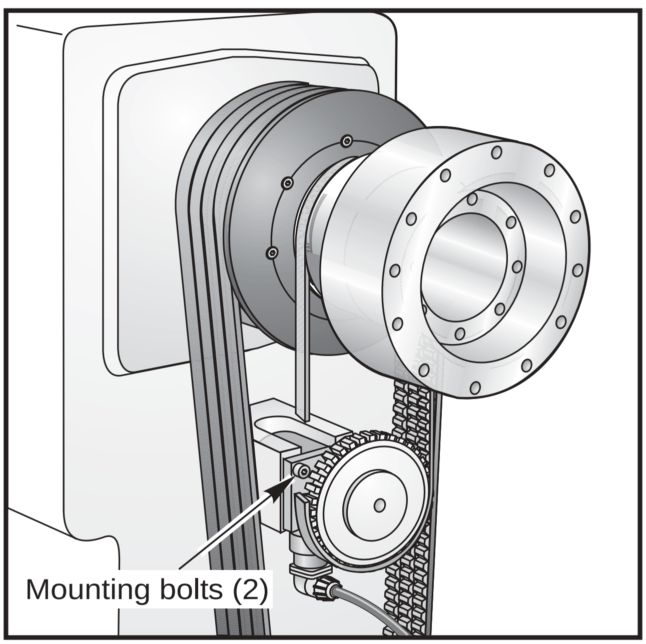


Figure 4.6-1. Encoder belt locations.

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.

Sub-Spindle Two-Speed Gear Transmission

The spindle motor is directly coupled to the transmission, which is between the motor and the spindle casting, The transmission is V belt-coupled to the spindle pulley. An electric motor drives the gearbox shifter into high or low gear.

5.2 Two-Speed Gear Transmission (SL-30 and 40)

The spindle motor is directly coupled to the transmission, which is between the motor and the spindle casting, The transmission is V 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 its 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 Tool Changer (VTC Series)

Tools are always loaded through the spindle and should never be installed directly in the carousel in order to avoid crashes. All wiring to the tool changer goes through connector P6 on the side of the control cabinet.

Low air pressure or insufficient volume will reduce the pressure applied to the tool unclamp piston and will slow down tool change time or will not release the tool. The air pressure is checked prior to moving the carousel on a mill with a side mount tool changer and alarm 120 LOW AIR PRESSURE is generated if such a problem exists.

WARNING

An inadequate air supply will cause tool changer faults

Follow these guide lines:

Minimum air supply pressure to machine is 100psi
Observe gauge during a tool change there should be no more than a 10psi drop
Using the Air gun during tool changes may cause faults if the air supply to the machine is marginal
Allow 2 HP of air compressor per machine (i.e. 5 machines require a 10HP compressor)
Use a minimum of 1/2 I.D. hose.

Avoid quick disconnects in supply lines; they are restrictive.

If the tool changer 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. Never put your hands near the tool changer when powered unless the EMERGENCY STOP button is pressed.

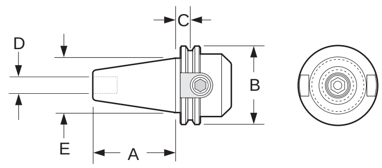
There is a fuse for the tool changer motors. It might be blown by an overload or jam of the tool changer. Operation of the tool changer can also be interrupted by problems with the tool clamp/unclamp and the spindle orientation mechanism. Problems with them can be caused by low air pressure or a blown solenoid circuit breaker CB4.

Pull Studs

The tool holders used are CT #50 taper, V flange, commonly called “CT 50”. Use A “45 Degree, P50T Type 1” pull stud built to JMTBA standard “MAS 403-1982”. This pull stud is characterized by a long shaft and a 45˚ shoulder under the head. Do not use the short shaft or pull studs with a sharp right angle (90˚) head as they will not work and will cause serious damage. If the machine is equipped with the optional BT tool changer, use BT tooling only. **Pull studs are available through HAAS.**

Tool Holders/Pull Studs

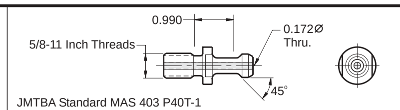
CT CAT V-Flange



	A	B	C	D	E
40T	2.69	2.50	.44	5/8"-11	1.75
45T					
50T	4.00	3.87	.44	1"-8	2.75

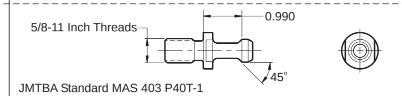
40T

20-7594 (TSC)



Kit # TPS24CT

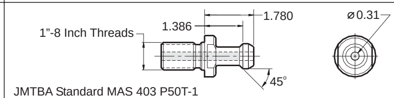
20-7164 (non-TSC)



Kit # PS24CT

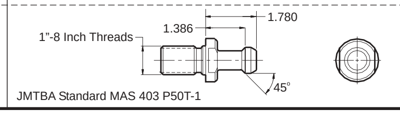
50T

22-0075 (TSC)



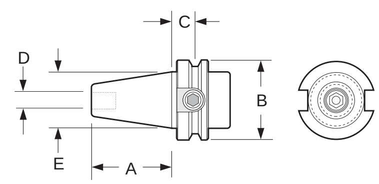
Kit # TPS24CT50

22-0039 (non-TSC)



Kit # PS24CT50

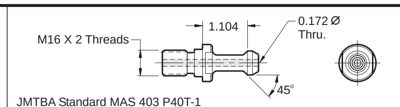
BT MAS 403



	A	B	C	D	E
40T	2.57	2.48	.65	M16X2	1.75
45T	3.26	3.35	.83	.82	2.25
50T	4.00	3.94	.91	M24X3	2.75

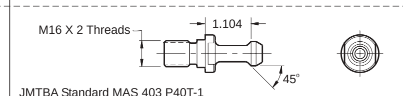
40T

20-7595 (TSC)



Kit # TPS24BT

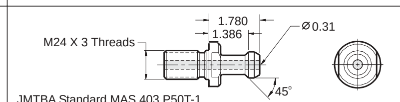
20-7165 (non-TSC)



Kit # PS24BT

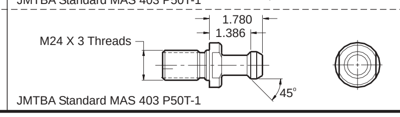
50T

22-7171 (TSC)



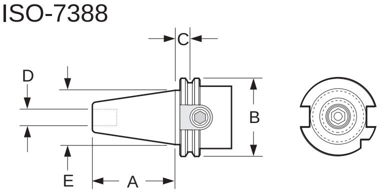
Kit # TPS24E50

22-7170 (non-TSC)



Kit # PS24E50

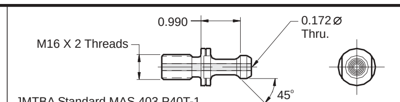
DIN-69871 (MIKRON) ISO-7388



	A	B	C	D	E
40T	2.69	2.50	.44	M16X2	1.75
45T	3.25	3.23	.44	.82	2.25
50T	4.00	3.84	.44	M24X3	2.75

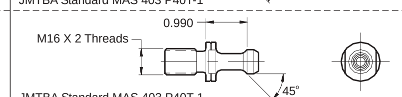
40T

20-7556 (TSC)



Kit # TPS24E

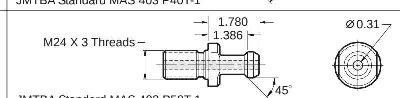
20-7164A (non-TSC)



Kit # PS24E

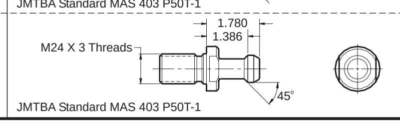
50T

22-7171 (TSC)



Kit # TPS24E50

22-7170 (non-TSC)



Kit # PS24E50

NOTE: CT 40T Pullstud = One Identification Groove
BT 40T Pullstud = Two Identification Grooves
MIKRON 40T Pullstud = Three Identification Grooves

Tool holders and pull studs must be in good condition and tightened together with wrenches or they may stick in the spindle taper. Clean the tool tapers with a lightly-oiled rag to leave a film to prevent rusting. Tools that make a loud bang when being released indicate a problem and should be checked before serious damage to the shuttle occurs. When the TOOL RELEASE button is pressed, the tool should be pushed out of the spindle by a small amount (approximately .07"). This is an indication that the pull stud is correctly touching the release mechanism.

5.4 Tool Clamp/Unclamp

The tool holder drawbar is held clamped by spring pressure. Air pressure is used to release the tool clamp. When the tool is unclamped, air is directed down the center of the spindle to clear the taper of water, oil, or chips. Tool unclamp can be commanded from a program (but this is quite dangerous), from the keyboard, and from the button on the side of the spindle head. The two manual buttons only operate in MDI or JOG modes.

Tool Clamp/Unclamp Air Solenoids

A single solenoid controls the air pressure to release the tool clamp. When the tool clamp relay is activated, 115V AC is applied to the solenoid. This applies air pressure to release the tool. The relay is on the I/O PCB. A circuit breaker will interrupt power to this solenoid.

Remote Tool Unclamp Switch

The Remote Tool Unclamp switch is mounted on the side of the cover to the spindle head. It operates the same as the button on the keyboard. It must be held for ½ second before the tool will be released and the tool will remain released for ½ second after the button is released.

While the tool is unclamped, air is forced down the spindle to clear chips, oil, or coolant away from the tool holder.

5.5 Live Tooling Operation

Live tool motor speed functions are controlled primarily by the **Q** address code. The **Q** address specifies RPM in integer values from 1 to maximum spindle speed (Parameter 131). NOT TO BE CHANGED BY USER! The maximum spindle speed is 5000 RPM.

Speeds from S1 to the value in Macro variable 730 (usually 1200) will automatically select low gear and speeds above the value in Macro variable 730 will select high gear. Two **M** codes, M41 and M42 can be used to override the gear selection. M41 for low gear and M42 for high gear. Low gear operation above S1250 is not recommended. High gear operation below S100 may lack torque or speed accuracy. Accuracy is best at the higher speeds and in low gear.

Live Tool Warm-Up Program

Live tooling motors, which have been idle for more than 4 days, must be thermally cycled prior to operation. This will prevent possible overheating of the motor due to settling of lubrication. A 20-minute warm-up program has been supplied with the machine, which will bring the motor up to speed slowly and allow the motor to thermally stabilize. This program may also be used daily for warm-up prior to high-speed use. The program number is O02020 (Live Tool Warm-Up).

```
O02020 (Live Tooling Warm–Up)
M133 Q250;
G04 P200.;
M133 Q500;
G04 P200.;
M133 Q1250;
G04 P200.;
M133 Q2500;
G04 P200.;
M133 Q3750;
G04 P200.;
M133 Q5000;
G04 P200.;
M30;
```

Live Tooling Run-In Program

Live tooling motors must go through a run-in cycle at the time of machine installation prior to operating at speeds above 1,000 RPM. A program has been supplied with the machine that will run-in the live tooling motor during machine installation and should also be used after long periods of machine down-time (two weeks or more). The program number is O02021 (Live Tool motor Run-In). Cycle Time: 2 hours. See Installation Section for copy of the program.

Live Tooling Orientation

Orientation of the spindle is automatically performed for tool changes and can be programmed with M119 commands. Orientation is performed by turning the spindle until the encoder reference is reached, the spindle motor holds the spindle locked in position. If the spindle is orientated and electronically locked, commanding spindle forward or reverse will release the lock.

5.6 Servos (brushless)

Servo Encoders (brushless)

Haas machines are equipped with brushless motors, which provide for better performance, and no maintenance. In addition to the performance differences, these machines differ from brush type machines in the following areas:

•The brushless motors have 8192 line encoders built in, which result in a resolution of 32768 parts per revolution.

•"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 user interface and motion profiling have not changed however, and the user should not see any functional differences between a brush type machine and a brushless machine.

Servo Amplifiers (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 either 12.5 KHz or 16 KHz. The amplifiers are current limited to 30 amps peak (45A peak for a medium amplifier). However there are fuse limits both in hardware and software to protect the amplifiers and motors from over current. The nominal voltage for these amplifiers is 320 volts. Therefore the peak power is about 9600 watts or 13 H.P. The amplifiers also have short circuit, over temperature and over voltage protection.

There is a 15 amp (20A for a medium amplifier) supply fuse for failure protection. This fuse is relatively slow, therefore it can handle the 30 amp peak. Continuous current limit to the motor is controlled by software.

The user should never attempt to replace these fuses.

Commands to the amplifier are +/-5 volts current in two legs of the motor and a digital enable signal. A signal from the amplifier indicates drive fault or sustained high current in a 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.

5.7 Input/Output Assembly

The IOPCB 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 and K10 are used for the Barfeeder (when equipped).

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

5.8 Control Pendant

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 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 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.

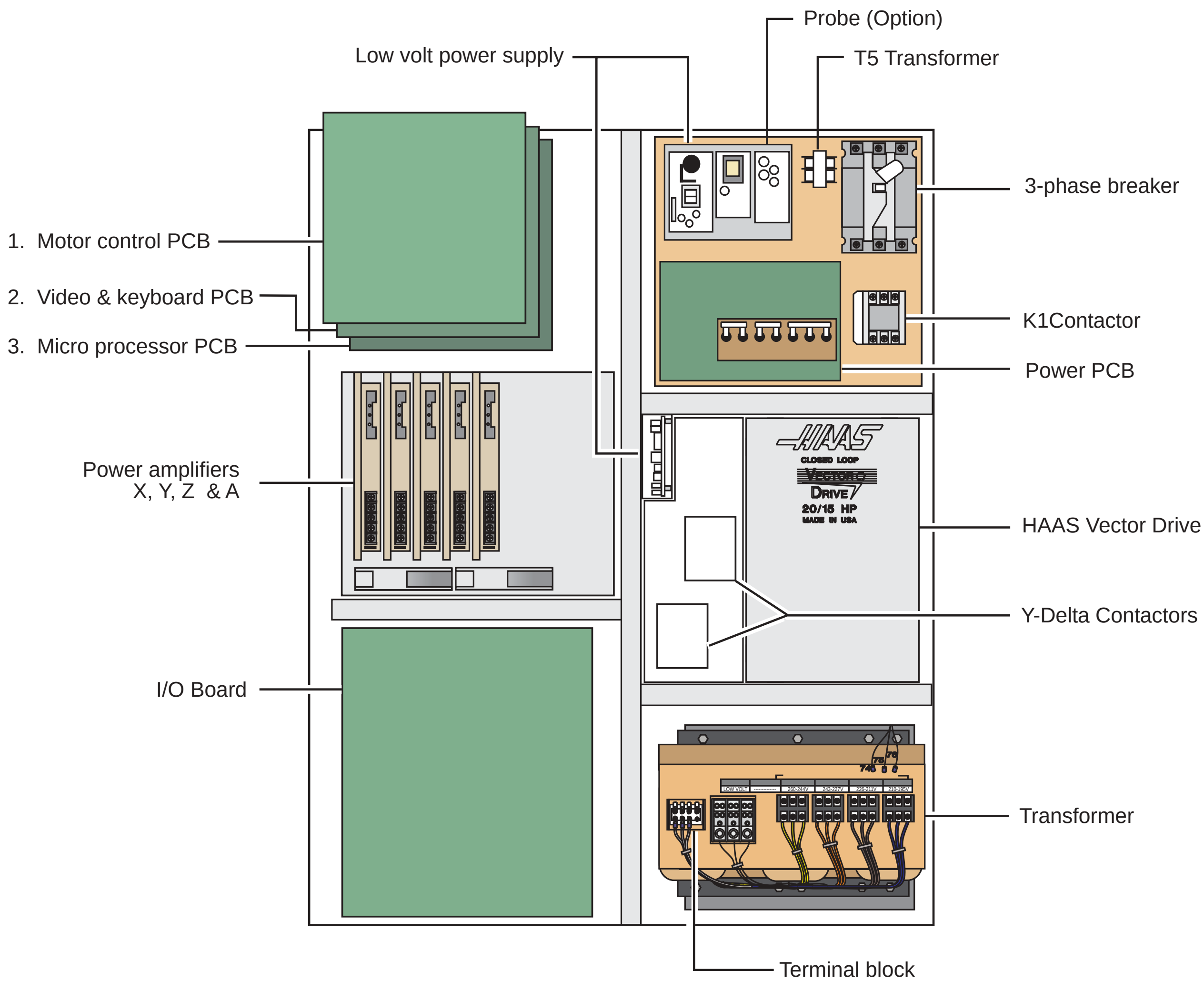
If the turret should become jammed, the control will automatically come to an alarm state. To correct this, push the EMERGENCY STOP button and remove the cause of the jam. Push the RESET key to clear any alarms. Push the ZERO RETURN and the AUTO ALL AXES keys to reset the Z-axis and turret. Never put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

Keyboard Beeper

There is a beeper under 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.

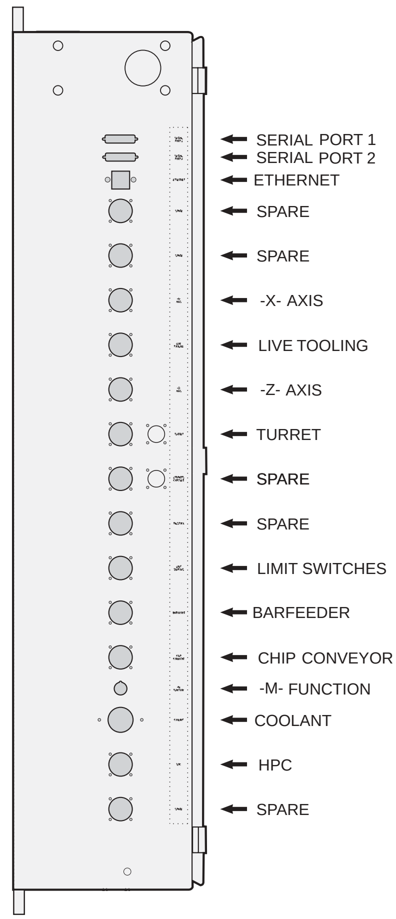
If the beeper is not audible when buttons are pressed, the problem could be in the keypad, keyboard interface PCB or in the speaker. Check that the problem occurs with more than one button and check that the beeper volume is not turned down.

SL-Series Control Cabinet



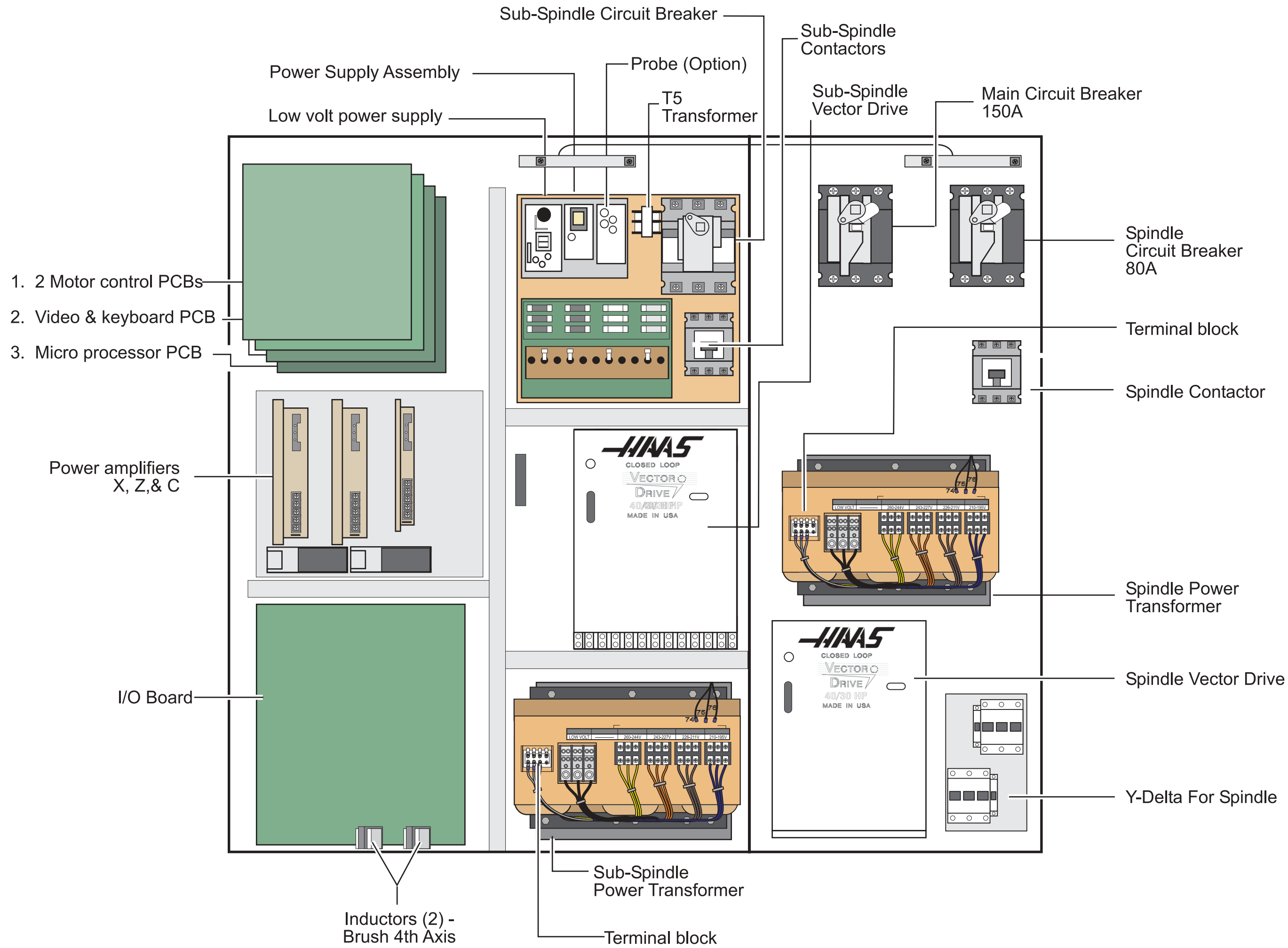
Control cabinet general overview.

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

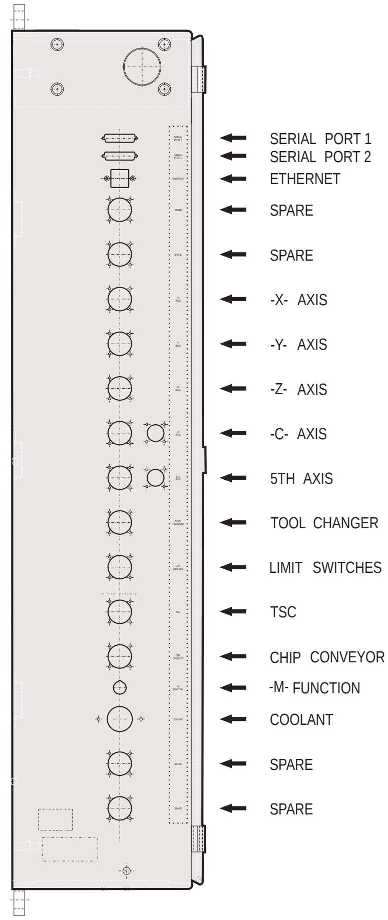


Side of SL-Series control cabinet.

VTC-Series Control Cabinet



Control cabinet general overview.



Connectors on side of VTC-Series control cabinet.

5.9 Microprocessor Assembly

The microprocessor assembly is in the rear cabinet at the top left position. It contains three large boards. They are: microprocessor, the video and the MOCON. All three boards of the processor assembly receive power from the low voltage power supply. The three PCB's are interconnected by a local buss on dual 50-pin connectors. At power-on of the control, some diagnostic tests are performed on the processor assembly and any problems found will generate alarms 157 or 158. In addition, while the control is operating, it continually tests itself and a self test failure will generate Alarm 152.

Microprocessor PCB (68ECO30)

The Microprocessor PCB contains the 68ECO30 processor running at 40 MHz, one 128K EPROM; between 1MB and 16MB of CMOS RAM and between 512K and 1.5MB of FAST STATIC RAM. It also contains a dual serial port, a five year battery to backup RAM, buffering to the system buss, and eight system status LED's.

Two ports on this board are used to set the point at which an NMI* is generated during power down and the point at which RESET* is generated during power down.

The eight LED's are used to diagnose internal processor problems. As the system completes power up testing, the lights are turned on sequentially to indicate the completion of a step. The lights and meanings are:

RUN **Program Running Without Fault Exception. (Normally On)**
If this light does not come on or goes out after coming on, there is a problem with the microprocessor or the software running in it. Check all of the buss connectors to the other two PCB's and ensure all three cards are getting power.

PGM **Program signature found in memory.(Normally On)**
If this light does not come on, it means that the main CNC program package was not found in memory or that the auto-start switch was not set. Check that switch S1-1 is on and the EPROM is plugged in.

CRT **CRT/VIDEO initialization complete. (Normally On)**
If this light does not come on, there is a problem communicating with the VIDEO PCB. Check the buss connectors and ensure the VIDEO PCB is getting power.

MSG **Power-on serial I/O message output complete. (Normally On)**
If this light does not come on, there is a problem with serial I/O or interrupts. Disconnect anything on the external RS-232 and test again.

SIO **Serial I/O initialization complete. (Normally On)**
If this light does not come on, there is a problem with the serial ports. Disconnect anything on the external RS-232 and test again.

POR **Power-on-reset complete. (Normally On)**
If this light does not come on, there is a serious problem with the processor PCB. Check that the EPROM is plugged in. Test the card with the buss connectors off.

HALT **Processor halted in catastrophic fault. (Normally Off)**
If this light comes on, there is a serious problem with the processor PCB. Check that the EPROM is plugged in. Test the card with the buss connectors off.

+5V **+5V logic power supply is present. (Normally On)**
If this light does not come on, check the low voltage power supply and check that all three phases of 230V input power are present.

There is a two-position DIP switch on the processor PCB labeled S1. Switch S1-1 must be ON to auto-start the CNC operational program. If S1-1 is OFF, the PGM light will remain off.

Switch S2-1 is used to enable FLASH. If it is disabled it will not be possible to write to FLASH.

The processor connectors are:

J1	Address buss
J2	Data buss
J4	Serial port #1 (for upload/download/DNC) (850)
J5	Serial port #2 (for auxiliary 5th axis) (850A)
J3	Power connector
J6	Battery

Memory Retention Battery

The memory retention battery is 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 Disk PCB

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	Low Voltage Power Supply PCB (860)
P3*	Keyboard info. (700)
P4	Address Buss
P5	Data Buss
P10	Disk Dr. Power
P11	Spare
P12	Disk Dr. Signal
P13	Video Signal (760)
J9	RS422 B
J13	Serial Data (850)

Motor Controller (MOCON) Brushless

The brushless machining centers are equipped with a microprocessor based brushless motor controller board (MOCON) that replaces the motor interface in the brush type controls. It runs in parallel with the main processor, receiving servo commands and closing the servo loop around the servo motors.

In addition to controlling the servos and detecting servo faults, the motor controller board, (MOCON), is also in charge of processing discrete inputs, driving the I/O board relays, commanding the spindle and processing the jog handle input. Another significant feature is that it controls 6 axes, so there is no need for an additional board for a 5 axis machine.

5.10 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.

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.

5.11 Resistor Assembly

The Resistor Assembly is located on top of the control cabinet. It contains the servo and spindle drive regen load resistors.

Spindle Drive Regen Resistor

A 5.6-ohm (8.6-ohm (6-ohm for SL-30 and 40) for older machines), 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. 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 (older machines)

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 the time period, specified by parameter 297, of an overheat condition, an automatic shutdown will occur in the control.

5.12 Power Supply Assembly

All power to the control passes through the power supply assembly. It is located on the upper right corner of the control cabinet.

Main Circuit Breaker CB1

Circuit breaker CB1 is rated at 40 amps (20 amps for High Voltage option, 80 amps for SL-30 and 40) 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.

Circuit Breakers

The main circuit breaker is used to protect the wiring in the machine 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. The main circuit breaker furnishes power to the spindle and sub-spindle circuit breakers. These breakers do not have extended handles and can be set/reset only with the cabinet door open. Normally, the spindle and Subspindle circuit breakers would be left ON at all times. Since power is removed from the control by turning the main circuit breaker OFF (turn the handle counterclockwise), there is no danger in leaving the other two breakers ON at all times. However, when troubleshooting a power fault, it may be necessary to have the main breaker ON after the door is opened, in which case the operator may decide to turn either the spindle or sub-spindle breaker to the OFF position. It should be remembered that turning the sub-spindle breaker OFF will removes power to the spindle contactor as well as the sub-spindle contactor, but the reverse is not true. Turning the spindle breaker OFF will not remove power from any control electronics except for the spindle transformer and spindle vector drive.

A trip of any of these three breakers indicates a serious overload problem and this should not be reset without investigating the cause of the trip. The breaker ratings are as follows:

VTC- Series Main Circuit Breaker	150A
VTC-Series Spindle Circuit Beaker	80A
VTC-Series Sub-Spindle Circuit Breaker	80A

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.

VTC-Series Sub-Spindle Contactor

The sub-spindle contactor K1 is used to turn the control on and off. This contactor is located on the power supply assembly in the top middle section of the control cabinet. The Power On switch on the front panel applies power to the coil of K1 through the 24VAC control transformer T5. The power OFF switch on the front panel will always remove power from this contactor.

This contactor is used to provide AC power to the sub-spindle transformer and vector drive. The sub-spindle transformer provides 118V and 235V to the power supply assembly, which supplies power to all of the non-spindle related machine functions. The 118V is used as a control signal to enable the spindle contactor, which in turn provides power to the spindle power transformer and vector drive.

When the sub-spindle contactor is OFF, the only power used by the control is supplied through two 1/2 amp fuses to the circuit that activates the contactor. An overvoltage or lightning strike will blow these fuses and shut off the sub-spindle contactor, which, in turn will remove power from the spindle contactor.

The power to operate the sub-spindle contactor is supplied from the 24VAC control transformer T5 also located on the power supply assembly. This transformer has two input connectors that allows its use over two input voltage ranges 195-220V and 220-260V. The low voltage output ensures that the only voltage available in the control or at the front panel when the machine is turned off is non-lethal.

VTC-Series Spindle Contactor

This contactor furnishes 230V power to the spindle transformer, which power the spindle vector drive, which in turn drives the main spindle (platter). This contactor is enabled by the 118V on the power supply assembly. As a result, this contactor will not be energized unless both the sub-spindle and spindle circuit breakers are in the ON position and the sub-spindle contactor has been energized. This contactor has no effect on the reset of the power control circuits.

Low Voltage Power Supply

There are two low voltage power supplies. One, the stack supply, operates from 118VAC and provides +5V, +12V and -12V power to all of the logic sections of the control. Mouned on top of this supply is the servo power supply, which furnishes +12V and -12V power to the servo amplifiers. This supply is powered from the 335VDC bus from the sub-spindle vector drive.

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.

Power-Up Low Voltage Control Transformer (T5)

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

Secondary Circuit Breakers

The following circuit breakers are located on the Power supply assembly.

CB2 controls the 115 volt 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 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

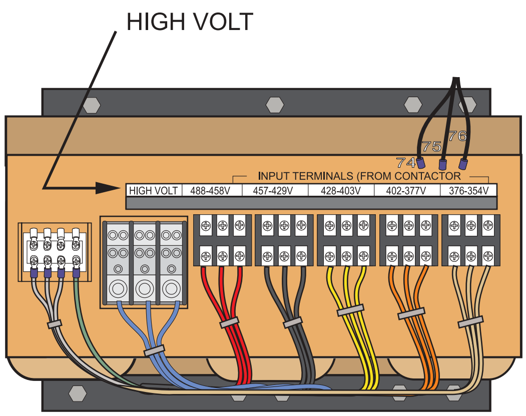
The operator's lamp is using 115 VAC taken from P19 on the main power distribution.

5.13 Power Transformer Assembly (T1)

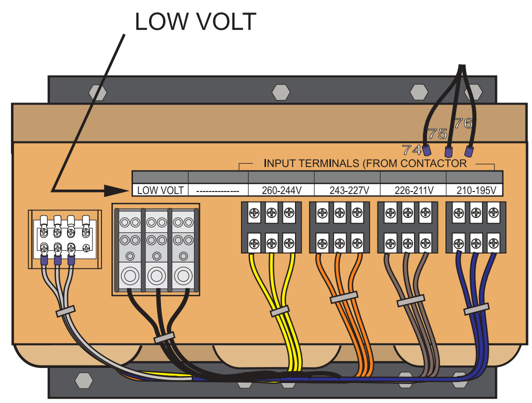
The power transformer assembly is used to convert three-phase input power (50/60Hz) to three phase 230V and 115V power. Two different transformers are used depending on the input voltage range. The low voltage transformer has four different input connections to allow for a range of voltages from 195 V RMS to 260 V RMS. The high voltage transformer has five different input connections and will accept a range of voltages from 354V RMS to 488 V RMS.

The 230 V is used to power the spindle drive, which also develops the 325 VDC power for the axis servo amplifiers. The 115 V is used by the video monitor, solenoids, fans and pumps, in addition to supplying power to the main LVPS used by the control electronics.

The transformer assembly is located in the lower right hand corner of the main cabinet. Besides the high/low voltage variations, two different power levels are available depending on the spindle motor used. The small and large transformers have power ratings of 14 KVA and 28 KVA, respectively. They are protected by the main circuit breaker to the levels shown in the preceding table.



Transformer with 354-488V range



Transformer with 195-260V range

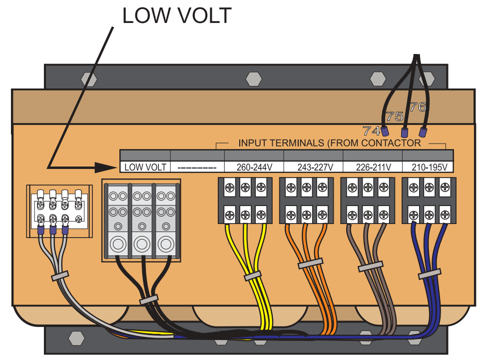
VTC-Series Power Transformer Assembly (T1)

There are two power transformer assemblies used to convert three phase input power (50/60Hz) to the voltage levels required to run the motors and other circuits effectively. Both have four different input connections that allow for a range of input voltages from 195VRMS to 260VRMS.\The sub-spindle power transformer produces a non-isolated 235VRMS and an isolated 118VRMS. The 235 VRMS is used to power the sub-spindle vector drive, which also develops the 335VDC power for the axis servo amplifiers. The 118V is routed to CB2 on the power card, a 10A breaker used to protect the low current windings of the transformer. The 118V is used by the video monitor, solenoids, fans and pumps, in addition to supplying power to the LVPS used by the control elctronics. This transformer is located at the bottom of the center section of the cabinet below the sub-spindle Vector Drive.

The Spindle Power Transformer also produces a non-isolated 235VRMS for use by the Spindle Vector Drive, which drives the main spindle (platter). This transformer is located in the middle of the right section of the cabinet above the Spindle Vector Drive.

Both transformers are rated for 30KVA. their respective 80A breakers protect them, and their associated loads.

Both transformers have four labeled input power terminal blocks of three terminals each for connecting the input power from theior respective contactors. Follow the instructions on the transformer and in the Installation section of the manual.



Optional 480V 60Hz Transformer

The VTC high voltage option uses a 75KVA external 480-240V isolation transformer.

For domestic installations and all others using 60Hz power, the primary side should be wired as follows:

Input Voltage Range	Tap
493-510	1 (504)
481-492	2 (492)
469-480	3 (480)
457-468	4 (468)
445-456	5 (456)
433-444	6 (444)
420-432	7 (432)

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 for . Each block has three connections for wires labeled 74, 75, and 76. Follow the instructions printed on the transformer.

Secondary Connection To T1

The secondary output from T1 is 115V AC three-phase CB2 protects the secondary of transformer T1 and is rated at 25 amps.

Optional 480V 60Hz Transformer

The external transformers have either 30 or 45 KVA ratings depending on the size of the machine to which they will be attached. SL-20 5K, SL-20 BB, SL-30 and SL-40 machines will get the 45KVA transformer while the smaller machines will get the 30KVA transformers.

For domestic installations and all others using 60Hz power, the primary side should be wired as follows:

Input Voltage Range	Tap
493-510	1 (504)
481-492	2 (492)
469-480	3 (480)
457-468	4 (468)
445-456	5 (456)
433-444	6 (444)
420-432	7 (432)

Optional 480V 50Hz Transformer

Input Voltage Range	Tap
423-440	1 (504)
412-422	2 (492)
401-411	3 (480)
391-400	4 (468)
381-390	5 (456)
371-380	6 (444)
355-370	7 (432)

5.14 Fuses

The brushless amplifier has one fuse, F1 15 amps. This fuse protects the amplifier itself from drastic damage. If this fuse is ever blown, the associated motor will stop. This will only happen if there is a failure of the amplifier card. **The user should never attempt to replace these fuses.**

The POWER PCB contains three ½-amp fuses located at the top right (FU1, FU2, FU3). If the machine is subject to a severe overvoltage or a lightning strike, these fuses will blow and turn off all of the power. Replace these fuses only with the same type and ratings. FU 4,5 and 5A protect the chip conveyor (FU6 is only used with 3 phase motors). FU7-12 are ultra fast 20A fuses. They will only blow in the case of a cable short for either the TSC or coolant pump. Spare fuses for the power card are located above the breakers on the spare fuse PCB.

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

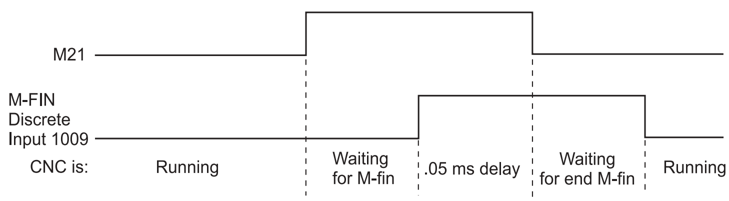
FU2 on the IOPCB is a spare.

5.15 Spare User M code Interface

The M code interface uses outputs M21-25 and one discrete input circuit. M codes M21 through M25 will activate relays labeled M21-25. These relay contacts are isolated from all other circuits and may switch up to 120V AC at three amps. The relays are SPDT. **WARNING!** Power circuits and inductive loads must have snubber protection.

The M-FIN circuit is a normally open circuit that is made active by bringing it to ground. The one M-FIN applies to all of the user M codes.

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



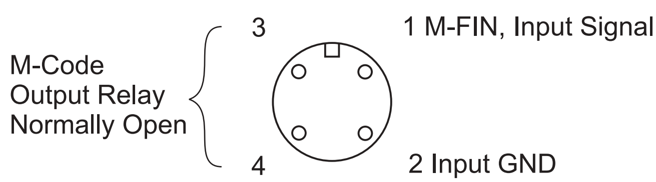
The Diagnostic Data display page may be used to observe the state of these signals.

NOTE: See the 8M option section for more details.

M Function Relays

The M code relay board has five relays (M21-25) that may be available to the user. M21 is already wired out to P12 at the side of the control cabinet. This is a four-pin DIN connector and includes the M-FIN signal.

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



NOTE: Some or all of the M21-25 on the I/O PCB may be used for factory installed options. Inspect the relays for existing wires to determine which have been used. Contact the Haas factory for more details.

M-FIN Discrete Input

The M-FIN discrete input is a low voltage circuit. When the circuit is open, there is +12V DC at this signal. When this line is brought to ground, there will be about 10 milliamps of current. M-FIN is discrete input #10 and is wired from input #10 on the I/O PCB. The return line for grounding the circuit should also be picked up from that PCB. For reliability, these two wires should be routed in a shielded cable where the shield is grounded at one end only. The diagnostic display will show this signal a “1” when the circuit is open and a “0” when this circuit is grounded.

Turning M Functions On And Off

The M code relays can also be separately turned on and off using M codes M51-M55 and M61-M65. M51 to M55 will turn on one of the eight relays and M61 to M65 will turn the relays off. M51 and M61 correspond to M21, etc.

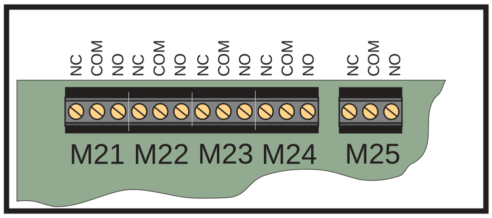
NOTE: Refer to the Diagnostic section in the manual for specific machine Inputs and Outputs.

Wiring the Relays

The relays are marked on the IOPCB, with their respective terminals forward of them. If the optional 8M relay board is installed then the connections on the IOPCB are to be left unused as they are replaced by the relays on the optional board. Refer to the figure, and the Probe Option figure in the Electrical Diagrams section for the terminal labeling.

WARNING!

Power circuits and inductive loads must have snubber protection.



IOPCB Relays

CAUTION! If a screw terminal is already in use **DO NOT** connect anything else to it. Call your dealer.

5.16 Lubrication Pump

The lubrication system is a resistance type system which forces oil through metering units at each of the 16 lubricating points within the machine. The system uses one metering unit at each of the lubricating points: one for each linear guide pad, one for each lead screw and one for spindle lubrication. A single oil pump is used to lubricate the system. The pump is powered only when the spindle and/or an axis moves. Once powered the pump squirts approximately 3 cc of oil every 30 minutes with 60 Hz power (36 minutes with 50 Hz power) throughout the oil lines to the lube points. Each lube point receives approximately 1/16 of oil.

The lube pump and spindle fan are on the same circuit. This circuit is turned on whenever a program is running, and it remains on after a program is stopped for the time specified by SPIN. FAN OFF DELAY(Parameter 208).

There is an internal level switch in the reservoir and external pressure switch on the lube panel. These are wired in series and provide a signal to the control system. An input value of 0 means that oil level and pressure are high. A value of 1 means low pressure or low oil level. Under normal conditions the pressure will remain high for a period of several minutes after each pump cycle.

The control system monitors both the amount of time the input is 0 and the amount of time its 1. If the input value is 0, meaning acceptable, for at least two minutes, the low-time counter is restarted. If the input value is 1, meaning unacceptable, even for an instant, the high-time counter is restarted. If the low-time counter exceeds the LUBE CYCLE TIME, (Parameter 117), nominally 36 minutes, and the control is not running a program or in jog lock, Alarm 121 shall be generated. Lube pressure is checked only when the pump is activated.

VTC-48

The VTC has 3 lubrication pumps. One pump is dedicated to the sub-spindle. A similar pump lubricates

the remaining 13 lube points. The third is a continuously running pump that lubricates the platter gears, which turn the main spindle, through a closed-loop system.

Parameter 616, SS LUBE CYCLE TIME, controls the lube pressure check. If Parameter 616 is not zero, the lube pressure is checked for cycling high within that period. Parameter 616 has units of, 1/50 seconds.

5.17 Switches

Lamp On/Off Switch

An on/off switch is supplied for the operator's lamp. It is located on the front panel.

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

Door Open Sense Switch

The DOOR OPEN switch is in the open position when the door is open and closed when the door is fully closed.

When the doors open, 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 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 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.

5.18 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:

Discrete Inputs / Outputs

DISCRETE INPUTS

#	Name	#	Name
1000	Tool Turret Unlock	1016	Spare
1001	Tool Turret Lock	1017	Spare
1002	Spare	1018	Spare
1003	Low Coolant	1019	Spare
1004	Automatic Door	1020	Low hyd pressure
1005	Spindle In Hi Gear	1021	T.S. Foot Switch
1006	Spindle In Low Gear	1022	Probe Not Home
1007	Emergency Stop	1023	Spare 2b
1008	Door Switch	1024	Tool Unclamp Rmt*
1009	M Code Finish	1025	Low Phasing 115V
1010	Over Voltage	1026	B F End of Bar
1011	Low Air Pressure	1027	Bar Feeder Fault
1012	Low Lube Press.	1028	Ground Fault
1013	Regen Overheat	1029	G31 Block Skip
1014	Spare	1030	B F Spindle Intlk
1015	Spare	1031	Conveyr Overcrnts

DISCRETE OUTPUTS

#	Name	#	Name
1100	Hyd Pump Enable	1116	Move Spigot CW
1101	Spare	1117	Move Spigot CCW
1102	Spare	1118	Pal Ready Light
1103	Spare	1119	T.S. High Pressure
1104	Spindle Brake	1120	Tool Turret Out
1105	Coolant Pump on	1121	T.S. Reverse
1106	Power Off	1122	T.S. Forward
1107	Way Lube Pump	1123	(CE) Door Locked
1108	SB Motor Load PR	1124	M21 (Auto Door Clutch)
1109	SB Motor Load Bar	1125	M22 (Parts Catcher)
1110	Auto Door Open	1126	M23 (C Axis Engage)
1111	Auto Door Close	1127	HPC Coolant
1112	Spindle Hi Gear	1128	Green Beacon On
1113	Spindle Low Gear	1129	Red Beacon On
1114	Unclamp Chuck	1130	Enable Conveyor
1115	Lock Spindle	1131	Reverse Conveyor

The names of discrete outputs **1124, 1125** and **1126** will change if options are installed. The options and associated Discrete Outputs are:

1124 Auto Door Clutch
1125 Parts Catcher
1126 C axis Engage

If the machine does not have these options the discrete outputs will remain M21, M22 and M23.

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	Name
X-axis Z Channel	X Motor Over Heat
Y-Axis Z Channel	Y Motor Over Heat
Z-axis Z Channel	Z Motor Over Heat
A-axis Z Channel	A Motor Over Heat
B-axis Z Channel	B Motor Over Heat
C-axis Z Channel	C Motor Over Heat
X Home Switch	X drive fault
Y Home Switch	Y drive fault
Z Home Switch	Z drive fault
A Home Switch	A drive fault
B Home Switch	B drive fault
C Home Switch	C drive fault
X Cable Input	S Z CH Spindle Z Channel
Y Cable Input	
Z Cable Input	
A Cable Input	
B Cable Input	
C Cable Input	

When equipped with the Temp-Track option, the X and Z ball screw temperatures are now displayed on the INPUTS2 diagnostics screen just above SP LOAD when parameter 266 or 268 (respectively) bit 9 TEMP SENSOR is set to 1.

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	Name
Spindle Forward	Spindle Fault
Spindle Reverse	Spindle Locked
Spindle Lock	Spindle Cable Fault
Spindle At Speed	Spindle Overheat
Spindle Stopped	

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 SL-__	Model number
DC BUSS	Mocon II

VTC-Series Discrete Inputs / Outputs

The inputs/outputs that are followed by an asterisk (*) are active when equal to zero (0).

DISCRETE INPUT

#	Name	#	Name
1000	TC Changer In	1025	Spare
1001	TC Changer Out	1026	Spare 3A
1002	C axis Disengage	1027	Spare 3B
1003	Spare	1028	Ground Fault
1004	C axis Engage	1029	G31 Block Skip
1005	High Gear	1030	Spigot Position
1006	Low Gear	1031	Chip Conveyor
1007	Emergency Stop	1032	Pocket Down
1008	Door Open	1033	Pocket Up
1009	M Code Finish*	1034	Tool One
1010	Over Voltage	1035	TC Mark
1011	Low Air Pressure	1036	Spare 6A
1012	Low SP Lube Press.	1037	Spare 6B
1013	Regen Over Heat	1038	Spare 7A
1014	Spare	1039	Spare 7B
1015	Spare	1040	Low Way Lube
1016	Spare	1041	Low SS Lube
1017	Spare	1042	Motor stop
1018	Spare	1043	Origin
1019	Spare	1044	Clamp / Unclamp
1020	Low Hydraulic	1045	Spare 9D
1021	Spare 1	1046	Spare 10A
1022	Probe Home	1047	Spare 10B
1023	Spare	1048	SS DB Open
1024	Rem Uncl	1049	SS DB Closed

The inputs are numbered the same as the connections on the inputs printed circuit board.

DISCRETE OUTPUTS

#	Name	#	Name
1100	Hydraulic Pump EN	1120	TT Out
1101	Pocket Up / Down	1121	HTC Shuttle Out
1102	SS Low Gear	1122	5TH Axis Brake
1103	SS Hi Gear	1123	CE Door Lock
1104	Spindle Brake	1124	SS Tool Unclamp
1105	Coolant	1125	SS Lube
1106	Auto Power Off	1126	C-axis Engage
1107	Spindle Fan / Luber	1127	TSC Coolant
1108	ATC Forward	1128	Green Beacon On
1109	ATC Reverse	1129	Red Beacon On
1110	Car CW	1130	Enable Conveyor
1111	Car CCW	1131	Reverse Conveyor
1112	Spindle Hi Gear	1132	M-fin
1113	Spindle Low Gear	1133	Probe
1114	Chuck Unclamp	1134	spare
1115	Δ-Y Switch	1135	spare
1116	Spigot CW	1136	spare
1117	Spigot CCW	1137	spare
1118	Spare (12V Output)	1138	spare
1119	TSC Purge	1139	spare

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

INPUTS 2

Name	Name	Name
X Axis Z Channel	X Overheat	X Cable Input
Y Axis Z Channel	Y Overheat	Y Cable Input
Z Axis Z Channel	Z Overheat	Z Cable Input
A Axis Z Channel	A Overheat	A Cable Input
B Axis Z Channel	B Overheat	B Cable Input
X Home Switch	X Drive Fault	Spindle Z Channel
Y Home Switch	Y Drive Fault	
Z Home Switch	Z Drive Fault	
A Home Switch	A Drive Fault	
B Home Switch	B Drive Fault	

The following inputs and outputs pertain to the Haas Vector Drive. If it is not enabled, these will display a value of *. Otherwise, it will display a 1 or 0.

Spindle Forward
Spindle Reverse
Spindle Lock
Spindle at Speed*
Spindle Stopped
Spindle Fault
Spindle is Locked
Spindle Over heat
Spindle Cable Fault

The following Discrete Inputs / Outputs 2 are available when parameter 278 SMNT BIT 1,2 or 3 (Side Mount Tool Changer) is set and parameter 209 MCD RLY BRD (M-Code relay board) is ON.

DISCRETE INPUTS 2

Name	Name
Spare Input 4A	Spare Input 8A
Spare Input 4B	Serp. Shot Pin*
Spare Input 5A	Motor Stop
Spare Input 5B	Origin
Spare Input 6A	Clamp / Unclamp
Spare Input 6B	Serp. Cam Count
Spare Input 7A	Spare Input 11A
Spare Input 7B	Spare Input 11 B

DISCRETE OUTPUTS 2

Name	Name
Spare Output 40	Spare Output 48
Spare Output 41	Spare Output 49
Spare Output 42	Spare Output 50
Spare Output 43	Spare Output 51
Spare Output 44	Spare Output 52
Spare Output 45	Spare Output 53
Spare Output 46	Spare Output 54
Spare Output 47	Spare Output 55

.ANALOG DATA

Name	Description
DC BUSS	Voltage from Haas Vector Drive
uP TEMP	Microprocessor enclosure temperature (displayed only when Parameter 278 bit "uP ENCL TEMP" is set to 1)
SP LOAD	Spindle load in %
SP SPEED	Spindle RPM CW or CCW
RUN TIME	Machine total run time
TOOL CHANGES	Number of tool changes
VER X.XXX	Software version number
MOCON	MOCON software version
YY/MM/DD	Today's date
MDL HS__	Machine model

5.19 Live Tooling

Live Tooling provides the ability to utilize standard 40mm VDI-driven tools, operated by a 5-HP motor. This auxiliary motor is capable of 0-3,000 RPM, controllable in 1 RPM increments.

Brake

13.25" (348mm) diameter disc, 500 psi (34 bar), with 1,000 lbs. (4450 N) clamp force.

A solenoid actuates a hydraulically operated brake. The brake is located on the main spindle and can be CLAMPED with an M14 command and UNCLAMPED with an M15 command.

A clamped brake will unclamp at any spindle speed command or while the spindle is at rest.

5.20 Hydraulic Counterbalance

The spindle head weight is balanced by the upward pull of a hydraulic cylinder. The hydraulic oil forces the piston to retract into the cylinder body. The oil is then pressurized by a nitrogen reservoir. The system is self contained and passive (no pump is required to maintain the lift). Normal Z-Axis of the gas/oil counter balance has the initial pressure to balance the weight at full system volume, plus an additional 50-75 psi overcharge for longevity.

5.21 The Equations of Motion

An analysis of the physics of motion of a machine tool can give some important insights into the famous “blocks per second” issue. The following mathematics calculates the block per second requirement in order to achieve a worst case chordal deviation error while moving around a curve made up of a series of points:

Let:

a = acceleration,
v=speed (or feed rate),
r = radius of curvature,
e = error from chordal deviation
l = block length (or travel length from point to point)
b = blocks per second

The following are known:
For a circular motion:

a = v*v/r (1)

and in motion:

v = b * l (2)

which gives:

b = v / l (3)

and

e = r – sqrt(r*r-l*l/4) (4)

which gives:

r*r – 2*r*e + e*e = r*r – l*l/4 (5)

and:

l= sqrt(8*r*e – 4*e*e) (6)

Since r>>e, e*e is small compare to r*e and we can assume:

l = sqrt(8*r*e) (7)

And combining we get:

b = sqrt(a*r) / sqrt (8*r*e) (8)

Or

b = sqrt(a / (8*e)) (9)

Thus, block per second is dependent only on the machine acceleration and the maximum chordal error allowed. For a Haas VTC-1, acceleration is about 60 inches per second per second. This means that if the maximum error is 0.00005 (one half of one ten-thousandth), the block per second required is 380 blocks per second. For a VTC-9, an acceleration of 30 inches/sec/sec, it would be 269 blocks per second.

Note also that an important equation (7) above is the relationship between radius of curvature (r), chordal error (e) and block length (l). If you have a radius or curvature close to 1/4 inch and your maximum chordal error is 0.00005 inch, the recommended block length is 0.01 inch. This shows that it is not always required to use very short blocks.

5.22 Formulas

TO FIND:

S.F.M

TO FIND THE SFM OF A CUTTER OR WORKPIECE

EXAMPLE: To find the SFM of a cutter rotating at 600 RPM with a diameter of 10 inches.

$$SFM = \frac{3.1416 \times d \times RPM}{12} = .262 \times d \times RPM$$

R.P.M.

TO FIND THE RPM OF A CUTTER OR WORKPIECE

EXAMPLE: To find the RPM of a cutter rotating at 150 SFM with a diameter of 8 inches.

$$SFM = \frac{12 \times SFM}{3.1416 \times d} = \frac{3.82 \times SFM}{d}$$

I.P.M.

TO FIND THE FEED (table travel in inches per minute)

EXAMPLE: To find the feed of a 10 tooth cutter rotating at 200 RPM with a feed per tooth of 0.012".

IPM = F.P.T. x T x RPM

TO FIND:

F.P.R.

TO FIND THE FEED PER REVOLUTION (in inches) OF A CUTTER.

EXAMPLE: To find the feed per revolution of a cutter rotating at 200 RPM with a table travel of 22 inches per minute.

$$F.P.R. = \frac{I.P.M.}{R.P.M.}$$

F.P.T.

TO FIND THE FEED PER TOOTH OF A CUTTER.

EXAMPLE: To find the feed per tooth of a cutter rotating at 200 RPM with a table travel of 22 inches per minute.

$$F.P.T. = \frac{I.P.M.}{T \times R.P.M.}$$

D = Depth of cut
d = diameter of cutter
I.P.M. = Feed (table travel in inches per minute)
K = Constant (cubic inches per minute per HPc). Power required to remove 1 cubic inch per minute.
HPc = Horsepower at the cutter
F.P.R. = Feed per revolution
R.P.M. = Revolutions per minute
T = Number of teeth in cutter
W = Width of cut (in inches)

6. PARAMETERS

Parameters are seldom-modified values that change the operation of the machine. These include servo motor types, gear ratios, speeds, stored stroke limits, ball screw compensations, motor control delays and macro call selections. These are all rarely changed by the user and should be protected from being changed by the parameter lock setting. If you need to change parameters, contact HAAS or your dealer. Parameters are protected from being changed by Setting 7.

The Settings page lists some parameters that the user may need to change during normal operation and these are simply called "Settings". Under normal conditions, the parameter displays should not be modified. A complete list of the parameters is provided here.

The PAGE UP, PAGE DOWN, up and down cursor keys , and the jog handle can be used to scroll through the parameter display screens in the control. The left and right cursor keys are used to scroll through the bits in a single parameter.

Parameter List

Parameter 1 X SWITCHES

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

0	REV ENCODER	Used to reverse the direction of encoder data.
1	REV POWER	Used to reverse direction of power to motor.
2	REV PHASING	Used to reverse motor phasing.
3	DISABLED	Used to disable the X-axis.
4	Z CH ONLY	With **A** only, indicates that no home switch.
5	AIR BRAKE	With **A** only, indicates that air brake is used.
6	DISABLE Z T	Disables encoder **Z** test (for testing only).
7	SERVO HIST	Graph of servo error (for diagnostics only).
8	INV HOME SW	Inverted home switch (N.C. switch).
9	INV Z CH	Inverted **Z** channel (normally high).
10	CIRC. WRAP.	With **A** only, causes 360 wrap to return to 0. Note for parameter 498 bit 10: When the bit is set to 1, the lathe will automatically unwind the C-axis no more than half a rotation. When the bit is set to zero, it behaves as if the C axis had been rotated many times then disengaged, when it is engaged again, the control will zero it by unwinding as many times as it had been wound.
11	NO I IN BRAK	With **A** only, removes **I** feedback when brake is active.
12	LOW PASS +1X	Adds 1 term to low pass filter.
13	LOW PASS +2X	Adds two terms to low pass filter.
14	OVER TEMP NC	Selects a normally closed overheat sensor in motor.
15	CABLE TEST	Enables test of encoder signals and cabling.
16	Z TEST HIST	History plot of Z channel test data.
17	SCALE FACT/X	If set to 1, the scale ratio is interpreted as divided by X; where X depends on bits SCALE/X LO and SCALE/X HI.

18	INVIS AXIS	Used to create an invisible axis.
19	DIAMETER PRG	Used to set diameter programming. When set to 1, it will interpret inputs as diameters instead of radii.
20	TRAVL LIMITS	Travel limits are used.
21	NO LIMSW ALM	Alarms are not generated at the limit switches.
22	D FILTER X8	Enables the 8 tap FIR filter. Used to eliminate high frequency vibrations, depending on the axis motor.
23	D FILTER X4	Enables the 4 tap FIR filter. Used to eliminate high frequency vibrations, depending on the axis motor.
24	TORQUE ONLY	For HAAS only.
25	3 EREV/MREV	The 2 EREV/MREV and 3 EREV/MREV bits have two definitions depending on whether one or two encoders are present. For single encoder systems, the bits are used to define the ratio between the electrical rotation of the spindle motor and the mechanical rotation of the motor. For two encoder systems, the definition is the electrical rotation of the motor to the mechanical rotation of the spindle motor encoder, which includes any pulley ratio between the motor and the motor encoder.
26	2 EREV/MREV	The 2 EREV/MREV and 3 EREV/MREV bits have two definitions depending on whether one or two encoders are present. For single encoder systems, the bits are used to define the ratio between the electrical rotation of the spindle motor and the mechanical rotation of the motor. For two encoder systems, the definition is the electrical rotation of the motor to the mechanical rotation of the spindle motor encoder, which includes any pulley ratio between the motor and the motor encoder.
27	NON MUX PHAS	For HAAS only.
28	BRUSH MOTOR	Enables the brush motor option.
29	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.
30	SCALE/X LO	With SCALE/X HI bit, determines the scale factor used in bit SCALE FACT/X,
31	SCALE/X HI	With SCALE/X LO bit, determines the scale factor used in bit SCALE FACT/X. See below

HI	**LO**	
0	0	3
0	1	5
1	0	7
1	1	9

Parameter 2 X P GAIN
Proportional gain in servo loop.

Parameter 3 X D GAIN
Derivative gain in servo loop.

Parameter 4 X I GAIN
Integral gain in servo loop.

Parameter 5 X RATIO (STEPS/UNIT)
The number of steps of the encoder per unit of travel. Encoder steps supply four (4) times their line count per revolution. Thus, an 8192 line encoder and 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
Used to limit average power to motor. If not set correctly, this parameter can cause an "overload" alarm.

Parameter 11 X BACK EMF
Back EMF of motor in volts per 1000 RPM times 10. Thus a 63 volt/KRPM motor gives 630.

Parameter 12 X STEPS/REVOLUTION
Encoder steps per revolution of motor. Thus, an 8192 line encoder gives: **8192 x 4 = 32768**

Parameter 13 X BACKLASH
Backlash correction in encoder steps.

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

Parameter 15 Y SWITCHES
See Parameter 1 for description.

Parameter 16 Y P GAIN
See Parameter 2 for description.

Parameter 17 Y D GAIN
See Parameter 3 for description.

Parameter 18 Y I GAIN
See Parameter 4 for description.

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

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

Parameter 21 Y ACCELERATION
See Parameter 7 for description.

Parameter 22 Y MAX SPEED
See Parameter 8 for description.

Parameter 23 Y MAX ERROR
See Parameter 9 for description.

Parameter 24 Y FUSE LEVEL
See Parameter 10 for description.

Parameter 25 Y BACK EMF
See Parameter 11 for description.

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

Parameter 27 Y BACKLASH
See Parameter 13 for description.

Parameter 28 Y DEAD ZONE
See Parameter 14 for description.

Parameter 29 Z SWITCHES
See Parameter 1 for description.

Parameter 30 Z P GAIN
See Parameter 2 for description.

Parameter 31 Z D GAIN
See Parameter 3 for description.

Parameter 32 Z I GAIN
See Parameter 4 for description.

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

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

Parameter 35 Z ACCELERATION
See Parameter 7 for description.

Parameter 36 Z MAX SPEED
See Parameter 8 for description.

Parameter 37 Z MAX ERROR
See Parameter 9 for description.

Parameter 38 Z FUSE LEVEL
See Parameter 10 for description.

Parameter 39 Z BACK EMF
See Parameter 11 for description.

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

Parameter 41 Z BACKLASH
See Parameter 13 for description.

Parameter 42 Z DEAD ZONE
See Parameter 14 for description.

Parameter 43 A SWITCHES
See Parameter 1 for description.

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:

0	REV CRANK	Reverses direction of jog handle.
1	DISABLE T.C.	Disables tool changer operations.
2	DISABLE G.B.	Disables gear box functions.
3	POF AT E-STP	Stops spindle then turns the power off at EMERGENCY STOP.

4	RIGID TAP	Indicates hardware option for rigid tap.
5	REV SPIN ENC	Reverses sense direction of spindle encoder.
6	SYNC THREADS	Threads will repeat between passes.
7	EX ST MD CHG	Selects exact stop in moves when mode changes.
8	SAFETY CIRC	This enables safety hardware, if machine is so equipped.
9	SP DR LIN AC	Selects linear deceleration for rigid tapping. 0 is quadratic.
10	UNUSED	
12	OVER T IS NC	Selects Regen over temp sensor as N.C.
13	SKIP OVERSHT	Causes Skip (G31) to act like Fanuc and overshoot sense point.
14	NONINV SP ST	Non-inverted spindle stopped status.
15	SP LOAD MONI	Spindle load monitor option is enabled.
16	SP TEMP MONI	Spindle temperature monitor option is enabled.
18	ENABLE DNC	Enables DNC selection from MDI.
19	ENABLE BGEDT	Enables BACKGROUND EDIT mode.
20	ENA GRND FLT	Enables ground fault detector.
21	M19 SPND ORT	This bit makes the P and R codes a protected feature which can only be enabled with an unlock code. The unlock code will be printed on the parameter listing of all new machines. If this bit is set to 0, an M19 will orient the spindle to 0 degrees regardless of the value of any P or R code in the same block. If this is set to 1, a P code in the block will cause the spindle to be oriented to the specified angle such as P180. Alternately, a decimal R code can be used, such as R180.53. Note that the P and R codes only work on a vector drive machine.
22	ENABLE MACRO	Enables macro functions.
23	INVERT SKIP	Invert sense of skip to active low=closed.
24	HANDLE CURSR	Enable use of jog handle to move cursor.
25	NEG WORK OFS	Selects use of work offsets in negative direction.
27	ENA QUIKCODE	Enables conversational programming.
28	OILER ON/OFF	Enables oiler power when servos or spindle is in motion.
29	NC OVER VOLT	Inverts sense of over voltage signal.
30	SP MOTOR ENC	This parameter bit enables a second encoder that is mounted on the spindle motor and wired into the "C" axis input of the Mocon. It is required to control the vector algorithm on a belted machine when the belts slip at high load. When two encoders are present, the first is mounted on the spindle or output of the transmission, and is wired to the "spindle" input on the MOCON. Most mills use a single encoder that is mounted on either the spindle (transmission output) or spindle motor but always connected to the spindle input on the Mocon.
31	DOOR STOP SP	Enables functions to stop spindle and manual operations at door switch.

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

Parameter 59 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 UNLOCK ERROR TIME
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 set to the lathe's configuration.

Parameter 66 SPINDLE ORI DELAY
Maximum delay allowed when orienting spindle. Units are in 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 LIVE TOOL CHNG DLAY
This parameter specifies the amount of time (in milli seconds) to wait after commanding the Live Tooling Drive motor to turn at thevelocity specified by parameter 143. This process is required to engage the live tooling motor and tool and is only performed prior to the first M133 or M134 after a tool change.

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 spindle encoder steps per revolution of the spindle. This number takes into account the pulley ratio between transmission and spindle, plus transmission and encoder. If there are 2 encoders employed, this number applies to the encoder on the spindle (connected to the SP input of the mocon) If only 1 encoder is employed, it will be for that encoder. In most installations, the single encoder will be mounted on the motor but will still connect to the SP input of the mocon.

Parameter 80 MAX SPIN DELAY TIME
The maximum delay time control will wait for spindle to get to commanded speed or to get to zero speed. Units are milliseconds.

Parameter 81 M MACRO CALL O9000
M code that will call O9000. This parameter can contain a value from 1 through 98, inclusive, zero causes no call. However it is best to use a value that is not already in use (see current M code list). Using M37 the value 37 would be entered in parameter 81 (for example). A program would be written to include the M37, such as:

```
G X0...
M37
.
.
M30
```

The control would run the program until it got to the M37, It would call program O9000, run that, and then return to the point that it left, and continue the main program.
Be aware that, if program O9000 contains another M37, it will call itself, and keep calling until it fills the stack (9 times) and then alarm out with 307 SUBROUTINE NESTING TOO DEEP. Note that if M33 (for example) is used, it would override the normal M33 Conveyor Stop function.

Parameter 82 M MACRO CALL O9001
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. This parameter can contain a value from 1 through 98, inclusive, zero causes no call. However it is best to use a value that is not already in use (see current G code list). Using G45 the value 45 would be entered in parameter 91 (for example). A program would be written to include the G45, such as:

```
G X0...
G45
.
.
M30
```

The control would run the program until it got to the G45, It would call program O9010, run that, and then return to the point that it left, and continue the main program.
Be aware that, if program O9010 contains another G45, it will call itself, and keep calling until it fills the stack (4 times) and then alarm out with 531 MACRO NESTING TOO DEEP.
Note that if G84 (for example) is used, it would override the normal G84 Tapping Canned Cycle.

Parameter 92 G MACRO CALL O9011
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 200ths of a step/ms/ms for spindle motor.

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

Parameter 122 Y PHASE OFFSET
See Parameter 121 for description.

Parameter 123 Z PHASE OFFSET
See Parameter 121 for description.

Parameter 124 A PHASE OFFSET
See Parameter 121 for description.

Parameter 125 X GRID OFFSET
This parameter shifts the effective position of the encoder **Z** pulse. It can correct for a positioning error of the motor or home switch.

Parameter 126 Y GRID OFFSET
See Parameter 125 for description.

Parameter 127 Z GRID OFFSET
See Parameter 125 for description.

Parameter 128 A GRID OFFSET
See Parameter 125 for description.

Parameter 129 GEAR CH SETTLE TIME
Gear change settle time. This is the number of one millisecond samples that the gear status must be stable before considered in gear.

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

Parameter 131 MAX SPINDLE RPM
This is the maximum RPM available to the spindle. When this speed is programmed, the D-to-A output will be +10V and the spindle drive must be calibrated to provide this.

Parameter 132 Y SCREW COMP. COEF.
This parameter is used to hold the thermal compensation coefficient. This is the coefficient of heating of the ball screw. This parameter should be set to zero.

Parameter 133 Z SCREW COMP. COEF.
This parameter is used to hold the thermal compensation coefficient. This is the coefficient of heating of the ball screw. The value entered for this parameter is always negative as it is used to shorten the screw length. It should be set to -6000000.

Parameter 134 X EXACT STOP DIST.

Parameter 135 Y EXACT STOP DIST.

Parameter 136 Z EXACT STOP DIST.

Parameter 137 A EXACT STOP DIST.
These parameters control how close each axis must be to its end point when exact stop is programmed. They apply only in G09 and G64. They are in units of encoder steps. A value of 34 would give 34/138718 = 0.00025 inch.

NOTE: To change the values of parameters 134-137 permanently the machine must be rebooted.

Parameter 138 X FRICTION COMPENSATION

Parameter 139 Y FRICTION COMPENSATION

Parameter 140 Z FRICTION COMPENSATION

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

Parameter 142 HIGH/LOW GEAR CHANG
This parameter sets the spindle speed at which an automatic gear change is performed. Below this parameter, low gear is the default; above this, high gear is the default.

Parameter 143 LIVE TOOL CHNG VEL
This parameter specifies the velocity to command the Live Tooling Drive motor for the period specified by parameter 72. This process is required to engage the live tooling motor and tool, and is only performed prior to the first M133 or M134 after a tool change.

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 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
See Parameter 101 for description.

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 COMPENSATION
See Parameter 138 for description.

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

Parameter 174 B SCREW COMP. COEF.
This parameter is used to hold the thermal compensation coefficient. This is the coefficient of heating of the ball screw. This parameter should be set to zero.

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

Parameter 176 Sp 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
This parameter is used when a Vector Drive is installed, see Parameter 4 for description. If Vector Drive is not installed this parameter is not used

Parameter 180 SLIP GAIN
This name is used when a Vector Drive is installed. The slip rate calculated depends on two other variables: speed and current.

Slip rate = slip gain x (speed/max speed) x (current/max current)

The slip gain value is the value that slip rate would assume at maximum speed, and maximum current (16.384=1 Hz). If a Vector Drive is not installed, this parameter is called: C AXIS RATIO (STEPS/UNIT) and is not used.

Parameter 181 MIN SLIP
This name is used when a Vector Drive is installed. The minimum value allowed from the slip rate. From the equation:

Slip rate = slip gain x (speed/max speed) x (current/max current)

it can be seen that at a zero speed, the slip rate would become zero. Therefore a minimum value for slip rate is required. (16.384 =1Hz). If a Vector Drive is not installed, this parameter is called: C AXIS MAX TRAVEL (STEPS) and is not used.

Parameter 182 C ACCELERATION
This name is used when a Vector Drive is installed. See Parameter 7 for description. If a Vector Drive is not installed this parameter is not used.

Parameter 183 C MAX SPEED
This name is used when a Vector Drive is installed. See Parameter 8 for description. If a Vector Drive is not installed this parameter is not used.

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
This name is used when a Vector Drive is installed. See Parameter 11 for description. If a Vector Drive is not installed this parameter is not used.

Parameter 187 C sp MOT HI GEAR ST/REV
This name is used when a Vector Drive is installed. This function takes on two meanings depending on how many spindle encoders are used on the machine. If only one encoder is present, it is the number of encoder steps per mechanical revolution of the spindle motor when the transmission is in high gear. (On direct drive machines, the encoder is mounted on the motor, while on others, it is on the spindle or transmission output.) N = (Encoder steps/enc rev)/(Enc pulley ratio X High Gear Ratio) For machines with a spindle and spindle motor encoder, it is the number of spindle motor encoder steps per mechanical revolution of the encoder. Its purpose is to specify the resolution of the spindle motor encoder. This parameter is used in conjunction with parameter 176 bits 25 and 26, which control the ratio between the electrical revolution of the motor to the mechanical revolution of the encoder.
If a vector drive is not installed, this parameter is called: STEPS/REVOLUTION and is not used.

Parameter 188 C ORIENT GAIN
This name is used when a Vector Drive is installed. The proportional gain is used in the position control loop when performing a spindle orientation. If a Vector Drive is not installed this parameter si called, C axis BACKLASH, and is not used.

Parameter 189 C BASE FREQ
This name is used when a Vector Drive is installed. This is the rated frequency of the motor. If a Vector Drive is not installed this parameter is called, C axis DEAD ZONE, and is not used.

Parameter 190 C HI SP CURR LIM
This name is used when a Vector Drive is installed. 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. If a Vector Drive is not installed this parameter is called, C axis IN POSITION LIMIT, and is not used.

Parameter 191 C MAX CURRENT
See Parameter 105 for description.

Parameter 192 C MAG CURRENT
This name is used when a Vector Drive is installed. This is the magnetization component of the current in the motor, also called the flux or the field current. If a Vector Drive is not installed this parameter is called, C axis D*D GAIN, and is not used.

Parameter 193 C SPIN ORIENT MARGIN
This name is used when a Vector Drive is installed. 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. If a Vector Drive is not installed this parameter is called, C axis ACC / DEC T CONST, and is not used.

Parameter 194 C SP STOP SPEED
This name is used when a Vector Drive is installed. The spindle is considered to be stopped (discrete input SP ST*=0) when the speed drops below this value. Units are encoder steps/ millisecond. If a Vector Drive is not installed this parameter is called, C axis PHASE OFFSET, and is not used.

Parameter 195 C START / STOP DELAY
This name is used when a Vector Drive is installed. This delay is used at the start of motion to magnetize the rotor before acceleration starts. Also when the motor comes to a stop, it remains energized for this amount of time. Units are milliseconds. If a Vector Drive is not installed this parameter is called, C axis GRID OFFSET, and is not used.

Parameter 196 ACCEL LIMIT LOAD
This name is used when a Vector Drive is installed. This is the percent of load limit during acceleration. If the load reaches this limit during acceleration, the control slows the acceleration. If a Vector Drive is not installed this parameter is called, C axis EXACT STOP DIST, and is not used.

Parameter 197 SWITCH FREQUENCY
This name is used when a Vector Drive is installed. This is the frequency at which the spindle motor windings are switched. Note that there is a hysteresis band around this point, defined by parameter 198. If a Vector Drive is not installed this parameter is called, C axis FRICTION FACTOR, and is not used.

Parameter 198 SWITCH HYSTERESIS
This name is used when a Vector Drive is installed. 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. If a Vector Drive is not installed this parameter is called, C axis FEED FORWARD, and is not used.

Parameter 199 PRE-SWITCH DELAY
This name is used when a Vector Drive is installed. This is the amount of time allowed for the current in the motor to drop before the winding change contactors are switched. Units are in microseconds. If a Vector Drive is not installed this parameter is called, C axis THERMAL COMP. COEF., and is not used.

Parameter 200 POST SWITCH DELAY
This name is used when a Vector Drive is installed. 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 are in microseconds. If a Vector Drive is not installed this parameter is called, C axis AIR BRAKE DELAY, and is not used.

Parameter 201 X SCREW COMP. COEF.
This parameter is used to hold the thermal compensation coefficient. This is the coefficient of heating of the ball screw. The value entered for this parameter is always negative as it is used to shorten the screw length. It should be set to -12000000.

Parameter 205 A SCREW COMP. COEF.
This parameter is used to hold the thermal compensation coefficient. This is the coefficient of heating of the ball screw. This parameter should be set to zero.

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:

0	LATHE T.C.	Designates control as a lathe.
1	RST STOPS T.C.	Tool changer can be stopped with RESET button.
2	BRIDGE	Not Used
3	ENA CONVEYOR	Enables chip conveyor, if machine is so equipped.
4	50% RPD KBD	When (1) the control will support the new style keyboards with the 50% rapid traverse key. For controls without a 50% rapid keypad set this bit to (0).
5	FRONT DOOR	When enabled the control will look for an additional door switch and will generate an operator message.
10	T SUBROUTINE	Not Used
11	RESERVED	
12	REV CONVEYOR	Reverses the direction of the chip conveyor.
13	M27-M28 CONVYR	Usually the chip conveyor motor and direction relays are attached to the user relays M21 M22. When this bit is set, the control expects to see the conveyor hooked up to M27 and M28.
15	GREEN BEACON	When (1) user relay M25 is used to flash a beacon. If the control is in a reset state, the beacon will be off. If the control is running normally, the beacon will be steadily on. If the control is in a M00, M01, M02, M30 feedhold, or single block state, then the beacon will flash.
16	RED BEACON	When (1) user relay M26 is used to flash a beacon. The beacon flashes if the control is experiencing an alarm or emergency stop condition.
17	CONVY DR OVRD	When (1) the conveyor will continue to run with the door open. When (0) the conveyor will stop when the door is open, but will resume when the door is closed. For safety it is recommended that the bit be set to (0).
18	RESERVED	
19	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.
20	RMT TOOL RLS	This bit supports the VTC-48. It specifies that the machine has a remote tool release button. It should be set to 1 on the VTC-48 and zero on all other lathes.
21	DISK ENABL	Enables an installed floppy disk drive.
23	MCD RLY BRD	If set to 1, adds 16 additional relays, for a total of 56.

24 HPC ENABLE When this parameter bit is set to zero the machine will behave normally. When it is set to 1, the High Pressure Coolant pump can be turned on with M88 (this will first turn off the regular coolant if it was on, just like an M9). High Pressure Coolant can be turned off with M89. Note also that if a tool change is commanded when the HPC pump is running, it will be turned off, followed by a pause of the length specified by parameter 237. HPC must then be turned back on by the user's program.

25 AUX JOG NACC — Does not allow accumulation on auxiliary axis jog. If the jog handle is moved rapidly the auxiliary axis will not develop extremely large lags.

27 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.

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

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

31 SPNDL NOWAIT — When (1), the machine will not wait for the spindle to come up to speed immediately after an M03 or M04 command. Instead, itwill 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 214 D:Y CURRENT RATIO%

This name is used when a Vector Drive is installed. This defines the ratio between the two winding configurations. This default winding is Y, and the parameters are set for the Y winding. This number is used to adjust the parameters for the delta winding when the windings are switched. If a Vector Drive is not installed, this parameter is called C axis TOOL CHANGE OFFSET, and is not used.

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

Parameter 227 DISK DIR NAME
When the floppy disk drive is enabled and a floppy disk 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 disk 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 Quick Code 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 BELT COMPENSATION
This parameter sets the belt compensation.

Parameter 235 AUTO DOOR PAUSE
This parameter that supports the Auto-Door feature. It specifies the length of a pause (in 50ths of a second) that occurs during the door close sequence. As the door closes and the switch is activated, the motor is turned off for this amount of time and the door coasts. This allows the door to close smoothly. This parameter should be set to 3 (0.06 seconds) nominally. It works in conjunction with parameter 236.

Parameter 236 AUTO DOOR BUMP
This parameter that supports the Auto-Door feature. It specifies the length of time (in 50ths of a second) that the motor should be reactivated after the pause specified by parameter 235. This causes the motor to close the door fully and smoothly. This parameter should be set to 15 (0.3 seconds) nominally.

Parameter 237 HPC PRESSURE BLEED
This parameter is for the HPC (High Pressure Coolant) feature. It is the amount of time given for the coolant to purge when the HPC system is shut off. This should be set to 250 on all lathes.

Parameter 238 SPINDLE AT SPEED %
This parameter is used to allow a program to command the spindle to a certain speed and then continue to the next block before the spindle has actually reached that speed. This is intended to make G-code programs run faster because the spindle can usually finish accelerating while approaching the part. It is recommended that this parameter be set to 20. The result will be that the lathe will act as though the spindle is at speed when it is within +/-20% of the commanded speed.

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

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

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

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

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

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

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

Parameter 246 3RD AUX 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 MAX SPINDLE SPEED ALLOWED
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 DLY AFTER CHUCK IS CLMPED
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 DLY AFTER CHUCK IS UNCLMP
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

This parameter specifies the number of milliseconds allowed for the door to open (move away from the door-closed switch). If the door is commanded to open, and does not open within the allowed time, alarm 127 DOOR FAULT is generated. Also, the value of this parameter plus one second specifies the number of milliseconds allowed for the door to close (activate the door-closed switch). If the door is commanded to close, and does not close within the allowed time, alarm 127 DOOR FAULT is generated. If an automatic door is installed, this parameter should be set to 2400 (2.4 seconds) nominally, otherwise it should be set to zero.

Parameter 252 TAILSTOCK OVERLOAD -DIR

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. This parameter is used for ballscrew tailstock or TL-15.

Parameter 253 TAIL STOCK OVERLOAD +DIR

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. This parameter is used for ballscrew tailstock or TL-15.

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. Note that this parameter value will cause the conveyor to shut off even if the intermittent feature is functioning. Note also that if this parameter is set to zero, the chip conveyor will shut off immediately, i.e., pressing CHIP FWD or CHIP REV will not turn it on.

Parameter 257 SPINDLE ORIENT OFSET

This is used for the Vector Drive and the value is determined at the time of assembly.

Parameter 266 X SWITCHES

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

0	X LIN SCALE EN	Used to enable linear scales for the X axis.
1	X INVRT LN SCL	Used to invert the X axis linear scale.
2	X DSBL LS ZTST	Used to disable the linear scale Z test.
3	TH SNSR COMP	This parameter is used for Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that the feature can only be used when temperature sensors are installed. The following parameters must be set appropriately: 201, 133 XZ SCREW COMP. COEF. =-190000000 272, 274 XZ SCREW COMP T. CONST =-27000000 351 TEMP PROBE OFFSET =450000
4	X 2ND HOME BTN	Used to move axis to coordinate specified in Work Ofset G129

5 X NEG COMP DIR — Used to negate the direction of thermal compensation

7 MAX TRAV INP

8 NO ZERO/NOHOME — This feature is intended for lathes that have extra tools mounted on the outside of the turret. If this bit is set to zero, it will have no effect. If it is set to 1, the associated axis will not move when POWER UP/ RESTART, HOME G28 or AUTO ALL AXES is pressed. The reason for this feature is to help prevent collisions between tools mounted on the outside of the turret and a sub-spindle mounted on the tailstock. It is important to note that a single axis HOME G28 (e.g., press Z then HOME G28) and any G28 specified in a program will still cause the axis to move regardless of the value of this parameter bit. The operator must exercise care when commanding any axis move.

Parameter 267 Y SWITCHES

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

0 Y LIN SCALE EN — Used to enable linear scales for the Y axis.

1 Y INVRT LN SCL — Used to invert the Y axis linear scale.

2 Y DSBL LS ZTST — Used to disable the linear scale Z test.

3 TH SNSR COMP — This parameter is used for Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that the feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 133 XZ SCREW COMP. COEF.	=-190000000
272, 274 XZ SCREW COMP T. CONST	=-27000000
351 TEMP PROBE OFFSET	=450000

4 Y 2ND HOME BTN — Used to move axis to coordinate specified in Work Ofset G129

5 Y NEG COMP DIR — Used to negate the direction of thermal compensation

7 MAX TRAV INP

8 NO ZERO/NOHOME — This feature is intended for lathes that have extra tools mounted on the outside of the turret. If this bit is set to zero, it will have no effect. If it is set to 1, the associated axis will not move when POWER UP/ RESTART, HOME G28 or AUTO ALL AXES is pressed. The reason for this feature is to help prevent collisions between tools mounted on the outside of the turret and a sub-spindle mounted on the tailstock. It is important to note that a single axis HOME G28 (e.g., press Z then HOME G28) and any G28 specified in a program will still cause the axis to move regardless of the value of this parameter bit. The operator must exercise care when commanding any axis move.

Parameter 268 Z SWITCHES

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

0 Z LIN SCALE EN — Used to enable linear scales for the Z axis.

1 Z INVRT LN SCL — Used to invert the Z axis linear scale.

2 Z DSBL LS ZTST — Used to disable the linear scale Z test.

3	TH SNSR COMP	This parameter is used for Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that the feature can only be used when temperature sensors are installed. The following parameters must be set appropriately: 201, 133 XZ SCREW COMP. COEF. =-190000000 272, 274 XZ SCREW COMP T. CONST =-27000000 351 TEMP PROBE OFFSET =450000
4	Z 2ND HOME BTN	Used to move axis to coordinate specified in Work Ofset G129
5	Z NEG COMP DIR	Used to negate the direction of thermal compensation
7	MAX TRAV INP	
8	NO ZERO/NOHOME	This feature is intended for lathes that have extra tools mounted on the outside of the turret. If this bit is set to zero, it will have no effect. If it is set to 1, the associated axis will not move when POWER UP/ RESTART, HOME G28 or AUTO ALL AXES is pressed. The reason for this feature is to help prevent collisions between tools mounted on the outside of the turret and a sub-spindle mounted on the tailstock. It is important to note that a single axis HOME G28 (e.g., press Z then HOME G28) and any G28 specified in a program will still cause the axis to move regardless of the value of this parameter bit. The operator must exercise care when commanding any axis move.

Parameter 269 A SWITCHES

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

0	A LIN SCALE EN	Used to enable linear scales for the A axis.
1	A INVRT LN SCL	Used to invert the A axis linear scale.
2	A DSBL LS ZTST	Used to disable the linear scale Z test.
3	TH SNSR COMP	This parameter is used for Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that the feature can only be used when temperature sensors are installed. The following parameters must be set appropriately: 201, 133 XZ SCREW COMP. COEF. =-190000000 272, 274 XZ SCREW COMP T. CONST =-27000000 351 TEMP PROBE OFFSET =450000
4	A 2ND HOME BTN	Used to move axis to coordinate specified in Work Ofset G129
5	A NEG COMP DIR	Used to negate the direction of thermal compensation
7	MAX TRAV INP	
8	NO ZERO/NOHOME	This feature is intended for lathes that have extra tools mounted on the outside of the turret. If this bit is set to zero, it will have no effect. If it is set to 1, the associated axis will not move when POWER UP/ RESTART, HOME G28 or AUTO ALL AXES is pressed. The reason for this feature is to help prevent collisions between tools mounted on the outside of the turret and a sub-spindle mounted on the tailstock. It is important to note that a single axis HOME G28 (e.g., press Z then HOME G28) and any G28 specified in a program will still cause the axis to move regardless of the value of this parameter bit. The operator must exercise care when commanding any axis move.

Parameter 270 B SWITCHES

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

0 B LIN SCALE EN — Used to enable linear scales for the B axis.

1 B INVRT LN SCL — Used to invert the B axis linear scale.

2 B DSBL LS ZTST — Used to disable the linear scale Z test.

3 TH SNSR COMP — This parameter is used for Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that the feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 133 XZ SCREW COMP. COEF.	=-190000000
272, 274 XZ SCREW COMP T. CONST	=-27000000
351 TEMP PROBE OFFSET	=450000

4 B 2ND HOME BTN — Used to move axis to coordinate specified in Work Ofset G129

5 B NEG COMP DIR — Used to negate the direction of thermal compensation

7 MAX TRAV INP

8 NO ZERO/NOHOME — This feature is intended for lathes that have extra tools mounted on the outside of the turret. If this bit is set to zero, it will have no effect. If it is set to 1, the associated axis will not move when POWER UP/ RESTART, HOME G28 or AUTO ALL AXES is pressed. The reason for this feature is to help prevent collisions between tools mounted on the outside of the turret and a sub-spindle mounted on the tailstock. It is important to note that a single axis HOME G28 (e.g., press Z then HOME G28) and any G28 specified in a program will still cause the axis to move regardless of the value of this parameter bit. The operator must exercise care when commanding any axis move.

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:

0 C LIN SCALE EN — Used to enable linear scales for the C axis.

1 C INVRT LN SCL — Used to invert the C axis linear scale.

2 C DSBL LS ZTST — Used to disable the linear scale Z test.

3 TH SNSR COMP — This parameter is used for Ball Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that the feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 133 XZ SCREW COMP. COEF.	=-190000000
272, 274 XZ SCREW COMP T. CONST	=-27000000
351 TEMP PROBE OFFSET	=450000

4 C 2ND HOME BTN — Used to move axis to coordinate specified in Work Ofset G129

5 C NEG COMP DIR — Used to negate the direction of thermal compensation

7 MAX TRAV INP

8	NO ZERO/NOHOME	This feature is intended for lathes that have extra tools mounted on the outside of the turret. If this bit is set to zero, it will have no effect. If it is set to 1, the associated axis will not move when POWER UP/ RESTART, HOME G28 or AUTO ALL AXES is pressed. The reason for this feature is to help prevent collisions between tools mounted on the outside of the turret and a sub-spindle mounted on the tailstock. It is important to note that a single axis HOME G28 (e.g., press Z then HOME G28) and any G28 specified in a program will still cause the axis to move regardless of the value of this parameter bit. The operator must exercise care when commanding any axis move.

Parameter 272 X THERM COMP T. CONST
This parameter supports Ball Screw Thermal Compensation. The value is the time constant that govern the rate of cool down of the screw. This parameter should be set to -5000.

Parameter 273 Y THERM COMP T. CONST
This parameter supports Ball Screw Thermal Compensation. The value is the time constant that govern the rate of cool down of the screw. This parameter should be set to 0.

Parameter 274 Z THERM COMP T. CONST
This parameter supports Ball Screw Thermal Compensation. The value is the time constant that govern the rate of cool down of the screw. This parameter should be set to -3000.

Parameter 275 A THERM COMP T. CONST
This parameter supports Ball Screw thermal Compensation. The value is the time constant that govern the rate of cool down of the screw. This parameter should be set to 0.

Parameter 276 B THERM COMP T. CONST
This parameter supports Ball Screw thermal compensation. The value is the time constant that govern the rate of cool down of the screw. This parameter should be set to zero.

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:

0	INVERT G.B.	Default is 0. When this bit is set to 1, the sense of the discrete inputs for SP HIGH and SP LOW (high and low gear) are inverted.
1	DPR SERIAL	Causes the main serial inputs/outputs to go through the floppy disk video board.
2	CK PALLET IN	
3	CK HIDDN VAR	
4	DISPLAY ACT	When set to 1, displays the actual spindle speed on the Current Commands display page.
6	HYDRAULIC TS	This bit enables the hydraulic tailstock
7	SPND DRV LCK	This bit must be set to 0 if machine is equipped with a Haas vector spindle drive.
8	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.

9	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.
10	TL SET PROBE	This bit must be set to 1 in order to enable the Tool Pre-Setter.
11	HAAS VECT DR	(Haas Vector Drive) This bit must be set to 1 if machine is equipped with a HAAS vector spindle drive. When set to 1, voltage to the Haas vector drive is displayed in the diagnostics display as DC BUSS.
12	uP ENCL TEMP	(Microprocessor enclosure temperature) When set to 1, the enclosure temperature will be displayed on INPUTS2 screen of the diagnostics display.
13	HAAS RJH	Haas remote jog handle. This bit must be set to 1 if the machine is equipped with a Haas 5-axis Remote jog handle.
14	SP MOT OT NC	Spindle Motor Over Temperature Normally Closed. This bit specifies the type (normally open normally closed) of the spindle temperature sensor. This bit should be set to 1 for machines with a Haas Vector Drive, and 0 for machines without a Vector Drive.
15	SUBSP TMP NC	(Subspindle Temperature Sensor Normally Closed) This bit specifies the type, normally open or normally closed, of the subspindle temperature sensor.
17	NO MFIN CKPU	When it is set, it will prevent checking of MFIN at power-up. It should be set to 1 for all machines that have the new Haas Automatic Pallet Changer attached, and 0 for all other machines.
18	D:Y SW ENABL	Delta Wye switch enable, this is used for machine with a Vector Drive. If this switch is set, but bit 19 is not, then winding switching will only be done when the spindle is at rest, depending on the target speed of the spindle
19	DY SW ON FLY	Delta Wye switch enable, this is used for machine with a Vector Drive. This parameter enables switching on the fly, as the spindle motor is accelerating or decelerating through the switch point.
20	CK BF STATUS	This bit has been added for the improved Bar Feeder interface. When this bit is set to 1, the control will constantly check the Bar Feeder Status on discrete input 1027. If this input goes high, alarm 450 BAR FEEDER FAULT will be generated and the servos and spindle will be turned off. Note that the spindle will simply coast to a stop.
21	CK BF SP ILK	This bit has been added for the improved Bar Feeder interface. When this bit is set to 1, the control will constantly check the Bar Feeder Spindle Interlock on discrete input 1030. If this input goes high, and the spindle is being commanded to turn, or coasting or being manually turned at 10rpm or more, alarm 451 BAR FEEDER SPINDLE INTERLOCK will be generated and the servos and spindle will be turned off. Note that the spindle will simply coast to a stop.
24	LIVE TOOLING	Lathes fitted with the Live Tooling drive this bit must be set to 1. For all other lathes, this bit is set to 0.
25	SUBSPINDLE	This bit enables G14, G15, M143, M144, M145. It must be set to 1 for all lathes with the subspindle. When this bit is set to 1, the control will display FUNCTION LOCKED when the AUTO ALL AXES, HOME G28, or POWER UP/RESTART buttons are pressed.
26	C AXIS DRIVE	This bit enables M154 and M155. It must be set to 1 for all lathes with the C axis.

29 SAFETY INVERT — This bit supports the CE door interlock that locks when power is turned off. For machines that have the regular door lock that locks when power is applied, this bit must be set to 0. For machines that have the inverted door lock, this bit must be set to 1.

31 INV SPD DCEL — Inverse spindle speed deceleration. When this parameter is set to 1, the spindle decelerates faster at lower speeds, resulting in a shorter deceleration time.

Parameter 285 X LINEAR SCREW OFFS
Reserved for future use; set to zero.

Parameter 286 Y LINEAR SCREW OFFS
Reserved for future use; set to zero.

Parameter 287 Z LINEAR SCREW OFFS
Reserved for future use; set to zero.

Parameter 291 HYDRAULIC TAIL STK NO MOTION DETEC TIME
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, prior to a target point, where the tailstock will transition from a rapid movement to a feed. For example, if this parameter is set to 30 (the default), this means the tailstock will slow to a feed 30 encoder steps before reaching the target point. Units are in encoder steps.

Parameter 294 MIN BUSS VOLTAGE
This parameter specifies the minimum Haas Vector Drive buss voltage. If the machine has a Haas Vector Drive, the parameter should be set to 270 (volts). Machines without a Vector Drive should be set to 0. Alarm 160 LOW VOLTAGE will be generated if the voltage falls below the minimum specified.

Parameter 296 MAX OVER VOLT TIME
Specifies the amount of time (in 50ths of a second) that an overvoltage condition (alarm 119 OVER VOLTAGE) will be tolerated before the automatic shut down process is started.

Parameter 297 MAX OVERHEAT TIME
Specifies the amount of time (in 50ths of a second) that an overheat condition (alarm 122 REGEN OVERHEAT) will be tolerated before the automatic shut down process is started.

Parameter 298 YAX RTAP BACKLASH
This parameter is normally set to zero, but can be adjusted by the user (to a number typically between 0 and 1000) to compensate for play in the center of the main spindle. It takes effect during G95 SUBSPIDLE RIGID TAP when the tool has reached the bottom of the hole and must reverse direction to back out.

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.

NOTE: 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.)

NOTE: 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.

NOTE: 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.

Parameter 304 SPINDLE BRAKE DELAY

This parameter specifies the amount of time (in milliseconds) to wait for the main spindle brake to unclamp when spindle speed has been commanded, and also the amount of time to wait after the main spindle has been commanded to stop before clamping it.

Parameter 305 SERVO PO BRK DLY

Specifies the time (in milliseconds) that the control should wait after turning off the Hyd Pump Enable relay (which will activate the brake) before turning off power to the servo motors via the MOCON. This is intended to allow time for the brake to engage. This parameter should be set to 200.

Parameter 315 COMMON SWITCH 4

0 ALIS M GRPHC — All user defined M codes (such as M50) will be ignored when a program is run in graphics mode if this bit is set to 0. If it is necessary to have graphics recognize such M codes, this bit should be set to 1.

5 DOOR OPEN SW — This ensures that when the door is opened automatically, it opens all the way. It is intended to be used in conjunction with an automatic parts loader. If this bit is set to zero, the control behaves as before. If this bit is set to 1, the control will look for a second door switch when the door is opened automatically. If the switch is not found, alarm 127 DOOR FAULT will be generated. This bit should be set to 1 on all machines fitted with the second door switch.

6	SIMPLE T.S.	This parameter supports the SL-10 tailstock, which has no encoder. It should be set to 1 only on an SL-10 with a hydraulic tailstock. It should be set to zero on all other machines.
7	BRLESS BF	This parameter bit supports the brushless bar feeder. When it is set to 1, it indicates that a brushless bar feeder is present.
8	MINI PWRSPLY	This parameter bit is intended for the Mini Lathe. When it is set to zero, the control behaves as before. This parameter bit must be set to 1 on all Mini Lathes. Note: Parameter 294 MIN BUSS VOLTAGE must be set to zero on all Mini Lathes.
9	APL	This parameter indicates that a Haas Lathe APL is installed. When this bit is set to 1, a COMMANDS screen for the HAAS APL is displayed.
10	ZRET C ENG	This parameter bit controls what the C-axis will do upon engagement. If this bit is set to zero, the C-axis will rapid to zero upon engagement. When this bit is set to 1, the C-axis will perform a zero return upon engagement. Note that in either case, the spindle is oriented upon C-axis engagement. Note also, that in order to avoid spindle oscillation during movement of the C-axis, the spindle is shifted to high gear (on lathes with a gear box) before engaging the C-axis.
11	SETING 92 EN	This parameter bit is intended to prevent damage to lathes fitted with a pneumatic double-chuck. If setting 92 CHUCK CLAMPING is switched from O.D. to I.D. or back while the spindle is turning, the chuck will be considered clamped in the opposite direction and will move immediately. A pneumatic double-chuck will be damaged if it is moved while the spindle is turning. This parameter bit must be set to 1 before setting 92 can be altered, and since parameters can only be altered after ESTOP has been pressed, this ensures that the spindle will be at rest when the bit is altered. It is strongly advised that this bit be returned to zero immediately after use.
16	SS REV SPN E	Reverses sense direction of subspindle encoder
17	SS VEC D ENC	Enables a second encoder that is mounted on the subspindle motor and wired into the “C” axis input of the Mocon. It is required to control the vector algorithm when the lathe’s belts might slip at high load.
18	SS VEC DRIVE	This bit must be set to 1 if the machine is equipped with a HAAS vector subspindle drive. When set to 1, voltage to the Haas vector drive is displayed in the diagnostics display as DC BUSS. For the TL-15 and VTC-48, this bit must be set to 1. For all others, it must be set to 0.
19	SS D:Y SW EN	Delta Wye switch enable. This is used for the Vector Drive. If this switch is set, but bit 19 is not, then winding switching will only be done when the subspindle is at rest, depending on the target speed of the subspindle.
20	SS DY SW FLY	Delta Wye switch on the fly. This is used for the Vector Drive. Enables switching on the fly, as the subspindle motor is accelerating or decelerating through the switch point. If bit 18 (SS VEC DRIVE) is not set, this switch will be ignored.

21 SS IN SPD DC	Subspindle Inverse Speed Deceleration. When this parameter is set to 1, the subspindle decelerates faster at lower speeds, resulting in a shorter deceleration time.
22 SS DISBLE GB	Disables gear box functions. For the TL-15 and VTC-48, this bit must be set to 1. For all others, it must be set to 0.
23 VERT TRN CTR	This bit is used for the VTC-48.
24 SS INVERT GB	This bit allows an alternate gearbox configuration. It inverts the sense of the gearbox inputs. The 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.

Parameter 316 MEASURE BAR RATE
This parameter supports the Haas Servo Bar 300 barfeeder. It is the rate at which the bars are measured. Units are inches*1000.

Parameter 317 MEASURE BAR INC
This parameter supports the Haas Servo Bar 300 barfeeder. This is the increment used for bar measurement. Units are inches*10,000

Parameter 318 GEAR MOTOR TIMEOUT
This parameter supports the Haas Servo Bar 300 barfeeder. This is the timeout value for gearmotor operations. Units are in milliseconds.

Parameter 319 MAX RETRACT POS
This parameter supports the Haas Servo Bar 300 barfeeder. This is the maximum V axis position when retracted. Units are inches * 10000.

Parameter 320 MIN RETRACT POS
This parameter supports the Haas Servo Bar 300 barfeeder. This is the minimum space between bar and push rod when retracted. Units are inches*10,000

Parameter 321 PUSH ROD ZERO POS
This parameter supports the Haas Servo Bar 300 barfeeder. This is the V axis position for loading and unloading a bar. Units are in inches*10,000.

Parameter 322 GEARMOTOR BUMP TIME
This parameter supports the Haas Servo Bar 300 barfeeder. Gear motor run time for bump and internal functions. Units are in milliseconds.

Parameter 323 PUSH RATE
This parameter supports the Haas Servo Bar 300 barfeeder. This is the rate at which the last 1/4 inch of feed is done. Units are inches per minute*1000.

Parameter 324 GEAR MOTOR SETTLE
This parameter supports the Haas Servo Bar 300 barfeeder. This is the minimum dwell time for reversing the gear motor direction. Units are in milliseconds.

Parameter 325 STANDARD BAR LEN
This parameter supports the Haas Servo Bar 300 barfeeder. This is the length of bar for G105 Q5. Units are in inches per minute*1000.

Parameter 326 G5 DECELERATION
This parameter supports the G05 FINE SPINDLE CTRL feature. This is the rate at which to decelerate the spindle during G5. Units are in encoder steps per second. It should be set to 15000.

Parameter 327 X LS PER INCH
This parameter is used on machines equipped with linear scales. It should be set to zero.

Parameter 328 Y LS PER INCH
Same as parameter 327.

Parameter 329 Z LS PER INCH
Same as parameter 327.

Parameter 330 A LS PER INCH
Same as parameter 327.

Parameter 331 B LS PER INCH
Same as parameter 327.

Parameter 333 X LS PER REV
This parameter is used on machines equipped with linear scales. It should be set to zero.

Parameter 334 Y LS PER REV
Same as parameter 333.

Parameter 335 Z LS PER REV
Same as parameter 333.

Parameter 336 A LS PER REV
Same as parameter 333.

Parameter 337 B LS PER REV
Same as parameter 333.

Parameter 339 X SPINDLE THERM COEF.
This parameter supports the Spindle Head Thermal Compensation feature. It should be set to 8000.

Parameter 340 Y SPINDLE THERM COEF.
This parameter supports the Spindle Head Thermal Compensation feature. It should be set to 0.

Parameter 341 Z SPINDLE THERM COEF.
This parameter supports the Spindle Head Thermal Compensation feature. It should be set to 3692.

Parameter 342 A SPINDLE THERM COEF.
This parameter supports the Spindle Head Thermal Compensation feature. It should be set to 0.

Parameter 343 B SPINDLE THERM COEF.
This parameter supports the Spindle Head Thermal Compensation feature. It should be set to 0.

Parameter 345 X SPINDLE THERM T.C.
This parameter supports the Spindle Head Thermal Compensation feature. It should be set to -12561.

Parameter 346 Y SPINDLE THERM T.C.
This parameter supports the Spindle Head Thermal Compensation feature. It should be set to 0.

Parameter 347 Z SPINDLE THERM T.C.
This parameter supports the Spindle Head Thermal Compensation feature. It should be set to -20000.

Parameter 348 A SPINDLE THERM T.C.
This parameter supports the Spindle Head Thermal Compensation feature. It should be set to 0.

Parameter 349 B SPINDLE THERM T.C.
This parameter supports the Spindle Head Thermal Compensation feature. It should be set to 0.

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

Parameter 352 RELAY BANK SELECT
In all previous versions, parameter 209 bit 23 MCD RLY BRD assumes that relay bank zero is to be used. This parameter allows the user to change which bank is to be used. It may be set to a number from 0 to 3 (inclusive). M codes M21 through M28 will be switched to the selected bank. Note that this feature requires the I/O-S board. If a previous board is installed without the additional banks of relays, this parameter should be set to zero.

Parameter 353 MAX SUBSPINDLE RPM
This is the maximum RPM available to the subspindle. This parameter works in conjunction with parameters 570 and 571
The following 6 parameters are reserved for future use:

354 U Axis Switches
390 V Axis Switches
426 W Axis Switches
462 Tt Axis Switches
498 C Axis Switches
534 Ss Axis Switches

Parameter 354 U SWITCH A
See Parameter 1 for description.

Parameter 390 V SWITCH A
See Parameter 1 for description.

Parameter 426 W SWITCH A
See Parameter 1 for description.

Parameter 498 C SWITCH A
See Parameter 1 for description.

Parameter 570 SUBSPIN ENC ST/REV
This parameter sets the number of encoder steps per revolution of the subspindle encoder.

Parameter 571 SUBSPINDLE ST/REV
This parameter sets the number of encoder steps per revolution of the subspindle. This parameter only applies to the subspindle rigid tapping option.

Parameter 572 C AXIS ENG TIMEOUT
Specifies the C axis timeout value for seeing the engaged switch on engagement or the disengaged switch on disengage. The units are in milliseconds and it should be set to 1000 for all lathes.

Parameter 573 C AXIS ENG DELAY 1
Specifies the C axis delay after spindle orientation and before engagement. Its purpose is to let the spindle orientation settle. The units are milliseconds and it should be set to 250 for all lathes.

Parameter 574 C AXIS ENG DELAY 2
Specifies the C axis delay after engagement before the motion completes. Its purpose is to allow the C axis engagement to come up to pressure. The units are milliseconds and it should be set to 250 for all lathes.

Parameter 575 THRD PTCH FACT PPM
This allows the customer to factor the feed rate on G32, G76 and G92 threading as necessary for particular applications. The units are ppm (parts per million.) This parameter can be adjusted as necessary, for example, increasing the value by 100 will advance the lead of the thread by 1 ten-thousandth of an inch per inch. Note that this parameter is internally limited to 1000. All lathes should be shipped with this parameter set to 200.

Parameter 576 MAX SS RPM LOW GEAR
Max subspindle RPM in low gear. This is the maximum RPM available to the subspindle. When this speed is programmed, the D-to-A output will be +10V and the subspindle drive must be calibrated to provide this. Gear ratio low to high is 4.1:1.

Parameter 577 SS ORIENT OFFSET
Subspindle Orientation Offset. It is used to orient the subspindle properly anytime it needs to be locked such as prior to a tool change, or orient subspindle command. This is used for the vector drive and the value is determined at assembly time. The Subspindle position is displayed on the POS-RAW DAT screen just to the right of SYSTEM TIME.

Parameter 578 SS HIGH GR MIN SPD
Command speed used to rotate subspindle motor when orienting subspindle in high gear. Units are maximum subspindle RPM divided by 4096.

Parameter 579 SS LOW GR MIN SPD
Command speed used to rotate subspindle motor when orienting subspindle in low gear. Units are maximum subspindle RPM divided by 4096.

Parameter 580 TS HYD RETRACT TIME
This parameter has been added for the SL-10 hydraulic no-encoder tailstock. It specifies the amount of time (in ms) that the tailstock center will be commanded to retract as a result of commanding an M22 and only takes effect when SIMPLE TS is set to 1.

Parameter 581 APL FLIPPER SETTLE
This parameter supports the Haas Lathe APL. It specifies the rotational time for the gripper after the switch is encountered and should be set to 100. Units are milliseconds.

Parameter 582 APL FLIPPER TIME OT
This parameter supports the Haas Lathe APL. It specifies the allowed rotational time when searching for the home switch and should be set to 2000. Units are milliseconds.

Parameter 583 APL MAX POSITIONS
This parameter supports the Haas Lathe APL. It specifies the number of switch positions in rotation and should be set to 7.

Parameter 584 APL GRIP OPEN TIME
This parameter supports the Haas Lathe APL. It specifies the maximum allowable time for opening the gripper and should be set to 500. Units are milliseconds.

Parameter 585 APL GRIP CLOSE TIME

This parameter supports the Haas Lathe APL. It specifies the maximum allowable time for closing the gripper and should be set to 500. Units are milliseconds.

Parameter 586 MAX DOOR OPN SP RPM

This parameter that specifies the maximum allowable spindle RPM while the door is open. If the door is open when the spindle is commanded to turn faster than this value, or already turning faster than this value when the door is opened, alarm 230 DOOR OPEN will be generated. For safety, this parameter should be set to a low value such as 100.

Parameter 587 EXTENDED PUSH TIME

This parameter supports the barfeeder pusher rod which is mounted on the barfeeder trolley (for barfeeders with the 1-foot extension option.) The units are 50th's of a second. It causes a delay of the amount of time specified to enable the pusher rod to full extend before the trolley begins to travel back to the home position. This parameter should be set to 150 (3 seconds) on the SL-30 Big Bore and SL-40 only. For all other lathes, it should be set to zero. On older lathes without the pusher rod, this parameter will have no effect. Note also that with this change, the I/O board discrete output has been changed from #23 to #1.

Parameter 588 X ENC. SCALE FACTOR

These are new axis parameters that work in place of the axis parameters called SCALE/X LO and SCALE/X HI. If SCALE FACT/X is set to 1, the scale ratio is determined by SCALE/X LO and SCALE/X HI as follows:

HI	LO	
0	0	3
0	1	5
1	0	7
1	1	9

If, however, SCALE FACT/X is set to zero, the value of ENC. SCALE FACTOR will be used for the scale ratio instead. Note that any value outside the range of 1 to 100 will be ignored and the scale ratio will remain unaffected. Note also that currently, these parameters are intended for use only on rotary axes (A and B).

Parameter 589 Y ENC. SCALE FACTOR

See parameter 588 for description

Parameter 590 Z ENC. SCALE FACTOR

See parameter 588 for description

Parameter 591 A ENC. SCALE FACTOR

See parameter 588 for description

Parameter 592 B ENC. SCALE FACTOR

See parameter 588 for description

Parameter 593 Sp ENC. SCALE FACTOR

See parameter 588 for description

Parameter 594 U ENC. SCALE FACTOR

See parameter 588 for description

Parameter 595 V ENC. SCALE FACTOR

See parameter 588 for description

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

Parameter 597 C ENC. SCALE FACTOR
See parameter 588 for description

Parameter 598 Tt ENC. SCALE FACTOR
See parameter 588 for description

Parameter 599 Ss ENC. SCALE FACTOR
See parameter 588 for description

Parameter 600 PEAK SPIN. PWR - KW
This parameter supports the spindle kilowatt (KW) load display which appears on the current commands page, next to the spindle load percentage. This parameter should be set to the peak power output in KW for the spindle motor.

Parameter 602 CHUCK FACE DISTANCE
This parameter supports the brushless bar feeder. When executing G105 Q4, a new bar is loaded, measured and pushed through the spindle and halted just before the chuck face. This parameter specifies the distance (in 1/10000 inch) that should be left between the bar and the chuck face. It should be set as follows:

Mini-Lathe 440000
SL-10 500000
SL-20 540000
SL-30 540000
SL-30BB 650000
SL-40 650000
TL-15 540000

Parameter 611 BARFEEDER TYPE
This parameter supports the Bar 100 Air-Driven bar feeder. It should be set to 2 on all lathes fitted with the Bar 100, lathes without the Bar 100 should be set to zero.

Parameter 616 SS LUBE CYCLE TIME
This parameter supports the VTC-48. It controls the subspindle lubrication in the same manner as parameter 117. The units are 50ths of a second. If a subspindle low lube condition is found, alarm 121 LOW LUBE OR LOW PRESSURE is generated and both the main spindle and the subspindle are shut down. It should be set to 108000.

Parameter 617 SS SPIN.FAN OFF DEL
This parameter supports the VTC-48. It specifies the time that the subspindle fan should continue to run after the subspindle has stopped. The units are 1/1000 of a second. It should be set to 6000.

Parameter 618 LUBE CHECK DELAY
This parameter supports the VTC-48. It specifies the time between checks on the status of the oil pressure on a VTC main spindle.

Parameter 619 PRE GEAR CHANGE DLY
It specifies the delay time (in ms) after the spindle has been commanded to stop and before the solenoid for the gear change is commanded to start. It should be set to 100 on all machines.

Parameter 632 X AXIS MOCON CHANNEL

This parameter enables each axis to be mapped to a particular mocon channel. Set to 0. The following gives the previous axis mapping and the current axis mapping for this set of parameters:

As shipped with version 5.01 and earlier software	**As shipped with version 5.02 and later software**
MOCON 1	MOCON 2
632 X Xaxis	X Xaxis
633 Y Live Tooling	Y APL V axis / Brushless bar feeder
634 Z Z-Axis	Z Z-Axis
635 A Tt Axis	A Tt Axis
636 B Tail stock / Sub spindle support	B Tail stock / Sub spindle support
637 C Main Spindle	C Main Spindle
MOCON 2	MOCON 2
638 X APL U axis	X APL U Axis
639 Y APL V Axis	Y Live Tooling
640 Z APL W axis	Z APL W axis
641 A C Axis	A C Axis
642 B Unused	B Unused
643 C Sub Spindle	C Sub Spindle

Parameter 633 Y AXIS MOCON CHANNEL

Same as Parameter 632. Set to 7 on machines originally shipped with 5.02 and later software.

Parameter 634 Z AXIS MOCON CHANNEL

Same as Parameter 632 Set to 2 on 5.02 and later software.

Parameter 635 A AXIS MOCON CHANNEL

Same as Parameter 632 Set to 3 on 5.02 and later software.

Parameter 636 B AXIS MOCON CHANNEL

Same as Parameter 632 Set to 4 on 5.02 and later software.

Parameter 637 C AXIS MOCON CHANNEL

Same as Parameter 632 Set to 5 on 5.02 and later software.

Parameter 638 X AXIS MOCON CHANNEL

Same as Parameter 632 Set to 6 on 5.02 and later software.

Parameter 639 Y AXIS MOCON CHANNEL

Same as Parameter 632 Set to 1 on machines originally shipped with 5.02 and later software.

Parameter 640 Z AXIS MOCON CHANNEL

Same as Parameter 632 Set to 8 on 5.02 and later software.

Parameter 641 A AXIS MOCON CHANNEL

Same as Parameter 632 Set to 9 on 5.02 and later software.

Parameter 642 B AXIS MOCON CHANNEL

Same as Parameter 632 Set to 10 on 5.02 and later software.

Parameter 643 C AXIS MOCON CHANNEL

Same as Parameter 632 Set to 11 on 5.02 and later software.

Parameter 692 STDY REST OUT RELAY

This parameter supports the steady rest option. If a lathe has the option, this parameter must be set to the output relay number that activates the clamping mechanism. This number can be 32 through 55 for relays #1132 through #1155, respectively. For lathes without the steady rest option, it must be zero.

Parameter 693 STDY REST INP RELAY

This parameter supports the steady rest option. If a lathe has the option and a foot pedal for the steady rest, this parameter must be set to the input relay number for the foot pedal switch. This number can be 1 through 49 for relays #1101 through #1049, respectively. For lathes without a steady rest foot pedal, this parameter should be zero.

Electronic Thermal Compensation

When ballscrews rotate they generate heat. Heat causes the ballscrews to expand. In constant duty cycles, the resultant ball screw growth can lead to cutting errors on the next morning start up. Haas' ETC algorithm can accurately model this heating and cooling effect and electronically expand and contract the screw to give near glass scale accuracy and consistency.

This compensation is based on a model of the ball screw which calculates heating based on the distance traveled and the torque applied to the motor. This compensation does not correct for thermal growth due to changes in ambient temperature or due to part expansion.

Electronic thermal compensation works by estimating the heating of the screw based on the total amount of travel over its length and including the amount of torque applied to the screw. This heat is then turned into a thermal coefficient of expansion and the position of the axis is multiplied by the coefficient to get a correction amount.

If the machine is turned off when there is some compensation applied (due to motion and heating of screw), when the machine is turned back on, the compensation will be adjusted by the clock indicated elapsed time.

Spindle Head Thermal Compensation

This feature integrates spindle speed over time and builds a model of thermal growth. As the model shows the spindle head warming up, the control adjusts the axes to compensate for thermal growth.

X-Axis Thermal Compensation

During machining, the heating of the ballscrews transfers heat by conduction to the thermal sensor body. This causes the resistance of the sensor to vary according to the temperature. The resistance value is read by the software which compensates for the change in temperature by adjusting the accuracy of the program accordingly.

The thermal sensor is connected to the ballscrew and compensates program accuracy for changes in ballscrew temperature.

7. MAINTENANCE

7.1 General Requirements

Operating Temperature Range	41°F to 104°F (5 to 40°C)
Storage Temperature Range	-4°F to 158°F (-20 to 70°C)

Ambient Humidity: 20% – 95% relative humidity, non-condensing
Altitude: 0-7000 ft.

Electricity Requirements

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 +/-10%

15 HP System	Voltage Requirements	High Voltage Requirements
SL-10	(195-260V)	(354-488V)
Power Supply	50 AMP	25 AMP
Haas Circuit Breaker	40 AMP	20 AMP
If service run from elec. panel is less than 100' use:	8 GA. WIRE	12 GA. WIRE
If service run from elec. panel is more than 100' use:	6 GA. WIRE	10 GA. WIRE

20 HP System	Voltage Requirements	High Voltage Requirements
[1]SL-20, TL-15	(195-260V)	(354-488V)
Power Supply	50 AMP	25 AMP
Haas Circuit Breaker	40 AMP	20 AMP
If service run from elec. panel is less than 100' use:	8 GA. WIRE	12 GA. WIRE
If service run from elec. panel is more than 100' use:	6 GA. WIRE	10 GA. WIRE

30-40 HP System	Voltage Requirements	High Voltage Requirements[2]
TL-15BB, SL-20BB, SL-30, SL-30BB, [1]SL-40, SL-40BB	(195-260V)	(354-488V)
Power Supply	100 AMP	50 AMP
Haas Circuit Breaker	80 AMP	40 AMP
If service run from elec. panel is less than 100' use:	4 GA. WIRE	8 GA. WIRE
If service run from elec. panel is more than 100' use:	2 GA. WIRE	6 GA. WIRE

55HP System	Voltage Requirements	High Voltage Requirements
[1]SL-40, SL-40BB, SL-40L	(195-260V)	(354-488V)
Power Supply	150 AMP	**Must use an external transformer**
Haas Circuit Breaker	125 AMP	
If service run from elec. panel is less than 100' use:	1 GA. WIRE	
If service run from elec. panel is more than 100' use:	0 GA. WIRE	

WARNING!

A separate earth ground wire of the same conductor size as the input power is required to be connected to the chassis of the machine. This ground wire is required for operator safety and for proper operation. This ground must be supplied from the main plant ground at the service entrance, and should be routed in the same conduit as the input power to the machine. A local cold water pipe, or ground rod adjacent to the machine cannot be used for this purpose.

Input power to the machine must be grounded. For wye power, the neutral must be grounded. For delta power, a central leg ground or one leg ground should be used. The machine will not function properly on ungrounded power. (This is not a factor with the External 480V Option)

The rated horsepower of the machine may not be achieved if the imbalance of the incoming voltage is beyond an acceptable limit. The machine may function properly, yet may not deliver the advertised power. This is noticed more often when using phase converters. A phase converter should only be used if all other methods cannot be used.

The maximum leg-to-leg or leg-to-ground voltage should not exceed 260 volts, or 504 volts for high-voltage machines with the Internal High Voltage Option.

[1] The current requirements shown in the table reflect the circuit breaker size internal to the machine. This breaker has an extremely slow trip time. It may be necessary to size the external service breaker up by 20-25%, as indicated by "power supply", for proper operation.

[2] The high-voltage requirements shown reflect the Internal 400V configuration which is standard on European machines. Domestic and all other users must use the External 480V option.

Air Requirements

The CNC Lathe requires a minimum of 100 PSI at 4 scfm at the input to the pressure regulator on the back of the machine. This should be supplied by at least a two horsepower compressor, with a minimum 20-gallon tank, that turns on when the pressure drops to 100 PSI.

Machine Type	Main Air Regulator	Input Airline Hose Size
SL-Series	85 psi	3/8" I.D.

The recommended method of attaching the air hose is to the barb fitting at the back of the machine with a hose clamp. If a quick coupler is desired, use at least a 3/8".

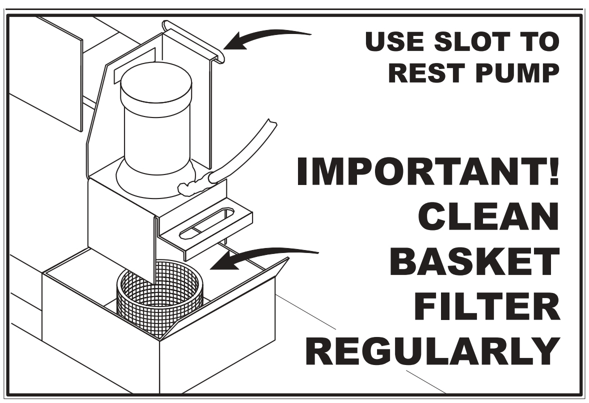
NOTE: Excessive oil and water in the air supply will cause the machine to malfunction. The air filter/regulator has an automatic bowl dump that should be empty before starting the machine. This must be checked for proper operation monthly. Also, excessive contaminants in the air line may clog the dump valve and cause oil and/or water to pass into the machine.

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

7.2 Maintenance Schedule

The following is a list of required regular maintenance for the HAAS SL-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.

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 for proper operation of auto drain on filter regulator. ✓ Check air guage / regulator for 85 psi. ✓ Clean exterior surfaces with mild cleaner. DO NOT use solvents. ✓ Clean out small chip catch pan in coolant tank.
Monthly	✓ Inspect way covers for proper operation and lubricate with light oil, if necessary. ✓ Remove pump from the coolant tank. Clean sediment from inside the tank. Reinstall 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. ✓ Check transmission oil level (if applicable). 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	✓ Replace gearbox oil. ✓ With the air pressure OFF, disassemble and clean the small filter at end of lubricator (right side of machine). ✓ Clean oil filter and remove residue from the bottom of filter. ✓ Replace air filter on control box every (2) years. The filter box must be removed on the SL-20 lathes in order to replace the air filter.



Poor Coolant flow can be caused by a dirty filter.

<u>To clean the filter:</u>

Turn off the coolant pump.
Lift the coolant tank LID.
Remove the filter.
Clean and reinstall filter.

7.3 Lubrication Chart

Item	Capacity	Fluid Type
Coolant	15 Gallons SL-10 35 Gallons for SL-20 50 for Gallons SL-30 77 Gallons for SL-40	Water soluble or synthetic
Way Lube	2-2.5 Qt. depending on pump style	Vactra #2
Transmission	54 oz.	Mobil DTE 25

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

WARNING!

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

Machining of ceramics and the like voids all warranty claims for wear and is done entirely at the customer's risk. Increased maintenance schedules are absolutely required with abrasive swarf. The coolant must be changed more often, and the tank thoroughly cleaned of sediment on the bottom. A larger coolant tank is recommended.

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

Lubrication Requirements:
Each jaw requires two strokes of grease: - Every 1000 clamp / unclamp cycles - or at least once a week Use provided grease gun for chuck lubrication **Lubrication type: Molybdenum Disulfide Grease (20% to 25% moly content)**

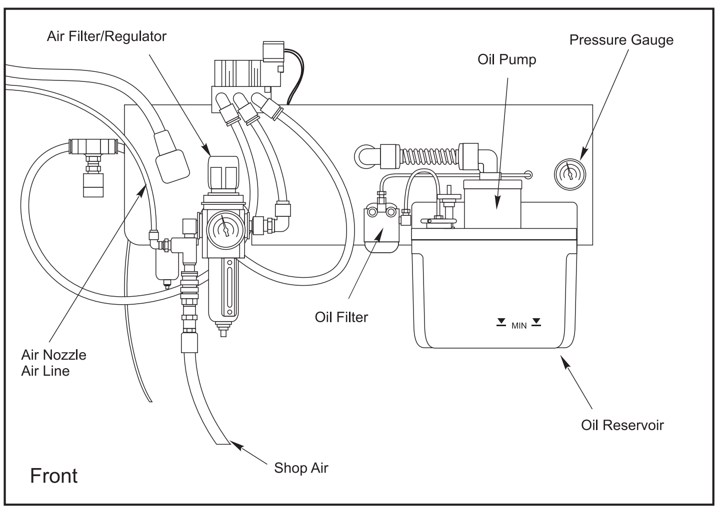
7.4 Chuck Maintenance

CHUCK MAINTENANCE

Ensure all moving part 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 manufactures' specifications.
Caution: Lack of grease significantly reduces clamping force and can result in chatter, improper clamping, or thrown parts.
Disassemble and inspect chuck once a year
Refer to chuck manual for disassembly procedures
    Check for excessive wear
    Check for galling or burnishing
    Clean guide ways of contamination, chips and coolant
Lubricate chuck before reassembly

7.5 Lubrication System

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



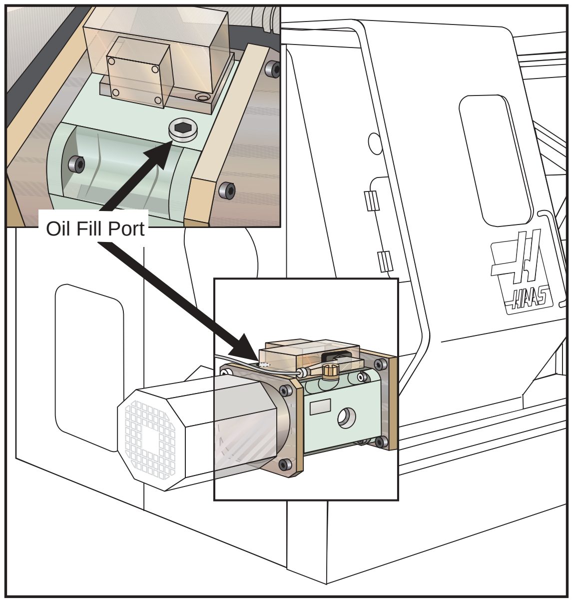
External Lubrication System

WARNING!

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

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

7.6 Transmission Filler Location



7.7 Chip Auger

MAINTENANCE

During normal operation, most chips are discharged from the machine at the discharge tube. However, very small chips may flow through the drain and collect in the coolant tank strainer. To prevent drain blockage, clean this trap regularly. Should the drain become clogged and cause coolant to collect in the machine's pan, stop the machine, loosen the chips blocking the drain, and allow the coolant to drain. Empty the coolant tank strainer, then resume operation.

7.8 Periodic Maintenance

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

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

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

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

7.9 Windows / Guarding

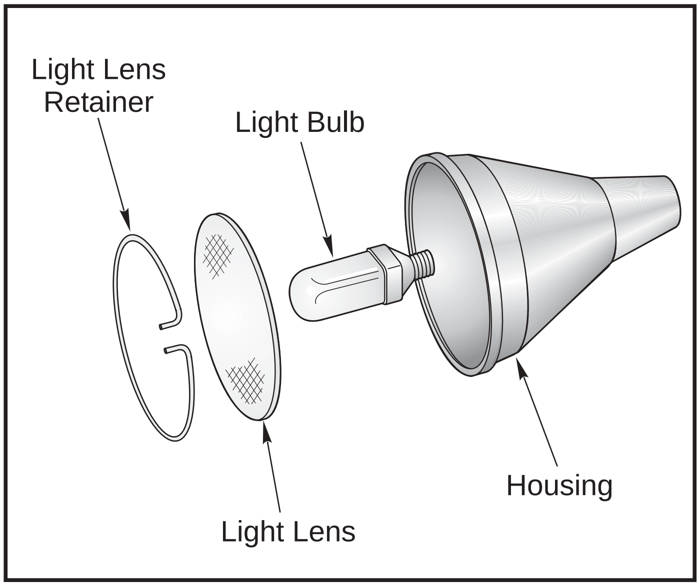
Polycarbonate windows and guarding can be weakened by exposure to cutting liquids and chemicals that contain amines. It is possible to loose up to 10% of the remaining strength annually. If degradation is suspected, window replacement should occur at no more than a two year interval.

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

7.10 Interior Worklight

Bulb Replacement

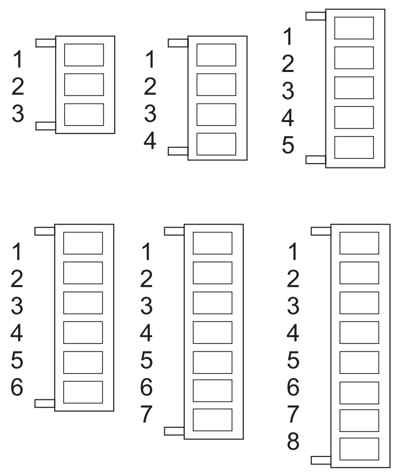
1. TURN OFF power to the machine at the main breaker.
3. Remove the retainer and the light lens.
4. Remove the light bulb and replace.
5. Replace the light lens and retainer.
6. Restore power to the machine.



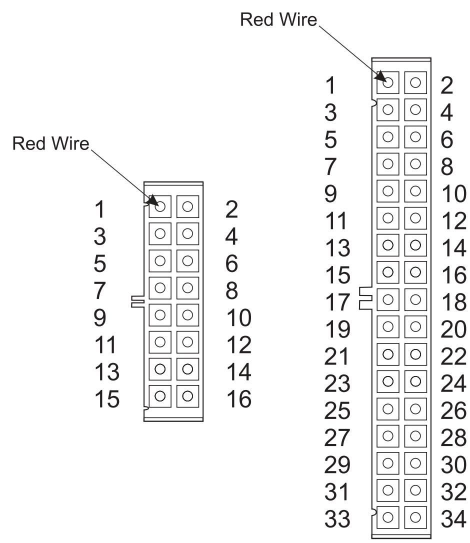
Interior worklight assembly.

8. PCB's, CABLE LOCATIONS AND BOARD DIAGRAMS

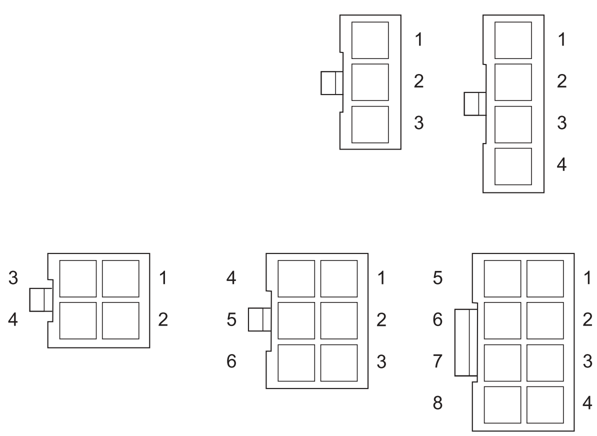
Shown below are three types of commonly used cable connectors. **They are shown as seen when plugged into the pc board.** These diagrams are to aid in locating the pins for trouble shooting.



Friction Lock



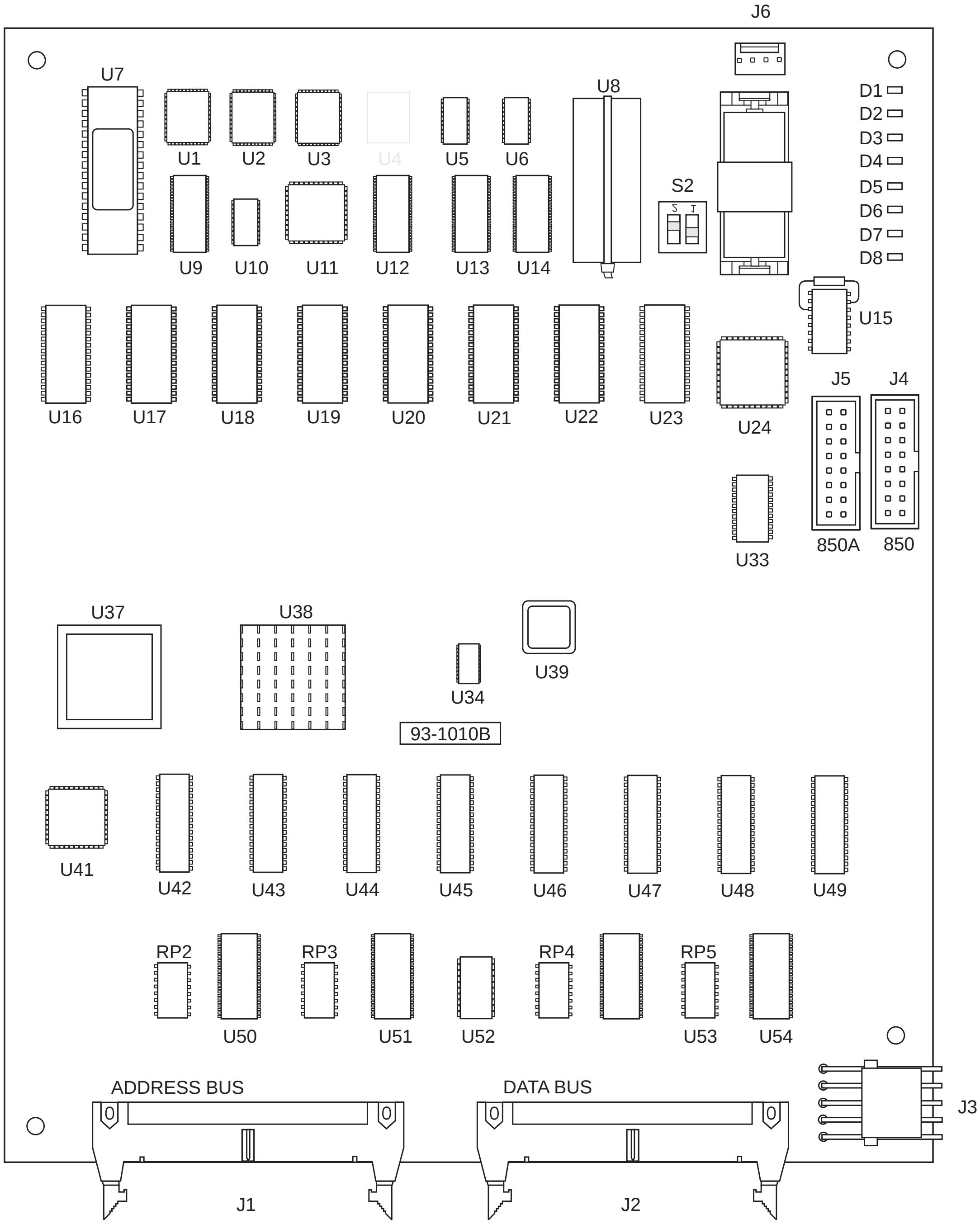
Ribbon Cables



Mini Fit

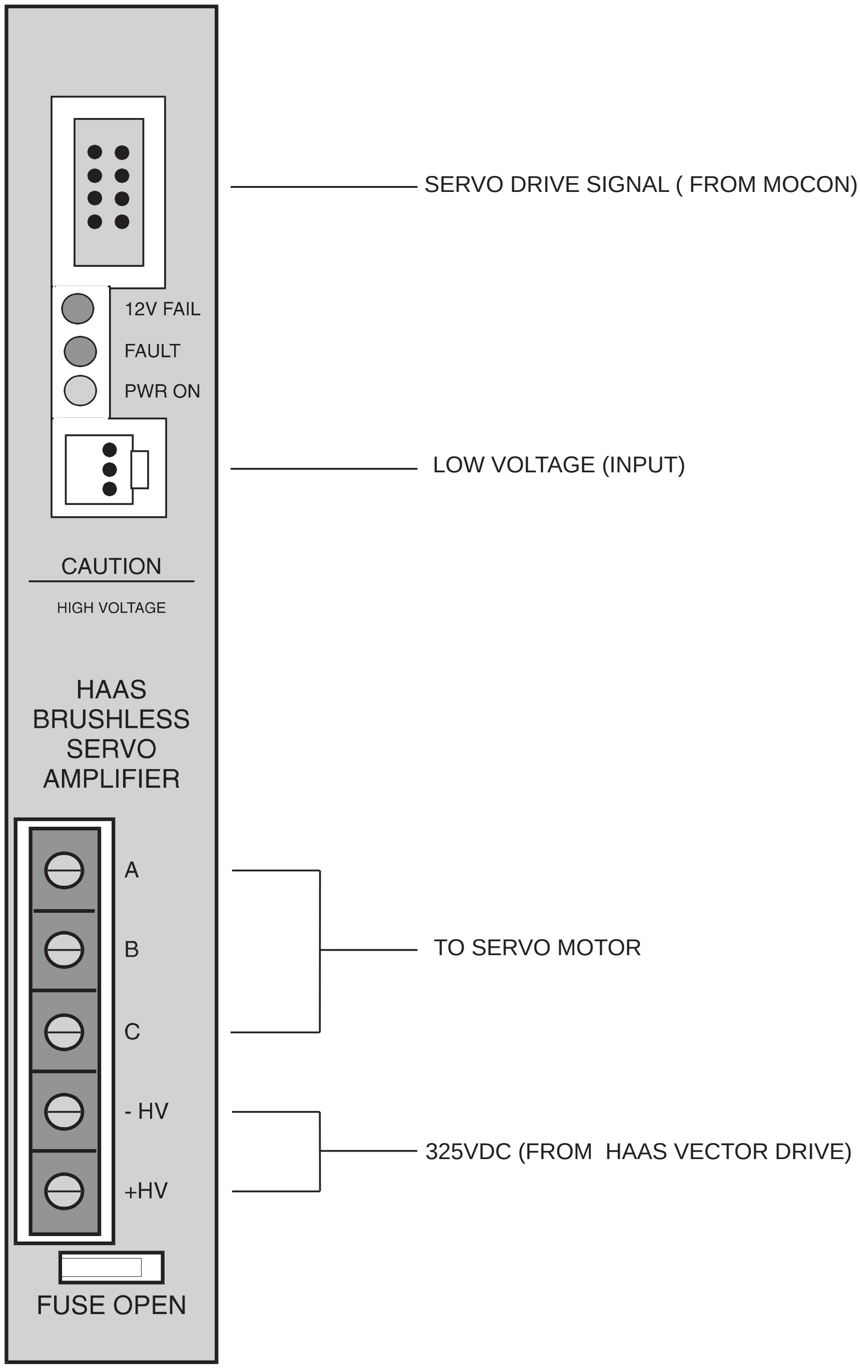
Note:The numbering sequence is the same regardless of the number of pins.

MICRO PROCESSOR PCB · P/N 93-1010B CABLE CONNECTIONS



PROC. PLUG #	CABLE #	SIGNAL NAME ⇨ TO ⇨	LOCATION	PLUG #
J1		ADDRESS BUSS	VIDEO	——
J2		DATA BUSS	MOTIF PCB	——
J3	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	——

BRUSHLESS SERVO AMPLIFIER - P/N 93-5550C

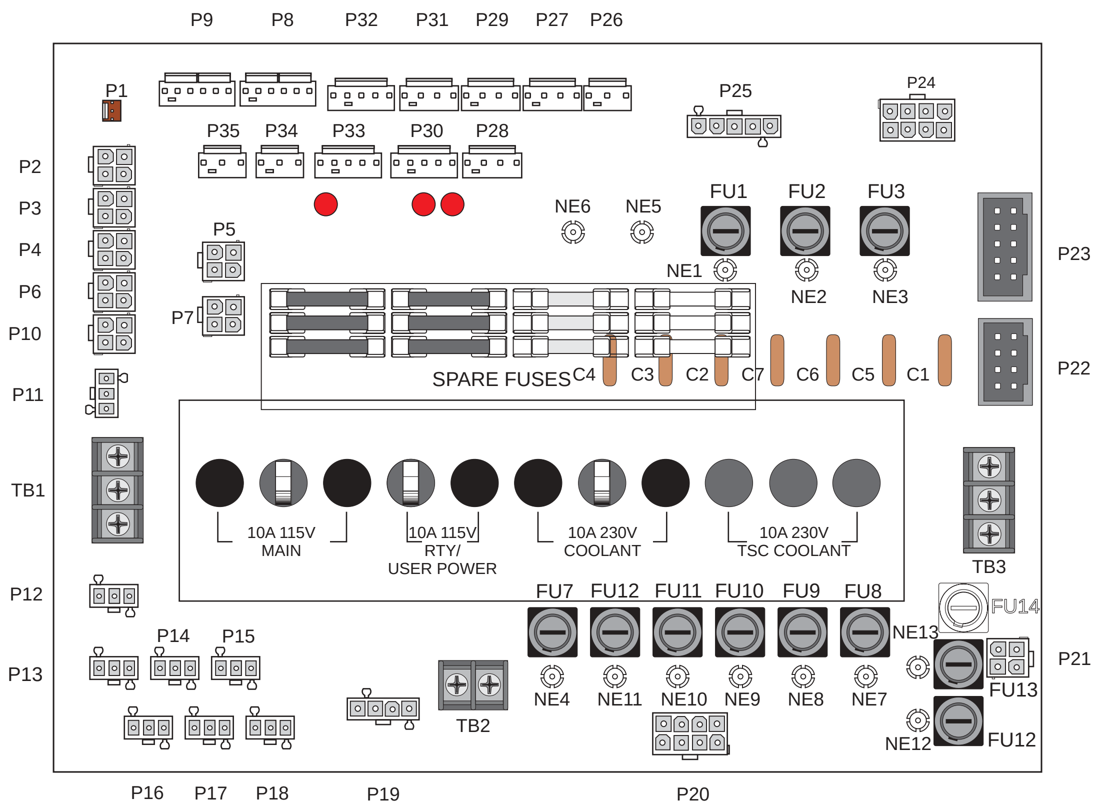


BRUSHLESS SERVO AMPLIFIER - P/N 93-5550C

CABLE CONNECTIONS

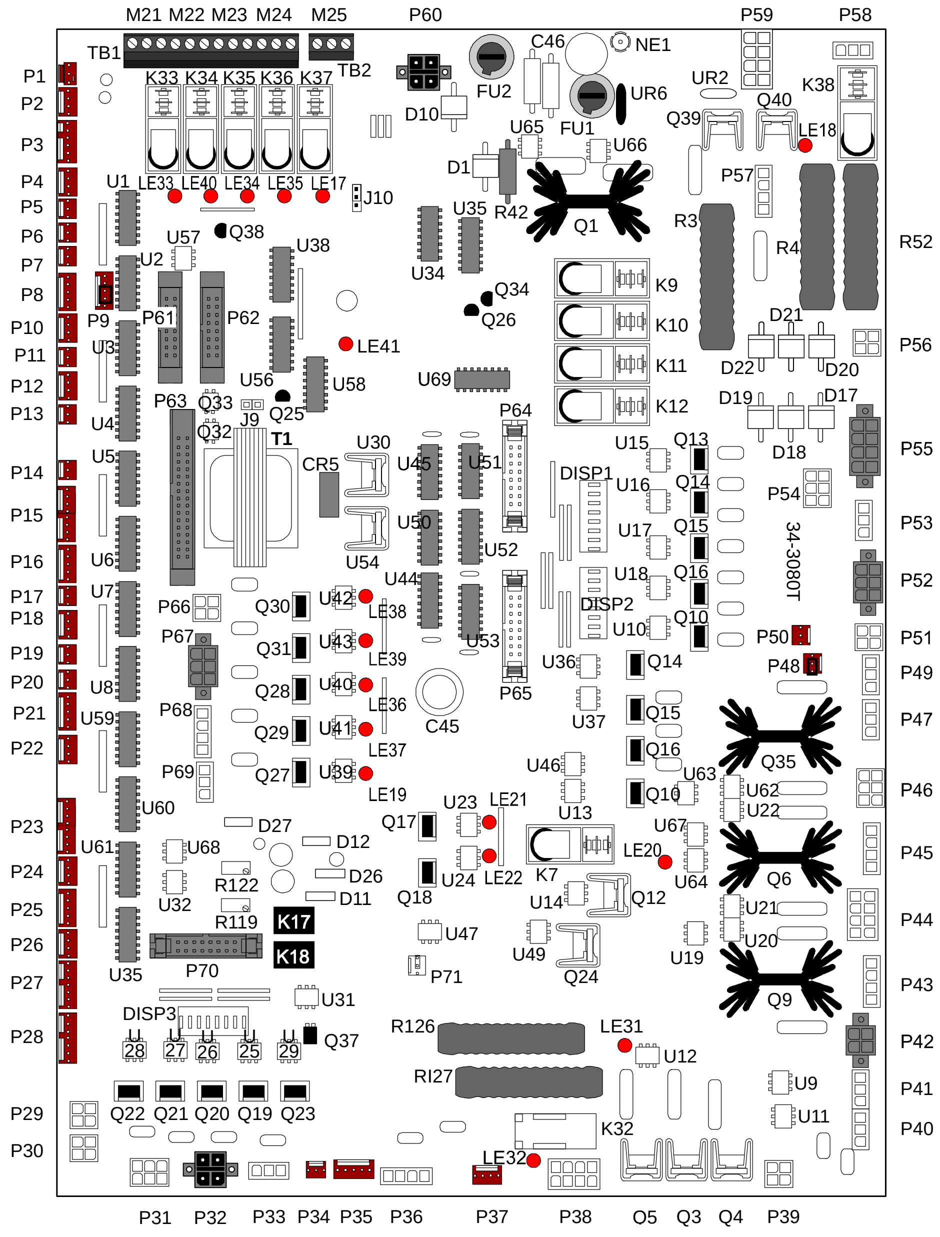
MOCON PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨	LOCATION	PLUG #
X AXIS AMP					
P	570	LOW VOLTAGE		L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE		X SERVO MOTOR	——
P	610	X DRIVE SIGNAL		MOCON PCB	P2
TB -HV +HV	490	320VDC		SPINDLE DRIVE	——
Y AXIS AMP					
P	570	LOW VOLTAGE		L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE		Y SERVO MOTOR	——
P	620	Y DRIVE SIGNAL		MOCON PCB	P3
TB -HV +HV	490	320VDC		SPINDLE DRIVE	——
Z AXIS AMP					
P	570	LOW VOLTAGE		L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE		Z SERVO MOTOR	——
P	630	Z DRIVE SIGNAL		MOCON PCB	P4
TB -HV +HV	490	320VDC		SPINDLE DRIVE	——
A AXIS AMP					
P	570	LOW VOLTAGE		L. V. POWER SUPPLY	——
TB A, B, C	——	MOTOR DRIVE		A SERVO MOTOR	——
P	640	A DRIVE SIGNAL		MOCON PCB	P5
TB -HV +HV	490	320VDC		SPINDLE DRIVE	——

POWER PCB - P/N 93-0227A



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

I/O PLUG #	CABLE #	SIGNAL NAME ⇨ TO ⇨	LOCATION	PLUG#
P1		+12VDC	CNC Unit Fan	
P2	90B	115VAC	Low Voltage Power Supply	
P3	90B	115VAC	Probe PS	
P4	90B	115VAC	Work Light	
P5	90B	115VAC	Switch Door Fan	
P6	90B	115VAC	Servo Fan	
P7	90B	115VAC	Delta-Wye	
P8	860	+12/-12/+5 VDC In	From Low Voltage Power Supply	
P9	860	+12/-12/+5 VDC In	From Low Voltage Power Supply	
P10	90B	115VAC	Door Fan	
P11	90B	115VAC	Monitor	
P12	90C	115VAC	Regen Fan	
P13	90C	115VAC	SMTC PCB	P4
P14	90C	115VAC	spare	
P15	90C	115VAC	spare	
P16	90C	115VAC	spare	
P17	90C	115VAC	Trans PCB	P2
P19	90	3PH 115VAC	IO PCB	P56
P18	90C	115VAC	spare	
P20	930	230V CLNT/TSC	IO PCB	P44
P21	160	Chip Conv. 230V 3PH	IO PCB	P39
P23	170	Auto Off/Contactor	Contactor K1/IO PCB	P42
P22	740	On/Off	Front Panel	
P24		Prim/Sec	To T5	
P25	71, 72, 73	Overvolt Protection	From Contactor K1	
P26	860	+12VDC	SKBIF	
P27	860	+12/+5 VDC	IO PCB	P60
P28	860	+12/+5 VDC	Motif PCB	P15
P29	860	+12/+5 VDC	Processor PCB	J3
P30	860	+12/-12/+5 VDC	spare	
P31	860	+12/+5 VDC	Video PCB	P1
P32	860	+12/-12/+5 VDC	Mocon 1 PCB	P15
P33	860	+12/-12/+5 VDC	Mocon 2 PCB	P15
P34	860	+12 VDC	SMTC PCB	P2
P35	860	+12 VDC	MCD Relay PCB	P2
TB1	94, 95, 96	115VAC	From Transformer	
TB2	90A	115 VAC Out	Barfeeder / T/C PCBA	P8
TB3	77, 78, 79	3PH 230V In	From Transformer	



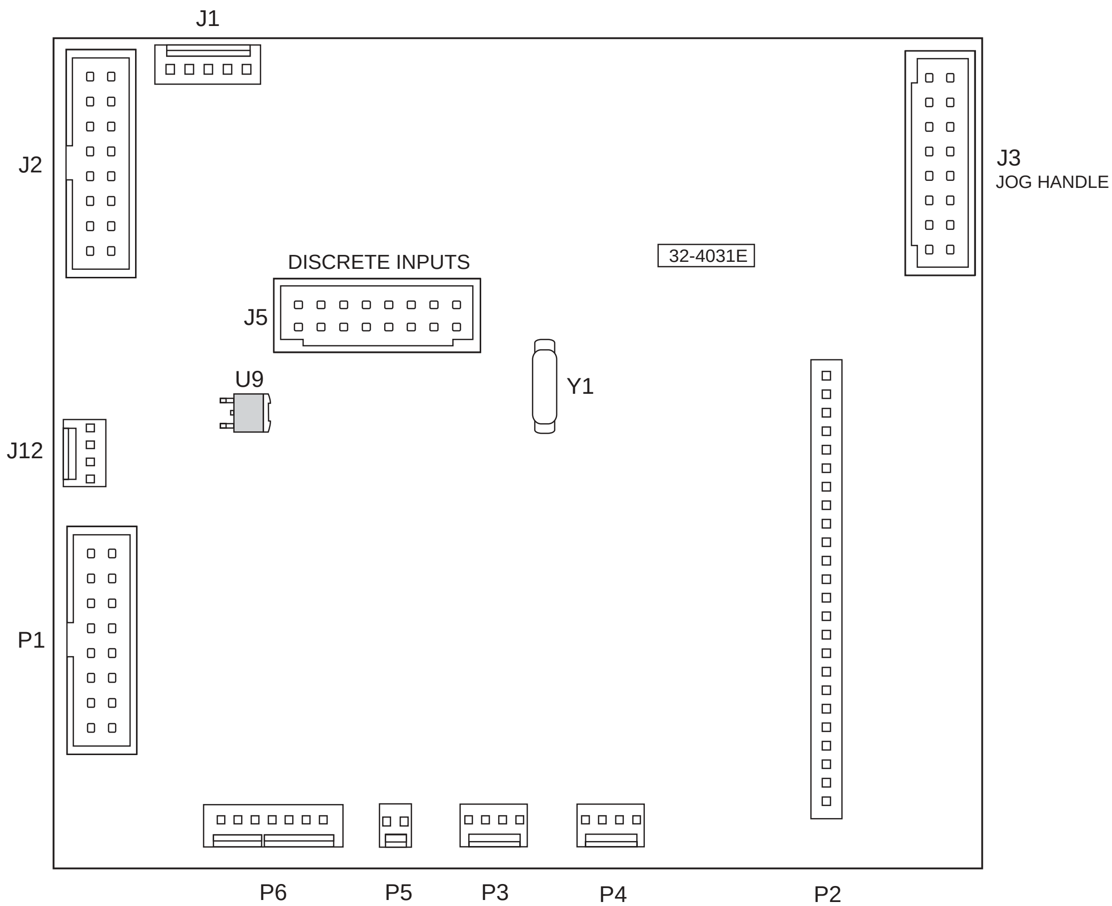
I/O PCB T - P/N 34-3080T CABLE CONNECTIONS

I/O PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1	140B		Chip Conveyor	
P2	820B		TT Unlock/Lock	
P3	820		C-axis Engage/Disengage	
P4	900		Spare	
P5	770		E-Stop Switch A	
P6	770A		E-Stop Switch B	
P7	770B		E-Stop Switch C	
P8	1050		Door Open	
P9	1050A		Door Open	
P10	100		(External) M-Fin	
P11	970		Over Volt	VD J1
P12	950		Low Air/Hyd. Pressure	
P13	960		Low Lube	
P14	830		Regen Overheat	

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

I/O PLUG #	CABLE #	⇨ TO ⇨ LOCATION	PLUG #
P15	890	Spare / Gearbox	
P16	780	Spare	
P17	410	TS Foot Sw, Sub Spndl Chuck Foot Switch	
P18	790	Probe Home	
P19	190	Chuck uncl foot switch / low phase	
P20	190A	Not Used	
P21	240	BF Load Bar/Q / RPL:cvr opn/slider rtrct/grnd flt	
P22	1070	Skip	
P23	420	Spare (VTC:pocket up/down / tool one /TC mark)	
P24	440	Auto Door Open	
P25	450	Steady Rest Foot Switch	
P26	460	Apl Rotator Mark, Home (VTC:low way/SS lube)	
P27	470	Spare (VTC: motor stop/origin/ cl/uncl)	
P28	480	Spare (VTC: rem uncl/ss db open/closed)	
P29	1040A	Not Used	
P30	1040	CE Door Lock	
P31	230	T/S Fwd	
P32	250	T/S Rev	
P33	270	T/S Rapid (VTC: purge)	
P34	260	Spare (12V output)	
P35	200	Spare (VTC spigot CW/CCW)	
P36	280	Beacons	
P37	140A	Not Used	
P38	140	Chip Conv En/Rev	
P39	160	250V For Chip C	
P40	300	SP fan/oil pump/luber	
P41	300A	Not Used	
P42	170	Auto Off	
P43	940	Coolant	
P44	930	230V For Coolant	
P45	940A	HP Cooloant	
P46	390	Spin Brake	
P47	350	Hyd Pump En	
P48	120	Not Used (Jumper)	
P49	350A	Brake Release	
P50	130	Not Used (Jumper)	
P51	430	APL Light/BF Extend Push	
P52	710	APL Gripper Grip 1, Grip 2	
P53	880C	Wye-Delta Switch	
P54	880B	High/Low Gear	
P55	880A	Chuck Unclamp/TT Out / MLB fast push	
P56	90	115V Power To IOPCB	PSUP P19
P57		External TC Motor Resistor	Jumper
P58	810A	spare	
P59	810	Auto Dr, BF ld bar/Q,APL Rtr(VTC:car CW/CCW)	
P60	860A	5V/12V Logic Power IOPCB	PSUP P27
P61	540	Outputs Cable 24-55	MOCON P14
P62	540A	Outputs Cable MCD Relay	MCD Realy P1
P63	550	Inputs Cable	MOCON P10
P64	520	Outputs Cable 8-15	MOCON P12
P65	510	Outputs Cable 0-7	MOCON P11
P66	M27	Air Blast	
P67	M28	Sub Spin Chuck Sol	
P68	310	APC Door Open	
P69	220	C-Axis Engage	
P70	530	Outputs Cable 16-23	MOCON P13
TB1	M21-24	Probe, M-Fin, User Spare	
TB2	M25	User Space	

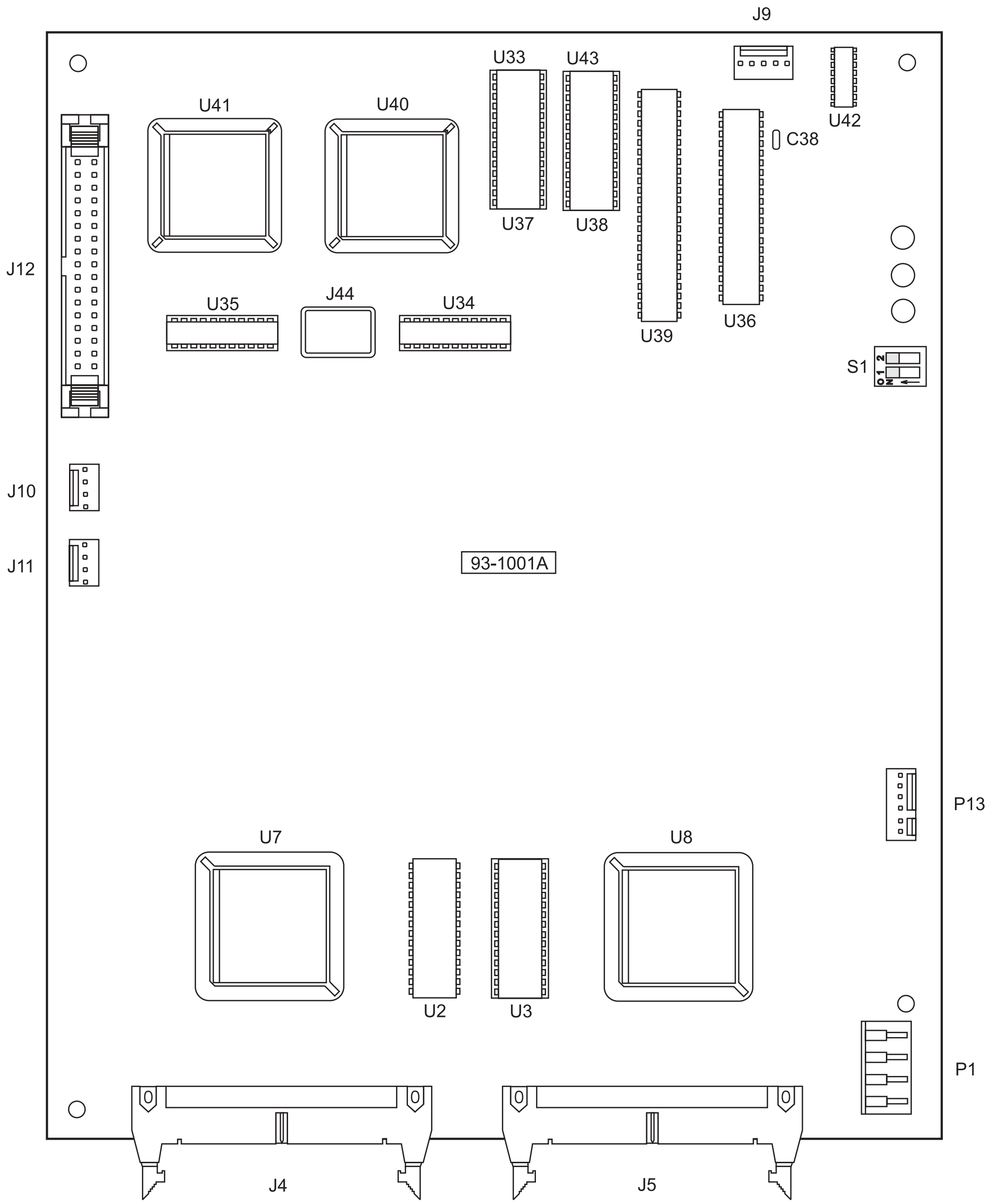
SERIAL KEYBOARD INTERFACE PCB WITH HANDLE JOG
P/N 93-1072B
CABLE CONNECTIONS



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			P5
P6	—			—
J1	750A			—
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.

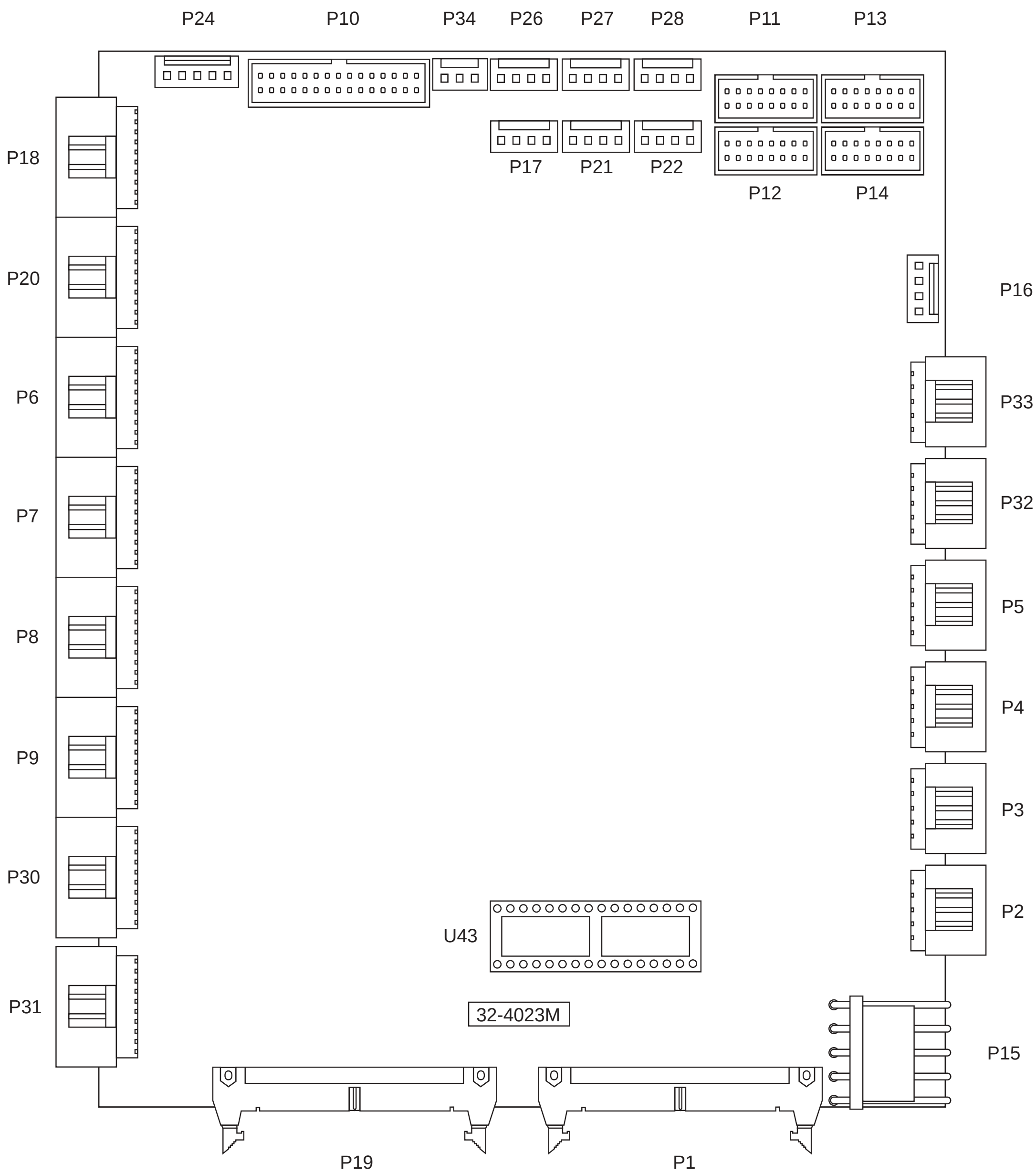
VIDEO & KEYBOARD PCB W/ FLOPPY DRIVE P/N 93-1001A CABLE CONNECTIONS



VIDEO PLUG #	CABLE #	SIGNAL NAME ð TO ð	LOCATION	PLUG #
P1	860	LOW VOLTAGE	POWER SUPPLY PCB	——
J3*	700	KEYBOARD INFO.	KEYBOARD INT.	——
J4	——	ADDRESS BUSS	MICRO PROC. PCB	——
J5	——	DATA BUSS	MOTIF PCB	——
J10	——	FLOPPY DR. POWER	FLOPPY DRIVE	——
J11	——	SPARE	N/A	N/A
J12	——	FLOPPY DR. SIGNAL	FLOPPY DRIVE	——
P13	760	VIDEO SIGNAL	CRT	——
J9	——	RS422 B	N/A	N/A
J13	850	SERIAL DATA	N/A	J1

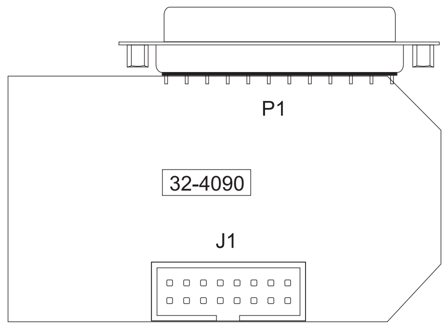
* Not used with Serial Keyboard Interface

MOCON PCB - P / N 93-1067F



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

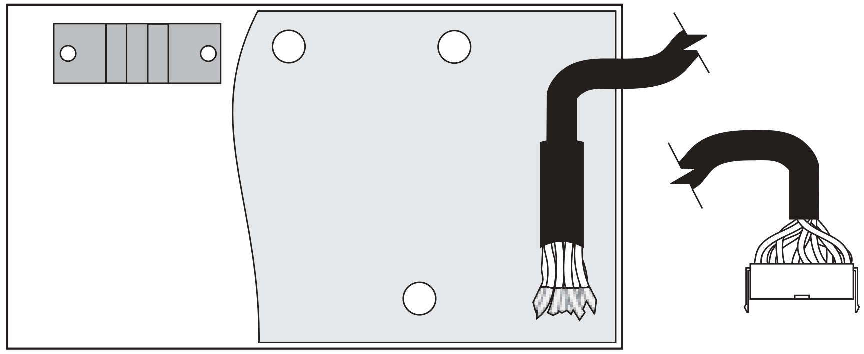
MOCON PLUG #	CABLE #	SIGNAL NAME	⇨ TO ⇨	LOCATION	PLUG #
P1	——	DATA BUSS		VIDEO PCB	——
				MICRO PROC. PCB	——
P2	610	X DRIVE SIGNAL		X SERVO DRIVE AMP.	P
P3	620	Y DRIVE SIGNAL		Y SERVO DRIVE AMP.	P
P4	630	Z DRIVE SIGNAL		Z SERVO DRIVE AMP.	P
P5	640	A DRIVE SIGNAL		A SERVO DRIVE AMP.	P
P32	640B	B DRIVE SIGNAL		B SERVO DRIVE AMP.	P
P6	660	X ENCODER INPUT		X ENCODER	——
P7	670	Y ENCODER INPUT		Y ENCODER	——
P8	680	Z ENCODER INPUT		Z ENCODER	——
P9	690	A ENCODER INPUT		A ENCODER	——
P30	690B	B ENCODER INPUT		B ENCODER	——
P10	550	MOTIF INPUTS/			
		I/O OUTPUTS		I/O PCB	P4
P11	510	I/O RELAYS 1-8 I/O		PCB	P1
P12	520	I/O RELAYS 9-16		I/O PCB	P2
P13	530	I/O RELAYS 17-24		I/O PCB	P51
P14	540	I/O RELAYS 25-32		I/O PCB	P3
P15	860	LOW VOLTAGE		POWER SUPPLY PCB	——
P16	720	SP. LOAD METER		LOAD METER	——
P17	980	VOLTAGE MONITOR		N/A	N/A
P18	750	JOG ENCODER INPUT		JOG HANDLE	——
P19		ADDRESS BUSS		VIDEO PCB	——
				MICRO PROC. PCB	——
P20	1000	SP. ENCODER INPUT		SPINDLE ENCODER	——
P21		X-AXIS TEMP SENSOR			
P22	730B	SP. DRIVE LOAD		SPINDLE DRIVE	——
P24	990	HOME SENSORS		X, Y & Z LIMIT	——
P26		Y-AXIS TEMP SENSOR			
P27		Z-AXIS TEMP SENSOR			
P31	690C	C-AXIS ENCODER INPUT		SPINDLE MOTOR (lathe)	
P33	640C	VCTR DR CUR. CMD.		VECTOR DRIVE	J3



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

CABLE CONNECTIONS

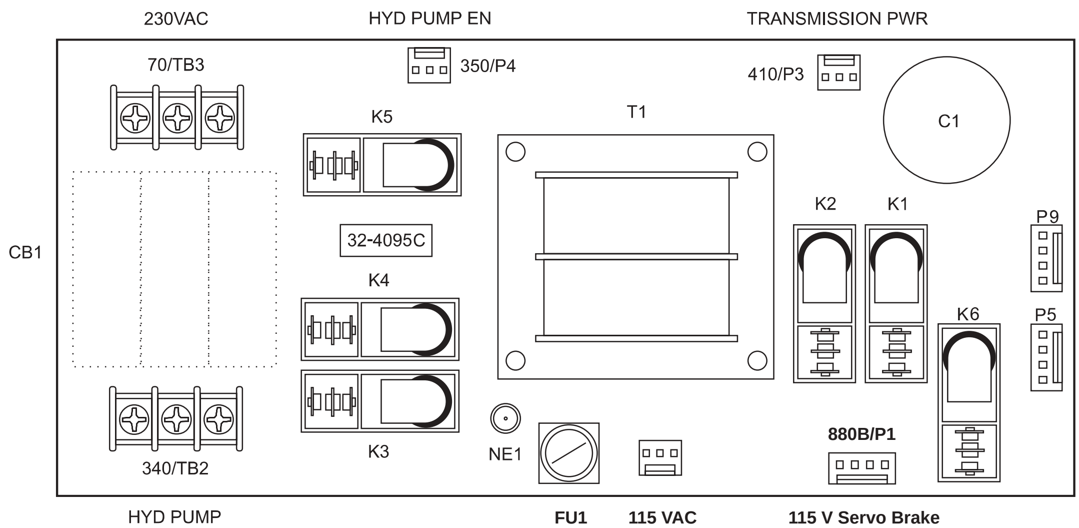
PLUG #	CABLE #	⇨ TO ⇨	LOCATION	PLUG #
P1 EXTERNAL	--------		-------------	-------
J1 EXTERNAL	850		VIDEO & KEYBOARD	J13



OPTICAL ENCODER PCB - P/N 32-0400A (SL-20, SL-30)

CABLE CONNECTIONS

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



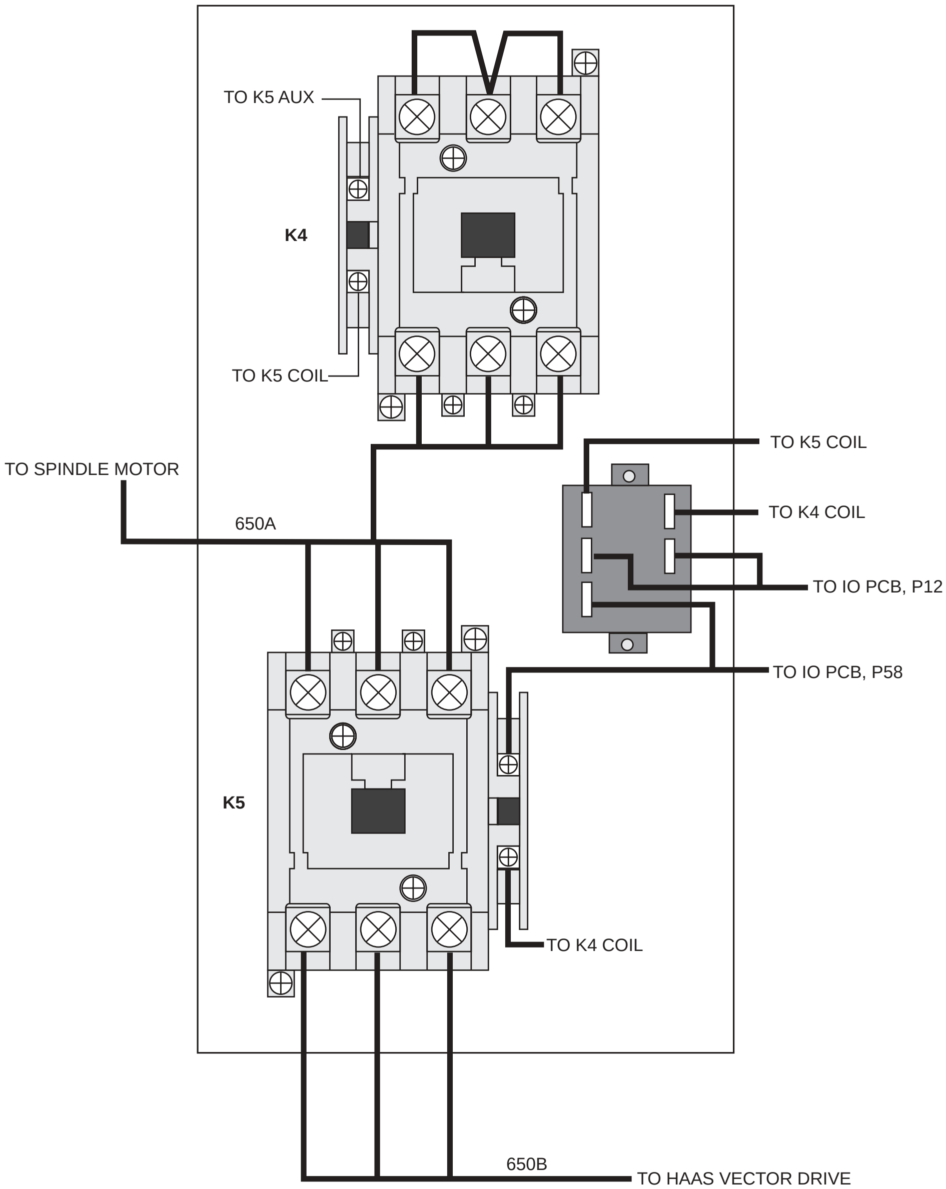
TRANSMISSION P.S. / HYDRAULIC C.B. PCB
P / N 93-4095C

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 32-5850B



9. CABLE LIST

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 LOAD BAR - BARFEEDER LOAD Q
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
310	AUTO DOOR CLUTCH - PARTS CATCHER
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
430	APL LIGHT/ BF EXTENDED PUSH
440	DOOR OPEN
450	STEADY REST FOOT SWITCH
460	APL ROTOR MARK - APL ROTOR HOME
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)
710	APL GRIP 1,2
720	ANALOG SIGNAL FROM MOCON TO SPINDLE DRIVE LOAD MONITOR
721	0 TO +10 VOLTS SPINDLE LOAD
722	COMMON
723	SHIELD DRAIN

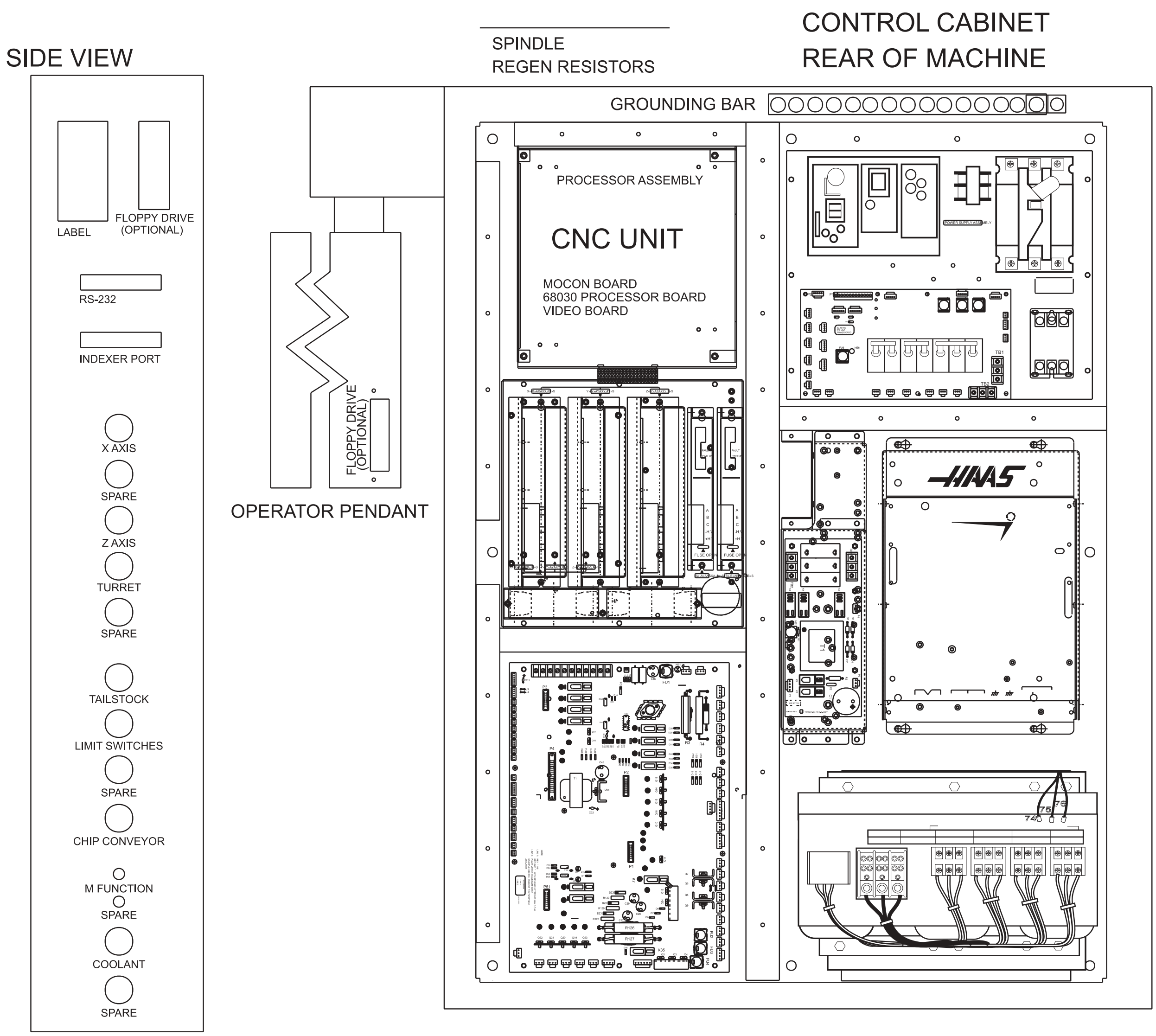
740	POWER ON/OFF CABLE TO FRONT PANEL - SHIELD +4
741	POWER ON SWITCH LEG 1 (24 VAC) #20
742	POWER ON SWITCH LEG 2 #20 N.O.
743	POWER OFF SWITCH LEG 1 (24 VAC) #20
744	POWER OFF SWITCH LEG 2 #20 N.C.
745	SHIELD DRAIN
750	JOG-CRANK DATA CABLE(REM JOG SIDE CONNECTION)(ALL #24)
750-1	LOGIC RETURN (D GROUND) 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

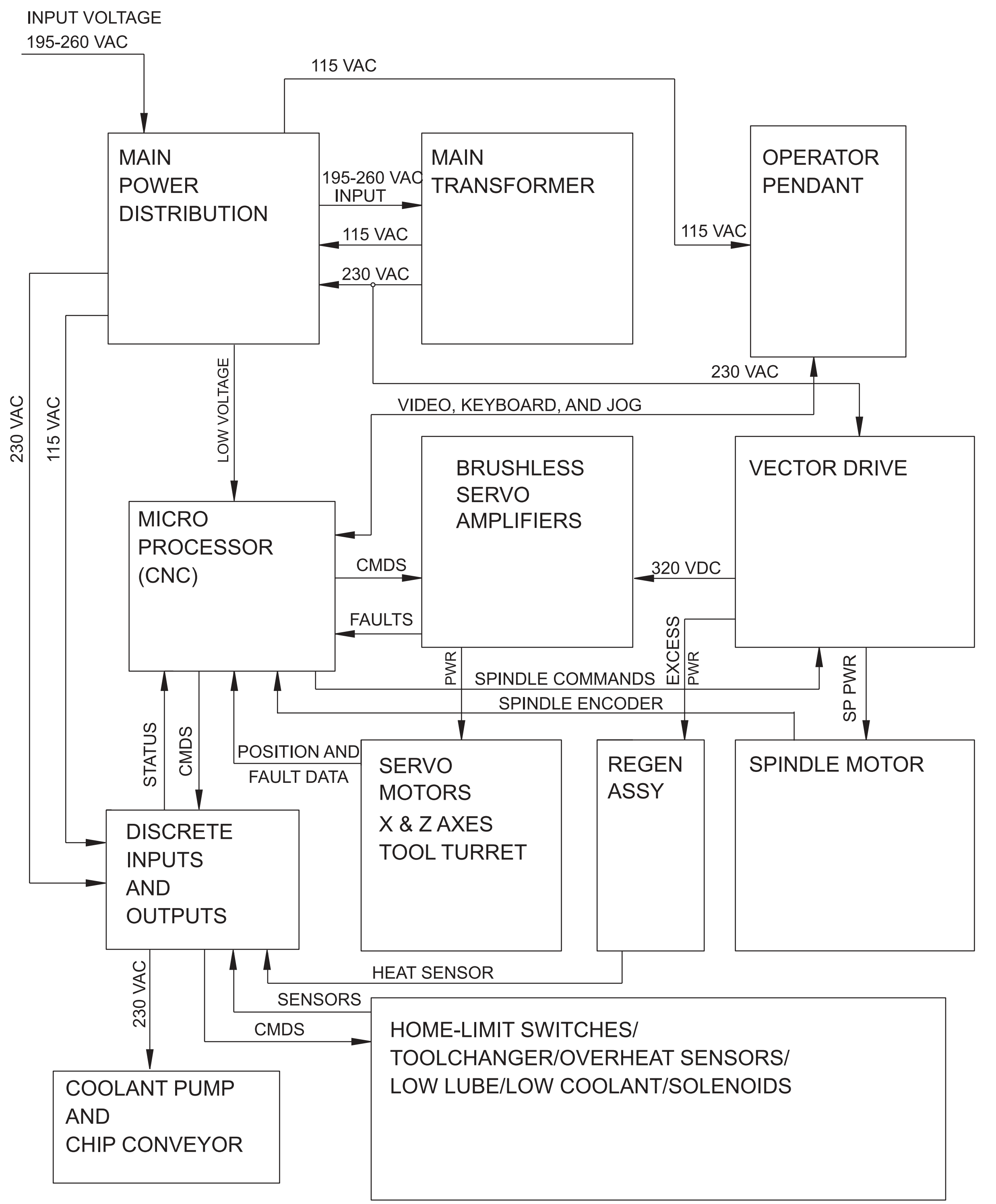
990	HOME SENSORS - SHIELD +4 (ALL #20)
991	COMMON (DATA GROUND)
992	X-AXIS HOME SWITCH
993	Y-AXIS HOME SWITCH
994	Z-AXIS HOME SWITCH
995	SHIELD DRAIN
1000	SPINDLE ENCODER CABLE (MOCON SIDE CONNECTION) ALL #24
1000-1	LOGIC RETURN (D GROUND)
1000-2	ENCODER A CHANNEL
1000-3	ENCODER B CHANNEL
1000-4	+5 VDC
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

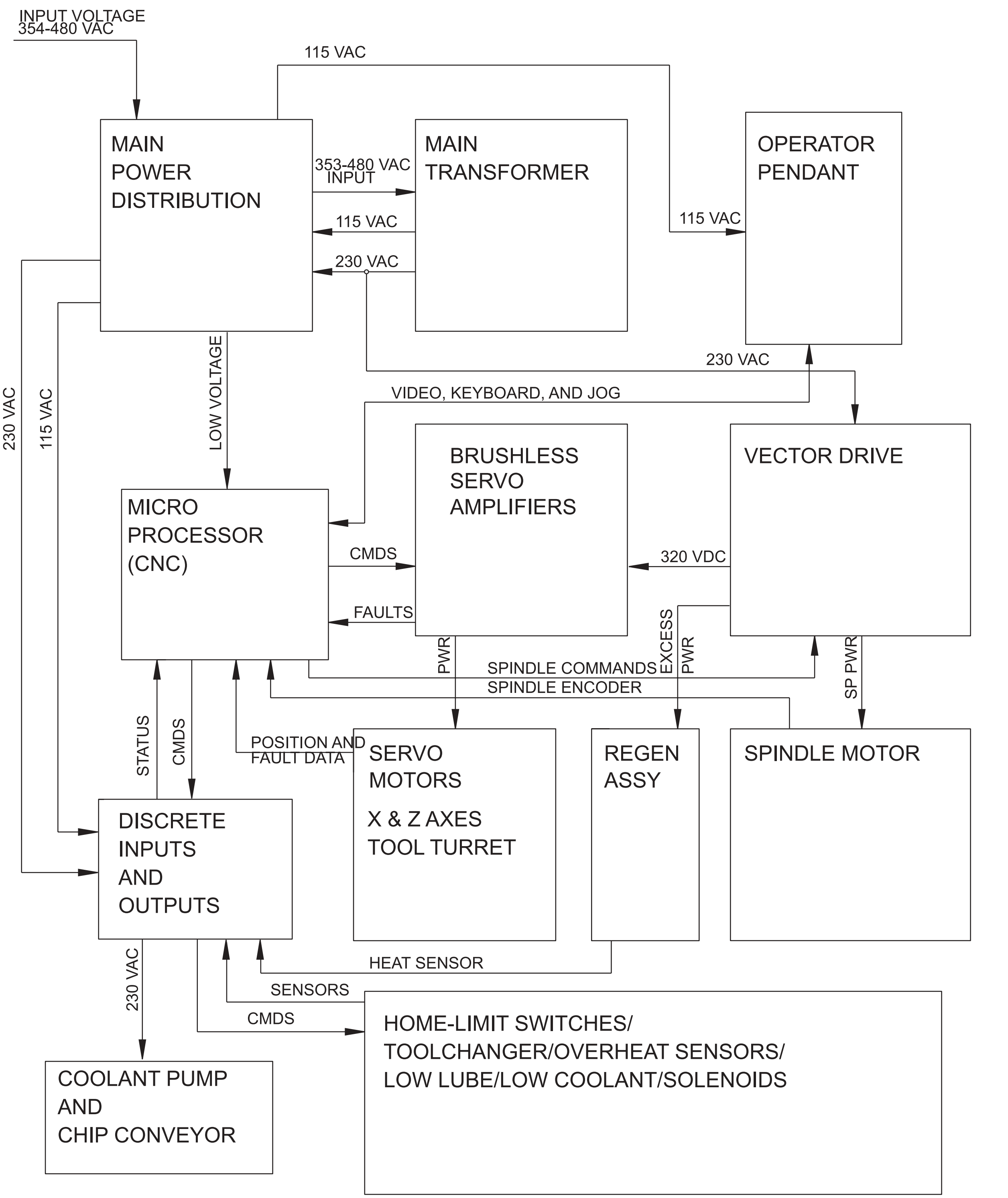
HAAS AUTOMATION SL SERIES PAGE A



NOTE FOR HIGH VOLTAGE IN, SEE PAGE C.

SYSTEM BLOCK DIAGRAM - LOW VOLTAGE

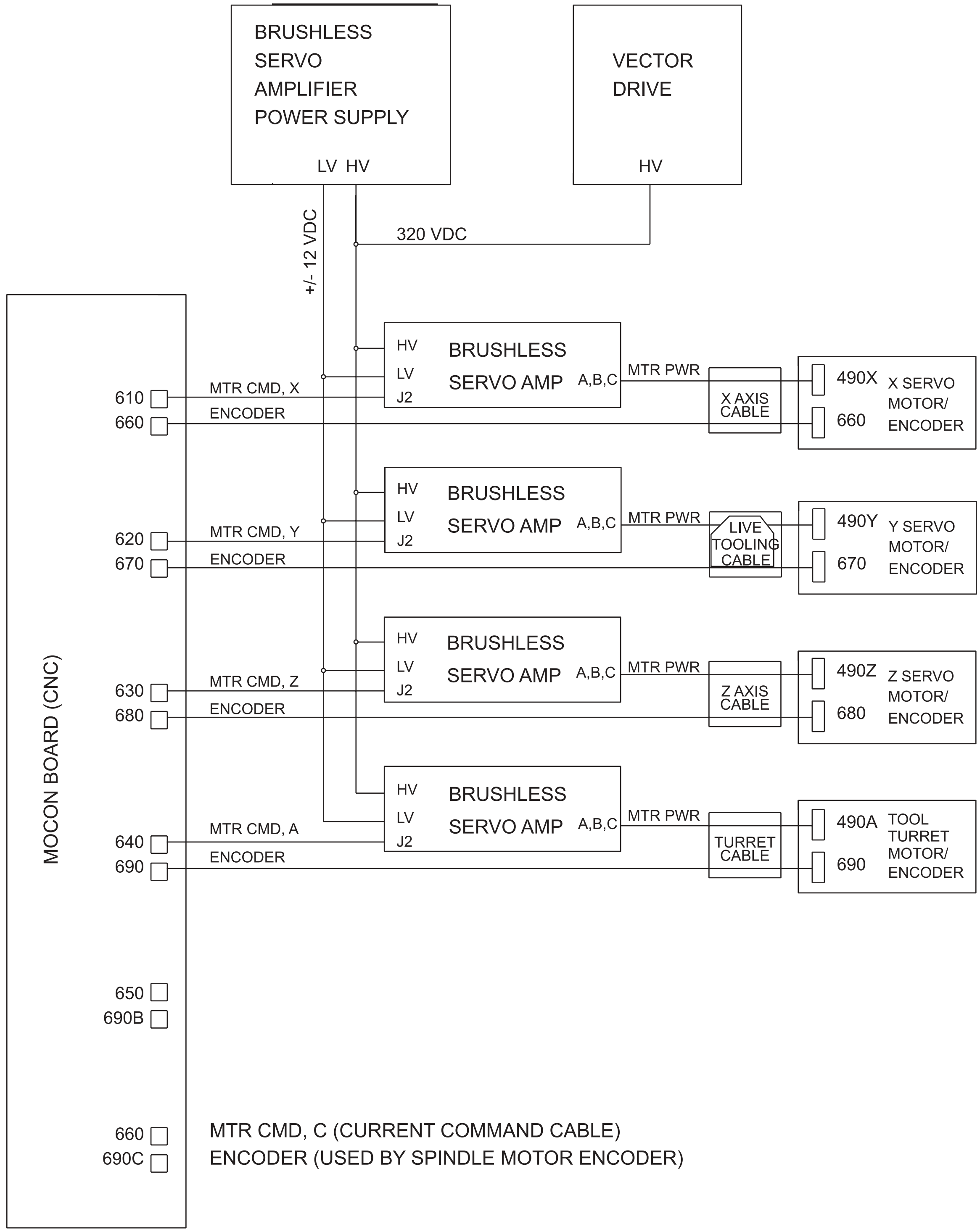
HAAS AUTOMATION SL SERIES PAGE B



NOTE FOR LOW VOLTAGE IN, SEE PAGE B.

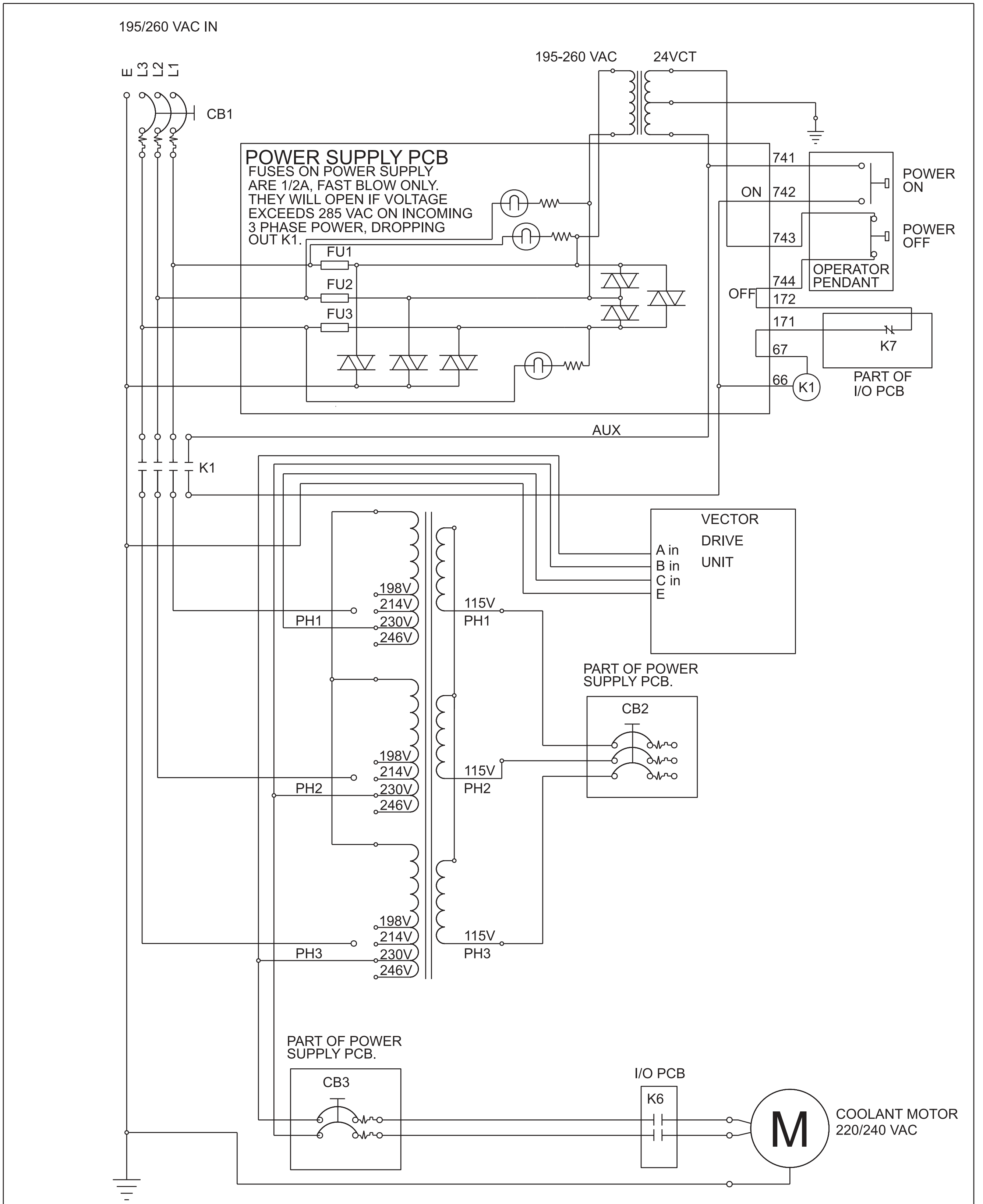
SYSTEM BLOCK DIAGRAM - HIGH VOLTAGE

HAAS AUTOMATION SL SERIES PAGE C

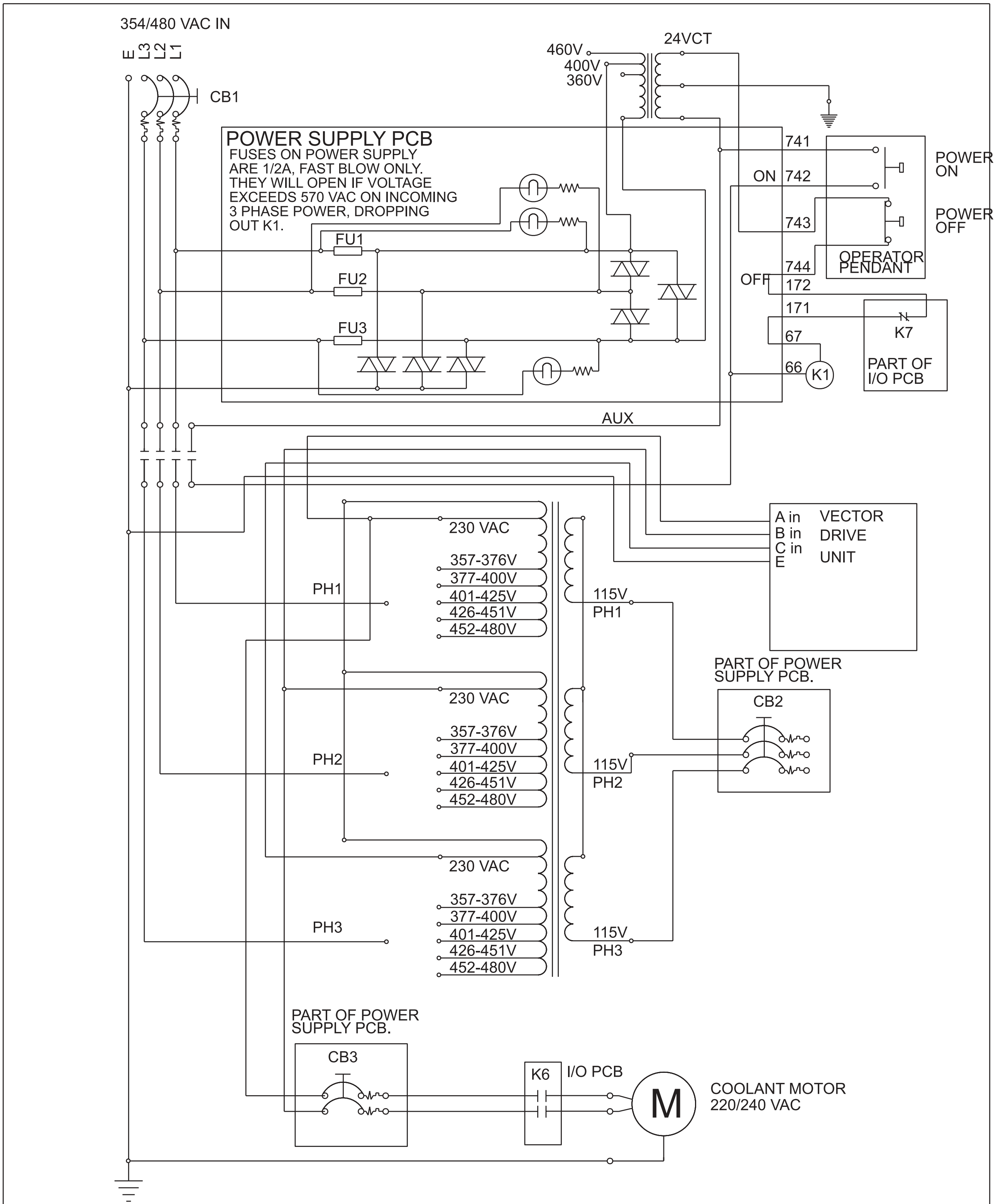


SERVO SYSTEM

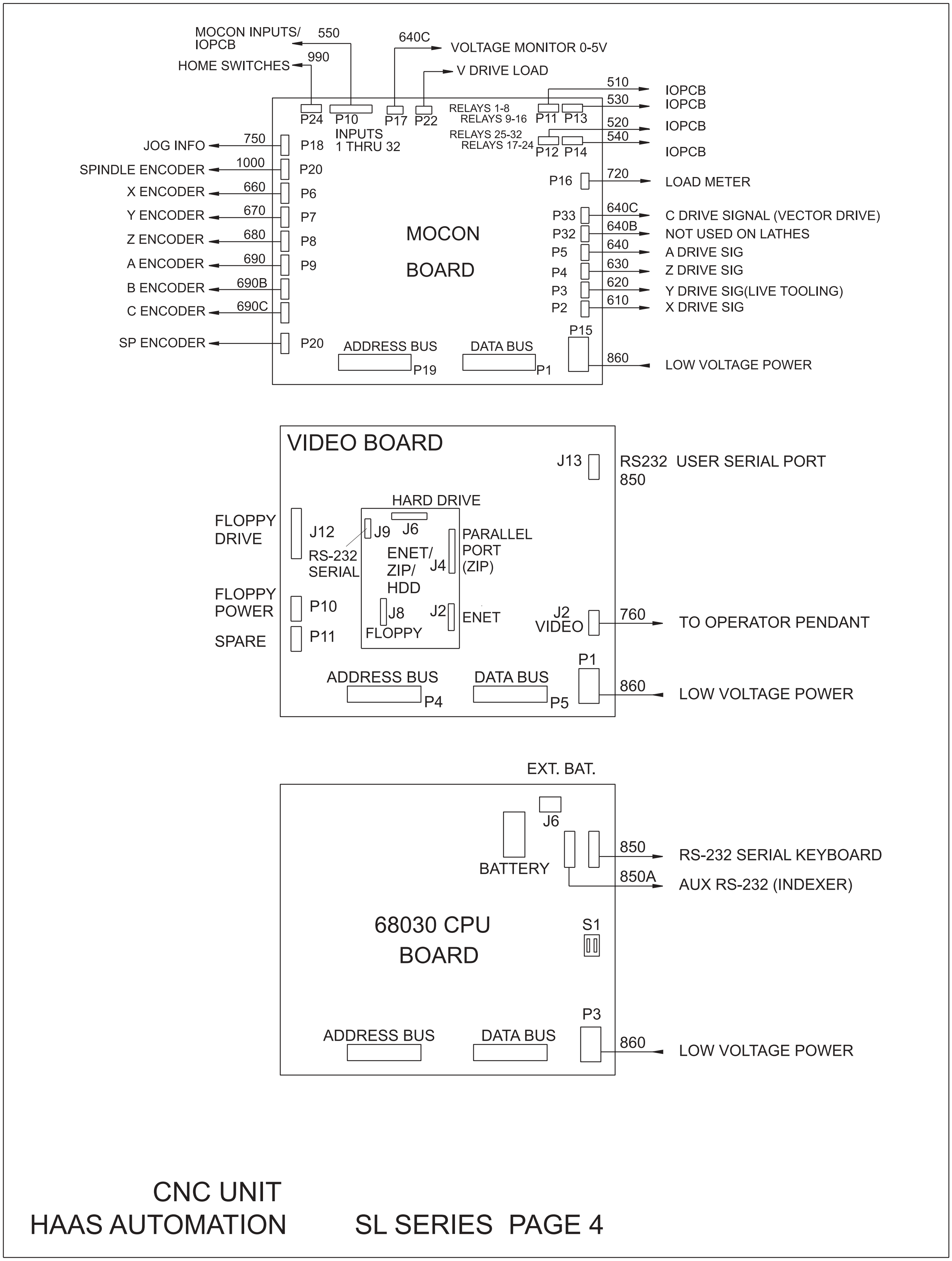
HAAS AUTOMATION SL SERIES PAGE 1

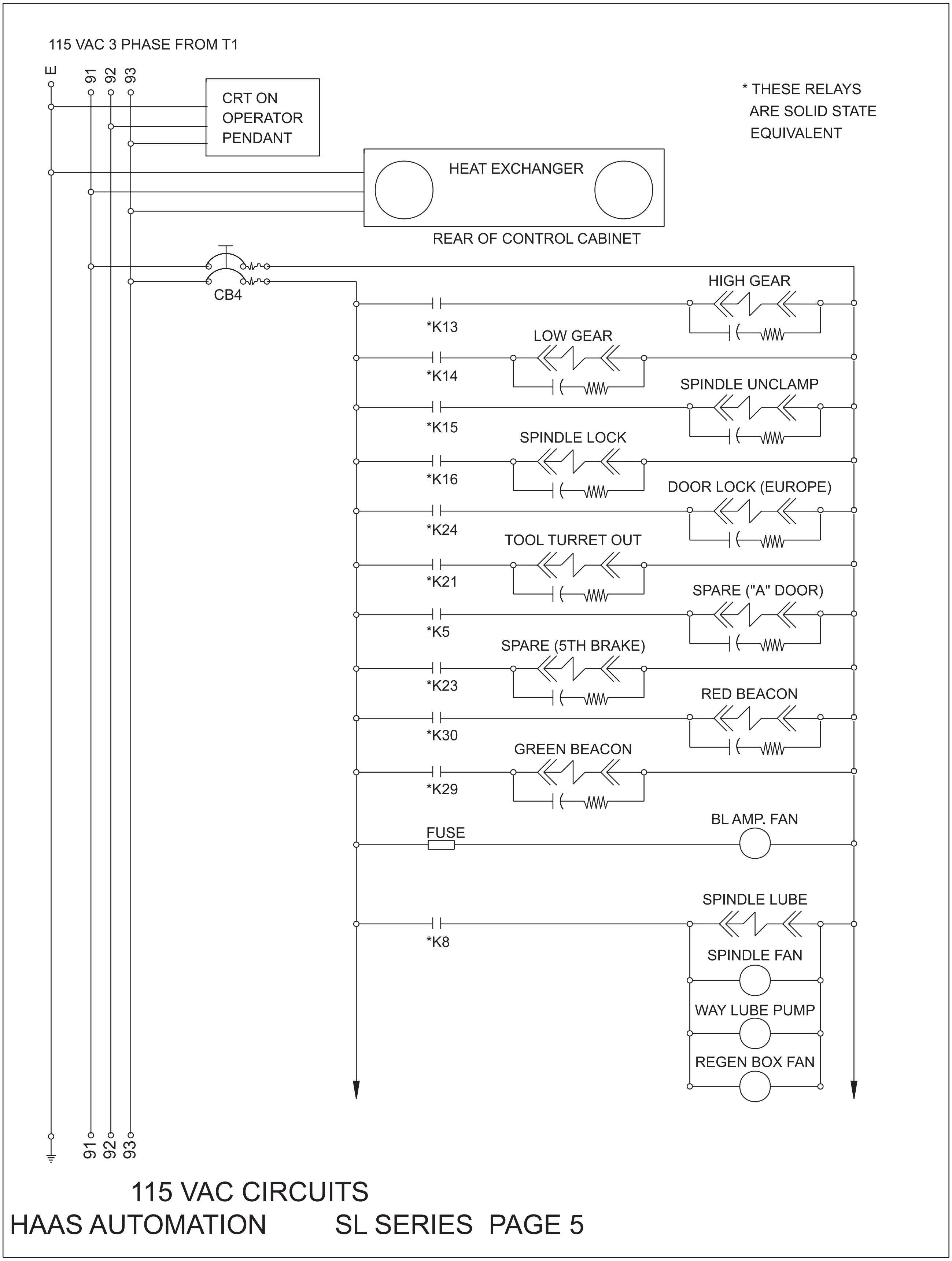


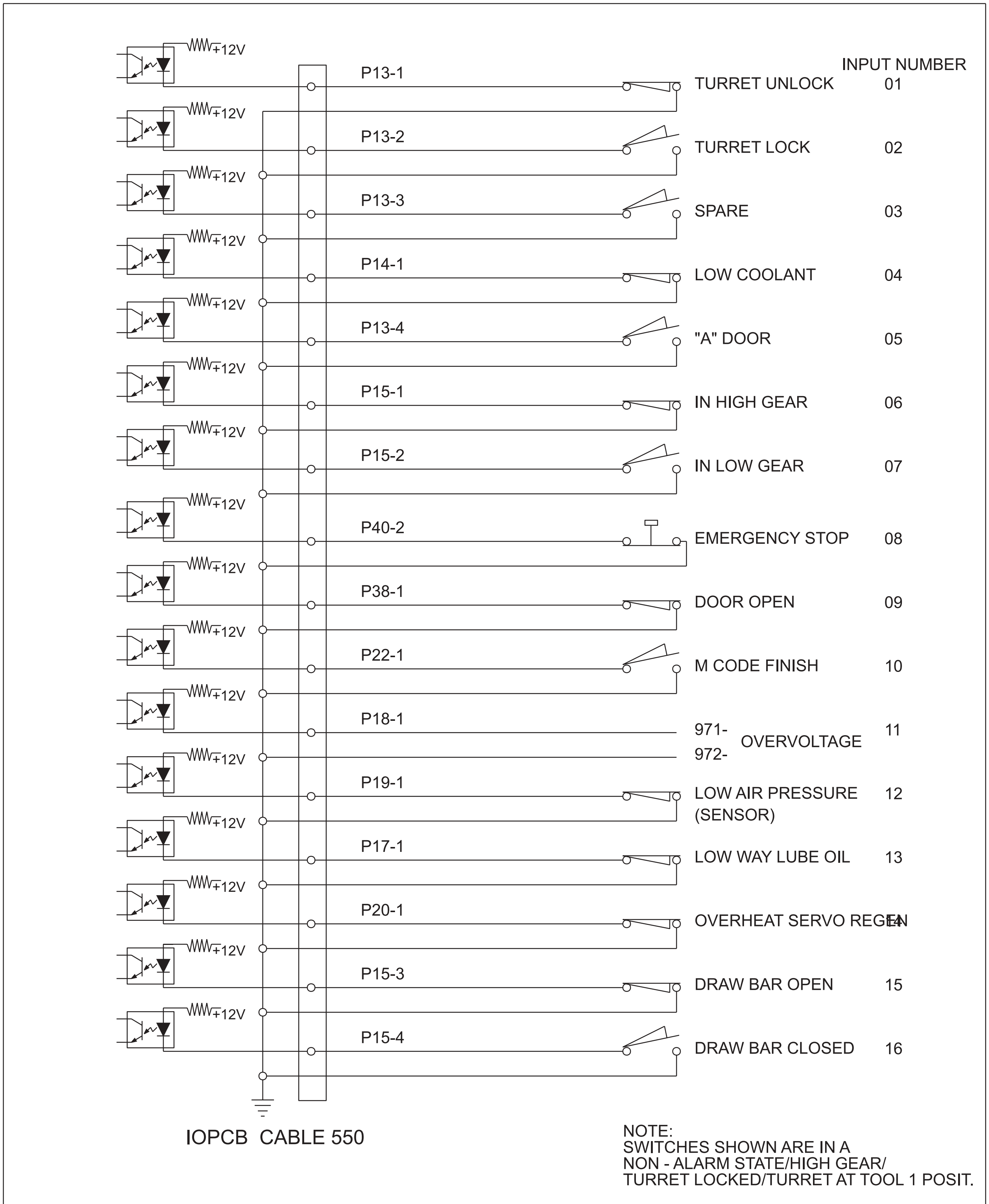
MAIN TRANSFORMER - LOW VOLTAGE
HAAS AUTOMATION SL SERIES PAGE 2



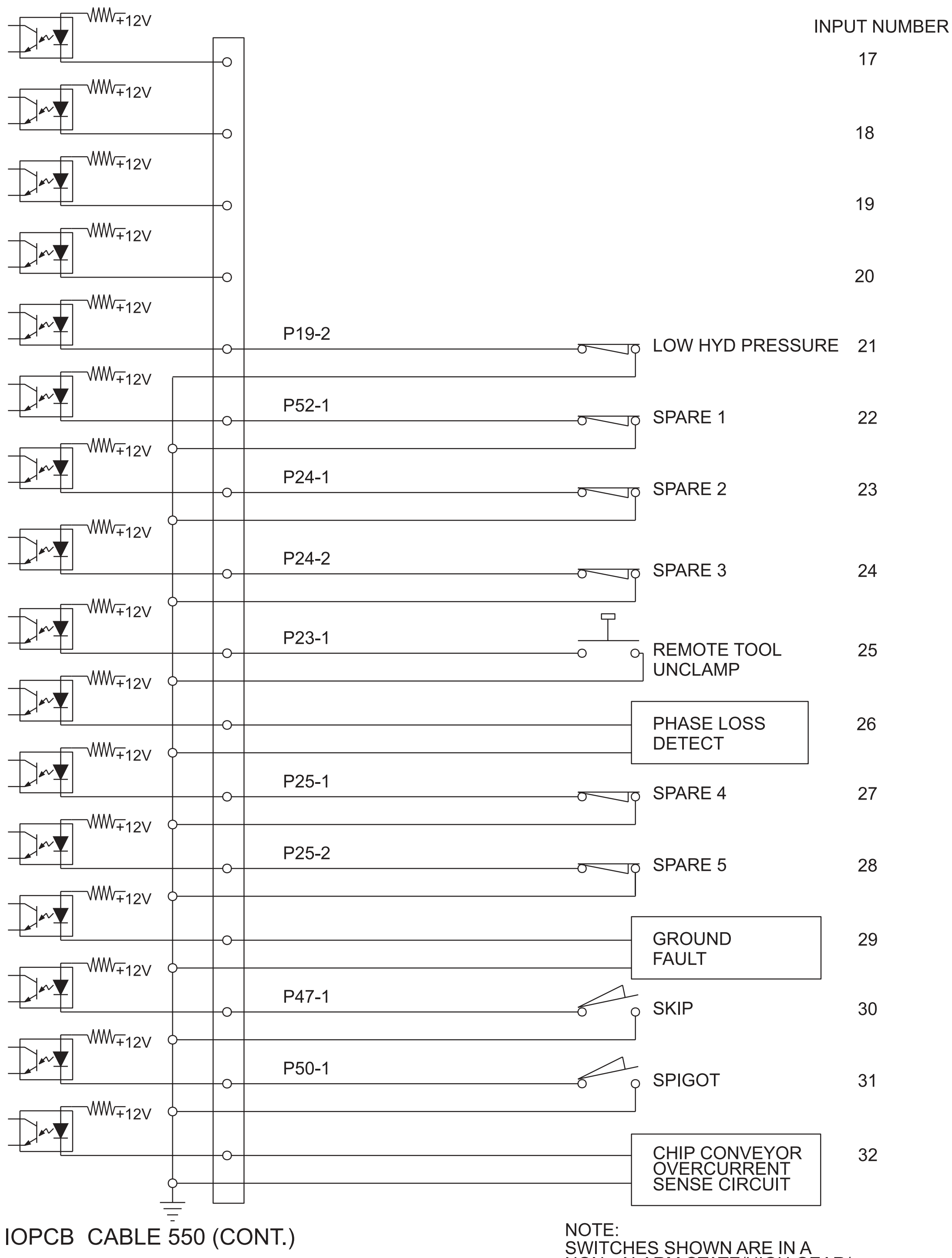
MAIN TRANSFORMER - HIGH VOLTAGE
HAAS AUTOMATION SL SERIES PAGE 3


MOCON INPUTS/ IOPCB
550
990
HOME SWITCHES
640C
VOLTAGE MONITOR 0-5V
V DRIVE LOAD
510
530
IOPCB
IOPCB
P24
P10
INPUTS
1 THRU 32
P17
P22
RELAYS 1-8
RELAYS 9-16
P11
P13
520
540
IOPCB
IOPCB
RELAYS 25-32
RELAYS 17-24
P12
P14
JOG INFO
750
P18
SPINDLE ENCODER
1000
P20
X ENCODER
660
P6
Y ENCODER
670
P7
Z ENCODER
680
P8
A ENCODER
690
P9
B ENCODER
690B
C ENCODER
690C
SP ENCODER
P20
MOCON
BOARD
P16
720
LOAD METER
P33
640C
C DRIVE SIGNAL (VECTOR DRIVE)
P32
640B
NOT USED ON LATHES
P5
640
A DRIVE SIG
P4
630
Z DRIVE SIG
P3
620
Y DRIVE SIG(LIVE TOOLING)
P2
610
X DRIVE SIG
P15
ADDRESS BUS
P19
DATA BUS
P1
860
LOW VOLTAGE POWER
VIDEO BOARD
J13
RS232 USER SERIAL PORT
850
HARD DRIVE
FLOPPY DRIVE
J12
J9
J6
RS-232 SERIAL
ENET/ ZIP/ HDD
J4
PARALLEL PORT (ZIP)
FLOPPY POWER
P10
J8
J2
ENET
J2 VIDEO
760
TO OPERATOR PENDANT
SPARE
P11
FLOPPY
ADDRESS BUS
P4
DATA BUS
P5
P1
860
LOW VOLTAGE POWER
EXT. BAT.
J6
BATTERY
850
RS-232 SERIAL KEYBOARD
850A
AUX RS-232 (INDEXER)
68030 CPU
BOARD
S1
ADDRESS BUS
DATA BUS
P3
860
LOW VOLTAGE POWER
CNC UNIT
HAAS AUTOMATION
SL SERIES PAGE 4


115 VAC 3 PHASE FROM T1
E
91
92
93
CRT ON
OPERATOR
PENDANT
* THESE RELAYS
ARE SOLID STATE
EQUIVALENT
HEAT EXCHANGER
REAR OF CONTROL CABINET
CB4
HIGH GEAR
*K13
LOW GEAR
*K14
SPINDLE UNCLAMP
*K15
SPINDLE LOCK
*K16
DOOR LOCK (EUROPE)
*K24
TOOL TURRET OUT
*K21
SPARE ("A" DOOR)
*K5
SPARE (5TH BRAKE)
*K23
RED BEACON
*K30
GREEN BEACON
*K29
FUSE
BL AMP. FAN
SPINDLE LUBE
*K8
SPINDLE FAN
WAY LUBE PUMP
REGEN BOX FAN
91
92
93
115 VAC CIRCUITS
HAAS AUTOMATION
SL SERIES PAGE 5



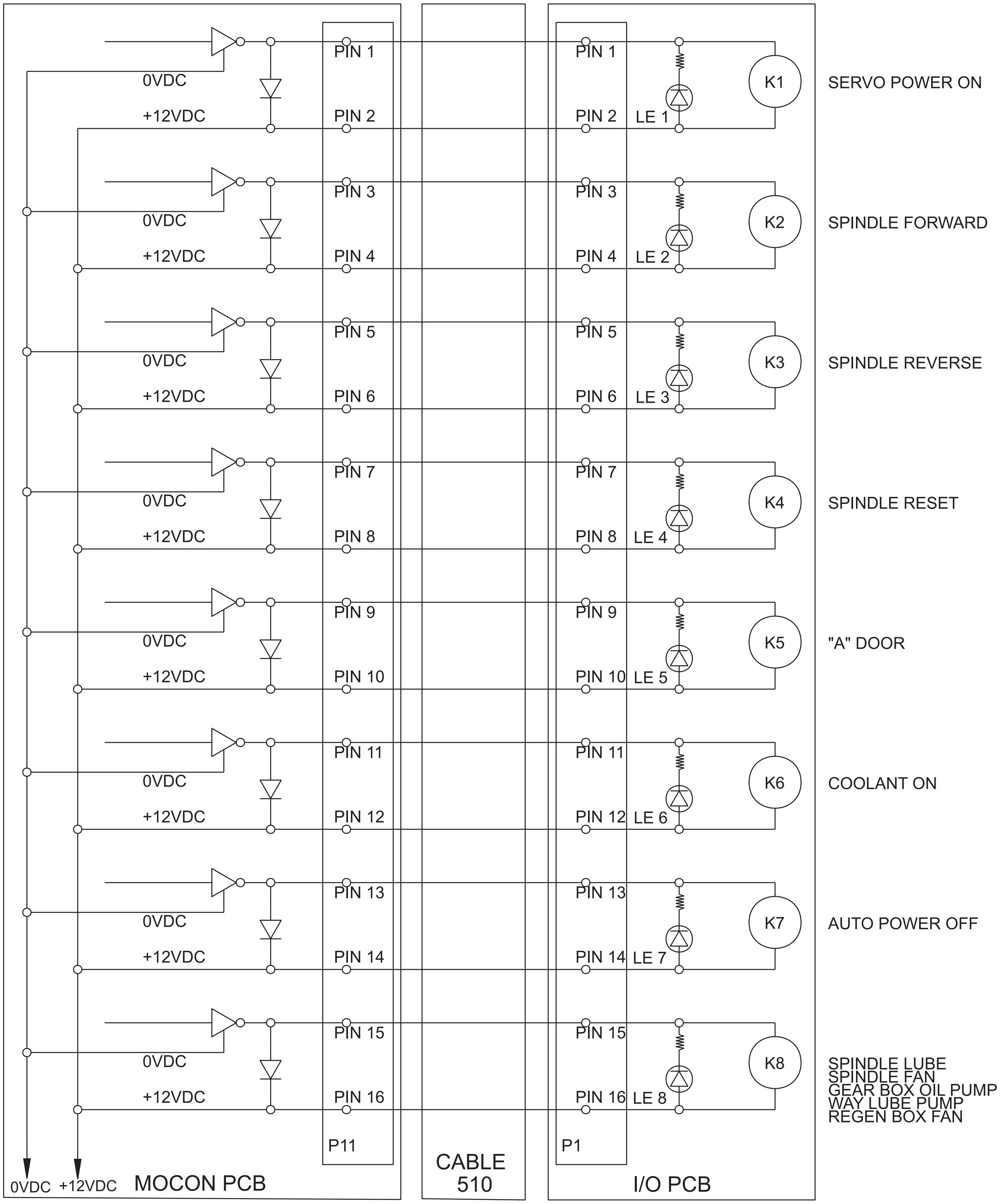
DISCRETE INPUTS 1 THROUGH 16
HAAS AUTOMATION SL SERIES PAGE 6



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

DISCRETE INPUTS 17 THROUGH 32

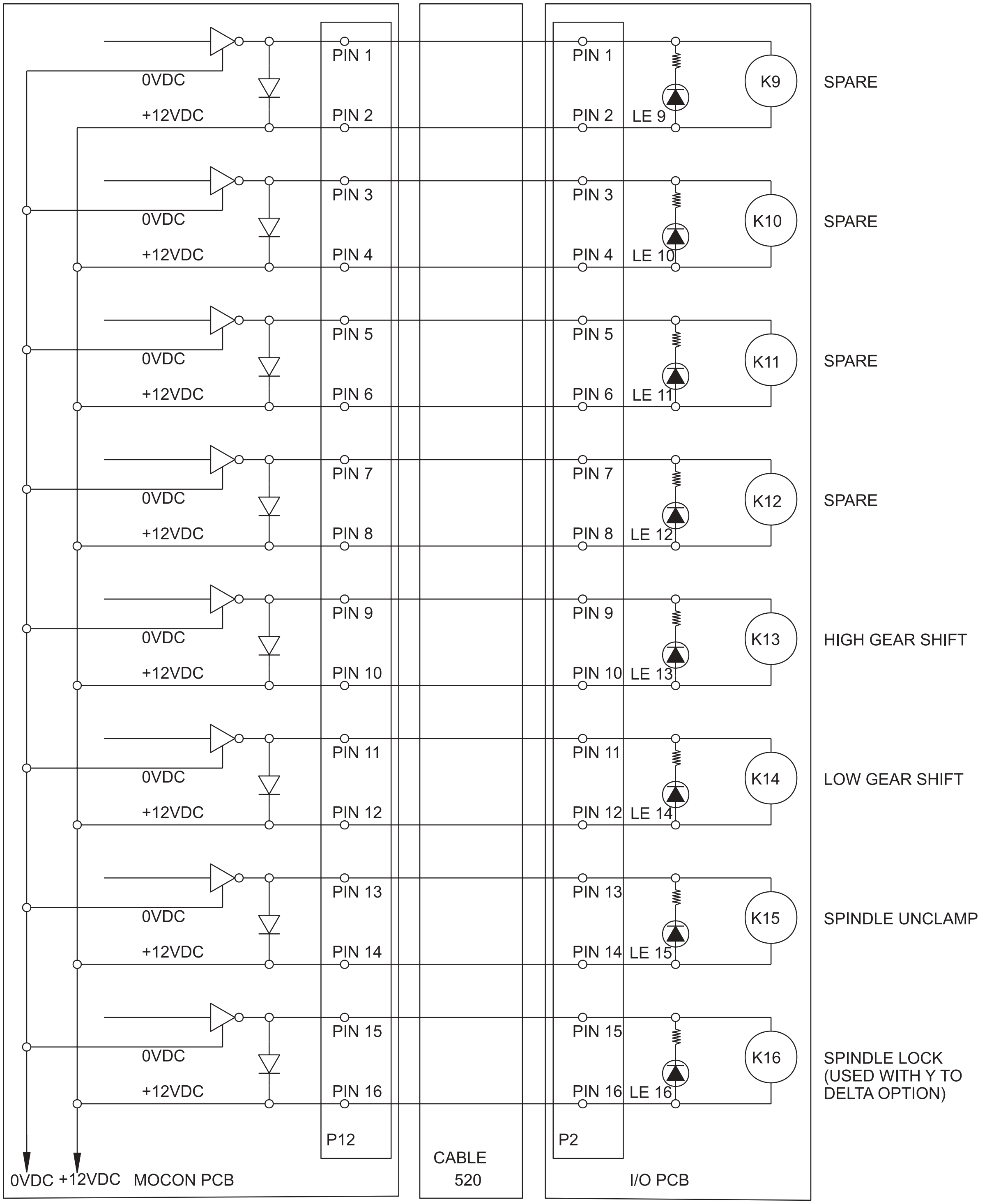
HAAS AUTOMATION SL SERIES PAGE 7



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

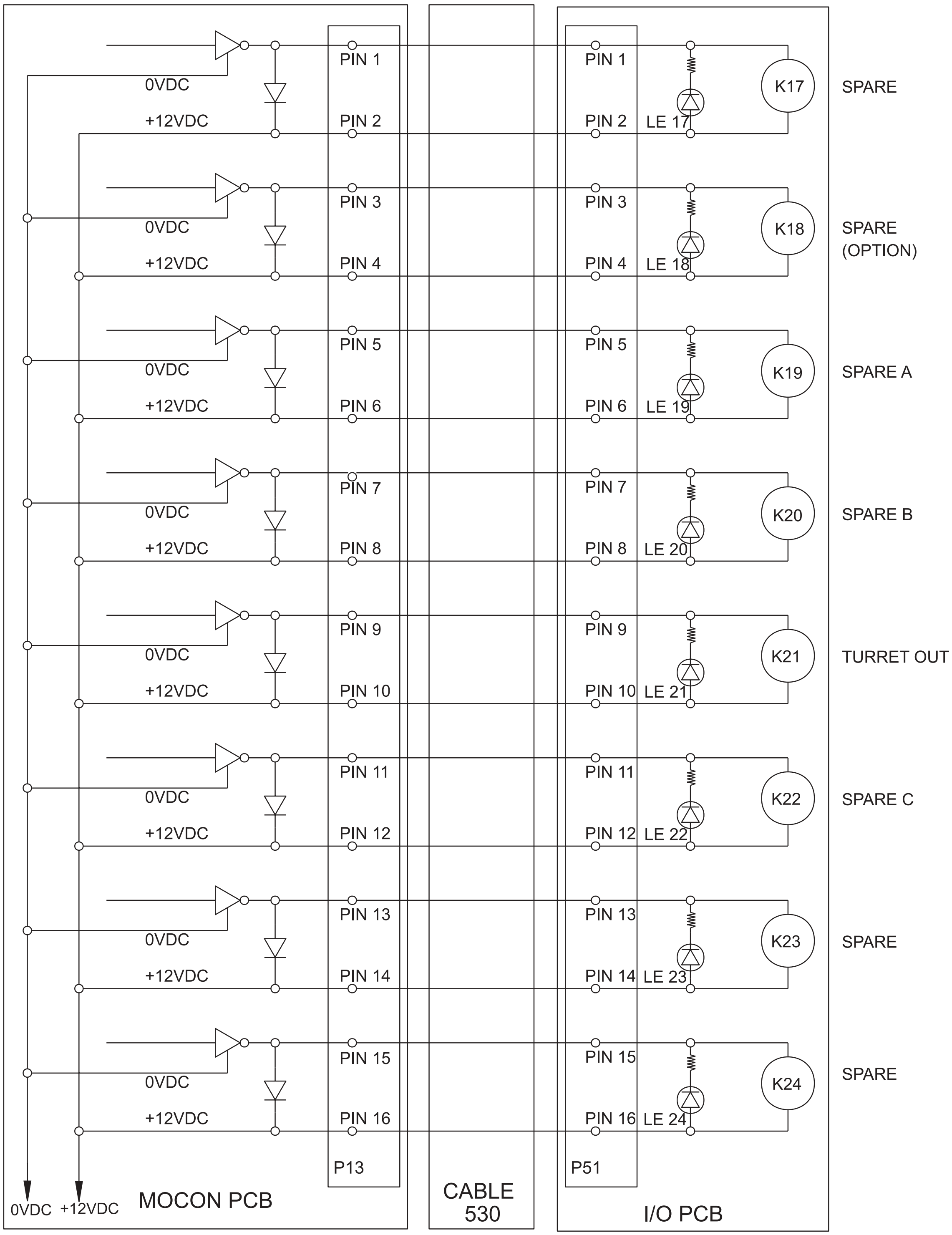
RELAY COIL DRIVERS, K1 THROUGH K8

HAAS AUTOMATION SL SERIES PAGE 8



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

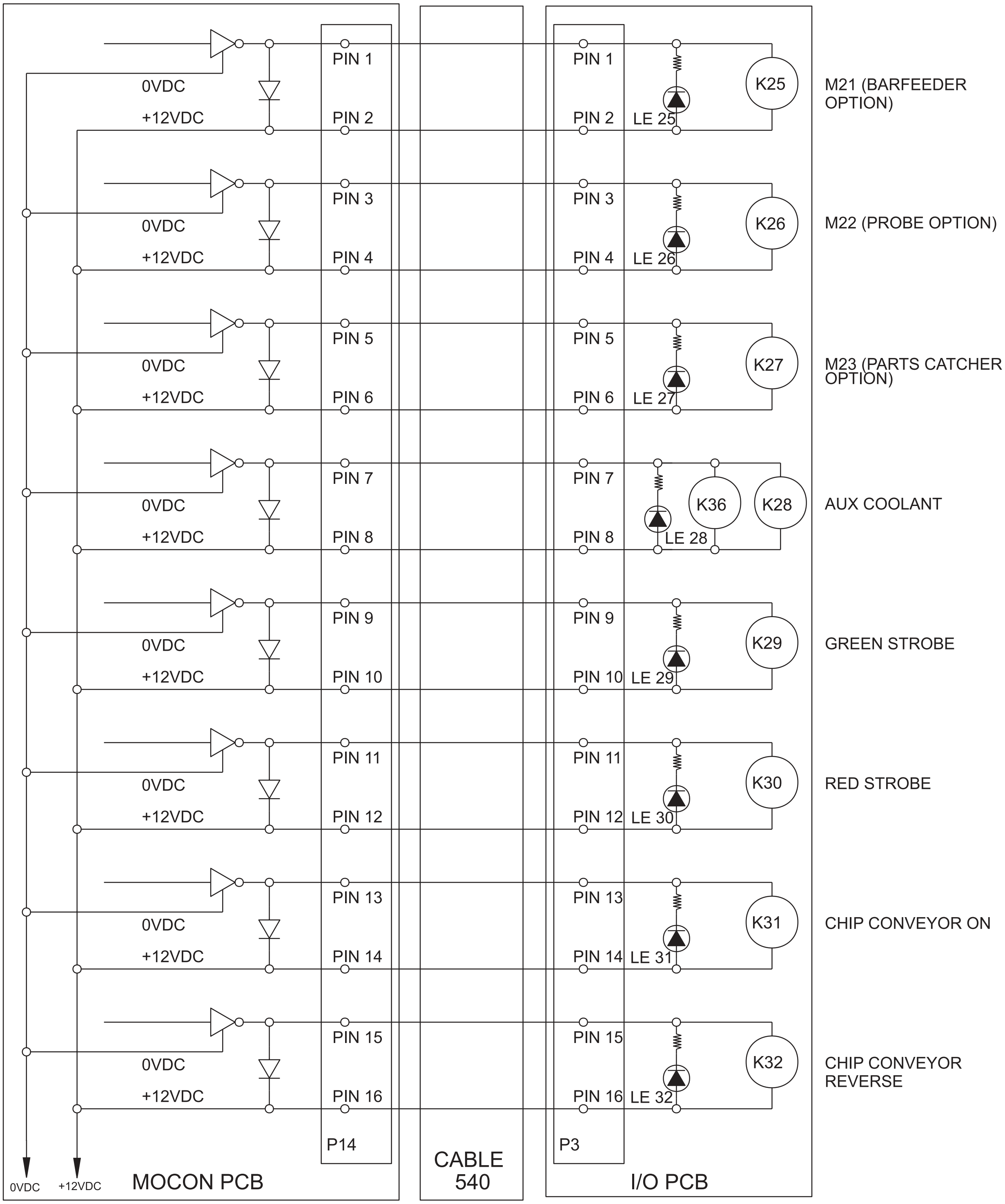
RELAY COIL DRIVERS, K9 THROUGH K16
HAAS AUTOMATION SL SERIES PAGE 9



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

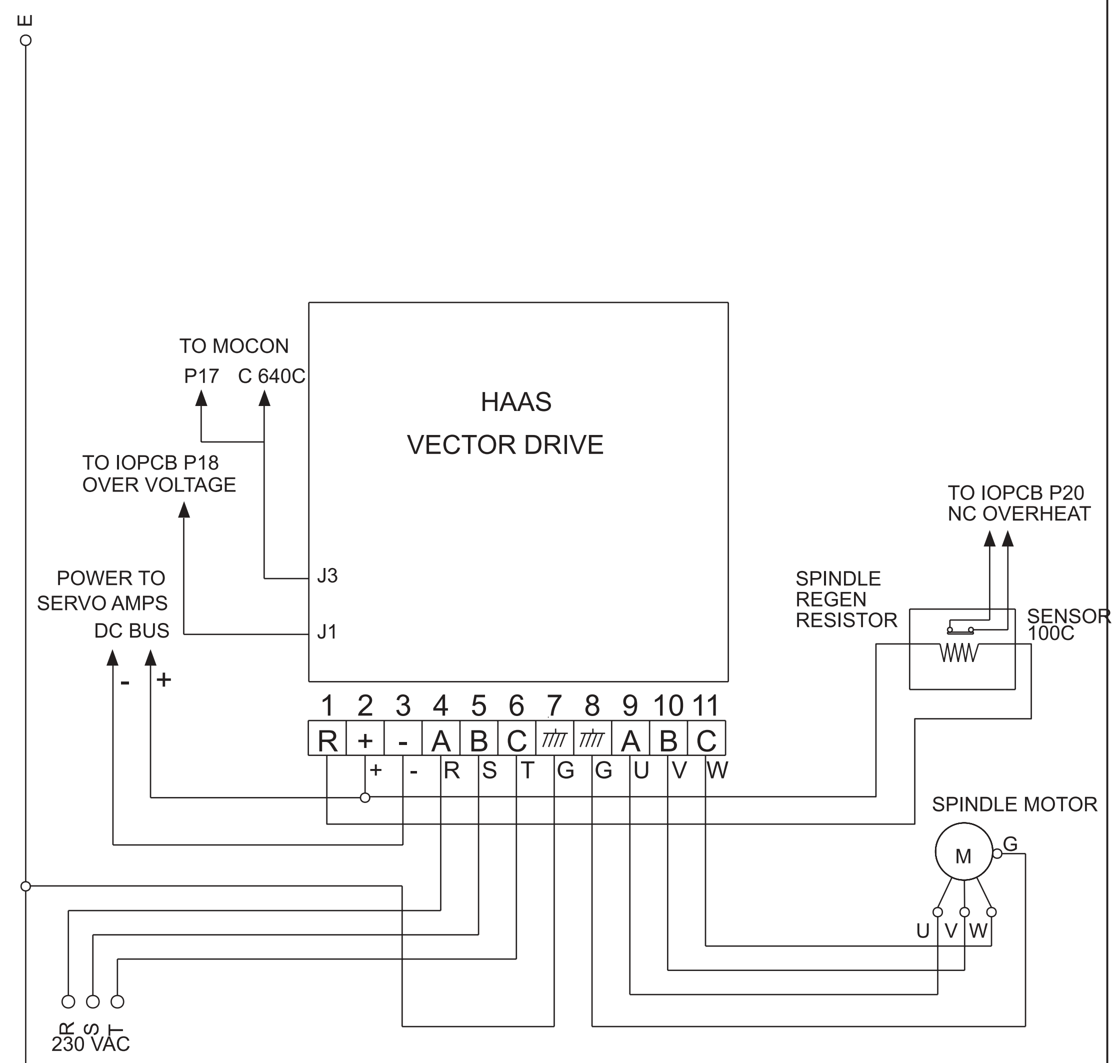
RELAY COIL DRIVERS, K17 THROUGH K24

HAAS AUTOMATION SL SERIES PAGE 10

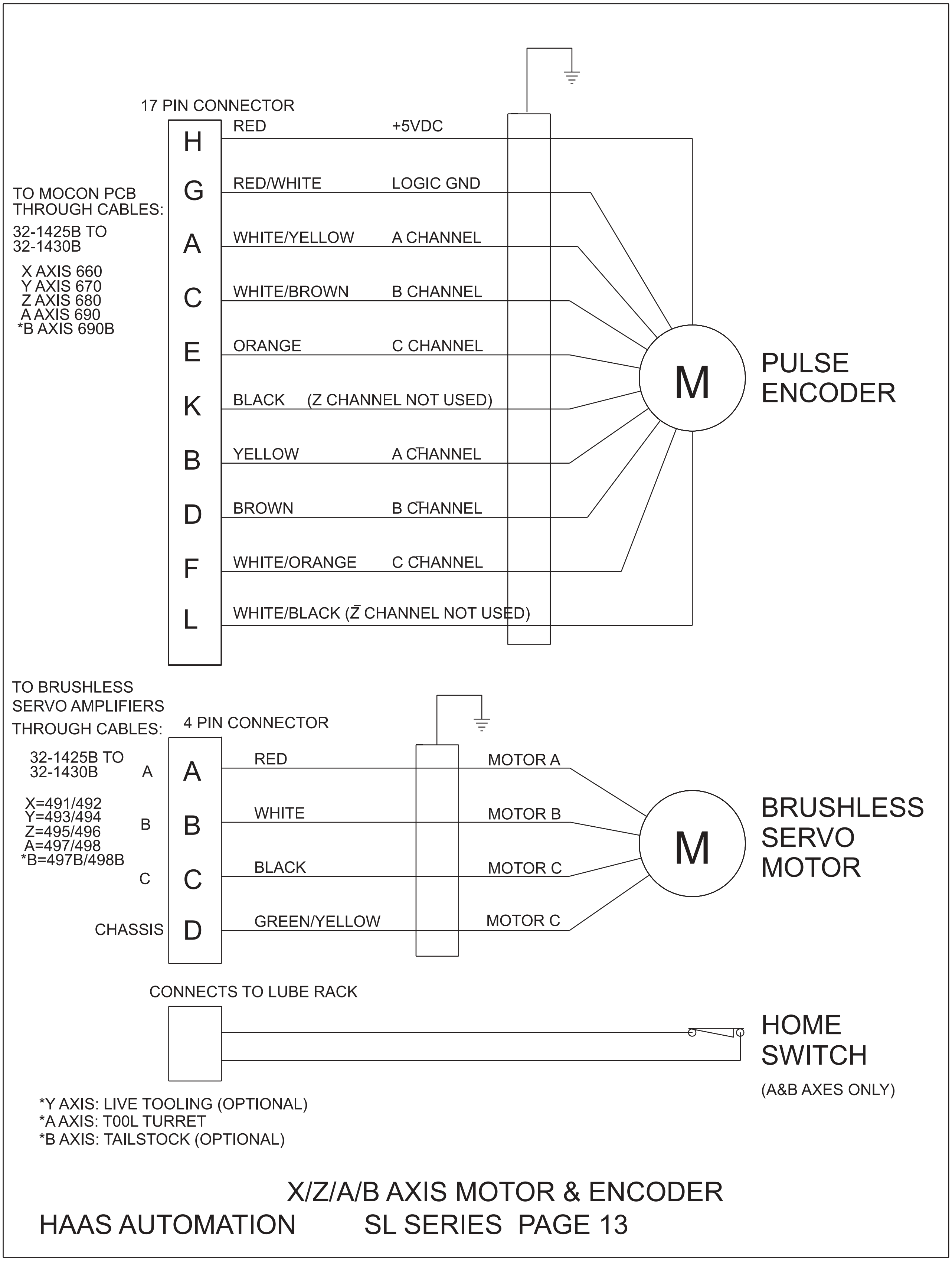


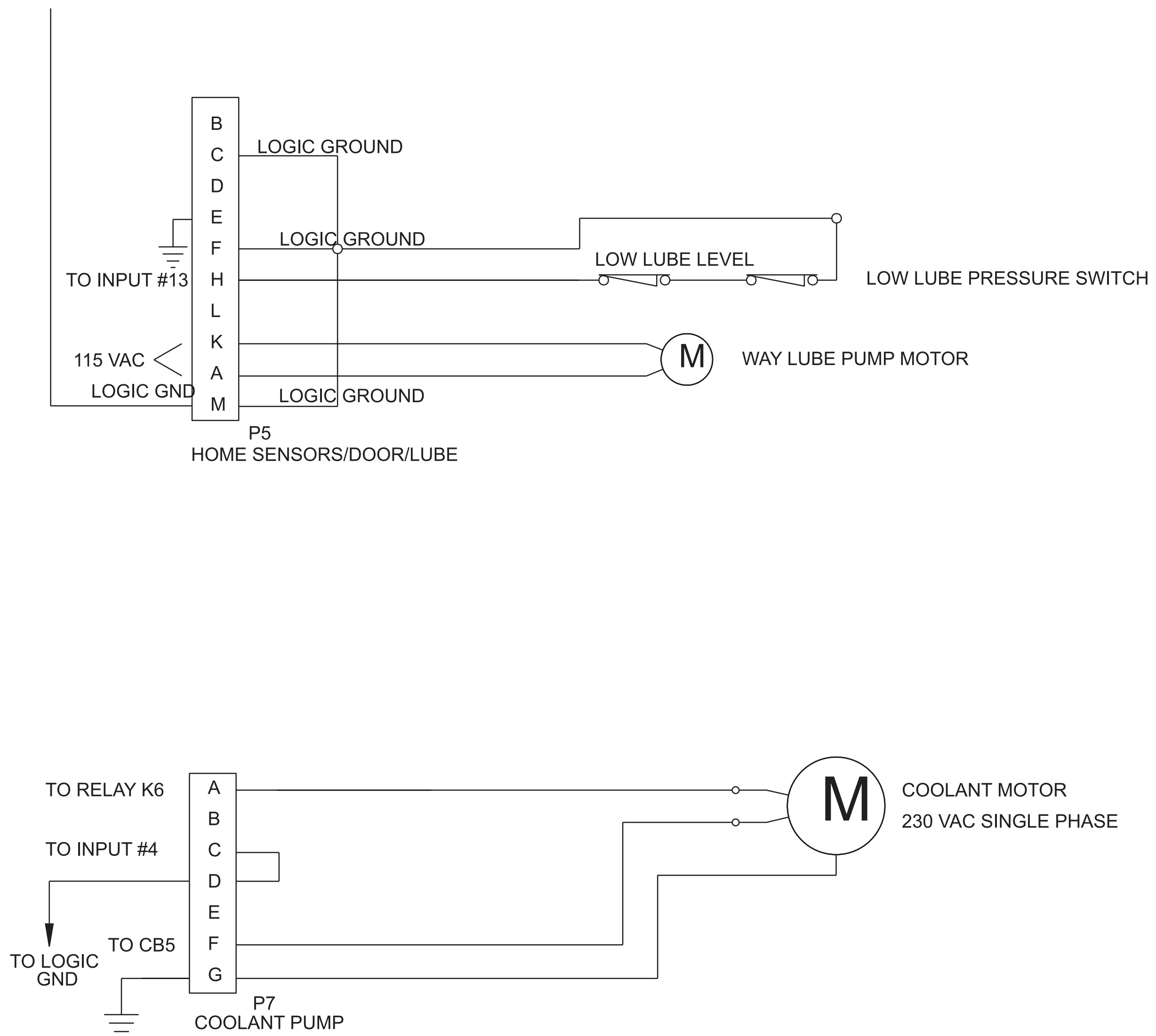
NOTE: ANY RELAY K1 ....K35 CAN BE REPLACED
WITH A SOLID STATE EQUIVALENT

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



HAAS VECTOR DRIVE UNIT
HAAS AUTOMATION SL SERIES PAGE 12

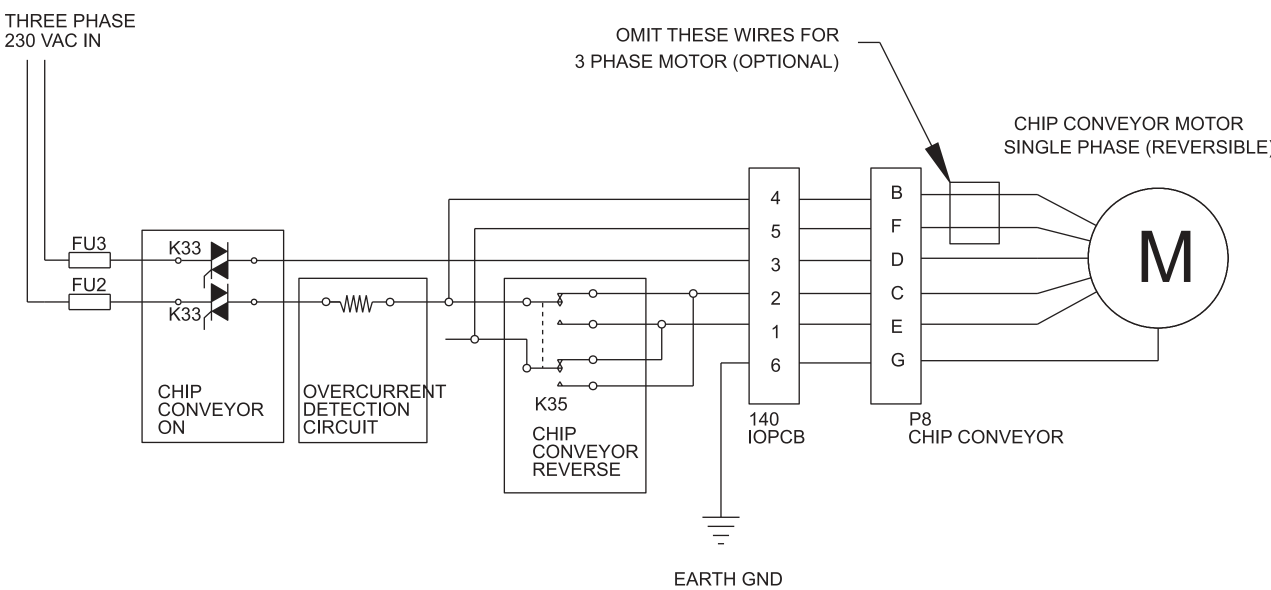

17 PIN CONNECTOR
TO MOCON PCB THROUGH CABLES:
32-1425B TO 32-1430B
X AXIS 660
Y AXIS 670
Z AXIS 680
A AXIS 690
*B AXIS 690B
H
G
A
C
E
K
B
D
F
L
RED
+5VDC
RED/WHITE
LOGIC GND
WHITE/YELLOW
A CHANNEL
WHITE/BROWN
B CHANNEL
ORANGE
C CHANNEL
BLACK
(Z CHANNEL NOT USED)
YELLOW
A CHANNEL
BROWN
B CHANNEL
WHITE/ORANGE
C CHANNEL
WHITE/BLACK (Z CHANNEL NOT USED)
M
PULSE ENCODER
TO BRUSHLESS SERVO AMPLIFIERS THROUGH CABLES:
32-1425B TO 32-1430B
X=491/492
Y=493/494
Z=495/496
A=497/498
*B=497B/498B
4 PIN CONNECTOR
A
B
C
CHASSIS
D
RED
MOTOR A
WHITE
MOTOR B
BLACK
MOTOR C
GREEN/YELLOW
MOTOR C
M
BRUSHLESS SERVO MOTOR
CONNECTS TO LUBE RACK
HOME SWITCH
(A&B AXES ONLY)
*Y AXIS: LIVE TOOLING (OPTIONAL)
*A AXIS: T00L TURRET
*B AXIS: TAILSTOCK (OPTIONAL)
X/Z/A/B AXIS MOTOR & ENCODER
HAAS AUTOMATION
SL SERIES PAGE 13



NOTE: CONNECTORS ARE LOCATED ON SIDE OF CONTROL CABINET.

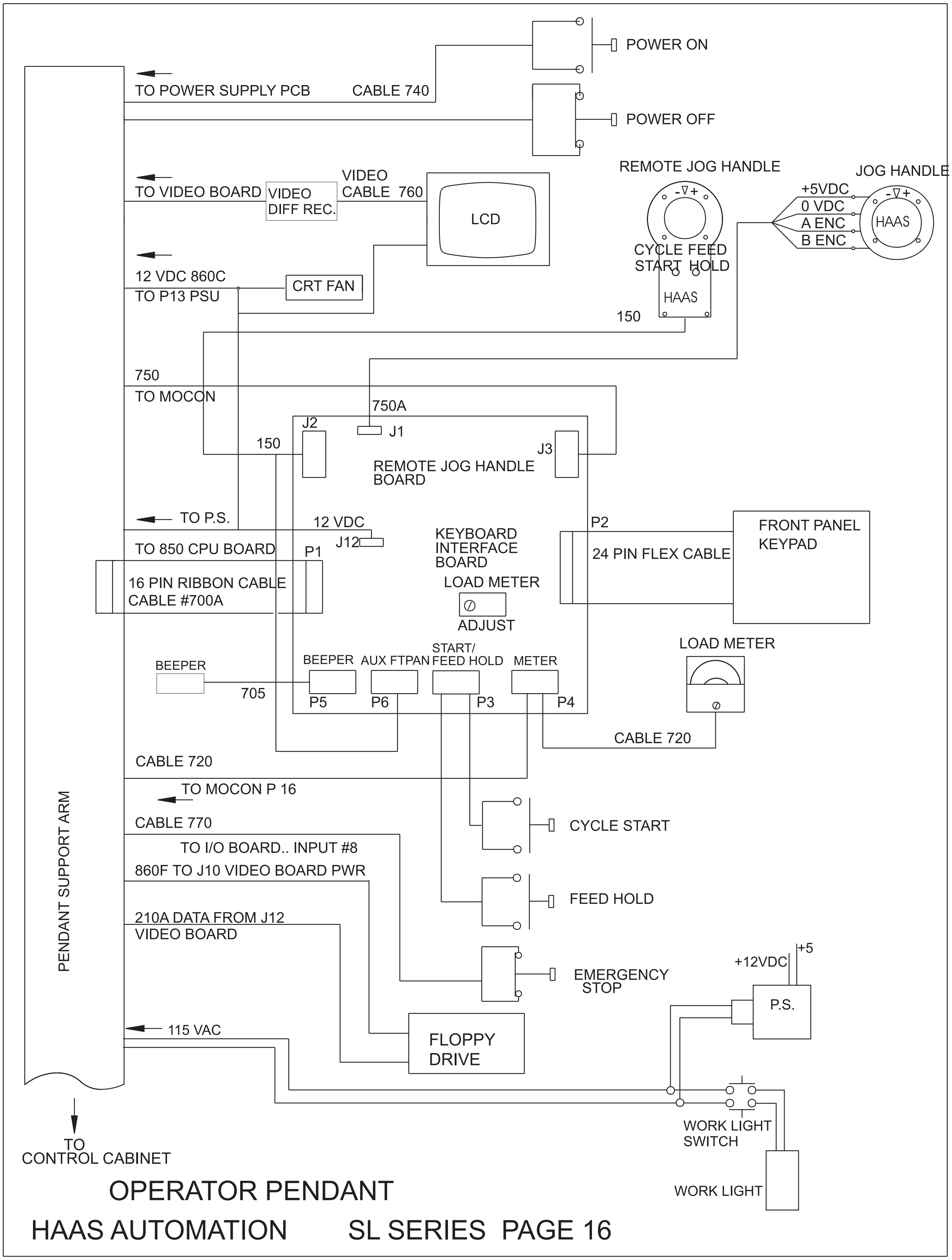
CABINET CONNECTORS

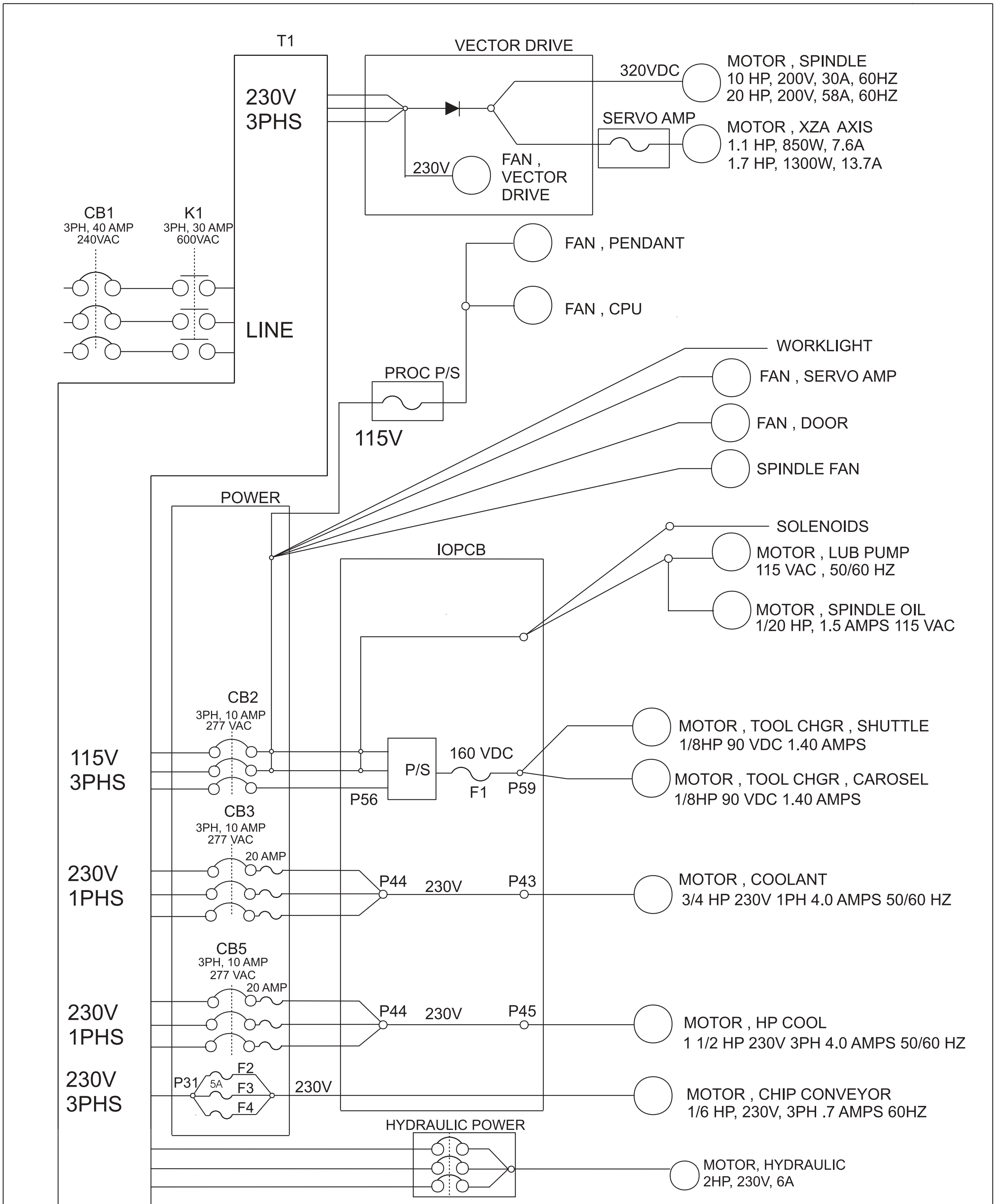
HAAS AUTOMATION SL SERIES PAGE 14



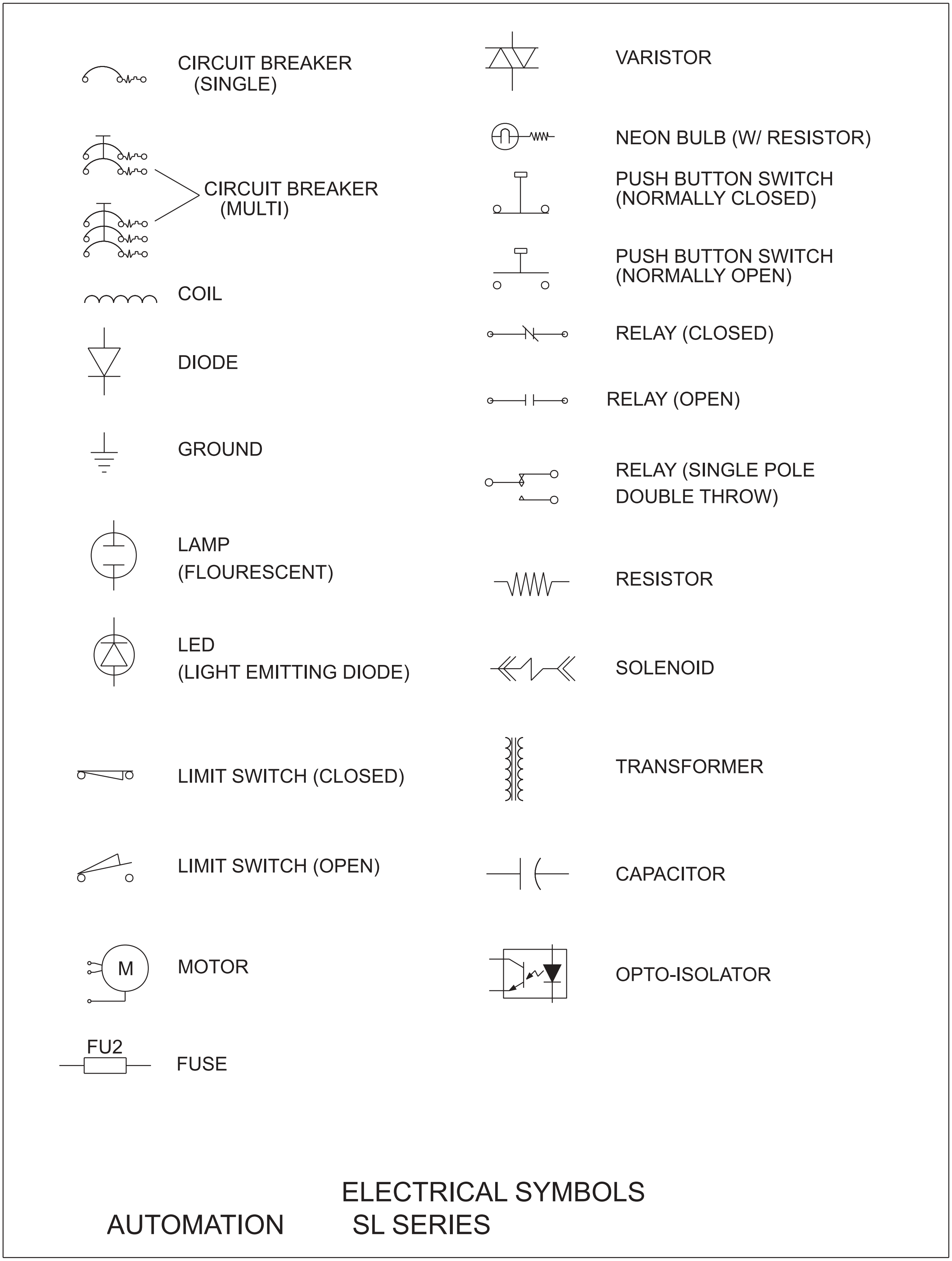
HAAS AUTOMATION

CHIP CONVEYOR MOTOR
SL SERIES PAGE 15


POWER ON
TO POWER SUPPLY PCB
CABLE 740
POWER OFF
REMOTE JOG HANDLE
JOG HANDLE
TO VIDEO BOARD
VIDEO DIFF REC.
VIDEO CABLE 760
LCD
+5VDC
0 VDC
A ENC
B ENC
HAAS
CYCLE FEED
START HOLD
HAAS
12 VDC 860C
TO P13 PSU
CRT FAN
150
750
TO MOCON
750A
J2
J1
150
J3
REMOTE JOG HANDLE BOARD
TO P.S.
12 VDC
P2
FRONT PANEL KEYPAD
TO 850 CPU BOARD
J12
P1
KEYBOARD INTERFACE BOARD
24 PIN FLEX CABLE
16 PIN RIBBON CABLE
CABLE #700A
LOAD METER
ADJUST
LOAD METER
BEEPER
BEEPER
AUX FTPAN
START/ FEED HOLD
METER
705
P5
P6
P3
P4
CABLE 720
CABLE 720
TO MOCON P 16
CABLE 770
CYCLE START
TO I/O BOARD.. INPUT #8
860F TO J10 VIDEO BOARD PWR
FEED HOLD
210A DATA FROM J12
VIDEO BOARD
PENDANT SUPPORT ARM
EMERGENCY STOP
+12VDC
+5
P.S.
115 VAC
FLOPPY DRIVE
WORK LIGHT SWITCH
TO CONTROL CABINET
WORK LIGHT
OPERATOR PENDANT
HAAS AUTOMATION
SL SERIES PAGE 16



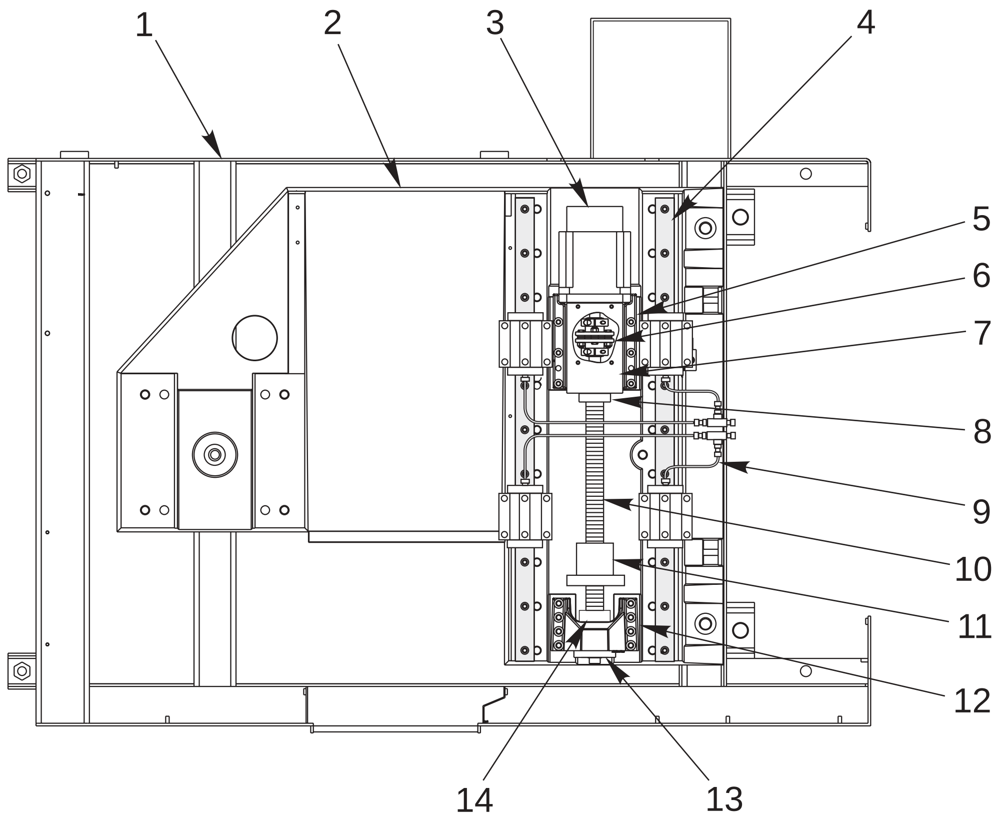
AUTOMATION SL SERIES PAGE 17

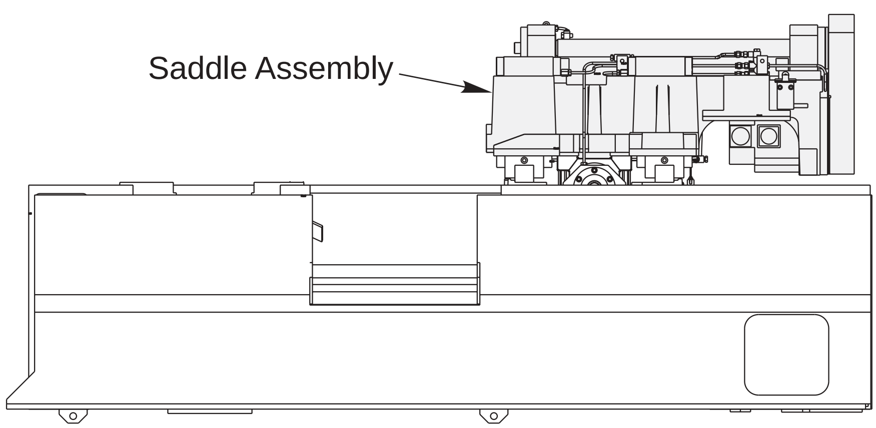

CIRCUIT BREAKER (SINGLE)
CIRCUIT BREAKER (MULTI)
COIL
DIODE
GROUND
LAMP (FLOURESCENT)
LED (LIGHT EMITTING DIODE)
LIMIT SWITCH (CLOSED)
LIMIT SWITCH (OPEN)
M
MOTOR
FU2
FUSE
VARISTOR
NEON BULB (W/ RESISTOR)
PUSH BUTTON SWITCH (NORMALLY CLOSED)
PUSH BUTTON SWITCH (NORMALLY OPEN)
RELAY (CLOSED)
RELAY (OPEN)
RELAY (SINGLE POLE DOUBLE THROW)
RESISTOR
SOLENOID
TRANSFORMER
CAPACITOR
OPTO-ISOLATOR
ELECTRICAL SYMBOLS
AUTOMATION
SL SERIES

ASSEMBLY DRAWINGS

AND

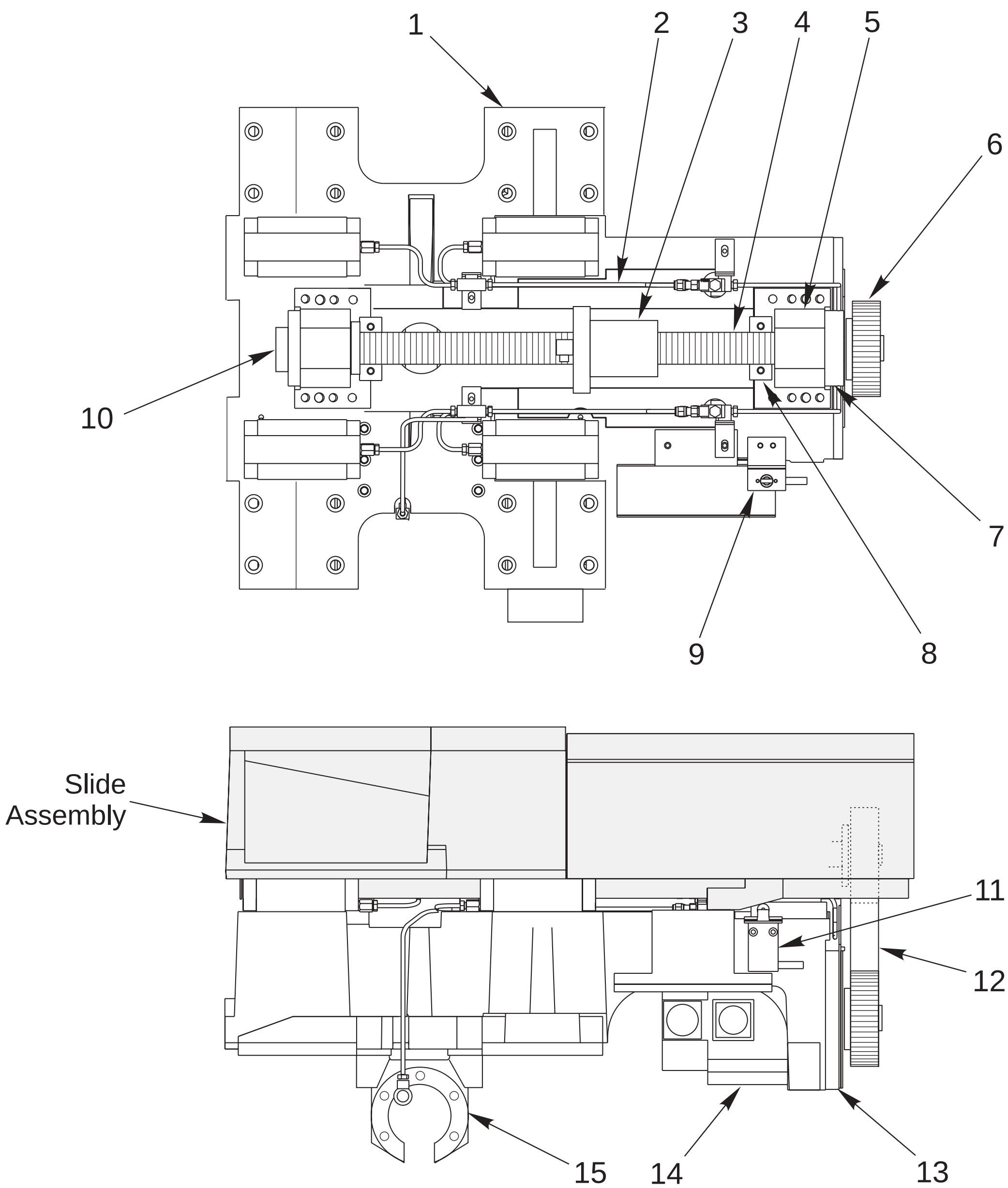
PARTS LISTS





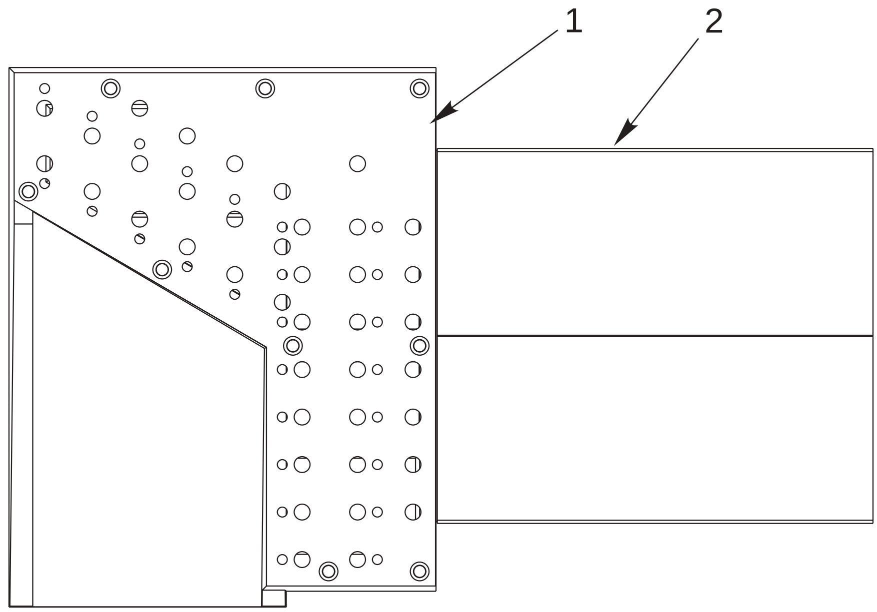
1. 20-1226A Base Assembly
2. 20-1336 Base Machined
3. 62-0014 Yaskawa Motor
4. 50-0017 X-Axis Linear Guide (2)
5. 20-7010A Motor Mount
6. 30-1220A Coupling Assembly
7. 25-7042 Motor Mount Cover
8. 20-1230 Motor Bumper
9. 30-2923 Oil Line Assembly
10. 24-8765 X-Axis Ballscrew
11. 24-8548 Screw Nut
12. 20-0773 Ballscrew Mount
13. 20-7416 Bearing Cartridge Housing
14. 20-4394 Support Bumper

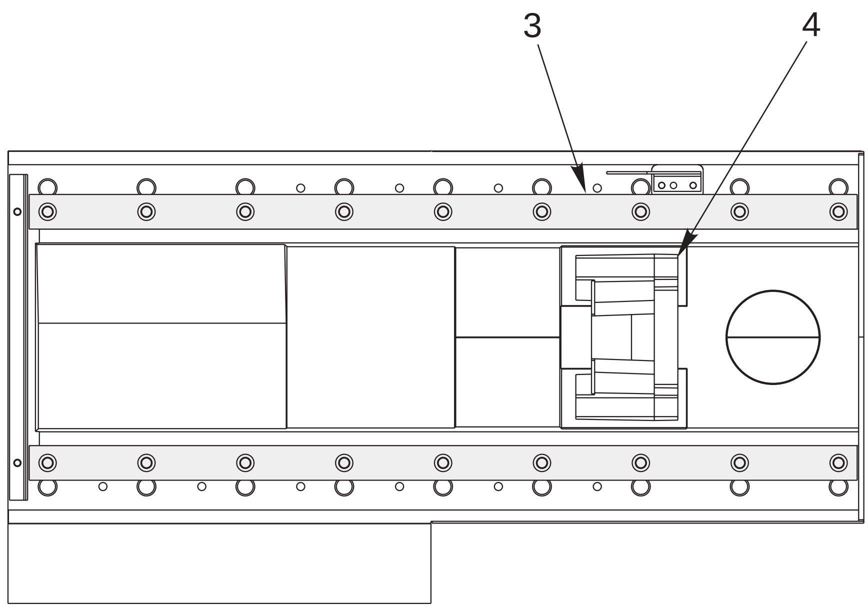
Mini Lathe Base Assembly and Parts List



1. 20-1337 Saddle Machined
2. 30-2924 Oil Line Assembly
3. 24-8548 Screw Nut
4. 24-8765 Z-Axis Ballscrew
5. 20-1237 Ballscrew Support
6. 20-4239 Sprocket (2)
7. 20-0488A Adapter Race
8. 20-1232 Support Bumper (2)
9. 25-7267 Switch Mount
10. 20-7416 Bearing Cartridge Housing
11. Telemecanique Switch
12. 54-0045 Belt
13. 20-1231 Motor Face Plate
14. 62-0014 Yaskawa Motor
15. 20-3006 Nut Housing Machined

Mini Lathe Saddle Assembly and Parts List

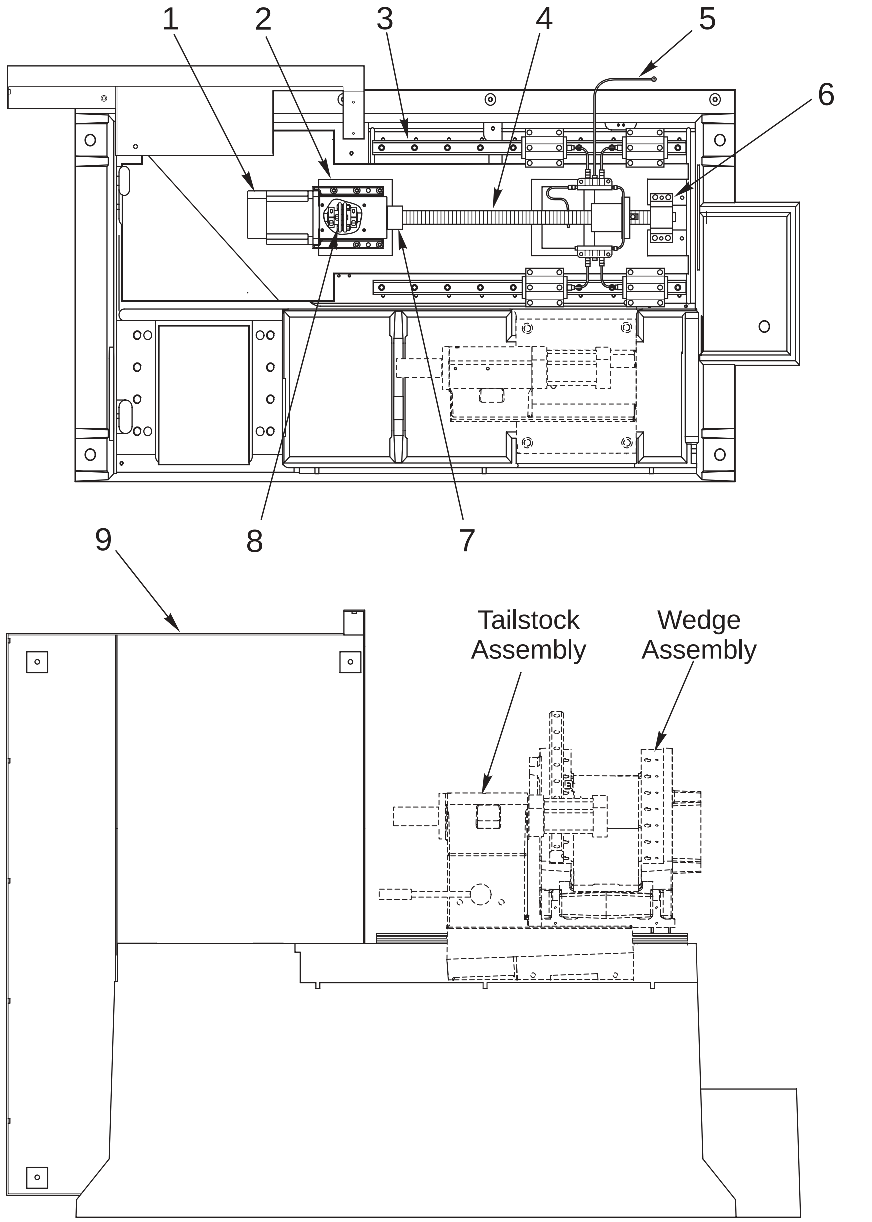




BOTTOM VIEW

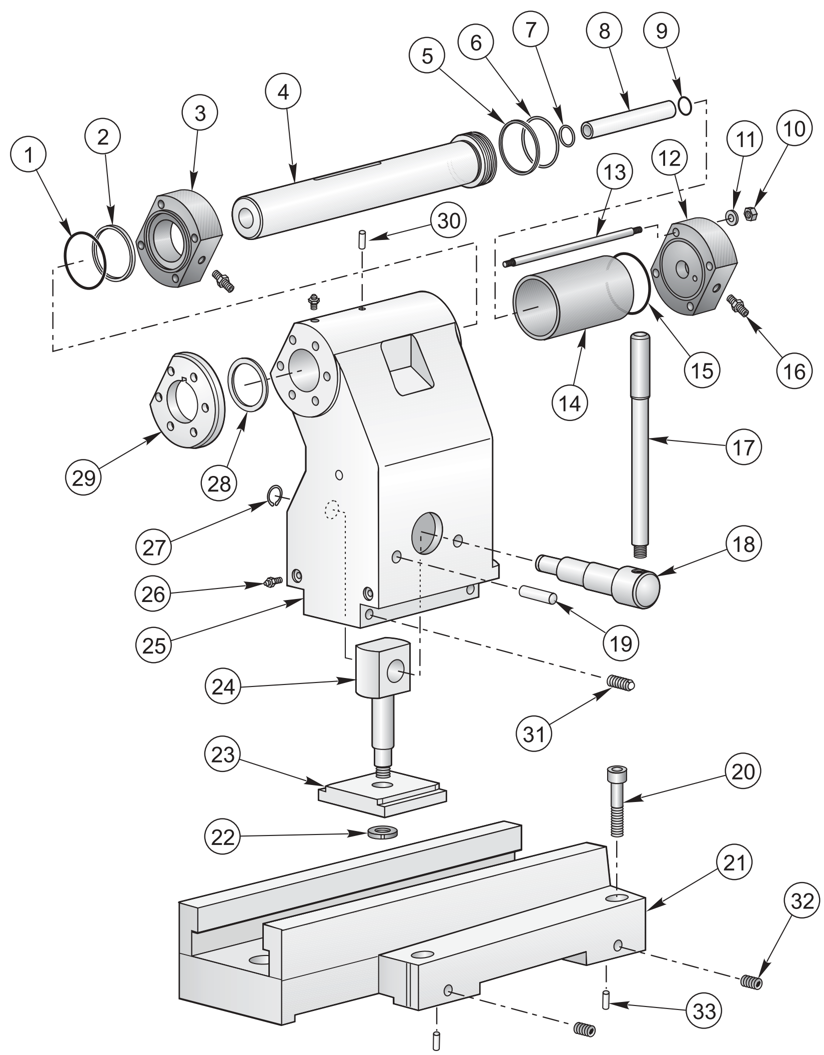
1. 20-1229 Tool Platter
2. 20-1338 Slide Machined
3. 50-0018 Z-Axis Linear Guide (2)

Mini Lathe Slide Assembly and Parts List



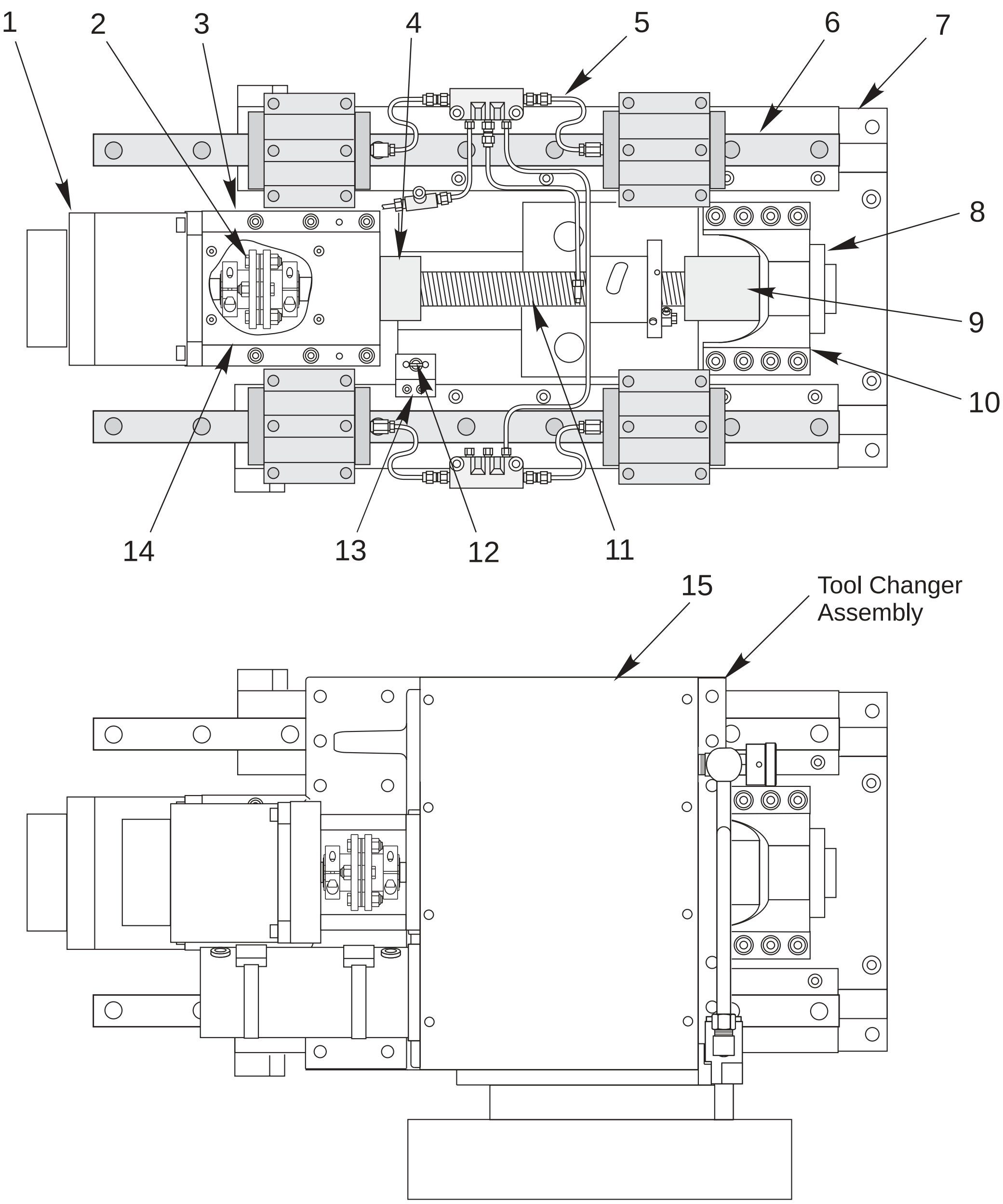
1. 62-0014 Yaskawa Sigma Motor
2. 20-7010A Motor Mount Machined
3. 50-8766 X-axis Linear Guide Assembly
4. 30-2290 Ball Screw Assembly
5. 30-2388A Oil Line Assembly
6. 30-0153 Support Bearing Assembly
7. 20-0735 Snap Lock Ring Bumper
8. 30-1220A Coupling Assembly
9. 25-0857B Control Box Bracket

SL-10 Casting Assembly and Parts List



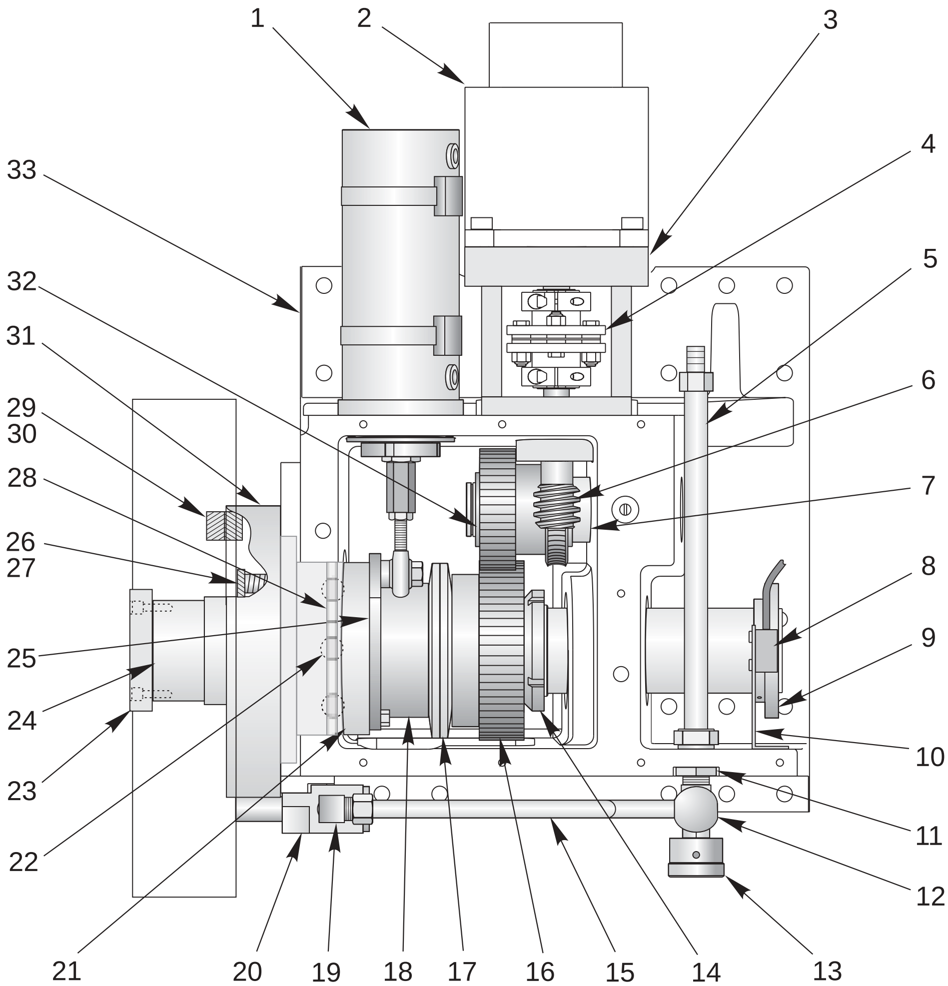
1. 57-0140 O-Ring
2. 20-1070 Gland Retainer
3. 20-1017 Cylinder Head
4. 20-1012A Shaft
5. 57-0141 Quad Ring
6. 57-0143 Rod Seal
7. 57-0136 Hydraulic Piston Seal
8. 20-1020 Knock-Out Tube
9. 57-0020 O-Ring
10. 46-1653 Hex Nut 5/16-18 (4)
11. 45-1600 Split Lock Washer (4)
12. 20-1014 End Cap
13. 20-1016 Tie Rod (4)
14. 20-1013 Cylinder Tube
15. 57-0140 O-Ring
16. 58-0045 Str Adapter (2)
17. 20-0858 Handle
18. 20-0859 Eccentric Clamp
19. 48-1755 Dowel Pin 1/2 x 2 (2)
20. 40-16643 SHCS 5/8-11 x 2-1/4 (4)
21. 20-1052 TS Base Machined
22. 51-2012 Bearing Locknut
23. 20-0861 Clamp Plate
24. 20-0860 Clamp Rod
25. 20-0988F TS Head Machined
26. 59-2016 Grease Fitting (6)
27. 56-2086 Retaining Ring
28. 57-0135 Wiper
29. 20-0857 Shaft Cap
30. 48-0041 Dowel Pin 1/4x1 (2)
31. 59-0255 Ball Plunger (2)
32. 44-1699 SSS 1/2-13 Flat PT (2)
33. 48-1750 Dowel Pin 1/2x1 1/2 (2)

SL-10 Tailstock Assembly and Parts List



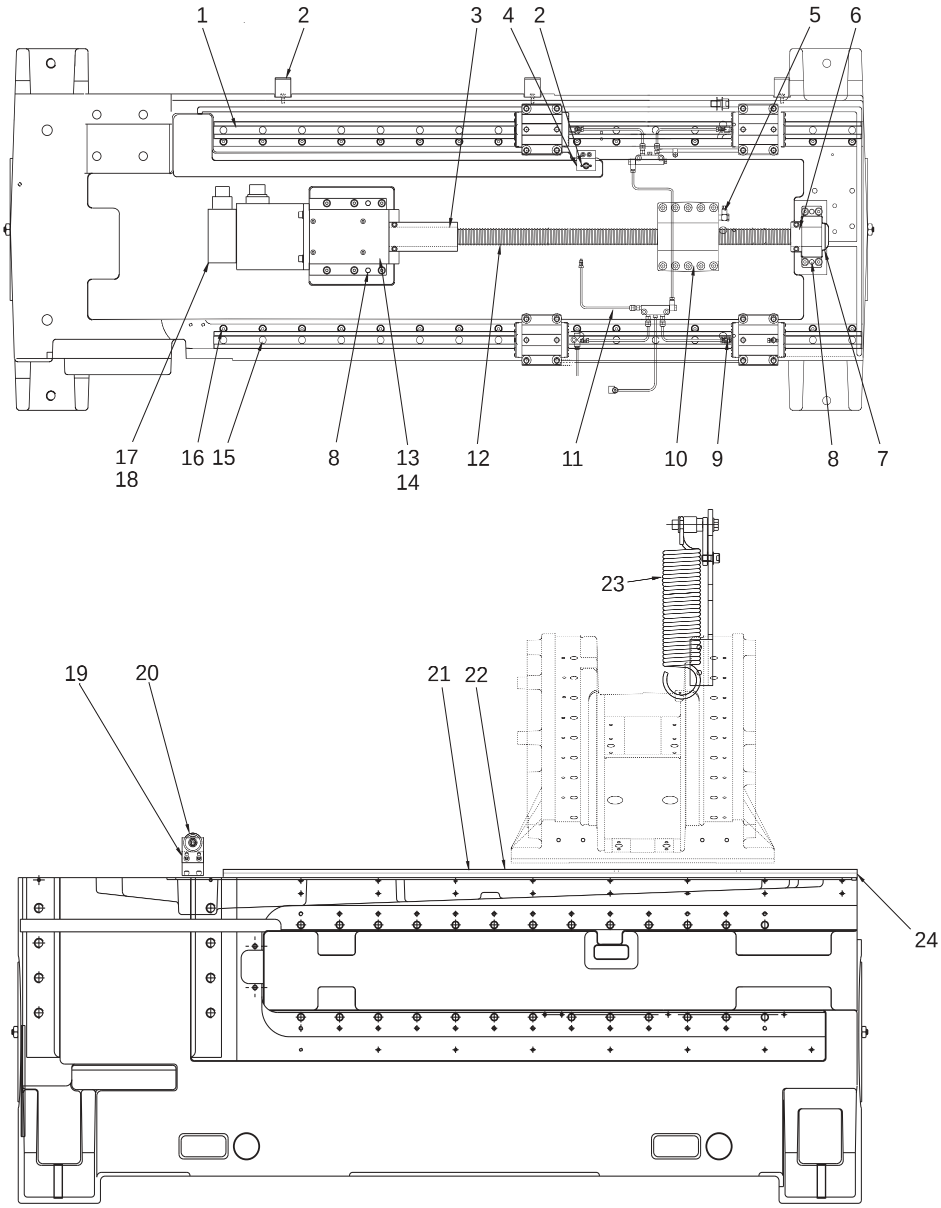
1. 62-0009 Yaskawa Sigma Motor
2. 30-1219 Coupling Assembly
3. 20-7010A Motor Mount Machined
4. 20-1126 Snap Lock Ring Bumper
5. 30-2387 Lube Line Assembly
6. 50-8766 X-axis Linear Guide Assembly
7. 20-0986B Wedge Machined
8. 30-0154 Bearing Motor Housing
9. 20-0928 Ring Bumper
10. 20-0773 Bearing Support Housing Machined
11. 30-2244 Ball Screw Assembly
12. 32-2051 X-axis Home Limit Switch
13. 25-7266 Switch Mounting Bracket
14. 25-7042A Motor Mount Cover
15. 20-0848 TC Housing Cover

SL-10 Wedge Assembly and Parts List



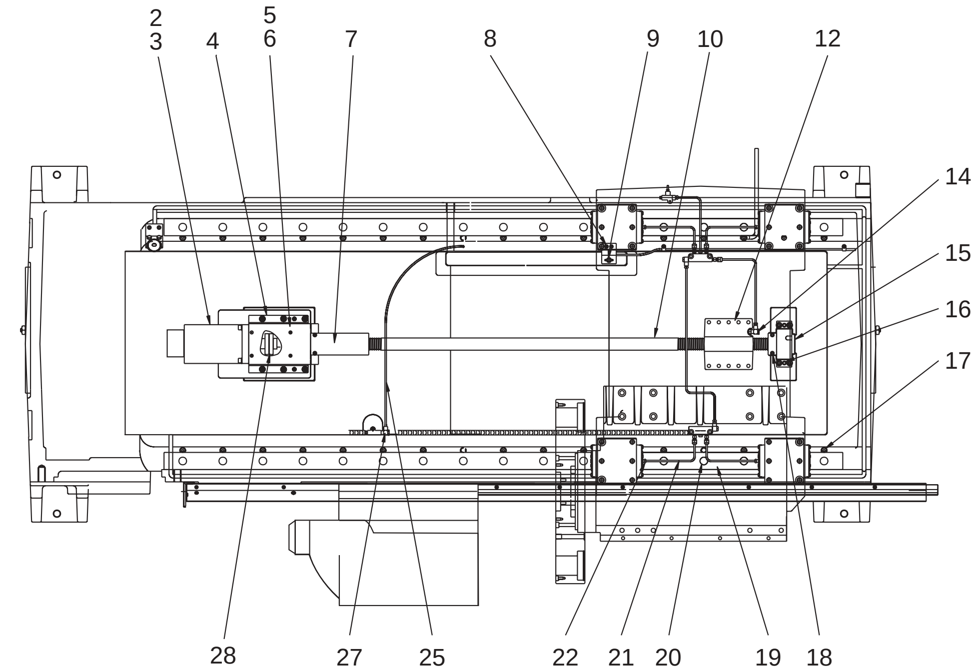
1. 30-3076 Air Cylinder Assembly
2. 62-0014 Yaskawa Sigma Motor
3. 20-8512A Worm Housing
4. 30-1220A Coupling Assembly
5. 30-3655 Coolant Line Assembly
6. 20-8509 Worm Shaft
7. 20-8510A TC Transfer Shaft
8. 32-2011 Telemecanique Switch
9. 20-8533 TC Switch Ring
10. 25-0981 Turret Switch Bracket
11. 58-1679 Bulkhead Fitting
12. 58-0203 Coolant Valve
13. 20-0929 Coolant Knob
14. 46-7016 Bearing Nut N-13
15. 58-0202 Coolant Line
16. 20-8522A TC Spur Gear
    22-8544 Spur Gear Key
17. 24-4010 Belleville Washers (2)
18. 22-8550A TC Belleville Spacer
19. 58-3052 Coolant Elbow
20. 30-3660A Coolant Transfer Assembly
21. 20-8517A TC Turret Cams (2)
22. 59-2059 15/16 Steel Balls (3)
23. 20-8532 Turret Retainer
24. 20-8530 TC Turret Sfaft
25. 20-8516 TC Cam Lever
26. 20-8518 Spring Retainer
27. 59-0035 Spring
28. 20-8576 Cam Cage
29. 20-8505A Male Turret Coupling
30. 20-8506A Female Turret Coupling
31. 20-0675 Turret Mount Coupling
32. 20-8511A TC Cluster Gear
33. 20-0985A TC Turret Housing

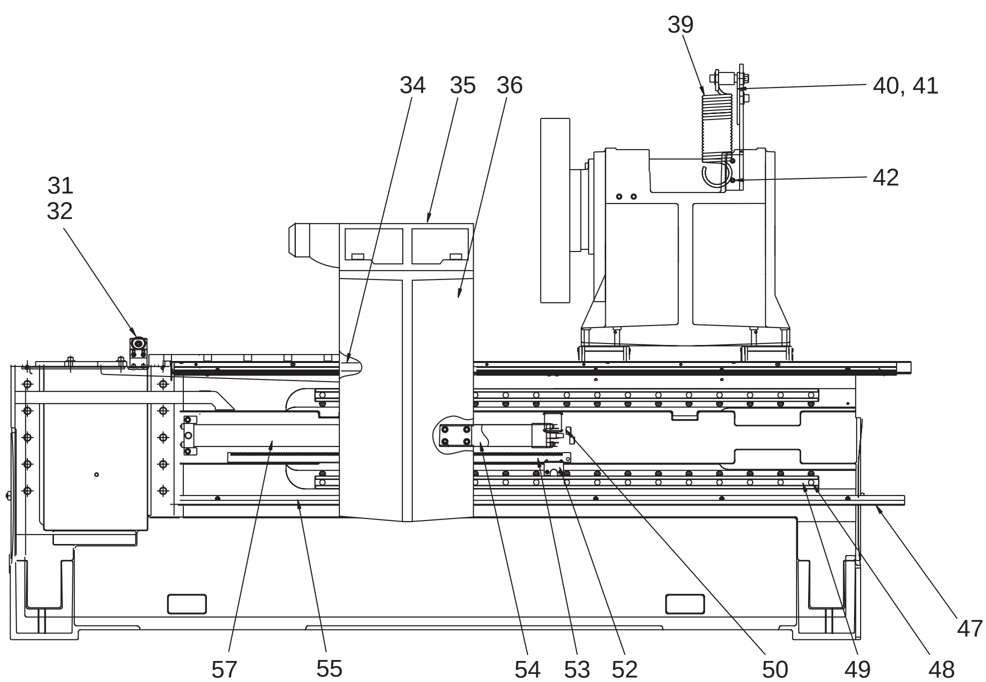
SL-10 Tool Changer Assembly and Parts List



1.	50-3400	Linear Guide
2.	25-9746	Cable Clamp Base
3.	20-9058	Ballscrew Bumper
4.	25-7266	X-Axis Mounting Bracket
5.	58-3030	Banjo Elbow 5/16 x M6
6.	25-7080	Bumper Bracket
7.	30-0153	Support Bearing Assembly
8.	48-0045	Dowel Pin
9.	24-7325	Str Fit Metric Linear Guide
10.	20-9007	Nut Housing
11.	30-8717A	Oil Line Assembly
12.	24-9013	Ballscrew
13.	20-7010A	Motor Mount
14.	30-0156	Motor Housing Bearing Assy
15.	59-6600	Guide Rail Plug
16.	22-7458	Linear Guide Cam
17.	22-2629	Stub Shaft/Worm Key
18.	62-0014	Yaskawa Sigma 09 Motor
19.	25-8653A	Roller Bracket
20.	54-0030	Guide Wheel
21.	26-8623	Seal Rail Wiper
22.	22-8624	Seal Rail Backing Bar
23.	33-0209	Slide Spring Service Kit
24.	36-8980B	Rail Interface

SL-20 Casting Assembly and Parts List

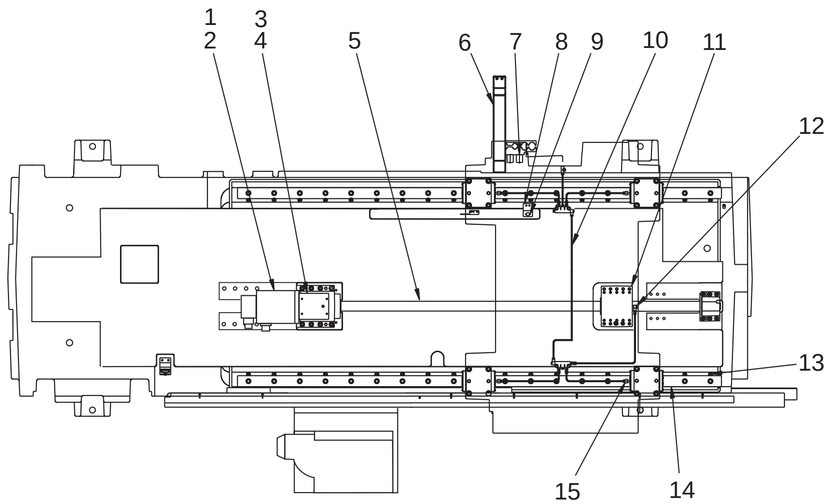


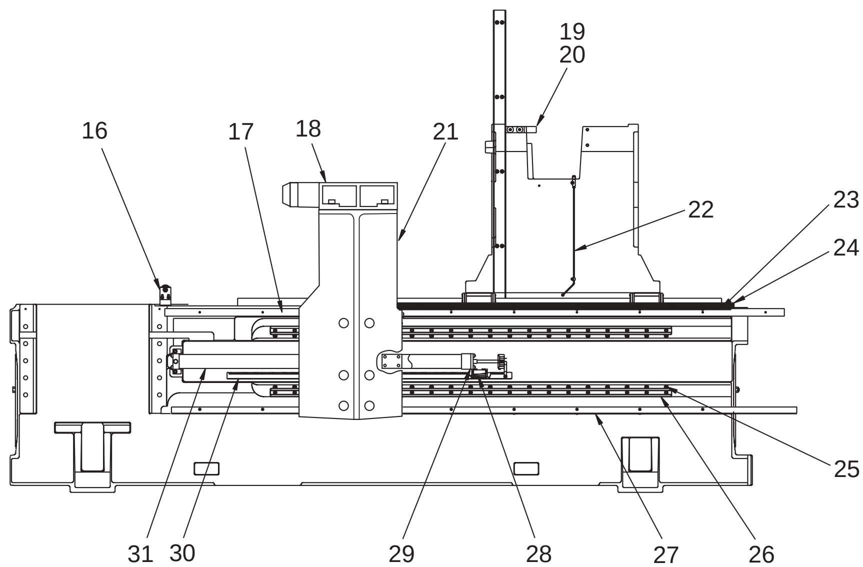


SL-30 Casting Assembly w/Tailstock

SL-30 Casting Assembly w/Tailstock Parts List

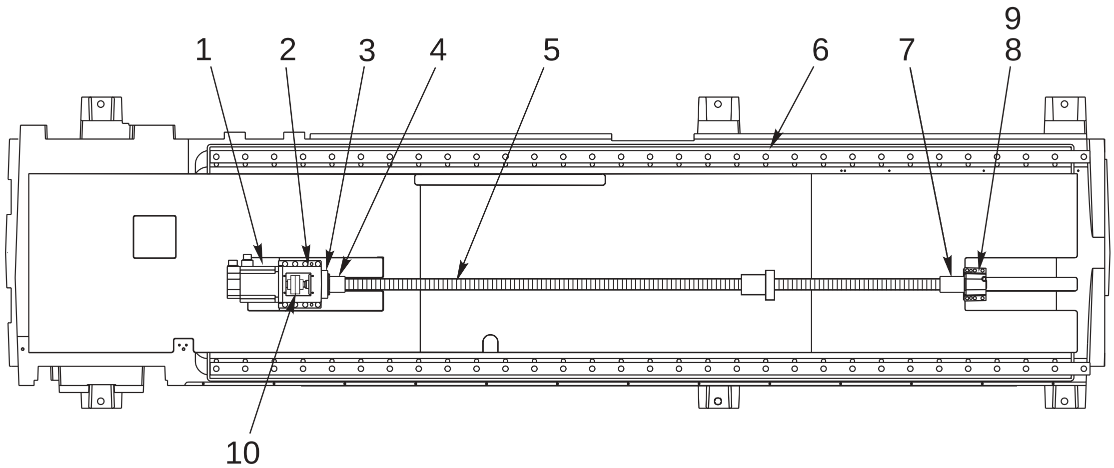
1. N/A
2. 22-2629 Key stub shaft
3. 62-0014 Yaskawa sigma motor 09
4. 20-7010A Motor mount
5. 25-7042A Snap lock motor mount cover plate
6. 26-7233A Gasket, deflector shield
7. 20-0143 Snap lock ring bumper
8. 25-7267 Brack mounting y-axis
9. 32-2040 Z-axis limit switch cable
10. 30-1962 Z-axis Ballscrew Assembly
11. N/A
12. 20-9007 Nut housing machined
13. N/A
14. 58-3031 Banjo Elbow 5/16F X M6 M
15. 25-7080 Bumper bracket
16. 48-0045 Dowel pin 3/8 x 1 1/2
17. 22-7458 Cam linear guide
18. 20-9058 Bumper
19. 50-9010 Linear guide X-axis
20. 59-6600 Guide rail plug
21. 30-8863 Oil line assembly
22. 58-1560 Adpt 1/8 M BSPT - 5/16 F
23. N/A
24. N/A
25. 58-2010 Nylon tubing 5/32
26. N/A
27. 58-3031 Banjo Elbow 5/16F X M6 M
28. 30-1220A Coupling assembly
29. N/A
30. N/A
31. 54-0030 Guide wheel
32. 25-8653A Roller Bracket
33. N/A
34. 25-8841 Seal strip
35. 20-8807 Tailstock head
36. 20-8808 Tailstock body
37. N/A
38. N/A
39. 93-0210 Spring cross slide
40. 20-8720 Swing arm spring
41. 20-8721A Bushing swing arm spring
42. 20-0534 Bracket spring T/C
43. N/A
44. N/A
45. N/A
46. N/A
47. 22-8064 Waycover bottom guide bs strip
48. 59-6655 Rubber plug guide rail
49. 50-3400 Linear guide
50. 20-8988A Tailstock cylinder attach bracket
51. N/A
52. 32-0400A Encoder read head assembly
53. 25-8024A Encoder strip
54. 20-9210A Tailstock arm
55. 25-8028 Guide, waycover ts bottom
56. N/A
57. 59-0013 Hydraulic cylinder

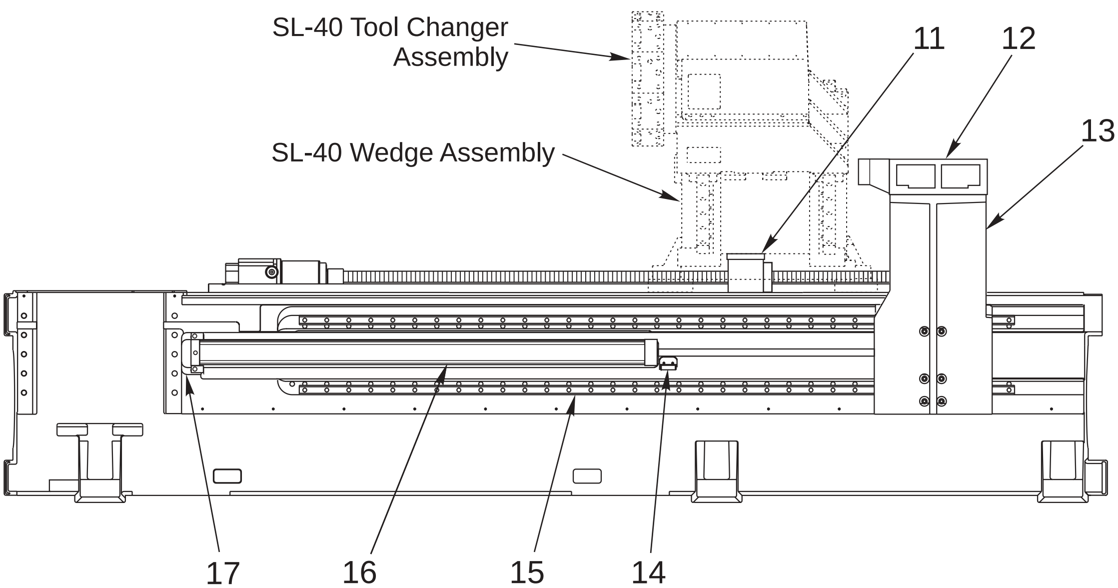




1. 22-2629 Stub Shaft Key
2. 62-0016 Yaskawa Sigma Motor 13
3. 25-9203 Motor Mount Cover Plate
4. 26-7233A Deflector Shield Gasket
5. 30-0450 Ball Screw Assembly
6. 20-0841 Rear Support
7. 55-7423 Standoff
8. 25-7267 Y-Axis Mounting Bracket
9. 32-2040 Z-Axis Limit Switch
10. 30-8325A Oil Line Assembly
11. 20-0150 Nut Housing Machined
12. 58-3031 Banjo Elbow 5/16 F x M6 M
13. 22-7458 Linear Guide Cam
14. 50-9305 Linear Guide
15. 24-7325 Str Fit Metric Linear Guide
16. 54-0030 Support Wheel
17. 25-8297 Tailstock Waycover Rail/Guide
18. 20-8807A Tailstock Head Machined
19. 20-8617 Strain Relief Conduit
20. 20-8618 Strain Relief Conduit
21. 20-8203A Tailstock Body Machined
22. 30-8335 Oil Line Assembly
23. 25-8296 Z-Axis Waycover Bottom Guide
24. 26-8320 Tailstock Guide Strip
25. 59-6655 Guide Rail Rubber Plug
26. 50-8205 Tailstock Linear Guide
27. 25-6651 Drip Rail
28. 32-0017 Read Head
29. 20-8228 Hydraulic Cylinder Mount
30. 25-8300 Encoder Strip
31. 59-0034 Hydraulic Cylinder

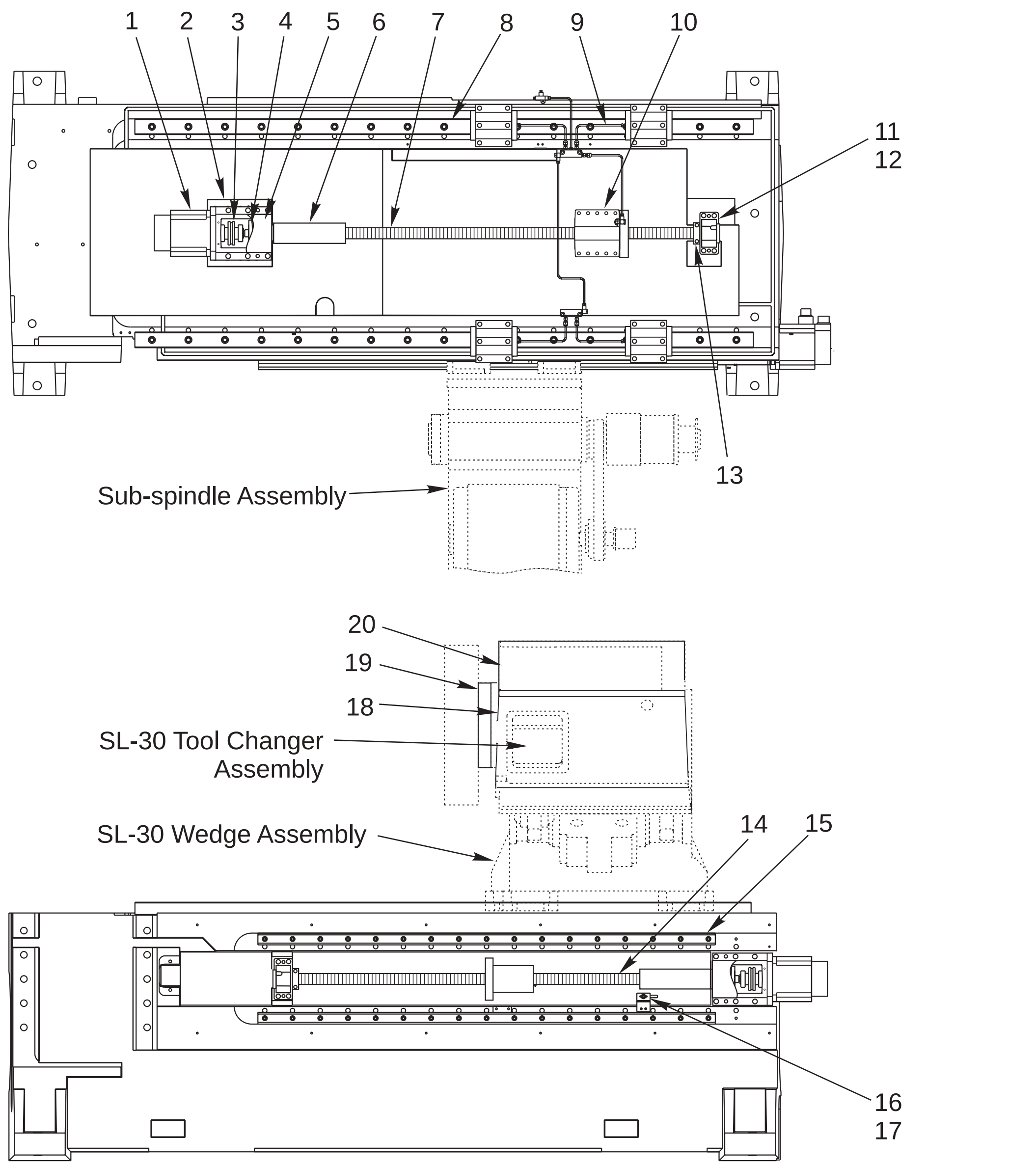
SL-40 Casting Assembly w/Tailstock and Parts List





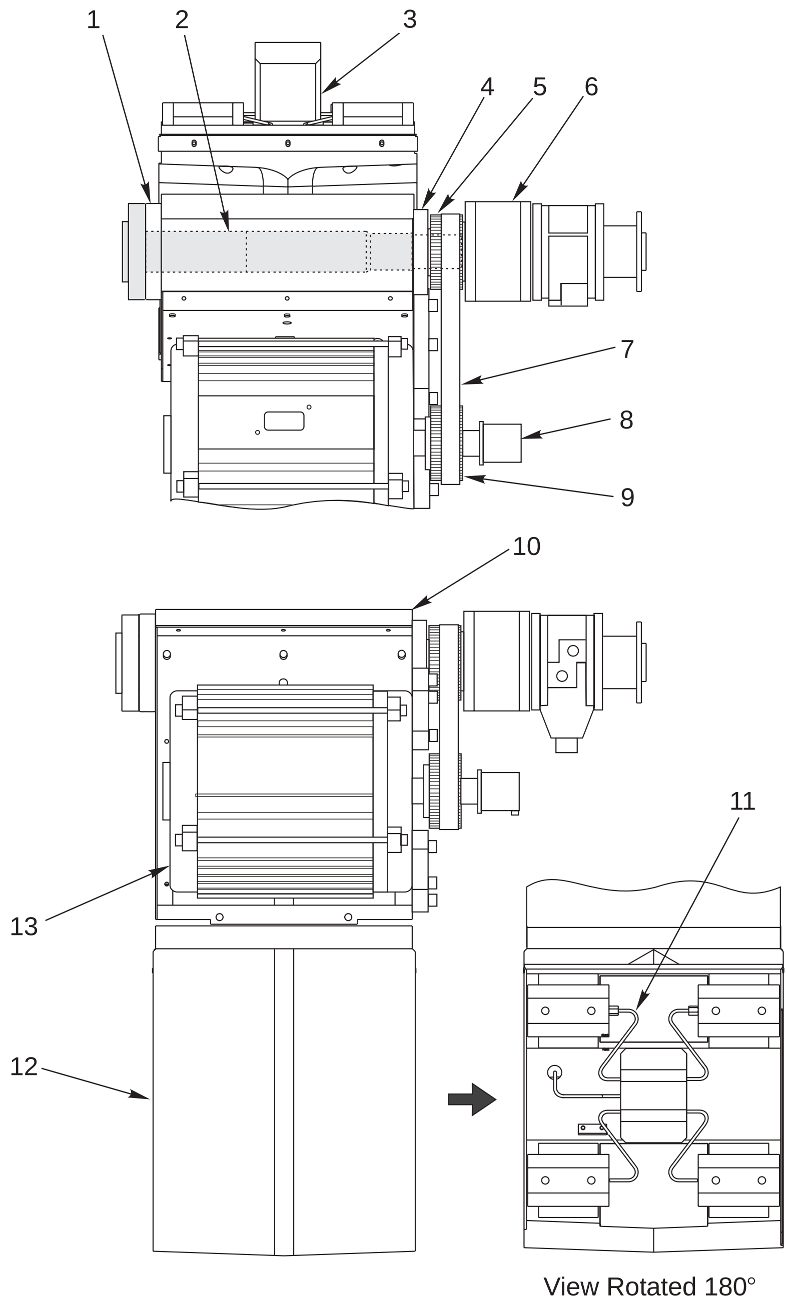
1. 62-0016 Yaskawa Motor
2. 20-0151 Motor Mount
3. 20-9212 Bearing Cartridge Housing
4. 20-0735 Snap Lock Ring Bumper
5. 24-9970C Z-Axis Ball Screw
6. 50-9971 Z-Axis Linear Guides (2)
7. 20-1769 Z-Axis Bumper (Support End)
8. 20-0152 Z-Axis Support Bearing Housing
9. 30-0201 Support Bearing Assembly
10. 30-1215 Coupling Assembly
11. 20-0150 Ball Screw Nut Housing Machined
12. 20-8807A Tailstock Head Machined
13. 20-1764 Tailstock Base Machined
14. 25-8001A Read Head
15. 50-0028 B-Axis Linear Guides (2)
16. 52-0042 Hydraulic Cylinder
17. 20-1767 Cylinder Attach Bracket

SL-40L Casting Assembly and Parts List



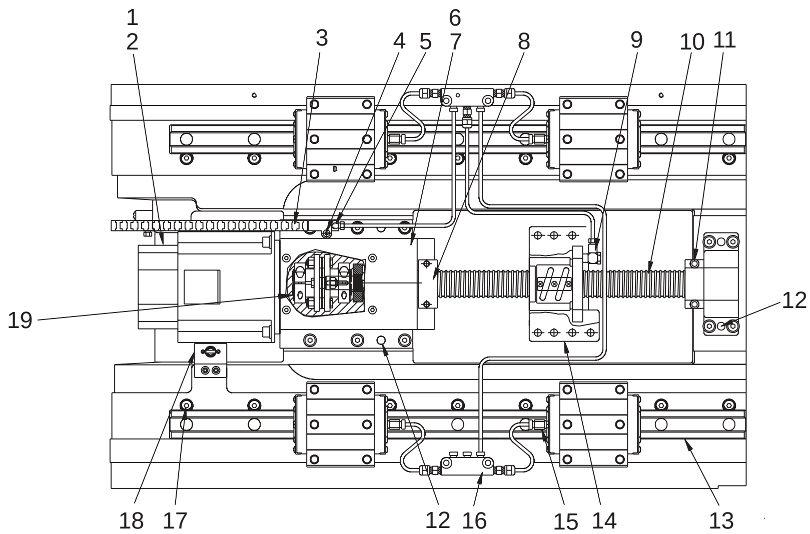
1.	62-0014	Yaskawa Motor (2)	11.	20-0132	Bearing Housing Machined (2)
2.	20-7010A	Motor Mount (2)	12.	51-2025	Bearing (2)
3.	30-1220A	Coupling Assembly (2)	13.	20-7185	Ball Screw Support Bumper (2)
4.	30-0154	Motor Housing Bearing (2)	14.	30-3556	B-Axis Ball Screw Assembly
5.	25-7042A	Motor Mount Cover (2)	15.	50-3400	Sub-spindle Linear Guide Rail (2)
6.	20-0143	Snap Lock Ring Bumper	16.	32-2040	Limit Switch
7.	30-1962	Z-Axis Ball Screw Assembly	17.	25-7267	Switch Mounting Bracket
8.	50-9010	Linear Guide Rail (2)	18.	20-8771A	Tool Changer Housing
9.	30-8863	Oil Line Assembly	19.	20-8507A	Turret Coupling Mount
10.	20-9007	Nut Housing Machined	20.	20-0169A	Tool Changer Housing Cover

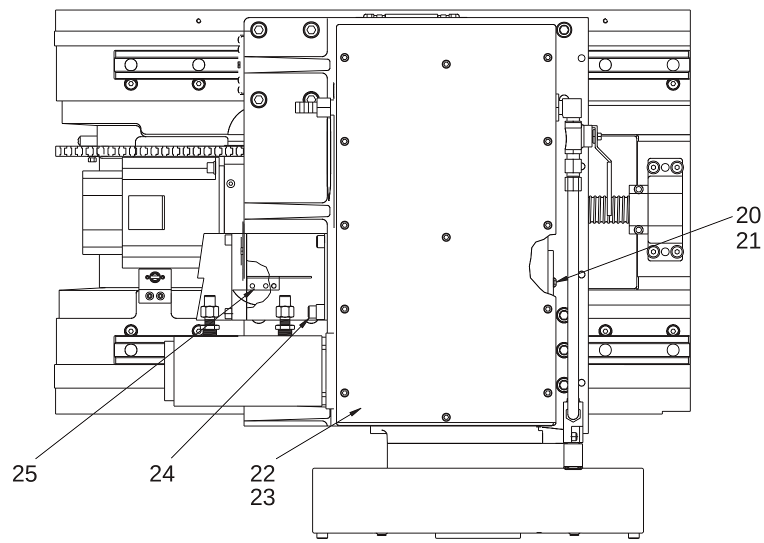
TL-25 Casting Assembly and Parts List



1.	20-0609	Front Cap		8.	Encoder	
2.	20-0608A	Spindle Shaft		9.	20-0611	Sub-spindle Motor Pulley
3.	20-0627	Nut Housing Machined		10.	20-0630A	Spindle Head Machined
4.	20-7442	End Cap		11.	30-1616A	Oil Line Assembly
5.	20-0610	Spindle Pulley		12.	20-5576	Sub-spindle Base Machined
6.	90-0008	ZKP100 Rotating Union		13.	62-1010D	Motor 5HP
7.	54-0095	Belt				

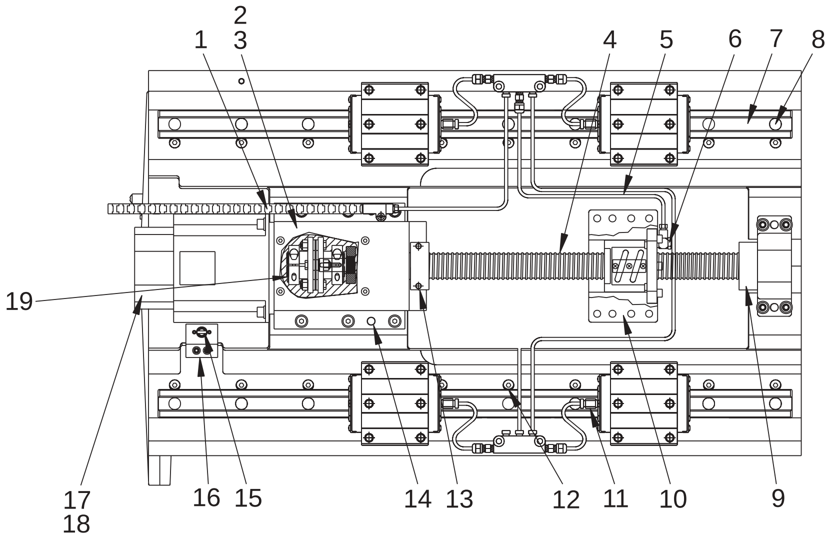
TL-25 Sub-spindle Assembly and Parts List

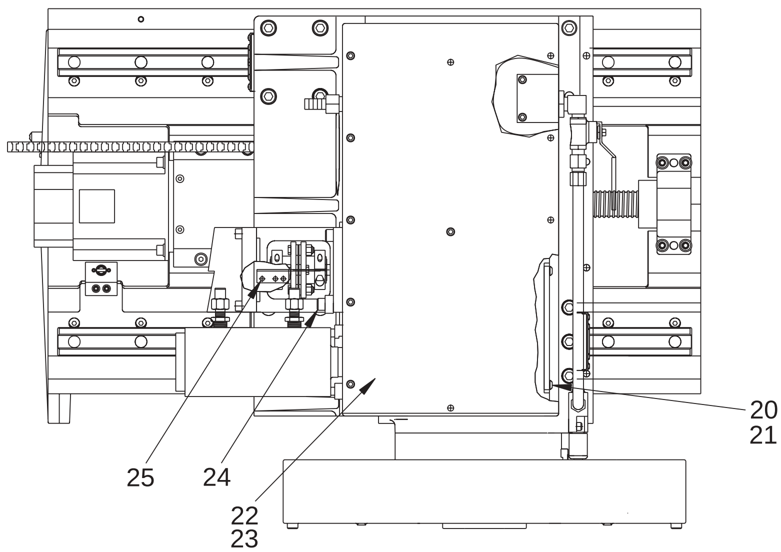




1.	62-0009	Yaskawa Sigma Motor 09 w/Brake
2.	22-2629	Stub Shaft Key
3.	30-1044	Oil Line Carrier
4.	41-1717	Long Stud/Set Screw
5.	58-2110	Sleeve Nuts Lube Assembly
6.	25-7042A	Snap Lock Motor Mount Cover Plate
7.	26-7233A	Deflector Shield Gasket
8.	20-7185	Z-Axis Motor End Bumper
9.	58-3031	Banjo Elbow 5/16 F x M6 M
10.	30-0616B	X-Axis Ball Screw Assembly
11.	20-7185	Z-Axis Support End Bumper
12.	48-0045	Dowel Pin
13.	50-8549	Linear Guide
14.	20-7008F	Nut Housing Machined
15.	24-7325	Str Fit Metric Linear Guide
16.	30-8716	Lube Line Assembly
17.	22-7458	Linear Guide Cam
18.	25-7266	X-Axis Mounting Bracket
19.	30-1220A	Coupling Assembly
20.	20-8535	Tool Changer Access Plate
21.	57-8546	TC Access Plate Gasket
22.	57-8576	TC Cover Gasket
23.	20-8545	TC Housing Cover
24.	20-8364	Spacer
23.	25-7459	Trip Table Bracket

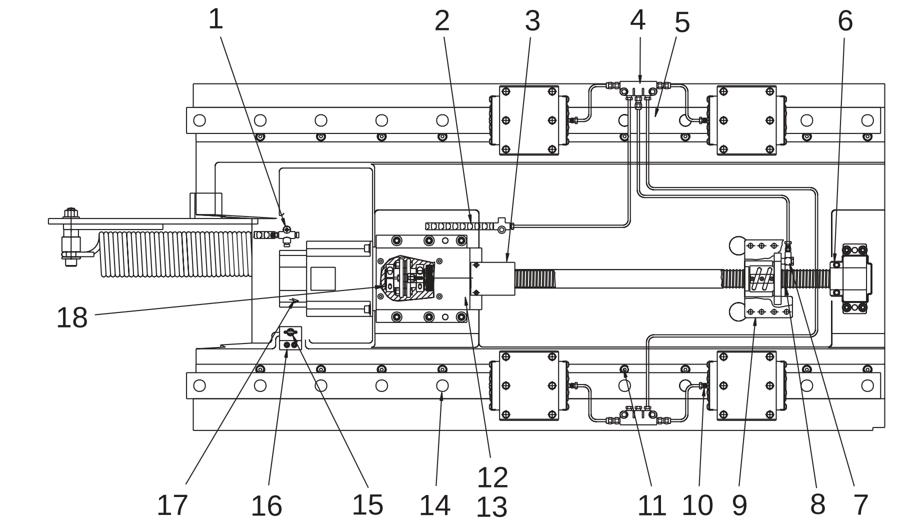
SL-20 Wedge Assembly and Parts List

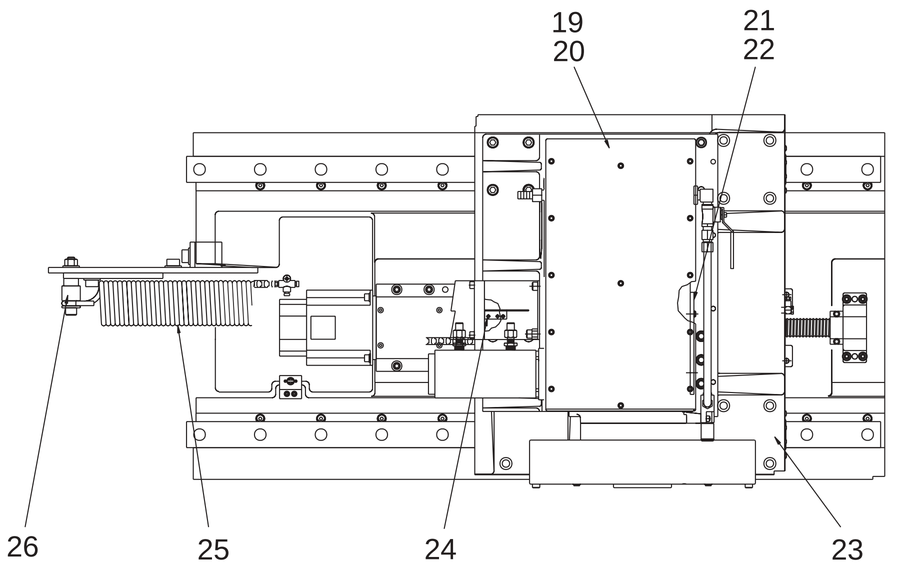




1	30-1044	Oil Line Assembly	14.	48-0045	Dowel Pin 3/8 x 1-1/2
2.	25-7042A	Snap Lock Motor Mount Cover Plate	15.	32-2055	X-Axis Home Limit Switch
3.	26-7233A	Deflector Shield Gasket	16.	25-7266	Limit Switch Mounting Bracket
4.	30-0618B	X-Axis Ball Screw Assembly	17.	22-2629	Stub Shaft Key
5.	30-0593	Wedge Oil Line Kit	18.	62-0009	Yaskawa Sigma Motor 09 w/Brake
6.	58-3031	Banjo Elbow 5/16 F x M6 M	19.	30-1220A	Coupling Assembly
7.	50-8766	X-Axis Linear Guide	20.	20-8535	Tool Changer Access Plate
8.	59-6600	Guide Rail Plug	21.	57-8546	TC Access Plate Gasket
9.	20-7474	Support End Bumper	22.	57-8576	TC Cover Plate
10.	20-7008F	Nut Housing Machined	23.	20-8545	TC Housing Cover
11.	24-7325	Str Fit Metric Linear Guide	24.	20-8364	Spacer
12.	22-7458	Linear Guide Cam	25.	25-7459	Table Trip Bracket
13.	20-7474	Motor End Bumper			

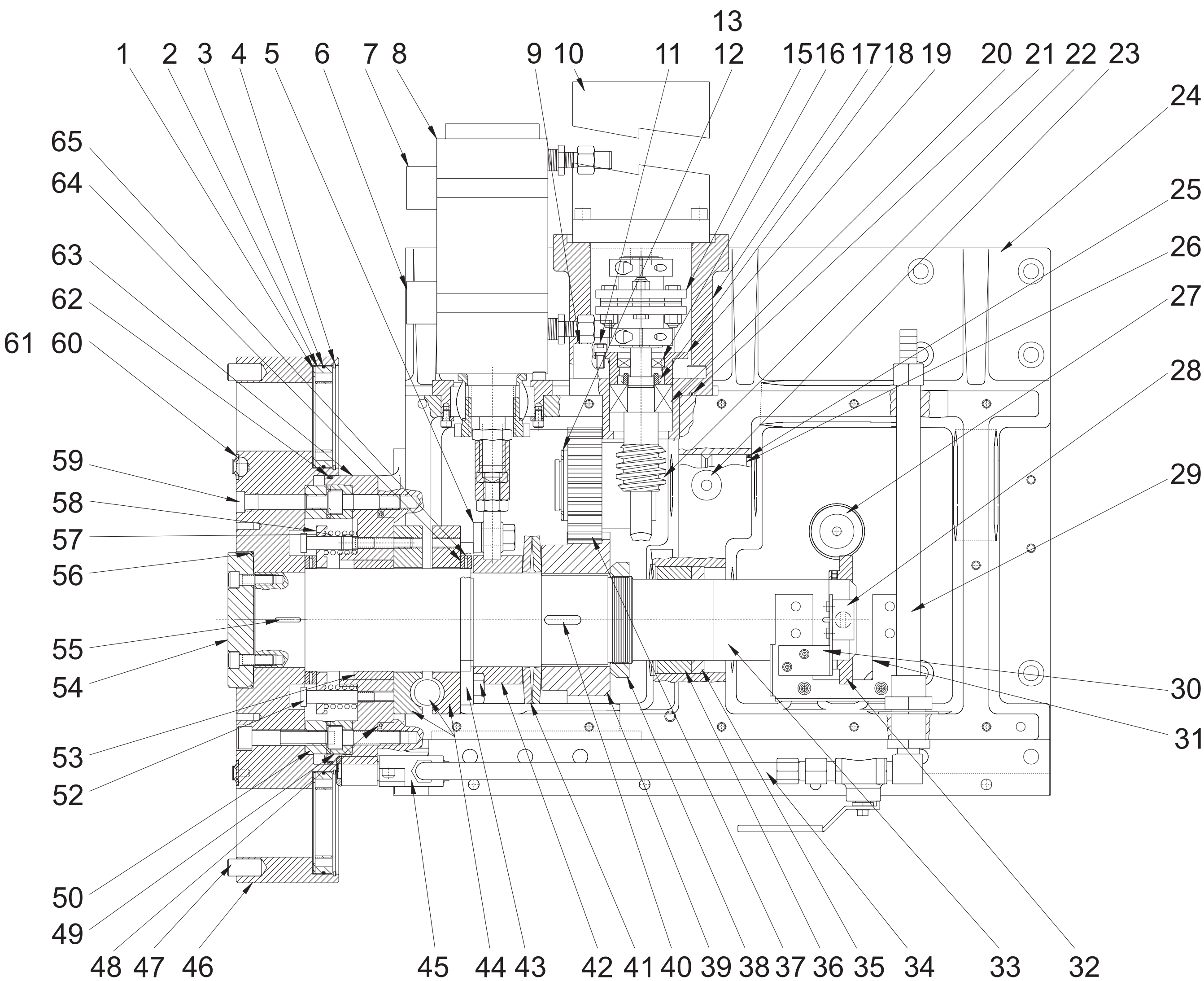
SL-30 Wedge Assembly and Parts List





1.	58-2760	2-Way Manifold
2.	30-1044	Oil Line Carrier
3.	20-7474	Motor End Bumper
4.	30-1530	Oil Line Assembly
5.	50-9011	Linear Guide
6.	20-7474	Support End Bumper
7.	58-3031	Banjo Elbow 5/16 F M6 M
8.	30-1397A	X-Axis Ball Screw Assembly
9.	20-9007	Nut Housing Machined
10.	24-7325	Str Fit Metric Linear Guide
11.	22-7458	Linear Guide Cam
12.	25-7042A	Snap Lock Motor Mount Cover Plate
13.	26-7233A	Deflector Shield Gasket
14.	59-6600	Guide Rail Plug
15.	32-2063	X-Axis Home Limit Switch
16.	25-7267	Limit Switch Mounting Bracket
17.	62-0009	Yaskawa Sigma Motor w/Brake
18.	30-1220A	Coupling Assembly
19.	20-8545	Tool Changer Housing Cover
20.	57-8576	TC Cover Gasket
21.	20-8535	TC Access Plate
22.	57-8546	TC Access Plate Gasket
23.	20-8204	X-Riser
24.	25-7459	Trip Table Bracket
25.	93-0211	Cross Slide Spring Kit
26.		Swing Arm Bushing

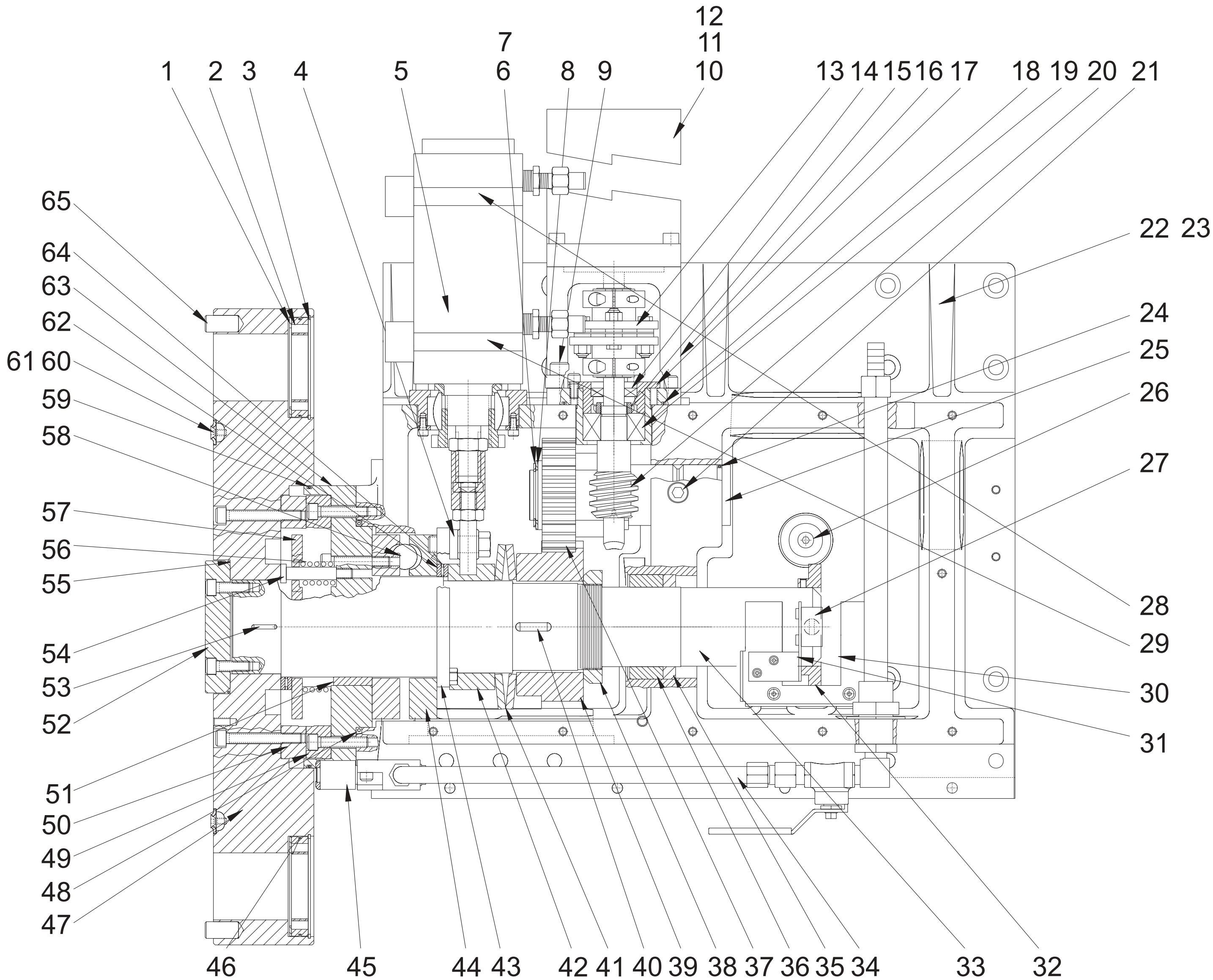
SL-40 Wedge Assembly and Parts List



SL-20 Tool Changer Assembly

SL-20 Tool Changer Assembly Parts List

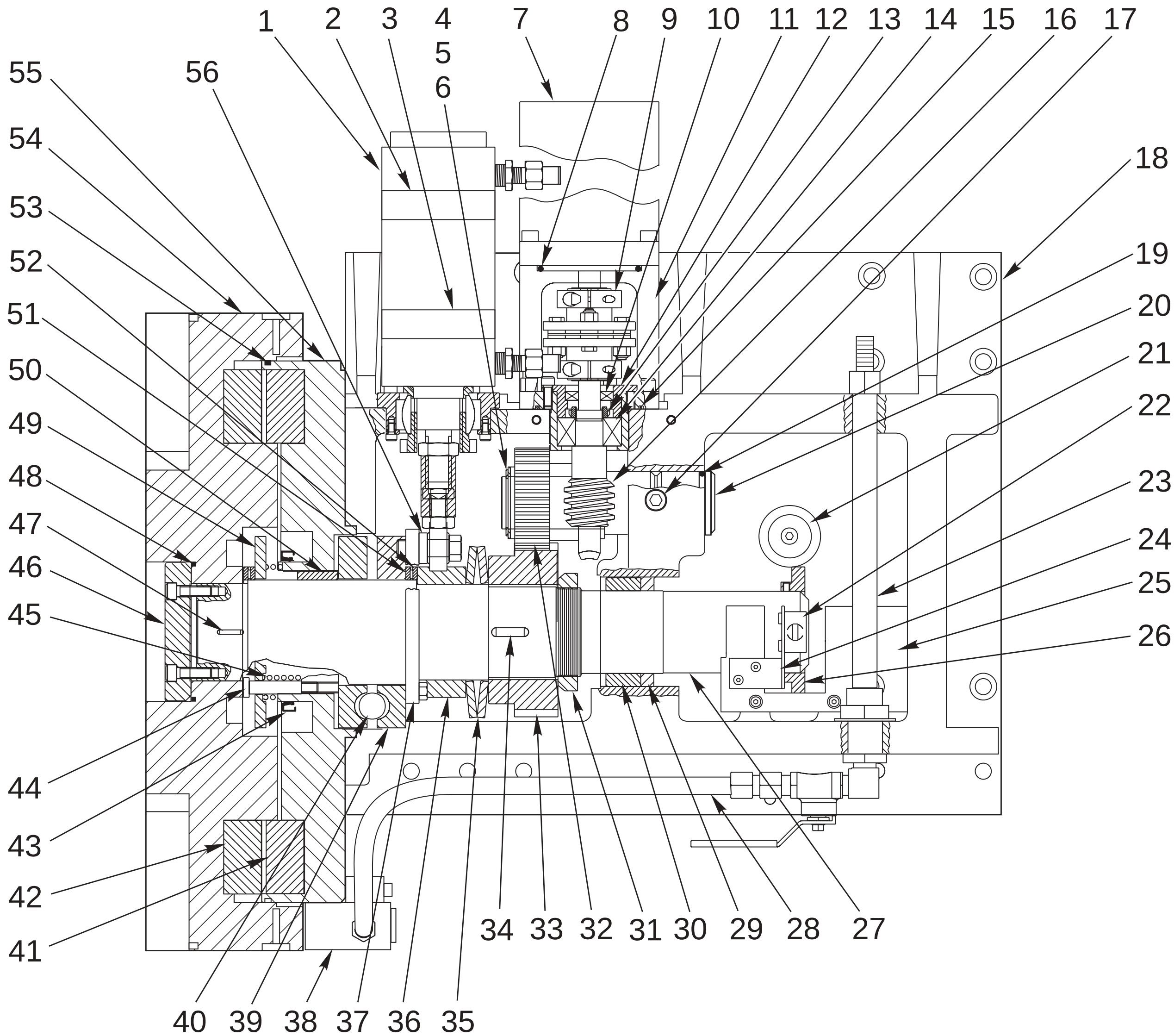
1. 51-2984 Thrust washer TRB-3446
2. 20-8523 Nut tool holder
3. 57-2994 O-ring
4. 56-2090 Retaining Ring RR-300
5. 22-8538 Rod end spacer
6. 32-2153 Unclamp switch
7. 32-2154 Clamp switch
8. 30-3650 Air Cylinder assembly
9. 20-8364 Spacer anti-rotate T/C
10. 93-0346 Yaskawa Sigma 09 motor
11. 40-1632 1/4-20 x 1/2
12. 49-4115 Washer
13. 56-9057 Retaining Ring
14. N/A
15. 30-1220A Coupling assembly
16. 57-2129 Seal
17. 20-8512A Housing worm
18. 51-2042 Bearing locknut BH-04
19. 20-8515 Clamp bearing worm
20. 51-7001 Bearing
21. 57-2022 O-ring
22. 20-8509 Shaft worm
23. 59-2057 5/16 steel ball
24. 20-8503A Turret housing
25. 57-2831 O-ring
26. 20-8510 Shaft transfer T/C
27. 20-8537 Retainer spring
28. 32-2010 30" Telemechanique switch
29. 30-3655 Coolant line assembly
30. 25-8534 Home bracket
31. 25-8536 Switch bracket
32. 20-8533 Ring switch T/C
33. 20-8530 Shaft Turret T/C
34. 58-8657Copper line
35. 57-1045 Seal
36. 20-8539 Bearing rear
37. 20-8511A Gear cluster T/C
38. 46-7016 Locknut
39. 20-8522A Gear spur T/C
40. 22-8544 Key gear spur T/C
41. 24-4010 Bellville washer
42. 22-8550A Spacer Bellville T/C
43. 20-8516 Lever cam T/C
44. 93-8138 Cam Turret T/C
45. 30-3660A Transfer housing
46. 20-8531B Turret T/C
47. 48-0049 Dowel pin 1/2 x 1
48. 57-0029 Seal CR29841
49. 20-8506A Coupling, turret female
50. 20-8505A Coupling, turret male
51. 59-2059 15/16 Steel Balls
52. 49-1010 Shoulder bolt 3/8 x 1 1/2
53. 20-8557 Bushing front turret
54. 20-8532 Reatiner turret T/C
55. 22-8543 Key
56. 57-2154 O-ring
57. 59-0035 Spring, Turret Coupling
58. 20-8518 Reatiner springs T/C
59. 58-3105 Pipe plug 1/4 NPT
60. 57-8970 Coolant plate gasket
61. 20-0516 Plate Cover coolant
62. 57-2150 O-ring
63. 20-8507A Turret mounting coupling
64. 51-3001 Bearing thrust needle
65. 51-2983 Thrust washer TRD-4860



SL-30 Tool Changer Assembly

SL-30 Tool Changer Assembly Parts List

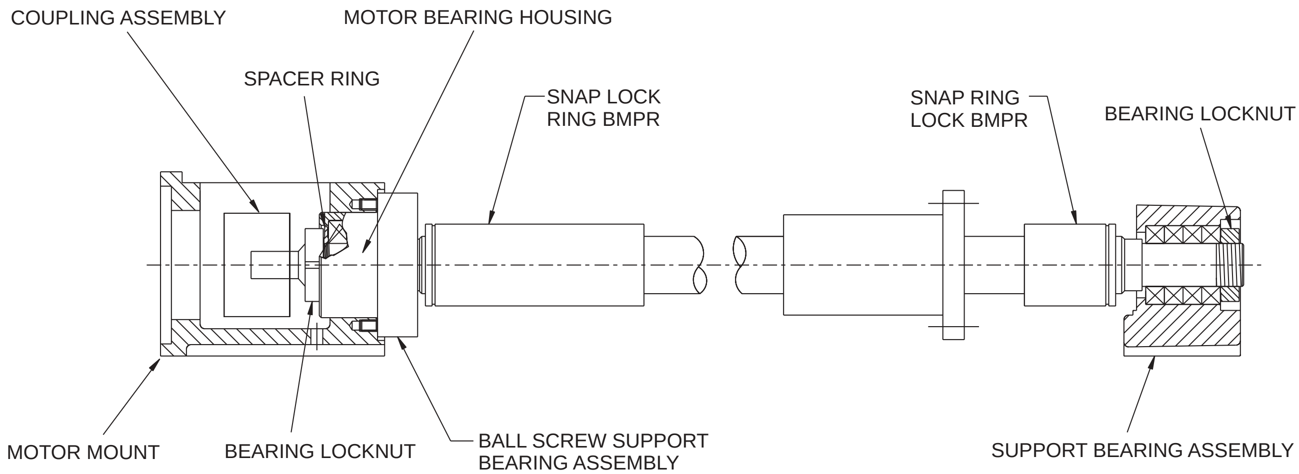
1. 51-2984 Thrust washer TRB-3446
2. 20-8321 Nut tool holder
3. 56-2090 Retaining ring RR-300
4. 22-8538 Spacer rod end T/C
5. 30-3650 Air cylinder assembly
6. 56-9057 Retaining ring 5100-150
7. 49-4115 Washer 1 1/2 steel
8. 45-2001 .002 Shim
9. N/A
10. 93-0346 Yaskawa sigma 09 motor
11. N/A
12. N/A
13. 93-30-1220A coupling assembly
14. 57-2129 Seal CR6372
15. 51-2042 Bearing locknut BH-04
16. 20-8512A Housing Worm
17. 20-8515 Clamp bearing worm T/C
18. 57-2022 O-ring 2-150 V-1164-75
19. 51-7001 Ball bearing
20. 20-8509 Shaft worm
21. 59-2057 5/16 steel ball
22. 20-0674 Machined housing
23. N/A
24. 57-2831 O-ring 2-130 buna
25. 20-8510 Shaft transfer T/C
26. 20-8537 Reatiner spring T/C
27. 32-2011 30" telemechanique switch
28. 32-2154 Clamp reed switch
29. 32-2153 Unclamp reed switch
30. 25-8536 Clamp bracket
31. 25-8534A "A" Home BracketT/C
32. 20-8533 Ring switch
33. 20-8530 Shaft turret T/C
34. 30-3655 Coolant tubing
35. 57-1045 Seal CR23646
36. 20-8539 Bearing Rear T/C
37. 20-8511A GEar Cluster T/C
38. 46-7016 Lock nut
39. 20-8522A Gear spur T/C
40. 22-8544 Key gear spur T/C
41. 24-4010 Bellville washer
42. 22-8550A Space Belleville T/C
43. 20-8516 Lever Cam T/C
44. 93-8138 Cam turret T/C
45. 30-1957 Transfer Housing
46. 57-2994 O-ring 2-039 buna
47. 20-0671 Turret
48. 57-0030 O-ring
49. 20-8768A Coupling Turret male
50. 20-8769A Coupling Turret Female
51. 20-8557 Bushing front turret
52. 20-8532 Reatiner Turret T/C
53. 22-8543 Key turret T/C
54. 49-1010 Shoulder bolt 3/8 x 1 1/2
55. 57-2154 O-ring 2-240 buna
56. 59-0035 Die springs
57. 20-8518 Spring Retainer T/C
58. 59-2059 15/16 balls
59. 57-2975 O-ring 2-172 buna
60. 20-0516 Plate turret cover
61. 57-8970 Gasket plate coolant T/H
62. 51-2983 Thrust washer TRD-4860
63. 20-0676 Mount, coupling turret
64. 51-3001 Bearing thrust needle
65. 48-0049 Dowel pin 1/2 x 1

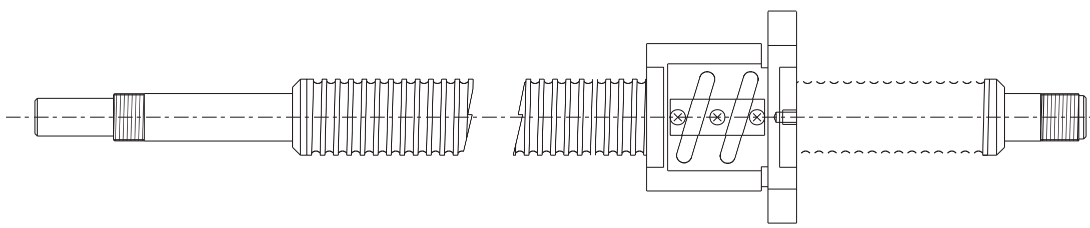


SL-40 Tool Changer Assembly

SL-40 Tool Changer Assembly Parts List

1.	30-3650	Air Cylinder Assembly
2.	32-2162	Clamp Switch
3.	32-2161	Unclamp Switch
4.	49-4115	1-1/2 Steel Washer
5.	56-9057	Retaining Ring 5100-150
6.	45-2001	Shim .002 Thick
7.	62-0014	Yaskawa Sigma 09 Motor
8.	57-0075	O-Ring 2-02 Buna
9.	30-1220A	Coupling Assembly
10.	57-2129	Worm Seal
11.	20-8512A	Worm Housing
12.	20-8515	Worm Bearing Clamp
13.	51-2042	Bearing Locknut BH-04
14.	51-7001	Ball Bearing 5204-1SB-Kff
15.	57-2022	O-Ring
16.	20-8509	Worm Shaft
17.	59-2057	5/16 Steel Balls
18.	20-0249	TC Housing Machined
19.	57-2831	O-Ring 2-130 Buna
20.	20-8510	TC Transfer Shaft
21.	20-8537	TC Spring Retainer
22.	32-2011	30" Telemechanique Switch
23.	30-3655	Coolant Line Assembly
24.	25-8534	Home Bracket
25.	25-8536	Clamp Bracket
26.	20-8533	TC Switch Ring
27.	20-8530	TC Turret Shaft
28.	58-7242	Coolant Tubing
29.	57-1045	Seal CR6372
30.	20-8539	TC Rear Bearing
31.	46-7016	Locknut
32.	20-8511A	TC Gear Cluster
33.	20-8522A	TC Spur Gear
34.	22-8544	TC Spur Gear Key
35.	24-4010	Belleville Washer (2)
36.	22-8550A	Belleville Spacer
37.	20-8516	TC Cam Lever
38.	30-3660A	Transfer Coolant Nozzle Haas Turret, (30-1159 BOT Turret, 30-6065 VDI Turret)
39.	93-8138	TC Turret Cam (2)
40.	59-2059	15/16 Steel Balls
41.	20-0247	Female Turret Coupling
42.	20-0248	Male Turret Coupling
43.	57-0029	Seal CR29841
44.	49-1010	Shoulder Bolt 3/8 x 1-1/2
45.	59-0035	Die Springs
46.	20-8532	TC Turret Retainer
47.	22-8543	TC Turret Key
48.	57-2154	O-Ring 2-240 Buna
49.	20-8518	Spring Retainer
50.	20-8557	Front Turret Bushing
51.	51-3001	Needle Thrust Bearing
52.	51-2983	Thrust Washer TRD-4860
53.		O-Ring
54.	20-0397	Turret Block
55.	20-0250	Coupling Mount
56.	22-8538	TC End Rod Spacer

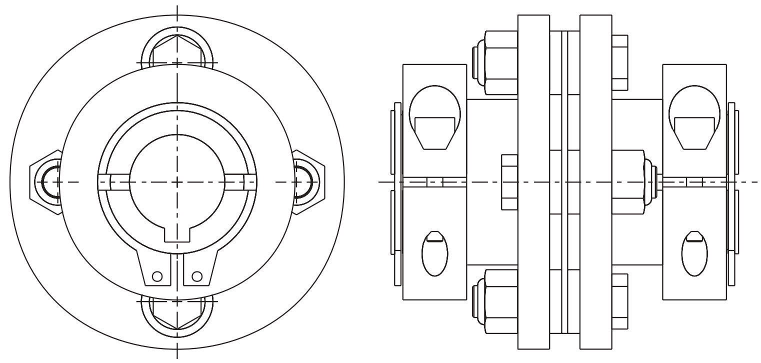




BALL SCREW ROTATED 90°

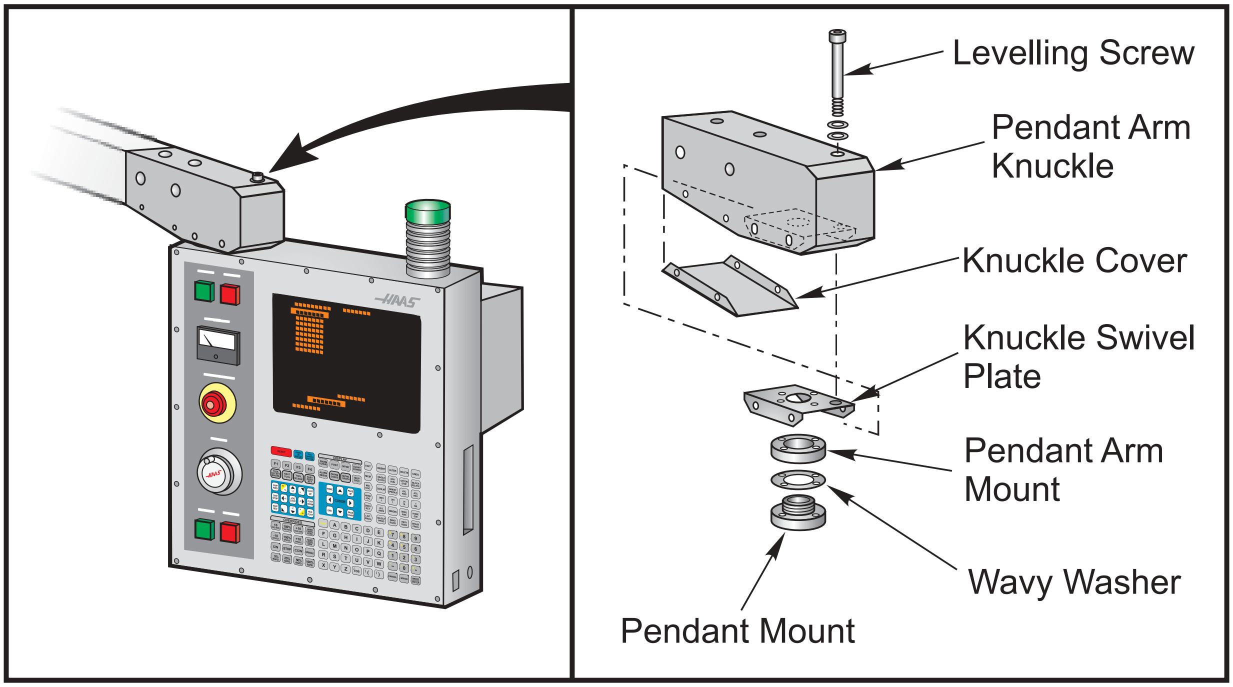
BALL SCREW ASS'Y "A"	BALL SCREW	SNAP LOCK RING BMPR	MOTOR MOUNT	COUPLING ASS'Y	APPLICATION
30-2977 BS ASS'Y 32mm	24-8765 BALLSCR 32mm	NONE	20-7010A	30-1220A	MINI LATHE (Z)
30-2972 BS ASS'Y 32mm	24-8765 BALLSCR 32mm	NONE	20-7010A	30-1220A	MINI LATHE (X)
30-2290 BS ASS'Y 32mm	24-7146 BALLSCR 32mm	20-0735 SNAP LOCK RING BMPR 1.75	20-7010A	30-1220A	SL10 (Z)
30-2244 BS ASS'Y 32mm	24-8548B BALLSCR 32mm	20-1126 SNAP LOCK RING BMPR 1.68	20-7010A	30-1220A	SL10 (X)
30-0615 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	20-7010A	30-1220A	SL20 (Z)
30-0617 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	20-7010A	30-1220A	SL30 (Z)
30-1397A BS ASS'Y 32mm (1.26) X 25.650	24-7146 BALLSCR 32mm (1.26) X 25.650	20-0141 SNAP LOCK RING BMPR 4.00	20-7010A	30-1220A	SL40 (X)
30-0618B BS ASS'Y 32mm (1.26) X 16.475	24-8765 BALLSCR 32mm (1.26) X 16.475	NONE	20-7010A	30-1220A	SL30 (X)
30-0616B BS ASS'Y 32mm (1.26) X 13.525	24-9548 BALLSCR 32mm (1.26) X 13.525	NONE	20-7010A	30-1220A	SL20 (X)
30-0450 BALLSCR 40mm (1.57) x 57.897	24-0003A BS ASS'Y 40mm (1.57) x 57.897			30-1215	SL40 (Z)

Ball Screw Assembly

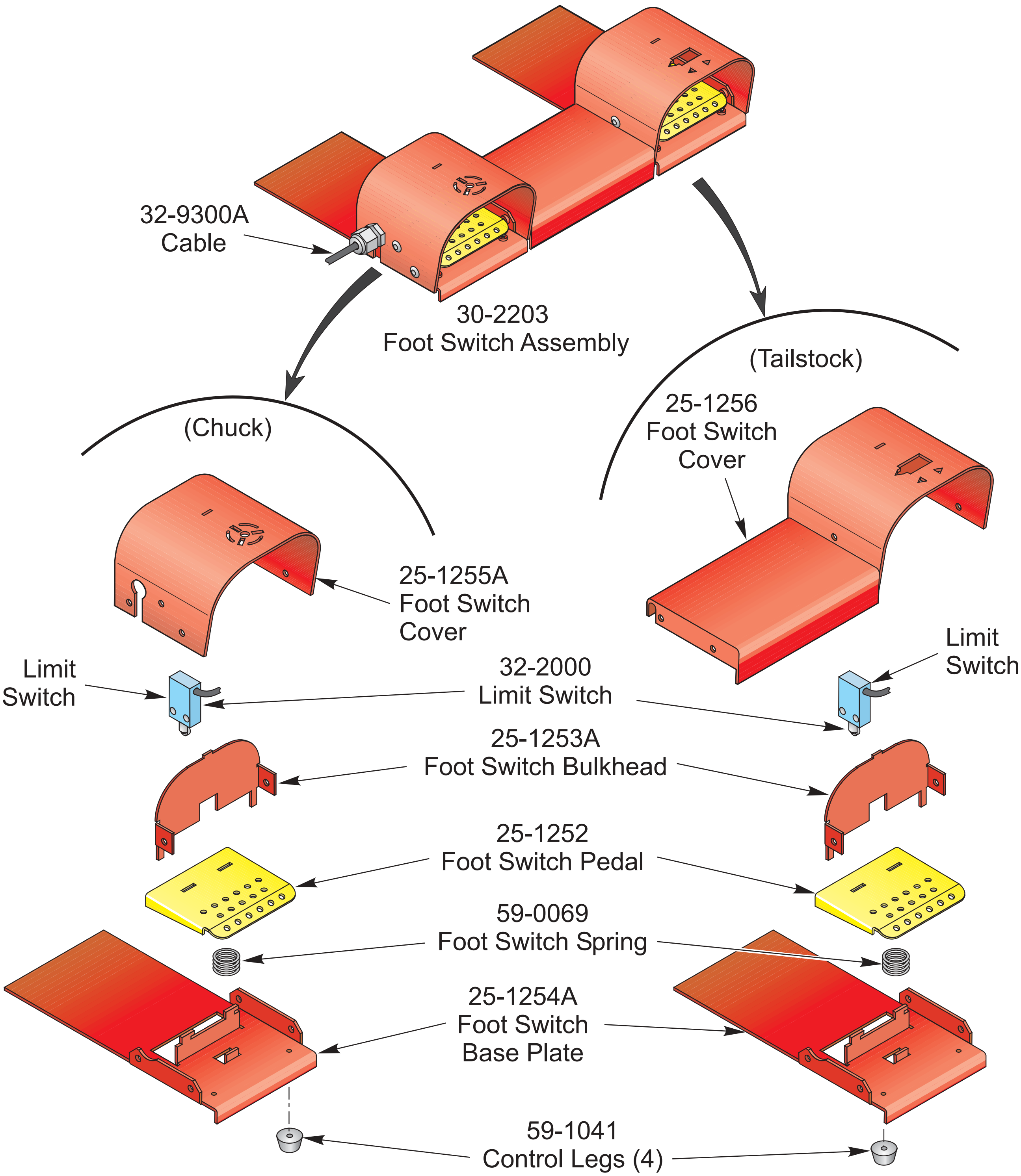


WHERE USED		APPLICATION
30-2972	BS ASS'Y 32mm	MINI LATHE (X)
30-2977	BS ASS'Y 32mm	MINI LATHE (Z)
30-2290	BS ASS'Y 32mm	SL10 (Z)
30-2244	BS ASS'Y 32mm	SL10 (X)
30-0615	BS ASSY 32mm(1.26) x 33.27	SL20 (Z)
30-1962	BS ASSY 32mm(1.26) x 48.23	SL30 (Z)
30-1397A	BS ASSY 32mm(1.26) x 25.65	SL40 (X)
30-0616B	BS ASSY 32mm(1.26) x 13.53	SL20 (X)
30-0618B	BS ASSY 32mm(1.26) x 16.78	SL30 (X)
30-0157	BS ASSY 32mm(1.26) x 25.65	SL40 (Z)
30-0450	BS ASSY 40mm (1.57) x 57.90	SL40 (Z)

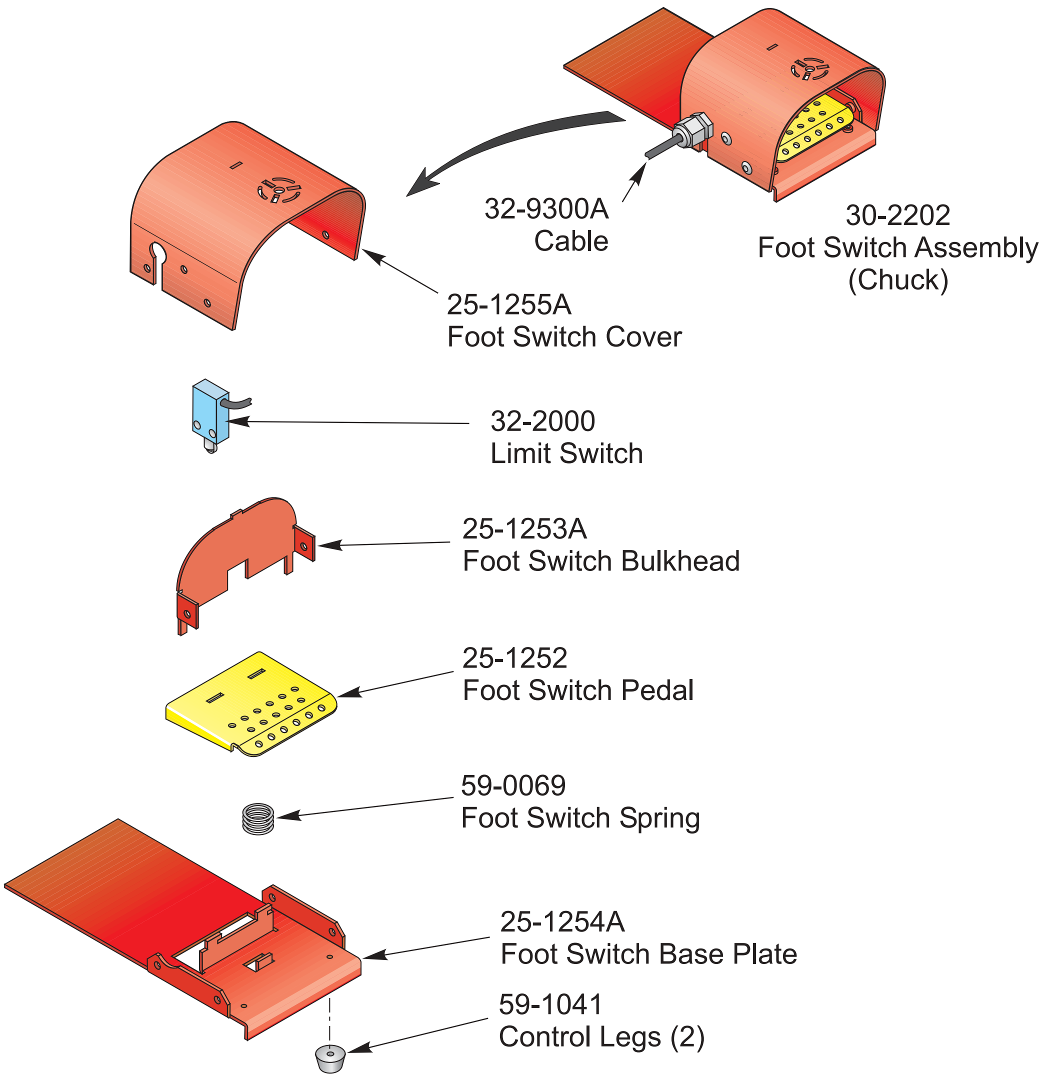
Coupling Assembly



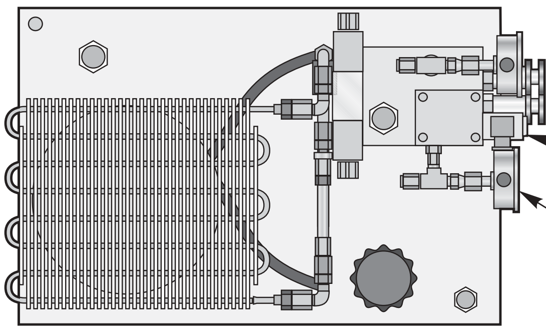
Pendant Levelling Assembly

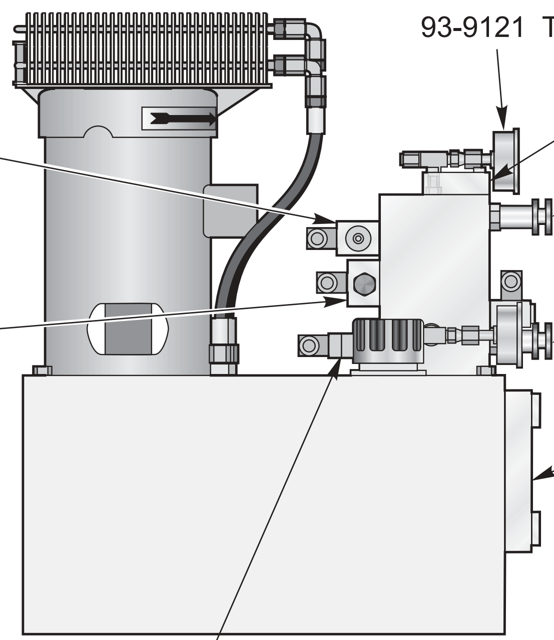


Foot Switch Assembly

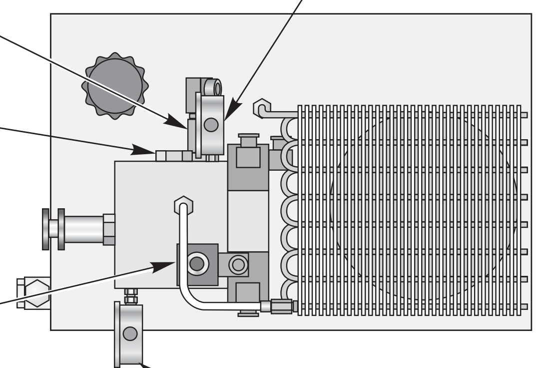


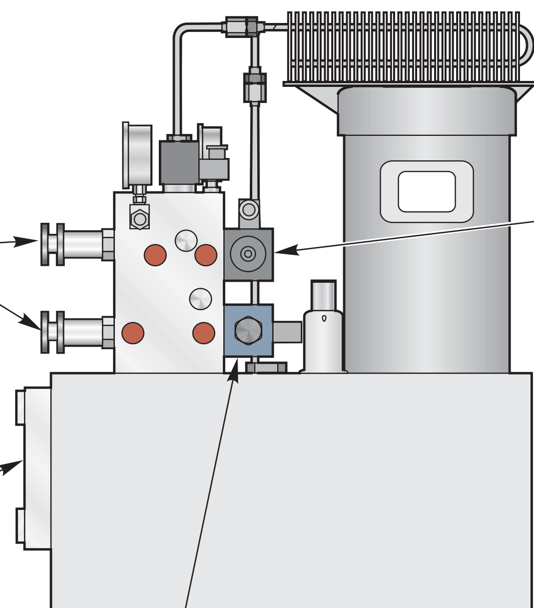
Foot Switch Assembly





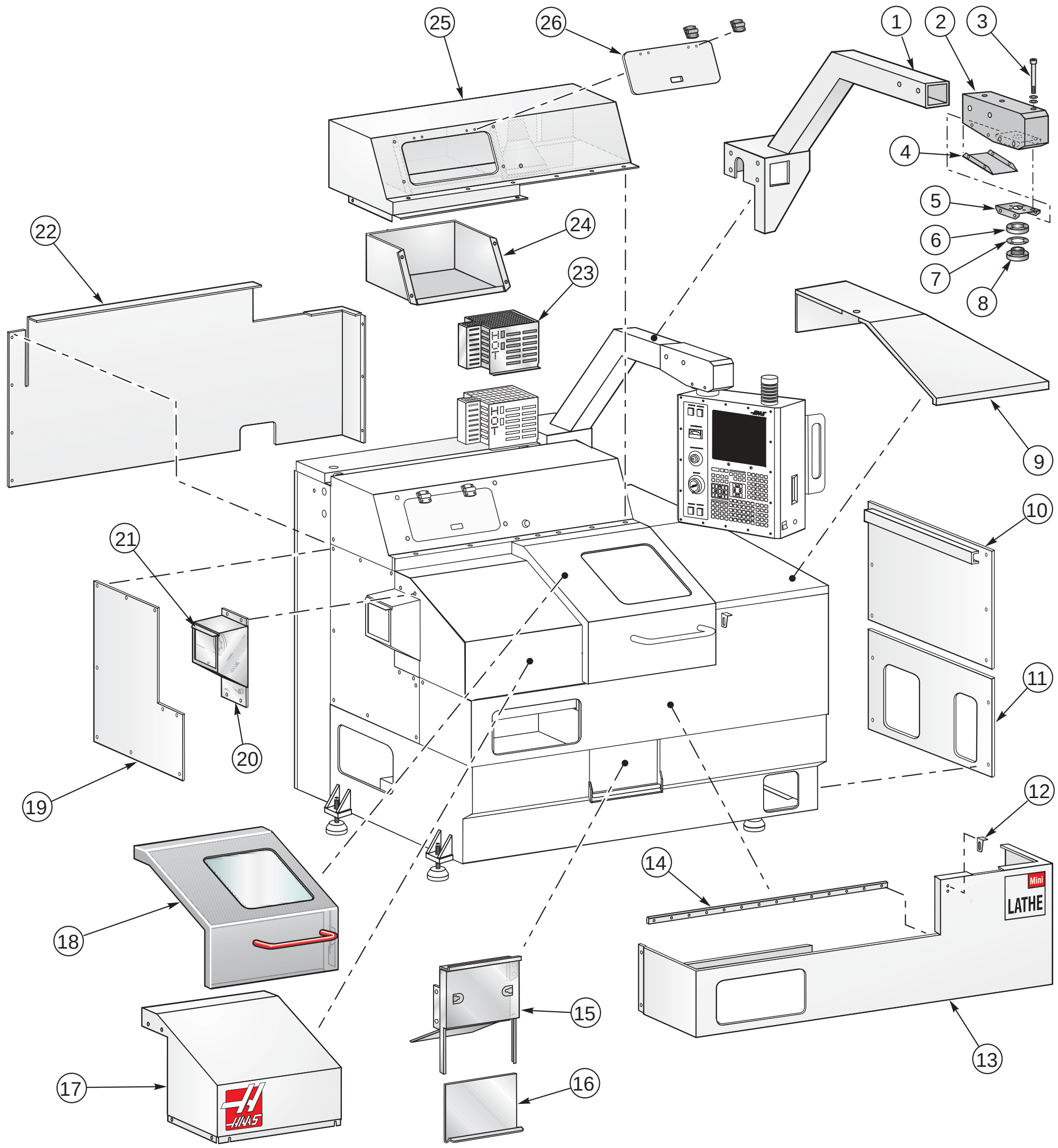
Parker Hydraulic Power Unit





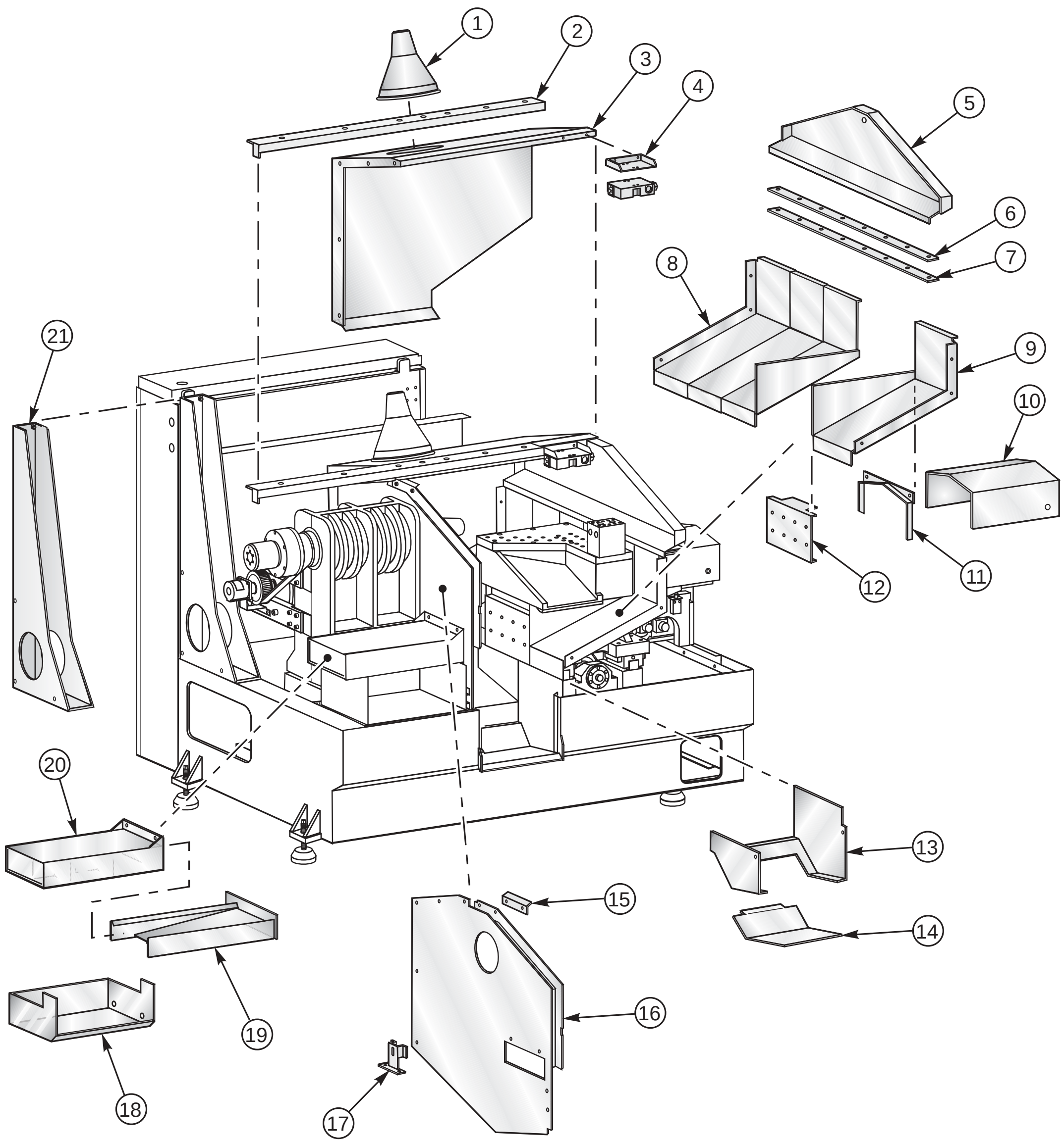
Rexroth Hydraulic Power Unit

Mini Lathe External Sheetmetal and Parts List



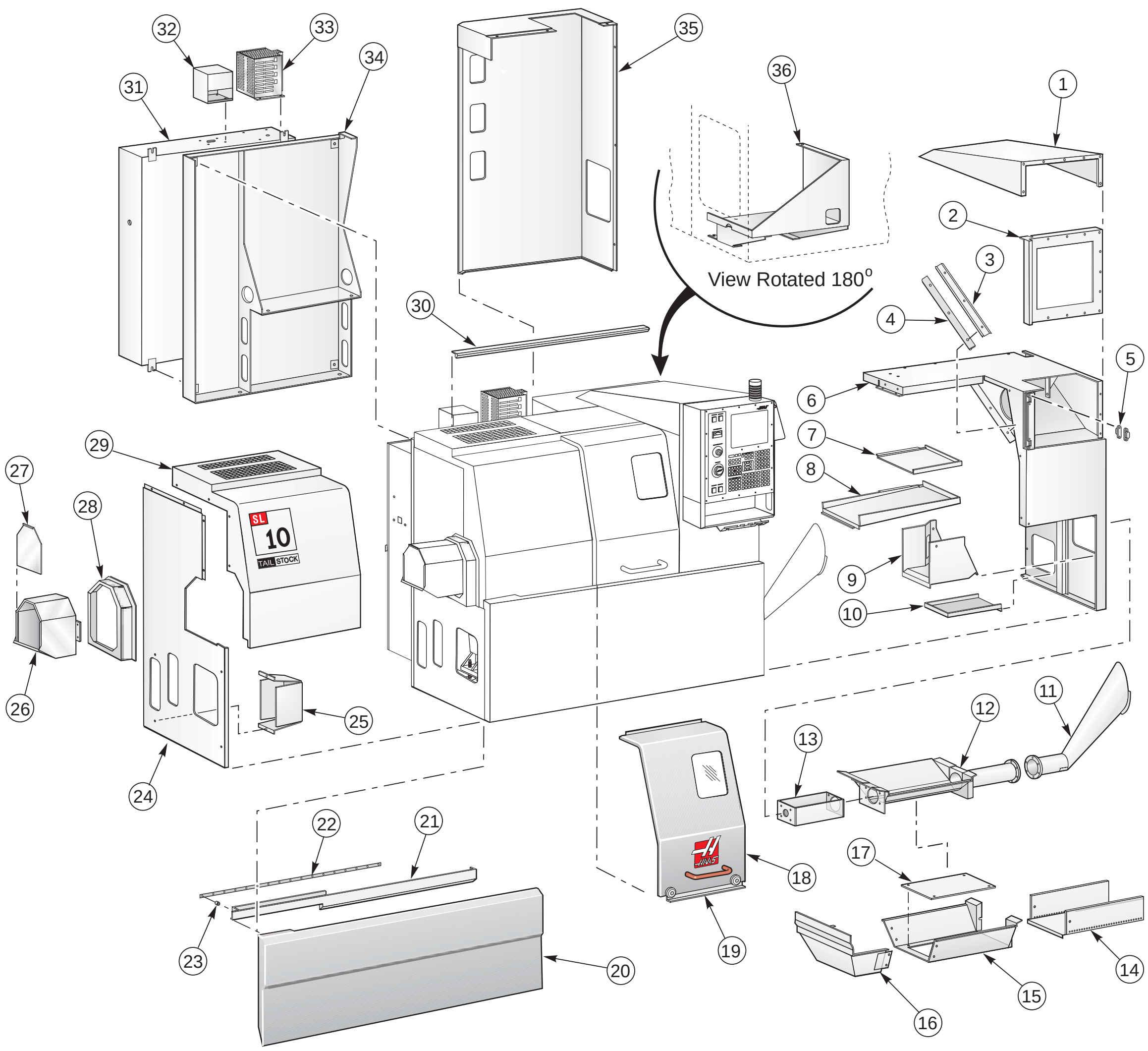
1	20-1292	Pendant Arm
2	25-6661	Pendant Arm Knuckle
3	Leveling SHCS	
4	25-6660	Knuckle Cover
5	25-6659	Knuckle Swivel Plate
6	20-7109A	Pendant Arm Mount
7	55-0020	Wavy Washer
8	20-7110A	Pendant Mount
9	25-4110	Top Right Cover
10.	25-4111	Right End Panel
11.	25-4106A	Lube Cover
12.	25-6152A	Air Hose Bracket
13.	25-4109	Front Skirt
14.	20-1224	Door V-Track
15.	25-4148	Chip Tray Door Bracket
16.	25-4128	Chip Tray Door
17.	25-4121	Spindle Cover
18.	30-2961	Door Assembly
19.	25-4122	Left End Panel
20.	25-4124	Coolant Collector
21.	25-4125	Coolant Collector Door
22.	25-4112	Back Panel
23.	32-0042	Regen Cover
24.	25-4144	Toolbox
25.	25-4108	Top Hat
26.	25-4145	Toolbox Door

Mini Lathe Internal Sheetmetal and Parts List



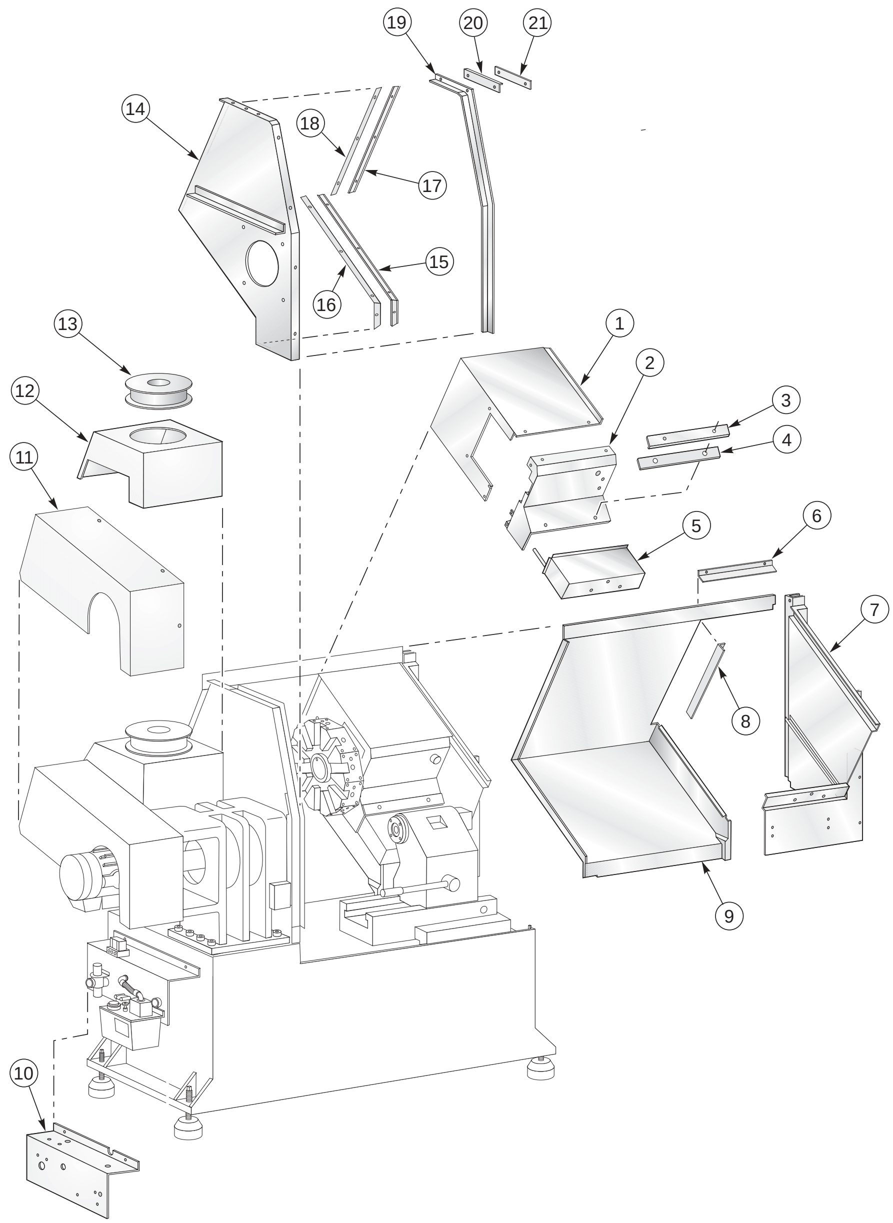
1	32-0106	Work Light Assembly	12	25-4132A	Saddle Bra
2	25-4092	Upper Roller Track	13	25-4143	Chip Tray Body
3	25-4105A	Splash Liner	14	25-4130	Chip Tray
4	25-4100	CE Hanger	15	26-0054	Door Brass Wiper
5	25-4136	Header	16	25-4104A	Fixed Bulkhead
6	Guide Bar		17	25-4107	Bulkhead Bracket
7	Space Bar		18	25-4089	Part Tray
8	25-4134A	Rear Way Cover	19	25-4138	Part Catcher Drawer
9	25-4135A	Front Way Cover	20	25-4147	Part Catcher Drawer Frame
10	25-4133	Z-Axis Sliding Cover	21	25-4102A	Stand
11	25-4139A	Z-Axis Way Cover Wiper			

SL-10 External Sheetmetal and Parts List



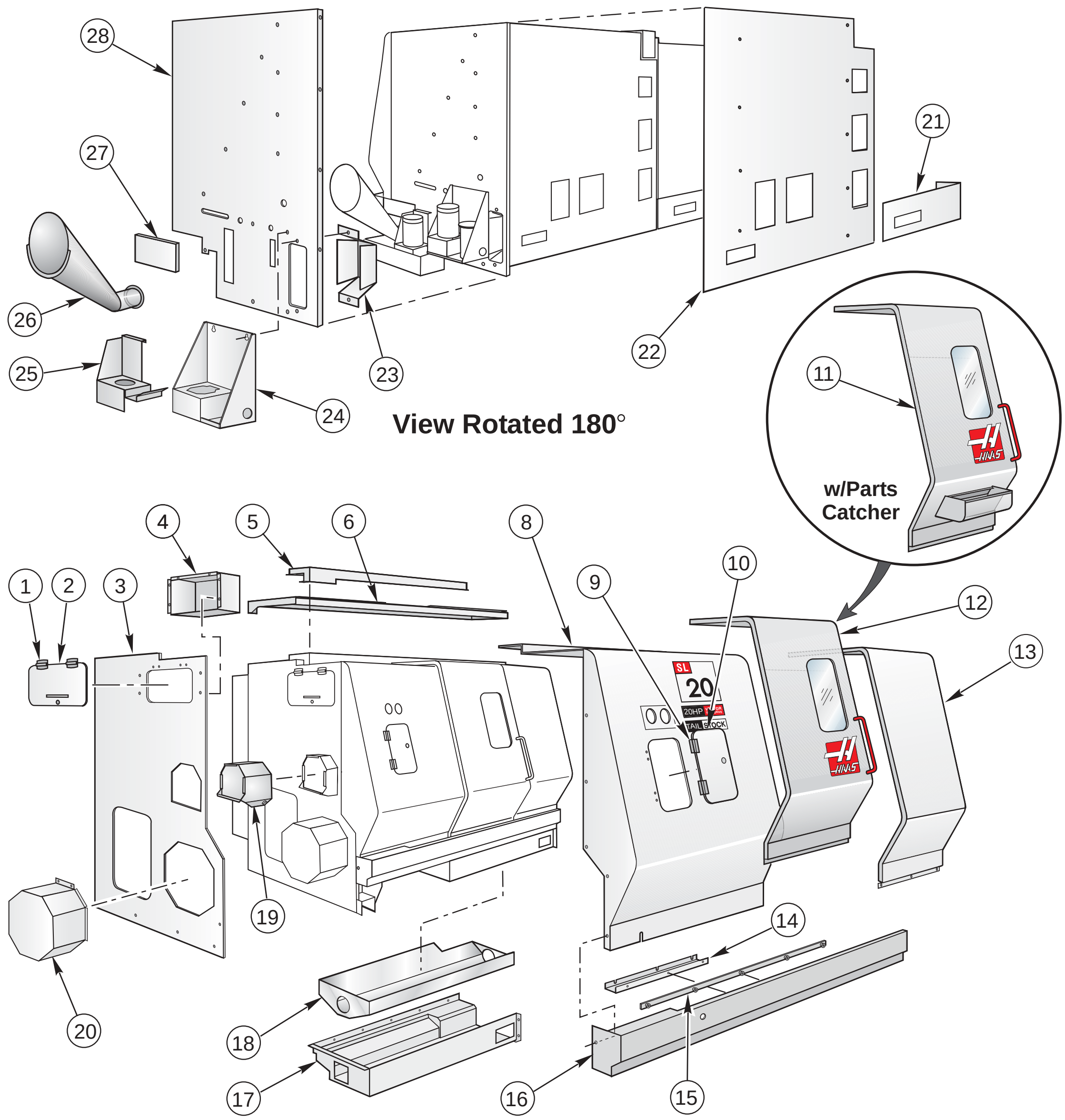
1	25-0875	Monitor Cover
2	25-0876	Pendant Back Cover
3	25-0879	Z-Axis Right Bottom Wiper Retainer
4	26-0030	Z-Axis Right Bottom Wiper Felt
5	59-0009	R-Type Hinge Half
6	25-0868A	Right Side Panel Weldment
7	25-1002	Tailstock Pan
8	25-0890	NOTS Tray
9	25-1023	Motor Pump Coolant Tray
10	25-0889	Coolant PM Tray
11	25-0548	Discharge Chute Weldment
12	25-0887	Auger Pan Weldment
13	25-6551	Auger Mount
14	25-0888	Chip Tray Extension
15	25-0878B	Chip Tray Right
16	25-0877B	Chip Tray Left
17	25-6574	Chip Tray Bottom
18	25-0858	Door Weldment (25-0016 Window)
19	25-0860	Door Inner Liner
20	25-0862	Front Skirt
21	25-0865	Lower Door Rail
22	22-6506	Door V-Track
23	20-6016	Door V-Track Spacer
24	25-6190	Bottom Left Side Panel
25	25-0398	Tramp Lube Oil Bottle Panel
26	25-6185	Coolant Collector
27	25-0606	Coolant Collector Door
28	25-6150	Coolant Collector Enclosure
29	25-6189A	Top Left End Panel
30	26-0869	Upper Door Rail
31	25-0025D	Main Electrical Control Box
32	25-8709	J-Box
33	32-0042	Regen Assembly
34	25-0857	Control Box Bracket
35	25-0867	Rear Panel
36	25-0863	Hydraulic Pump Mount Weldment

SL-10 Internal Sheetmetal and Parts List



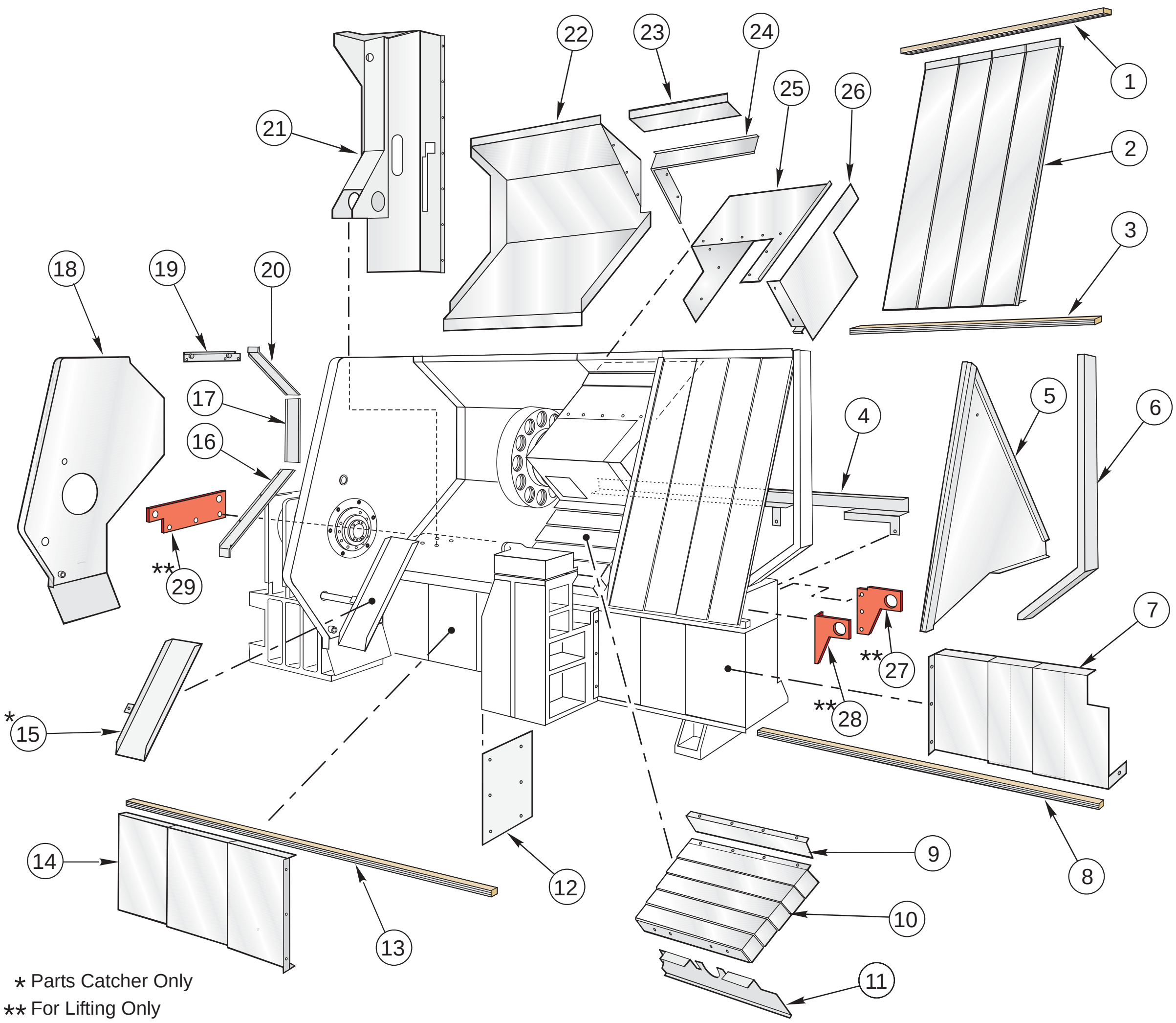
1	25-0870	X-Axis Top Cover	12	25-0886	Fan Mount
2	25-0871	X-Axis Front Cover	13	36-3035	Spindle Motor Fan
3	25-0983	X-Axis Wiper Retainer	14	25-0861	Fixed Bulkhead
4	26-0038	X-Axis Way Cover Felt	15	25-0880	Z-Axis Left Bottom Wiper Retainer
5	25-0872	X-Axis Way Cover	16	26-0032	Z-Axis Left Bottom Wiper Felt
6	26-0034	X-Axis Top Wiper Felt	17	25-0881	Z-Axis Left Top Wiper Retainer
7	25-0866	Moving Bulkhead	18	26-0033	Z-Axis Left Top Wiper Felt
8	26-0035	X-Axis Side Wiper Felt	19	25-0859	Door Drain
9	25-0873	Z-Axis Sliding Cover	20	26-0039	Door Wiper
10	25-7195	Lube Rack Bracket	21	25-0947	Top Wiper Retainer
11	25-0885	Belt Cover			

SL-20 External Sheetmetal and Parts List



1.	59-0023	Door Hinges
2.	25-1350	Toolbox Door
3.	25-8909F	Left Side Panel
4.	25-1349	Toolbox
5.	25-8935D	Top Door Roller Mount
6.	25-8916B	Top Panel
7.	Not Used	
8.	25-8924G	Left Front Panel
9.	59-0023	Door Hinges
10.	25-8021	Access Door
11.	30-1489	Door Assembly w/Parts Catcher
12.	30-1486A	Door Assembly
13.	25-8919C	Right Front Panel
14.	25-8784C	Door Drip Panel
15.	22-6506	Door V-Track
16.	25-8903C	Front Rail
17.	25-6550A	Chip Auger Tray
18.	25-8971C	Chip Auger Pan
19.	25-0607	Coolant Collector
	25-0606	Door
20.	22-6115A	Motor Enclosure
21.	25-0428	Left Bottom Rear Cover
22.	25-1459A	Rear Cover
23.	25-0398	Tramp Lube Oil Pan
24.		HP Pump Bracket
25.		Coolant Pump Mount
26.	25-0548	Discharge Chute
27.	25-6628	Discharge Chute Filler
28.	25-8914F	Right End Panel
	25-0623C	Right End Panel (TL-15)

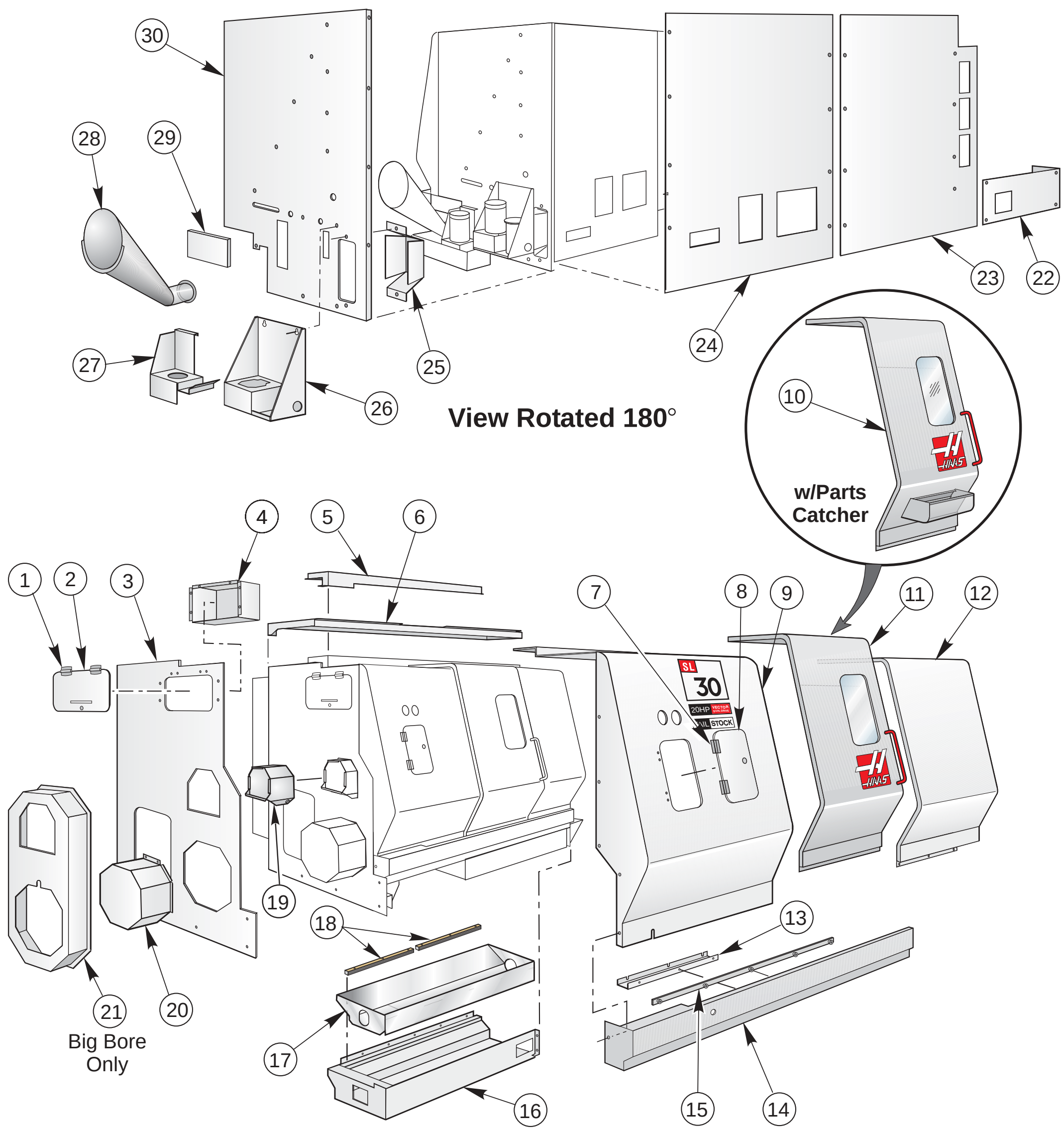
SL-20 Internal Sheetmetal and Parts List



* Parts Catcher Only
** For Lifting Only

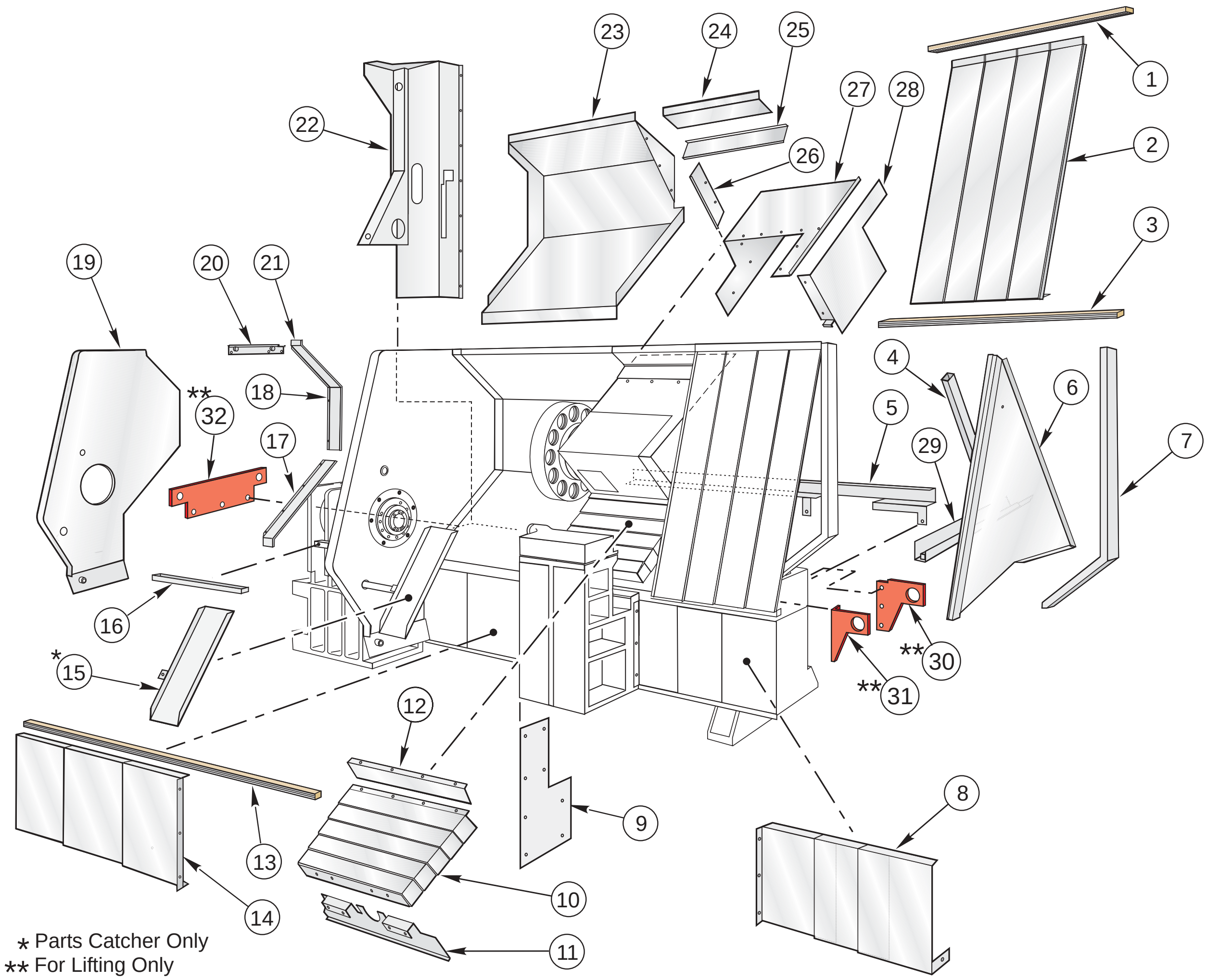
1.	22-8053	Upper Waycover Guide
2.	25-8051	Z-Axis Waycovers
3.	22-8052	Lower Waycover Guide
4.	25-4423	Cable Rail
5.	25-8933D	Moving Bulkhead
6.	25-8908A	Right Support
7.	25-4329	Tailstock Right Waycovers
8.	22-8075A	Lower Tailstock Waycover Guide
9.	25-6458	Tool Changer Front Plate
10.	25-8665A	Tool Changer Waycover
11.	25-8926C	Front Wedge Cover
12.	25-0250A	Tailstock Cover
13.		Upper Tailstock Waycover Guide
14.	25-4316	Left Tailstock Waycovers
15.	25-6512	Parts Catcher Tray (Optional)
16.	25-4320	Z-Axis Bottom Wiper
17.	25-4321	Z-Axis Back Wiper
18.	25-8938E	Fixed Bulkhead
19.	30-3191	Upper Door Wiper Assembly
20.	25-4322	Z-Axis Top Wiper
21.	25-8925C	Control Box Mounting Bracket
22.	25-8921D	Rear Sliding Cover
23.	25-8928A	Tool Changer Tunnel Panel
24.	25-4324	X-Axis Wiper
25.	25-8605B	Tool Changer Sliding Cover
26.	25-8694A	Tool Changer Splash Shield
27.	20-1633	Right Rear Lifting Bracket
28.	20-1632	Right Front Lifting Bracket
29.	20-1631	Left End Lifting Bracket

SL-30 External Sheetmetal and Parts List



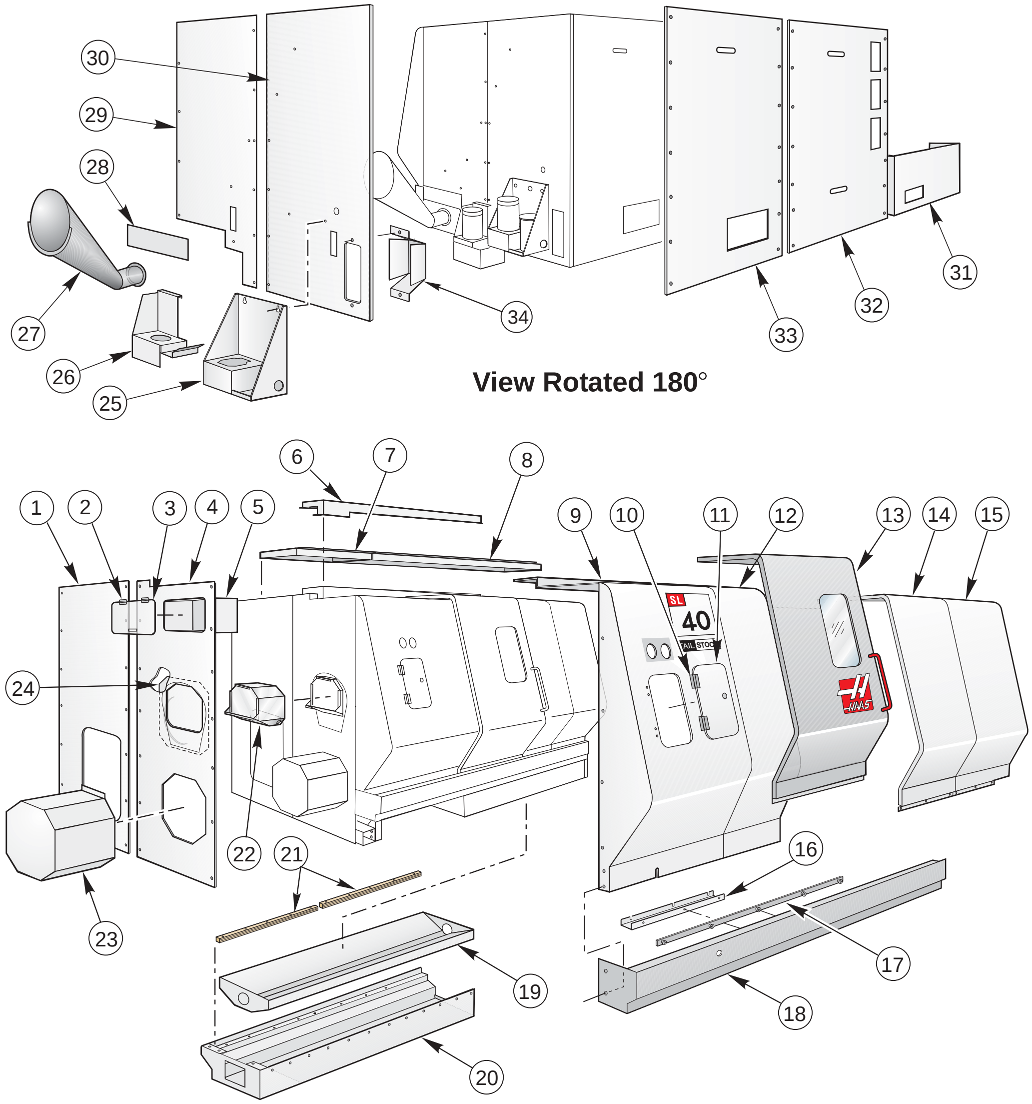
1.	59-0023	Door Hinges (2)
2.	25-1350	Toolbox Door
3.	25-8814E	Left Side Panel
4.	25-1349	Toolbox
5.	25-8819C	Top Door Roller Mount
6.	25-8818D	Top Right Panel
7.	59-0023	Door Hinges (2)
8.	25-8021	Access Door
9.	25-8820E	Left Front Panel
10.	30-1490	Door w/Parts Catcher Assy
11.	30-1487	Door Assy
12.	25-8786C	Right Front Panel
13.	25-6513A	Door Drip Tray
14.	25-8774C	Front Rail
15.	22-6023	Door V-Track
16.	25-6557	Chip Tray
17.	25-8880B	Chip Auger Pan
18.		Lower Tailstock Waycover Guide
19.	25-0607	Coolant Collector (25-0606 Door)
20.	25-6115A	Motor Enclosure
21.	25-6510	Motor Enclosure (Big Bore)
22.	25-0517	Left Bottom Rear Panel
23.	25-0526	Center Rear Panel
24.	25-0518	Right Rear Panel
25.	25-0398	Tramp Lube Oil Pan
26.		HP Pump Bracket
27.		Coolant Pump Mount
28.	25-0548	Auger Discharge Chute
29.	25-0283	Chip Tray Filler
30.	25-8813G	Right Side Panel

SL-30 Internal Sheetmetal and Parts List



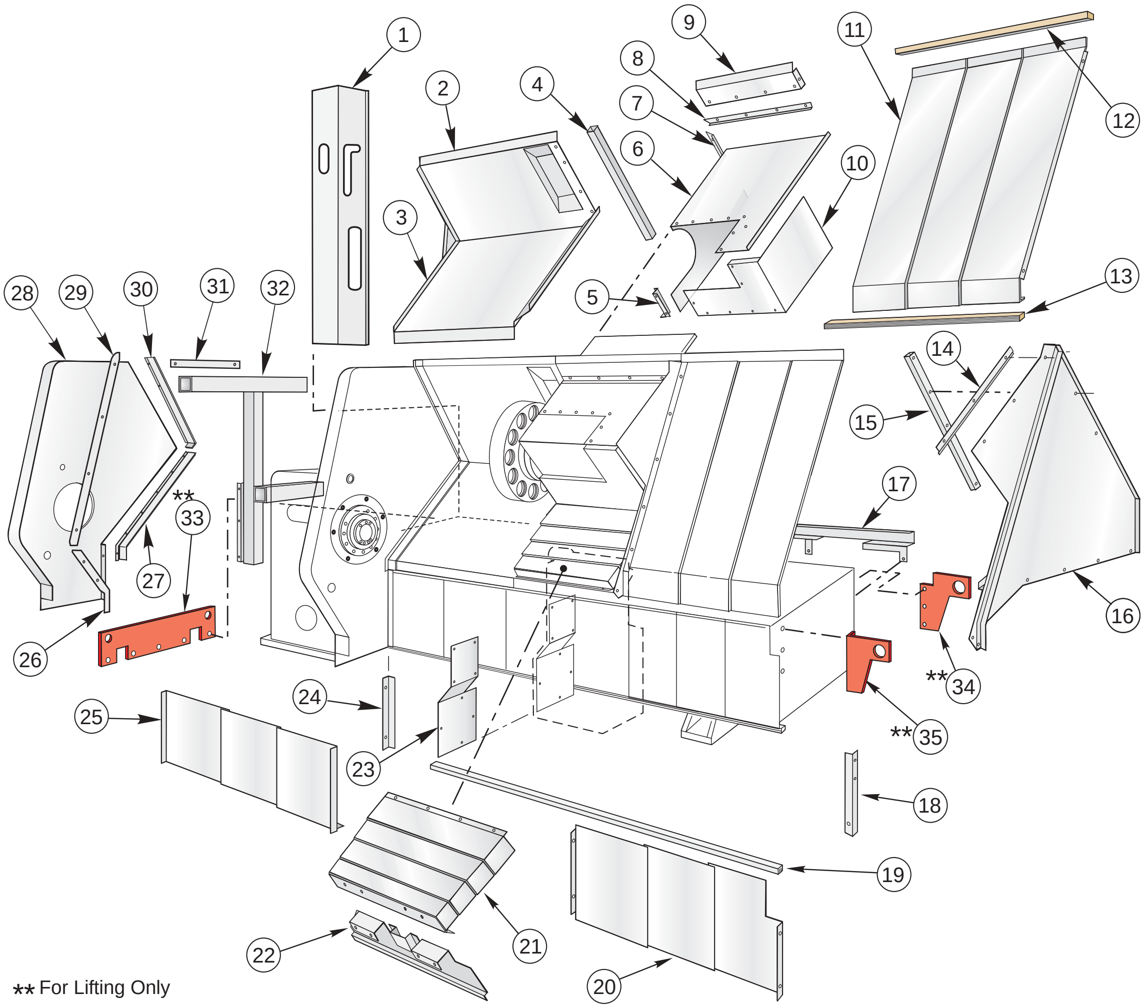
1.	22-8049	Z-Axis Top Waycover Guide	17.	30-3647	Z-Axis Lower Wiper Assembly
2.	25-8047	Z-Axis Waycover	18.	30-3646	Z-Axis Middle Wiper Assembly
3.	22-8048	Z-Axis Bottom Waycover Guide	19.	25-8824C	Fixed Bulkhead
4.	22-8783	Moving Bulkhead Support	20.	30-3192	Door Wiper Assembly
5.	22-0830	Cable Channel Cover	21.	30-3645	Z-Axis Upper Wiper Assembly
6.	25-8843A	Moving Bulkhead	22.	25-8807B	Control Box Mounting Bracket
7.	25-6543A	Right End Support Bracket	23.	25-8754C	Rear Sliding Cover
8.		Right Tailstock Waycover	24.	25-8782B	Tool Changer Tunnel Panel
9.		Tailstock Cover	25.	30-3648	X-Axis Top Wiper Assembly
10.	25-8757	Tool Changer Waycover	26.	30-3649	X-Axis Side Wiper Assembly
11.	25-8755C	Front Wedge Cover	27.	25-8823B	X-Axis Tool Changer Sliding Cover
12.	25-6458	Tool Changer Waycover Mount	28.	25-8772A	Tool Changer Splash Shield
13.		Upper Tailstock Waycover Guide	29.	25-8830A	X-axis Drip Channel
14.		Left Tailstock Waycover	30.	20-1591	Right Rear Lifting Bracket
15.	25-6512	Parts Catcher Tray (Optional)	31.	20-1590	Right Front Lifting Bracket
16.	25-8849A	Z-Axis Drip Tray	32.	20-1589	Left End Lifting Bracket

SL-40 External Sheetmetal and Parts list



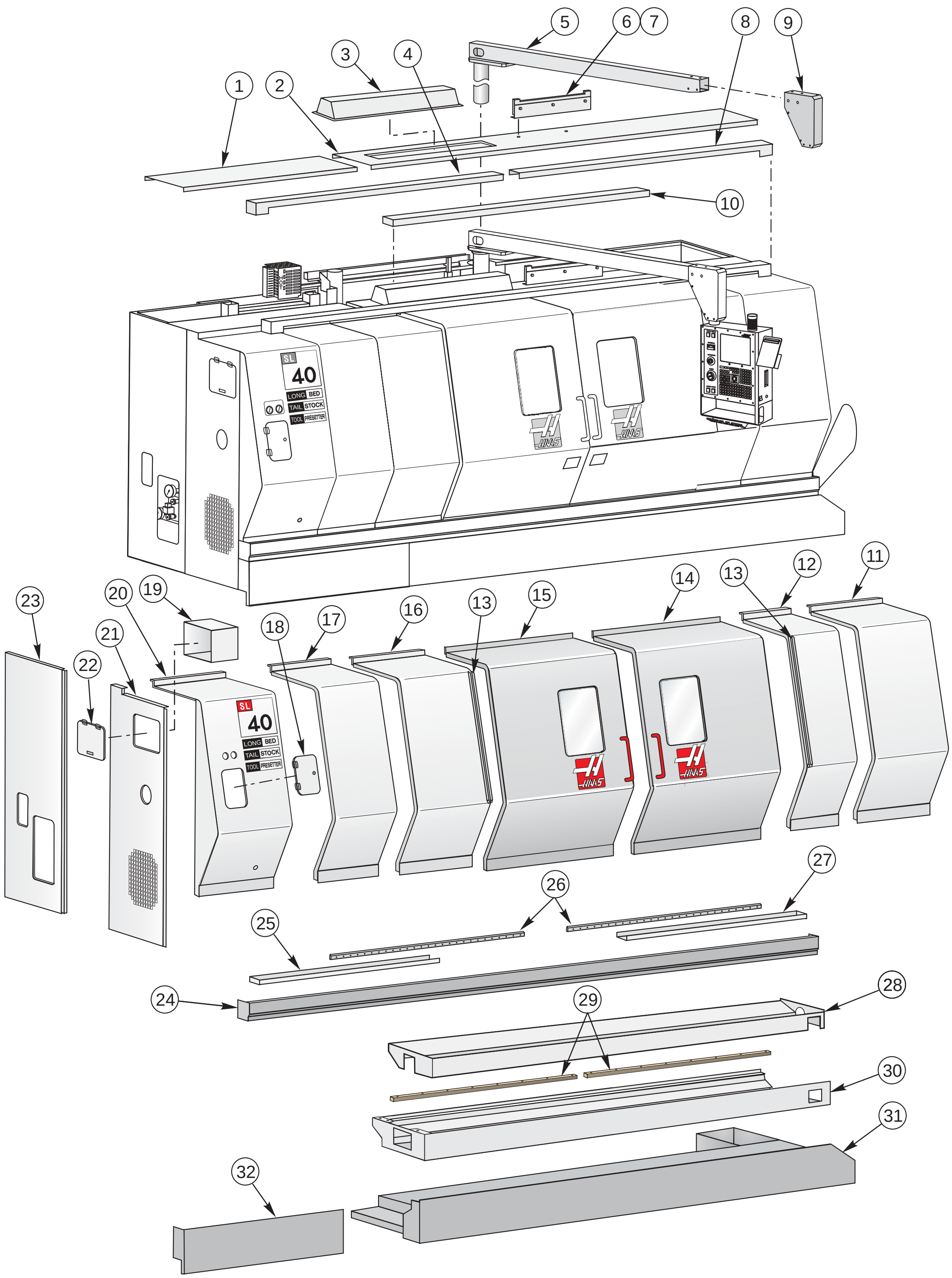
1.	25-0780	Left End Rear Panel	18.	25-8235	Front Rail
2.	59-0023	Toolbox Door Hinge	19.	25-8269A	Chip Auger Pan
3.	25-1350A	Toolbox Door	20.	25-6601	Chip Tray
4.	25-8211F	Left End Front Panel	21.	22-8301	Lower Tailstock Waycover Guide (2)
5.	25-4729	Toolbox	22.	25-0640C	Coolant Collector
6.	25-8285B	Door Rail Mount	23.	25-6129	Motor Enclosure
7.	25-8218A	Left Top Panel	24.	25-0641	Left End Front Panel Filler
8.	25-8219A	Right Top Panel	25.		HP Pump Bracket
9.	25-8206A	Front Left Panel	26.		Coolant Pump Mount
10.	59-0023	Access Door Hinge	27.	25-0548	Auger Discharge Chute
11.	25-8021	Access Door	28.	25-0164	Discharge Chute Filler
12.	25-8207A	Front Left Middle Panel	29.	25-8213C	Right End Front Panel
13.	30-1488	Door Assembly	30.	25-8214C	Right End Rear Panel
14.	25-8208B	Front Right Middle Panel	31.	25-0783	Rear Lower Left Cover
15.	25-8209A	Front Right Panel	32.	25-0784	Rear Middle Panel
16.	25-6311	X-Axis Drip Tray	33.	25-0781	Rear Right Panel
17.	22-6023	Door V-Track	34.	25-0398	Tramp Lube Oil Pan Bracket

SL-40 Internal Sheetmetal and Parts List

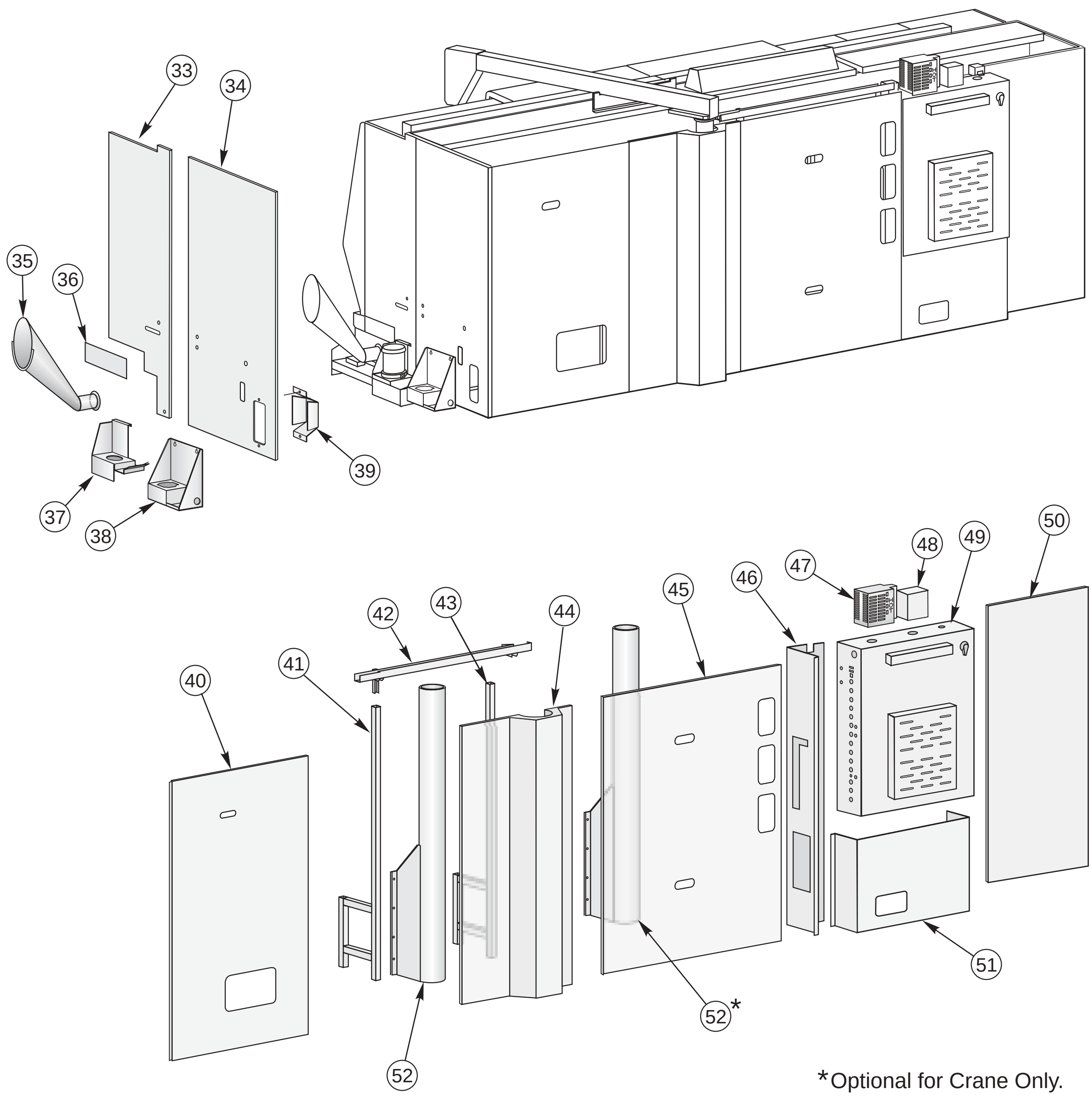


1.	25-0782	Control Box Mounting Bracket
2.	25-0145B	Z-Axis Top Rear Sliding Cover
3.	25-8246B	Z-Axis Bottom Rear Sliding Cover
4.	25-8653A	Z-Axis Waycover Support Bracket
5.	25-8261A	Tool Changer Cover Spacer
6.	25-8262C	Tool Changer Cover
7.	25-8253	X-Axis Vertical Wiper
8.	25-8254	X-Axis Horizontal Wiper
9.	25-8265	X-Axis Tunnel Panel
10.	25-8263	Tool Changer Splash Shield
11.	25-8247	Z-Axis Top Right Waycover
12.	25-8295	Z-Axis Top Waycover Guide
13.	25-8296	Z-Axis Bottom Waycover Guide
14.	25-8264	Z-Axis Strip
15.	22-8275	Moving Bulkhead Support
16.	25-8244C	Moving Bulkhead
17.	19-5793	Cable Channel Cover
18.	25-8241A	Right Enclosure Support
19.	25-8297	Tailstock Waycover Guide
20.	25-8249	Z-Axis Bottom Right Waycover
21.	25-8250	X-Axis Waycover
22.	25-8245A	Front Wedge Cover
23.	25-0252	Tailstock Cover
24.	25-8298	Spindle Housing Vertical Rail Drip
25.	25-8248	Z-Axis Bottom Left Waycover
26.	25-8267A	Lower Door Chip Seal
27.	25-8252A	Z-Axis Horizontal Wiper
28.	25-8243C	Fixed Bulkhead
29.	25-6312	Vertical Door Seal
30.	25-8251A	Z-Axis Vertical Wiper
31.	30-3193	Door Wiper Assembly
32.	22-8237A	Spindle Housing Support
33.	20-1634	Left End Lifting Bracket
34.	20-1636	Right Rear Lifting Bracket
35.	20-1635	Right Front Lifting Bracket

SL-40L External Sheetmetal (Sheet 1 of 2)



SL-40L External Sheetmetal (Sheet 2 of 2)

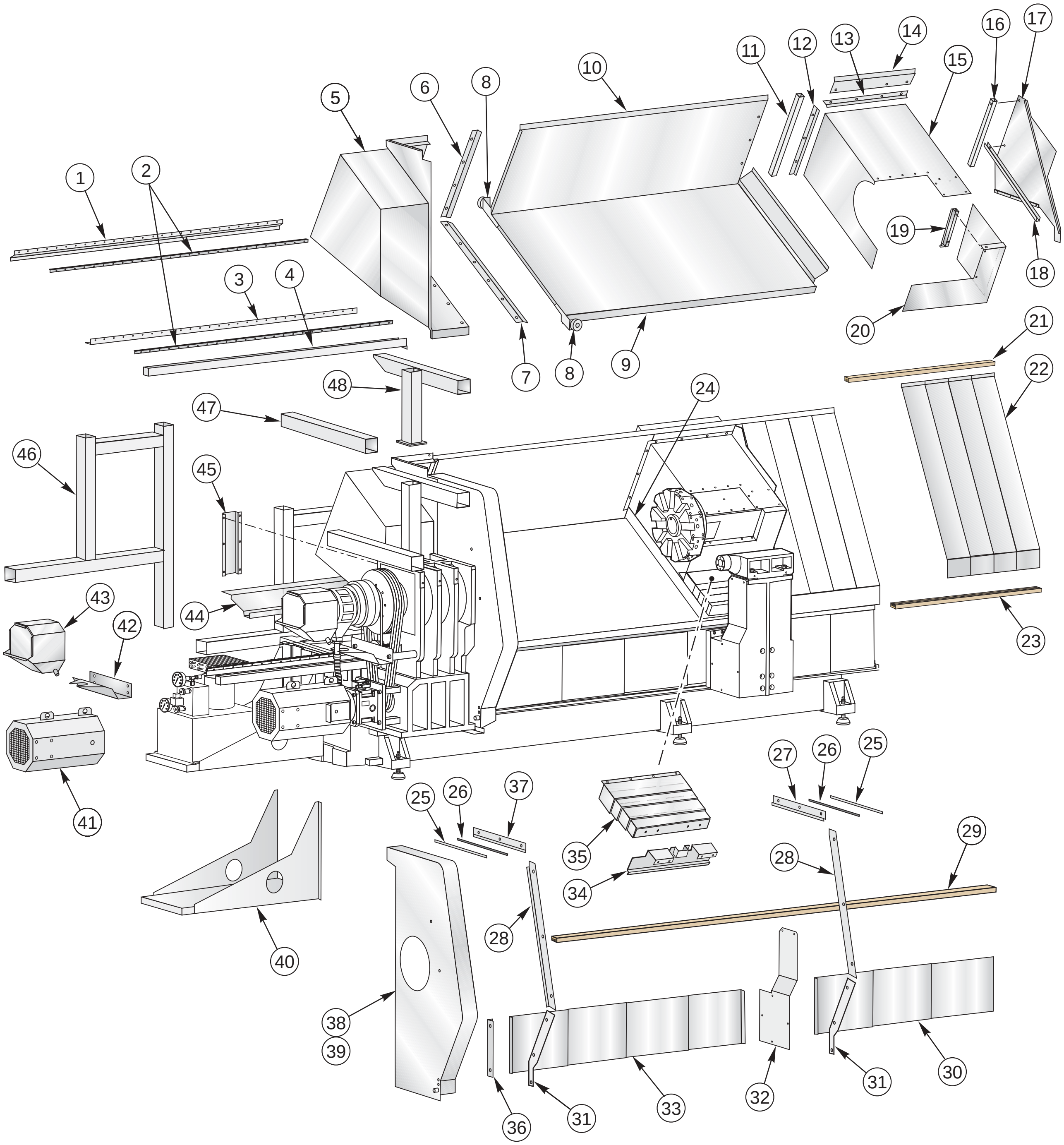


BACK VIEW

SL-40L External Sheetmetal Parts List

1. 25-4541 Left Top Front Panel
2. 25-4542 Right Top Front Panel
3. 25-4723 Light Fixture Body
4. 25-4563 Left Top Door Mount
5. 20-1775 Pendant Boom Arm
6. 20-1773 Boom Arm Detent
7. 25-4578 Boom Arm Detent Support
8. 25-4562 Right Top Door Mount
9. 25-4633 Pendant Arm End Cover
10. 25-4564 Door Support Bridge
11. 25-4539 Front Right Panel
12. 25-4535 Front Right Middle Panel
13. 25-6316 Drip Channel (2)
14. 25-4560 Right Door
15. 30-1488 Left Door
16. 25-8207A Front Left Middle Panel
17. 25-4543 Front Left Spacer Panel
18. 25-8021 Access Door
    59-0023 Hinges (2)
19. 25-1349 Toolbox
20. 25-8206A Front Left Panel
21. 25-5444 Left End Front Panel
22. 25-1350 Toolbox Door
    59-0023 Hinges (2)
23. 25-4546 Left End Rear Panel
24. 25-4533 Front Beam
25. 25-4558 Left Door Drip Rail
26. 20-1772 Z-Axis Roller V-Track (2)
27. 25-4557 Right Door Drip Rail
28. 25-4571 Chip Auger Pan
29. 25-4603 Lower Tailstock Waycover Guides (2)
30. 25-4570 Chip Tray
31. 25-4530 Coolant Tank
32. 25-4555 Lower Left Front Apron
33. 25-4540 Right Front Panel
34. 25-8214C Right Rear Panel
35. 25-0548 Auger Discharge Chute
36. 25-0164 Discharge Chute Filler
37. Coolant Pump Mount
38. HP Pump Mounting Bracket
39. 25-0348 Tramp Lube Oil Pan Bracket
40. 25-0781 Right Rear Panel
41. 20-0841 Right Back Panel Support
42. 25-4577 Monitor Cable Tray
43. 20-1768 Left Back Panel Support
44. 25-4554 Center Back Panel
45. 25-0784 Back Left Center Panel
46. 25-4532 Control Box Support
47. 30-3353 Regen Assembly
48. J-Box
49. Main Electrical Control Box Assembly
50. 25-4553 Left Back Panel
51. 25-0783 Left Back Lower Panel
52. 20-1254 Boom Support (2)

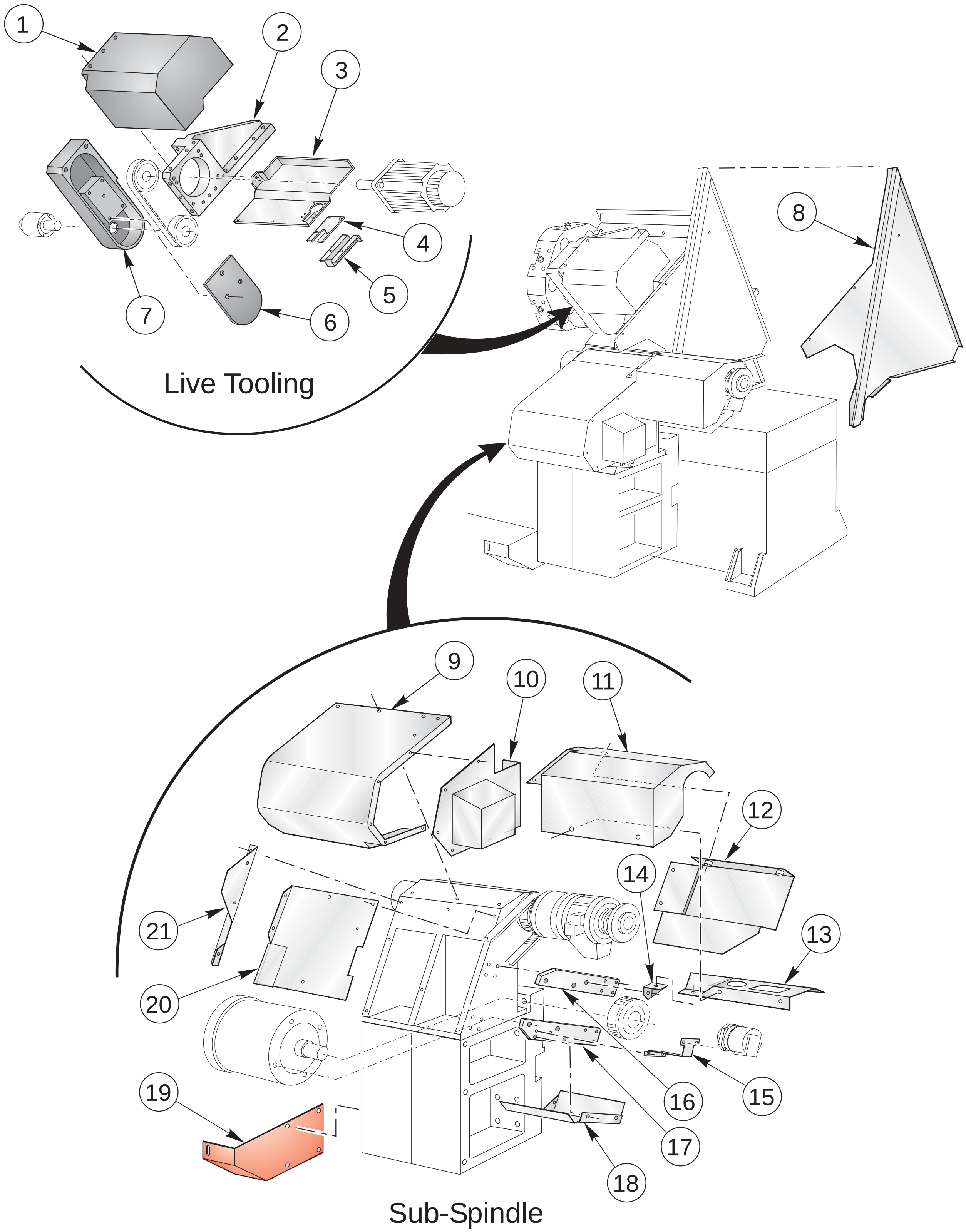
SL-40L Internal Sheetmetal



SL-40L Internal Sheetmetal Parts List

1.	25-4572	Rear V-Track Mount
2.	20-1772	Z-Axis V-Track (2)
3.	25-4573	Front V-Track Mount
4.	25-4556	Z-Axis Drip Channel
5.	25-4581	Tool Pocket
6.	25-4588	Z-Axis Top Wiper
	25-4590	Felt Clamp
7.	25-4589	Z-Axis Bottom Wiper
	25-4591	Felt Clamp
8.	25-4574	V-Track Rollers (2)
9.	25-4596	Z-Axis Bottom Left Waycover
10.	25-4595	Z-Axis Top Left Waycover
11.	22-8293A	Z-Axis Waycover Support Bracket
12.	25-8253	X-Axis Vertical Wiper
13.	25-8254	X-Axis Horizontal Wiper
14.	25-4587	X-Axis Tunnel Panel
15.	25-8262C	Tool Changer Cover
16.		Bulkhead Support
17.	25-4580	Moving Bulkhead
18.	25-8258	Drip Channel
19.	25-8263	Splash Shield Support
20.	25-8261A	Tool Changer Splash Shield
21.	25-4592	Z-Axis Top Front Waycover Guide
22.	25-4597	Z-Axis Right Waycovers
23.	25-4593	Z-Axis Bottom Front Waycover Guide
24.	26-8323	X-Axis Seal (Plastic)
25.	25-4566	Upper Door Wiper Back Plate (2)
26.	26-0086	Upper Door Wiper Felt (2)
27.	25-4568	Right Door Splash Shield
28.	25-6312	Vertical Door Seal (2)
	26-0087	Felt
29.	25-4585	Top Tailstock Waycover Guide
30.	25-4599	Tailstock Right Waycover
31.	25-8267A	Lower Door Chip Seal
32.	25-0252	Tailstock Cover
33.	25-4737	Tailstock Left Waycover
34.	25-4586	Front Wedge Cover
35.	26-8250	X-Axis Waycover
36.	25-8298	Spindle Housing Vertical Rail Drip
37.	25-4567	Left Door Splash Shield
38.	25-4579	Fixed Bulkhead
39.	25-4745	Fixed Bulkhead Support
40.	25-4531	Left End HPU Support
41.	25-0128	Motor Enclosure
42.	25-4071	Shield
43.	25-0640C	Coolant Collector
44.	25-4569	Bottom Cable Wedge Tray
45.	25-4583	Skate Board
46.	20-1776	Control Cabinet Truss
47.	25-4582	Box Support
48.	20-1777	Roof Support

TL-15 Live Tooling and Sub-Spindle Sheetmetal



TL-15 Sheetmetal Parts List

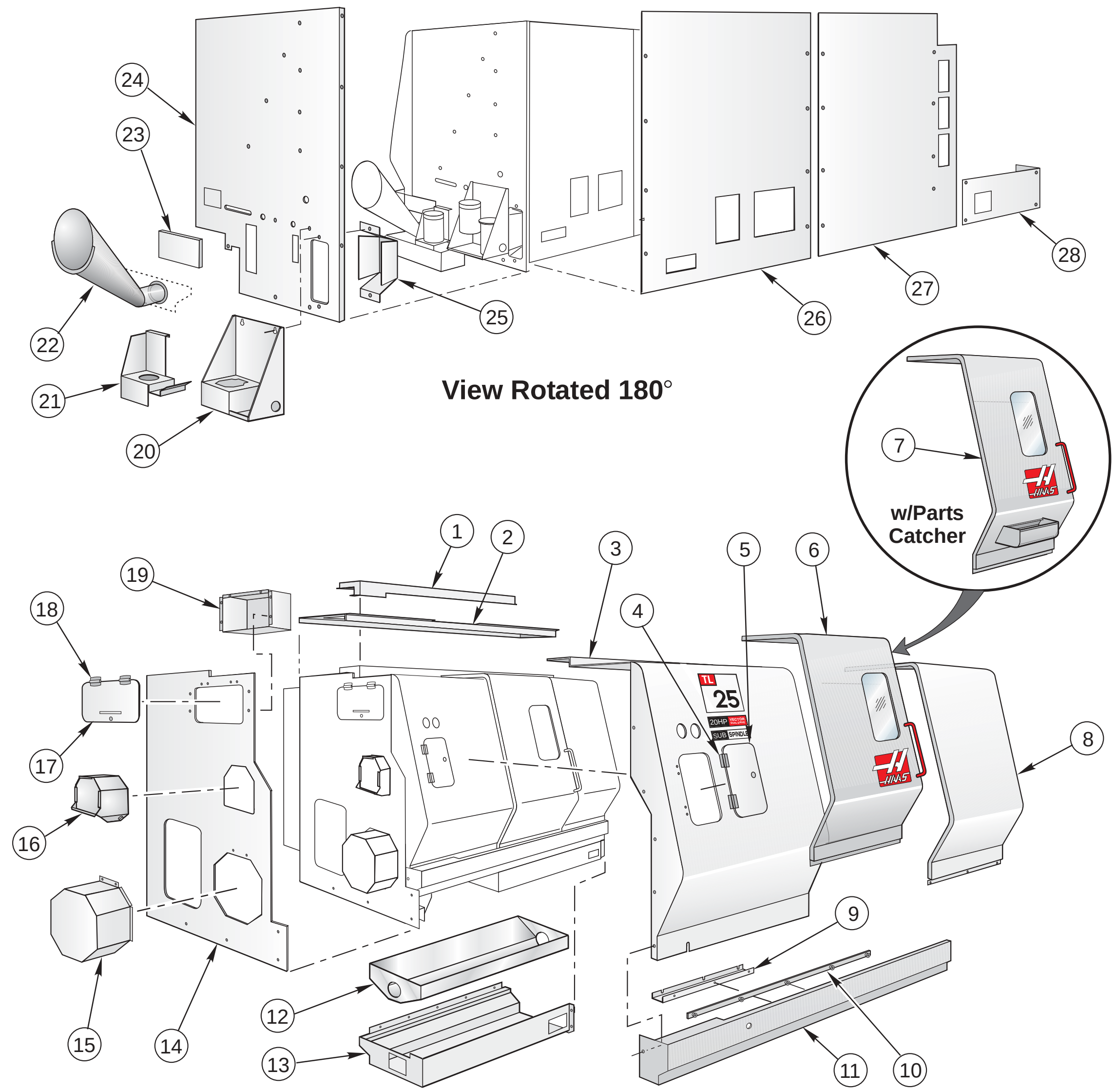
Live Tooling

1	25-0138	Hood
2	20-0163	Brace
3	25-0137	Tray
4	25-0135	Channel Cover
4a	25-6552	Channel Cover (Larger Turret)
5	25-0136	Channel
5a	25-6553	Channel (Larger Turret)
6	20-0161	Belt Arm Cover
7	20-0162	Belt Arm

Sub-Spindle

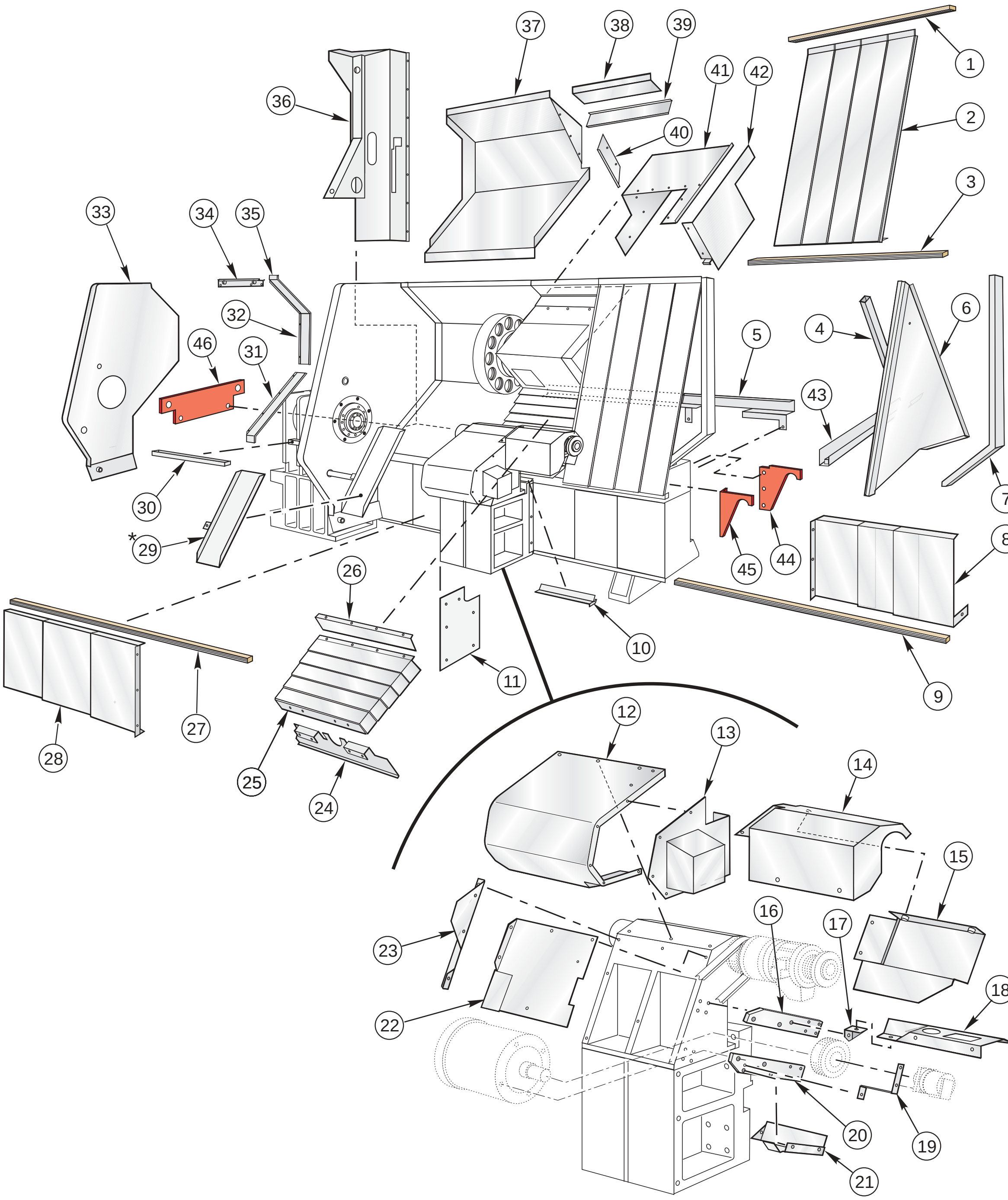
8	25-0617	Moving Bulkhead
9	25-0610	Motor Cover
10	25-0611	Encoder Cover
11	25-0619	Front Union Shroud
12	25-0618	Rear Union Shroud
13		Bottom Union Shroud
14	25-0621	Little Bracket
15	25-0615	Encoder Bracket
16	20-0631	Upper Motor Arm
17	20-0632	Lower Motor Arm
18	25-0613A	Duct Shield
19		Shipping Bracket
20	25-0612	Heat Shield
21	25-0614A	Fan Shield

TL-25 External Sheetmetal and Parts List



1	25-8819C	Top Door Roller Mount	15.	25-6115A	Motor Enclosure
2	25-8818D	Top Right Panel	16.	25-0607	Coolant Collector (25-0606 Door)
3	25-8820D	Left Front Panel	17.	25-1350	Toolbox Door
4	59-0023	Door Hinge (2)	18.	59-0023	Door Hinge (2)
5	25-8021	Access Door	19.	25-1349	Toolbox
6	30-1487A	Door Assembly	20.		High Pressure Pump Bracket
7	30-1490	Door w/Parts Catcher Assembly	21.		Coolant Pump Mount
8	25-8786C	Right Front Panel	22.	25-0548	Auger Discharge Chute
9	25-6513A	X-Axis Drip Tray	23.	25-0283	Chip Tray Filler
10	22-6023	Door V-Track	24.	25-4345A	Right End Panel
11	25-8774C	Front Rail	25.	25-0398	Tramp Lub Oil Pan Bracket
12.	25-8880B	Chip Auger Pan	26.	25-0518	Right Rear Panel
13.	25-6557A	Chip Tray	27.	25-0526	Center Rear Panel
14.	25-8814E	Left Side Panel	28.	25-0517	Left Bottom Rear Cover

TL-25 Internal Sheetmetal



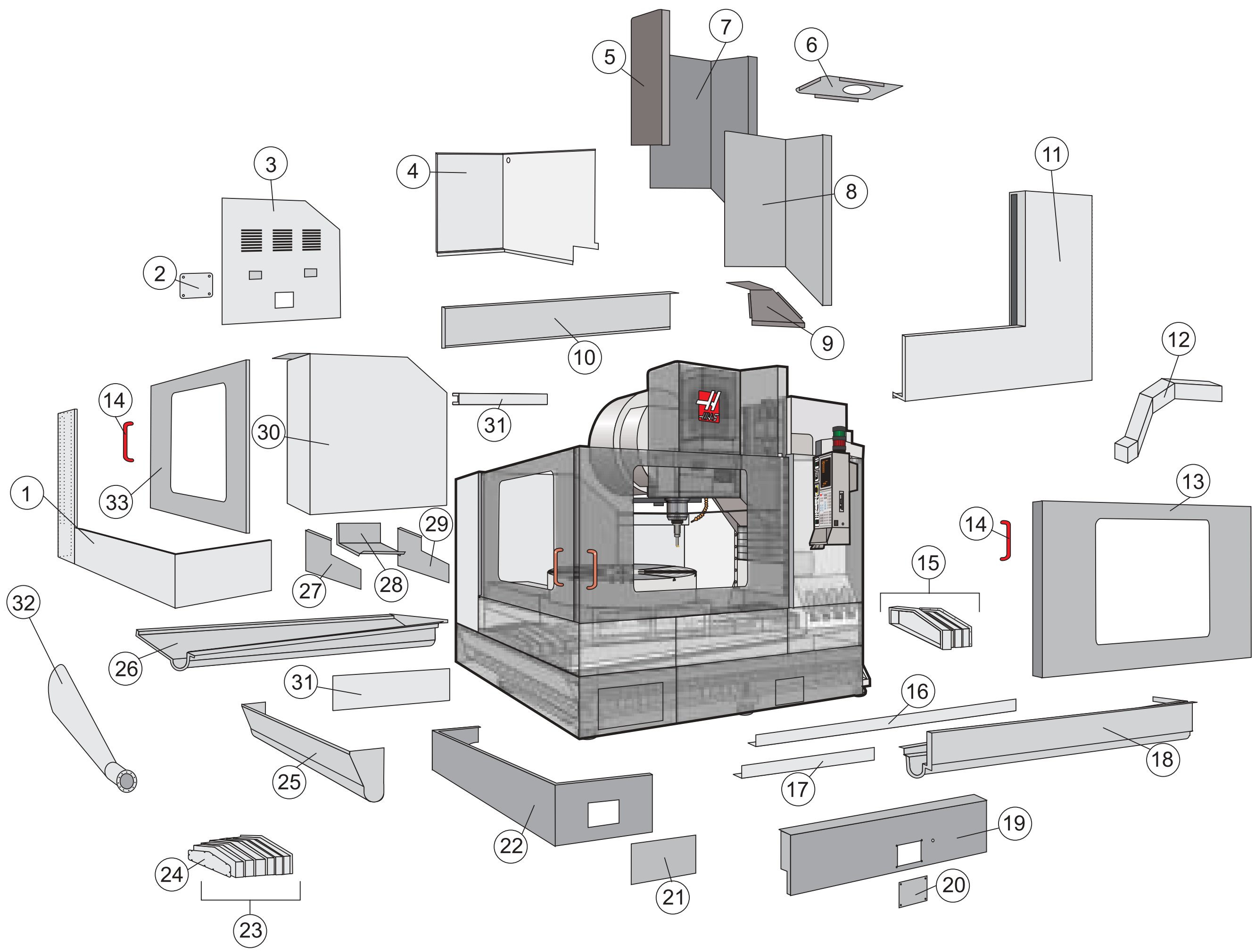
*Parts Catcher Only

SUB-SPINDLE ASSEMBLY

TL-25 Internal Sheetmetal Parts List

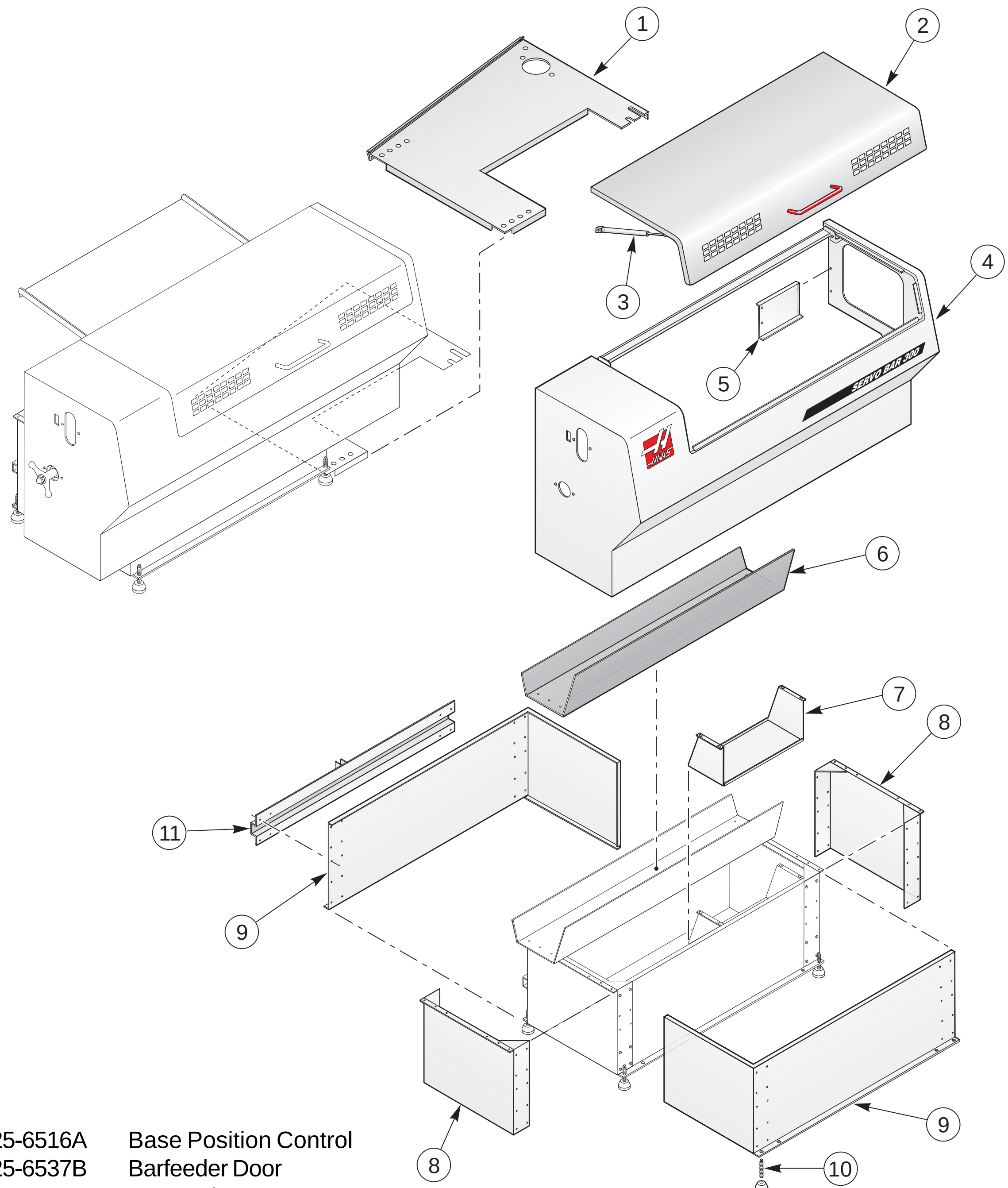
1	22-8049	Z-Axis Top Waycover Guide
2	25-8047	Z-Axis Waycover
3	22-8048	Z-Axis Bottom Waycover Guide
4	22-8783	Moving Bulkhead Support
5	22-0830	Cable Channel Cover
6	25-8843A	Moving Bulkhead
7	25-6543A	Right End Support Bracket
8	25-4348	Right Sub-spindle Waycover (4)
9	20-1521	Lower Tailstock Waycover Guide
10	25-8841A	Sub-spindle Base Plate
11	25-4344	Sub-spindle Base cover
12.	25-0610	Motor Cover
13.	25-0611	Sub-spindle Encoder Cover
14.	25-0619	Front Union Shroud
15.	25-0618	Rear Union Shroud
16.	20-0631A	Upper Motor Arm
17.	25-0621	Little Bracket
18.	25-0620	Conduit
19.		Encoder Mounting Bracket
20.	20-0632A	Lower Motor Arm
21.	25-0613B	Lower Heat Shield
22.	25-0612A	Heat Shield
23.	25-0614A	Fan Shield
24.	25-8755C	Front Wedge Cover
25.	25-8757	Tool Changer Waycover
26.	25-6458	Tool Changer Waycover Mount
27.		Upper Tailstock Waycover Guide
28.	25-4349	Left Sub-spindle Waycover (4)
29.	25-6512	Parts Catcher Tray (Optional)
30.	25-8849A	Z-Axis Drip Tray
31.	30-3647	Z-Axis Lower Wiper Assembly
32.	30-3646	Z-Axis Middle Wiper Assembly
33.	25-8824C	Fixed Bulkhead
34.	30-3192A	Door Wiper Assembly
35.	30-3645	Z-Axis Upper Wiper Assembly
36.	25-8807B	Control Box Mounting Bracket
37.	25-8754C	Rear Sliding Cover
38.	25-8782B	Tool Changer Tunnel Panel
39.	30-3648	X-Axis Top Wiper Assembly
40.	30-3649	X-Axis Side Wiper Assembly
41.	25-4354	X-Axis Tool Changer Sliding Cover
42.	25-8772A	Tool Changer Splash Shield
43.	25-8830A	X-Axis Drip Channel
44.	20-1591	Right Rear Lifting Bracket
45.	20-1590	Right Front Lifting Bracket
46.	20-1589	Left End Lifting Bracket

VTC Sheetmetal and Parts List



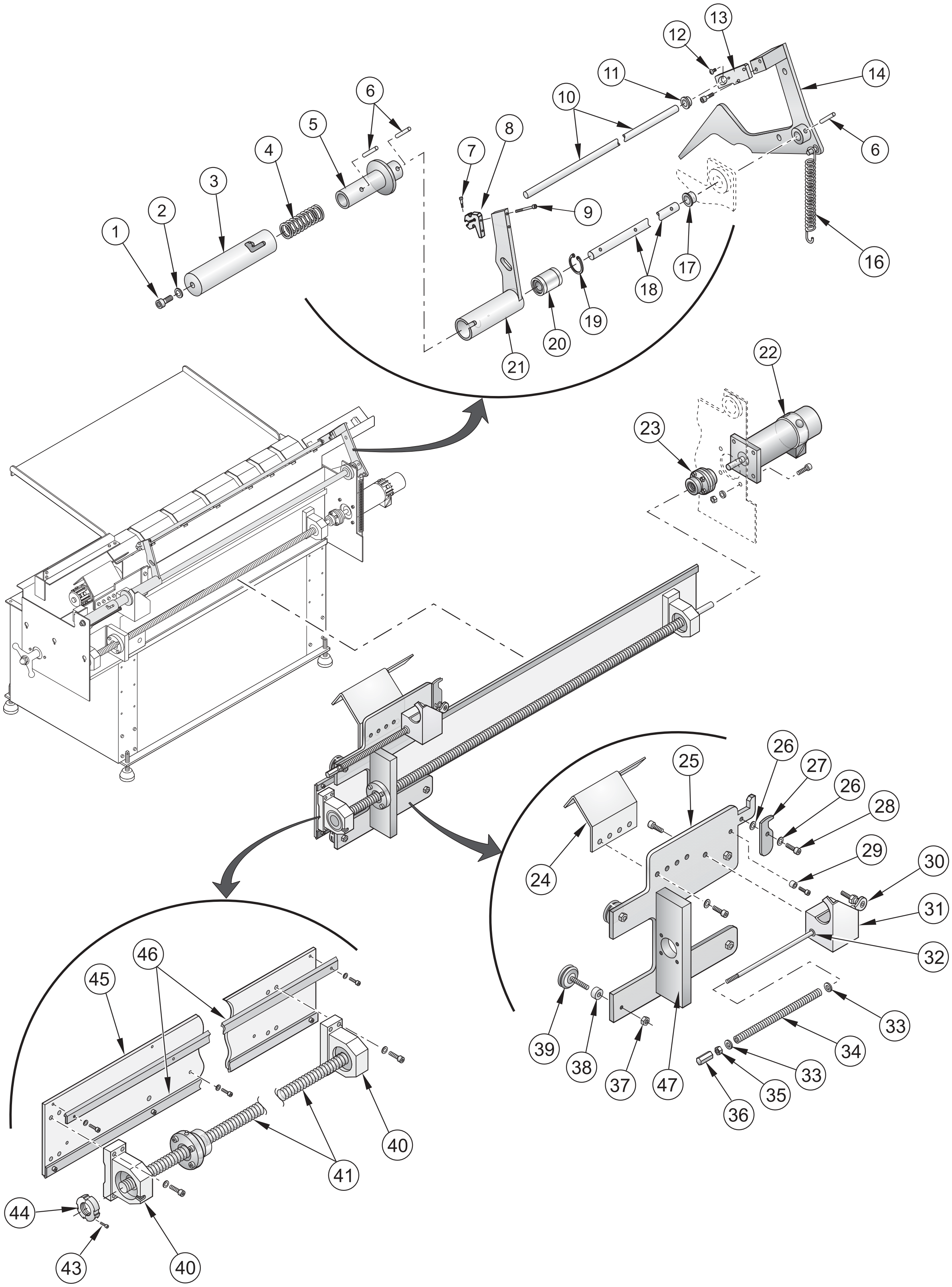
1. 25-0928b Panel, Front
2. 25-0998 Cover Oil Fill
3.
4. 25-0926c Panel, Back Left
5. 25-9277bb Cover, Front Head
6. 25-9278bb 2Cover, Top Head 50T
7. 25-9281ba Cover, Head Left 50T
8. 25-9282ba Cover, HEad Right 50T
9. 25-9280ba Cover, Bottom Head 50T
10. 25-0925a Apron, Back
11. 25-0927aa Panel, Right
12. 20-0912 Support Arm
13. 25-0929 Door
    28-0019 Window
14. 59-6210 Handle, Door
15. 25-9811 Waycover, Rear
16. 25-0923a Apron, Front
17. 25-0931 Chip Guard, Platter
18. 25-0920 Pan, Auger Right
19. 25-0924c Apron, Side
20.
21.
22.
23. 25-9811 Waycover, Front
24. 25-0914a Cover, Side
25. 25-0921c Pan, Auger Front
26. 25-0922 Pan, Auger Left
27.25-0940a Cover, Motor Mount Left
28. 25-0943 Cover, Motor Mount Front
29. 25-0941 Cover, Motor Mount Right
30.25-0930a Panel, Motor Shield
31. 25-0935a Cover, Cable

Barfeeder Sheetmetal and Parts List



1	25-6516A	Base Position Control
2	25-6537B	Barfeeder Door
3	59-0101	Gas Spring
4	25-6534A	Barfeeder Main Enclosure
5	25-0165	Right Rear Support
6	25-6542	Storage Pan
7	25-6526	Control Tray
8	25-6538	Adjusting End Supports
9	25-6539	Bottom Bar Base
10	44-0004	Leveling Screw
11	25-6540	Charging Table Beam

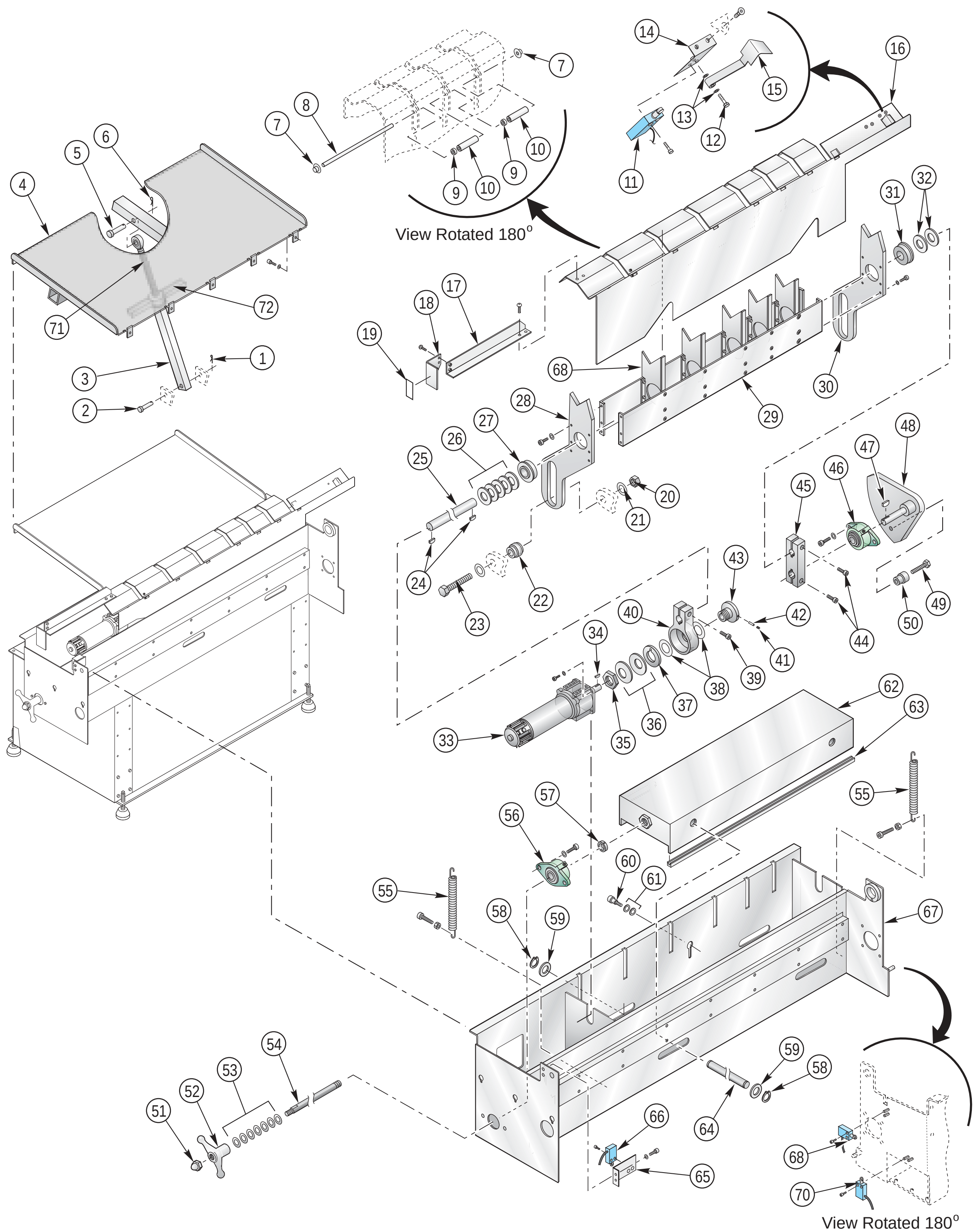
Barfeeder External Parts



Barfeeder External Parts List

1	Retaining Bolt	
2	20-6478	Ballscrew Bearing
3	20-6480	Rotation Control Push Rod
4	59-3024	Spring 1.5 X 6
5	20-6481	J-Slot Control Bushing
6	48-1657	Dowel Pin 5/8 X 1-1/2
7	49-1015	Shoulder Bolt 1/4 X 1/2
8	20-6483	Push Rod Connector
9		Retaining Bolt
10	20-6484	Push Rod
11	20-0357	Flange Bushing 3/4 in.
12	Bolt	
13	20-6032	Push Control Bushing 3/4 in.
14	20-6485	Control Arm Positioner
15		Removed
16	59-3026	Spring 1-1/8 X 8.5 X .148
17	20-0356	Flange Bushing 1 in.
18	20-6023	Rotational Control Shaft
19	56-0007	Retaining Ring 1-9/16 in.
20	51- 1016	Linear Bearing 1 in.
21	20-6482	Pusher Control Arm
22	62-2501	Servo Motor
23	30-1220P	Coupling Assembly
24	25-6520	Bar Pusher Finger
25	22-6501	Base Bar Carriage
26		Washer
27	25-6521	Latch Pusher Bar
28		Bolt
29	Spacer	
30	59-6701	5/16 Ball Joint w/Stud
31	25-6522	Fork Activator Bar
32	25-6502	Latch Linkage Rod Bar
33	54-0054	Flange Bushing 5/16 in.
34	59-3027	Spring 1/2 X 10
35		Nut
36	58-1750	Coupling Nut 5/16-24
37		Nut
38		Spacer
39	54-0030	Guide Wheel
40	30-0153	Support Bearing Assembly (2)
41	24-0007	Ballscrew Assembly
42		Removed
43	51-2012	Clamp Bolt For (44)
44	51-2012	Bearing Locknut TCN-04-F
45	25-6525	Rail Mounting Plate
46	22-6505	Barfeeder V-Rail
47	20-6478	Ballscrew Bearing

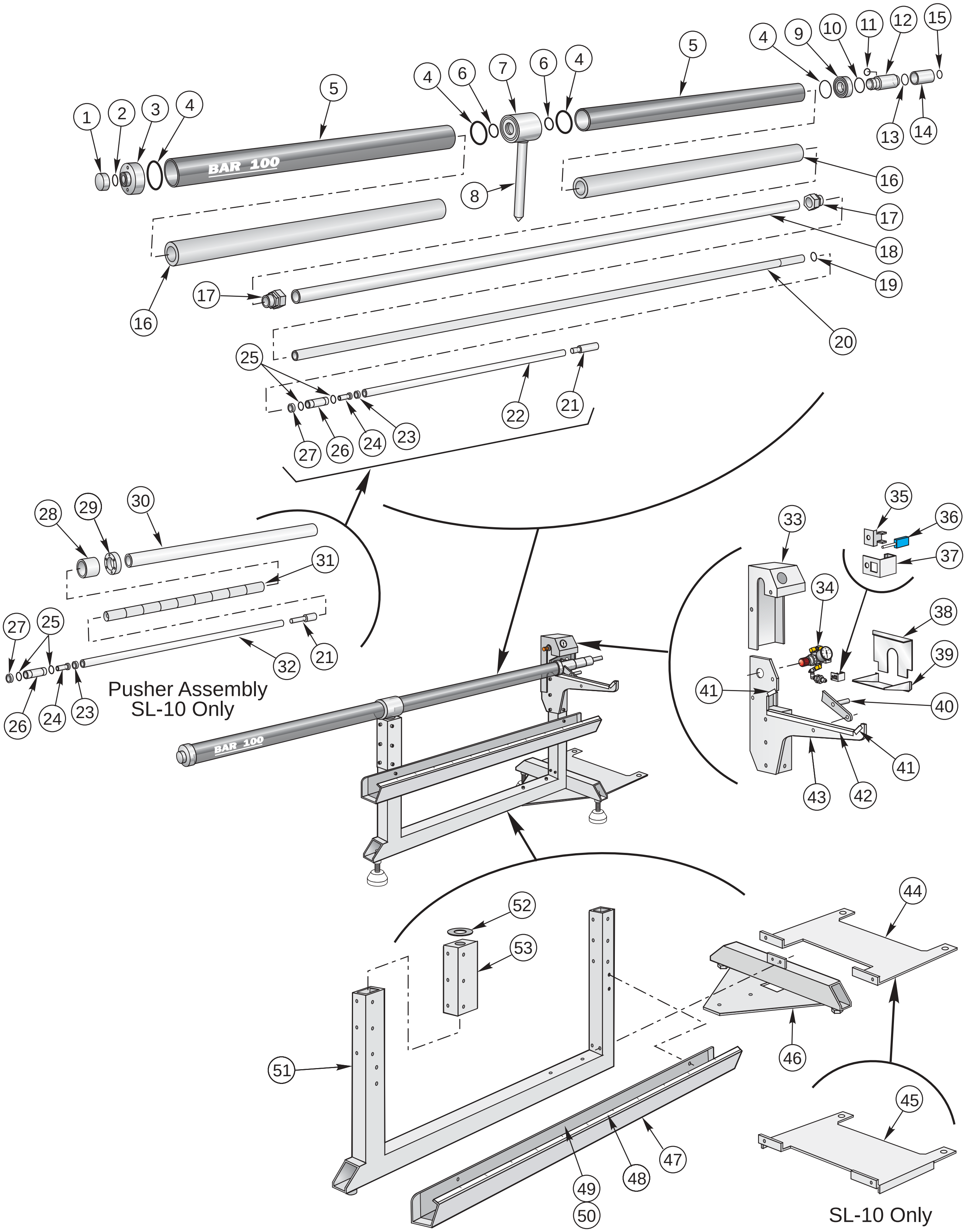
Barfeeder Internal Parts



Barfeeder Internal Parts List

1. 49-1203 1/8 x 1 Cotter pin
2. 49-1201 3/4 x 3 Clevis pin
3. 22-6503 Support stand
4. 25-6541 Charging table
5. 49-1202 1 x 6 Clevis pin
6. 49-1203 1/8 x 1 Cotter pin
7. 46-0011 1/4 Push cap nut
8. 20-0341 Transfer table
9. 22-9256 Bushing extractor
10. 58-1982 Tubing urethane 3/8 OD x 1/4 ID
11. 32-2036 Limit switch (end of bar)
12. 49-1019 Shoulder bolt 1/4 x 1
13. Washer
14. 25-6528 Bar end mounting
15. 25-6529 Bar end switch paddle
16. 25-6527A Bar transfer table
17. 25-6546 Height indicator support bracket
18. 25-6547 Height indicator flag
19. 29-0051 Height gauge decal
20. Nut
21. Washer
22. 54-0010 Cam follower
23. Bolt
24. Key
25. 20-6487 Lifting arm shaft
26. Washer
27. 51-1017 Bearing
28. 25-6530 Motion control lift arm
29. 25-6532 Motion control torque box
30. 25-6530 Motion control lift arm
31. 51-1017 Bearing
32. 22-7477 Pressure plate
33. 32-0011 Shuttle motor assembly
34. Key
35. 20-0216 Slip clutch nut
36. 55-0010 Spring washer
37. 22-7477 Pressure plate
38. Plastic washer
39. Clamp bolt for 20-6486 (40)
40. 20-6486 Motor end clutch linkage
41. Set screw
42. Dowel pin
43. 20-0215 Slip clutch hub
44. Clamp bolt for 20-6533 (45)
45. 20-6533 Cam end slip linkage
46. 51-1015 3/4 Flange bearing
47. Key
48. 20-6488 Cam shaft assembly
49. Bolt
50. 54-0010 Cam follower with 22-7034 spacer
51. 46-0010 3/4-10 Cap nut
52. 59-0102 Clamp handle 3/4-10
53. 45-0004 3/4 Flat washer
54. 20-6026A Height adjusting
55. 59-0110 Spring 6 x 27/32 x .106
56. 51-1015 Flange bearing 3/4
57. 54-0057 Shaft collar 3/4
58. Snap ring
59. Washer
60. Shoulder bolt
61. Plastic washer
62. 25-6549A Height adjusting box
63. 59-7200 Grommet material .125
64. 20-6490A Box cross rollers
65. 25-0338 Home switch bracket
66. 32-2039 Trolley home limit switch
67. 25-6523B Main frame
68. 32-2038 Load Q limit switch
69. Not used
70. 32-2037 Load bar limit switch
71. 22-6025 1" Acme adjusting screw
72. 49-1020 Acme wing nut 1-5

Barfeeder 100 Parts



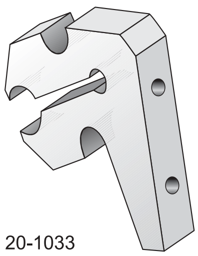
Barfeeder 100 Parts List

1. 20-1711 Rear End Cap
2. 57-0015 O-Ring 2-224 Buna
3. 20-1718 Rear End Interface
4. 57-2835 O-Ring 2-236 Viton
5. 20-1712 Outside Tube (2)
6. 57-2145 O-Ring 2-325 Viton
7. 20-1715 Center Interface
8. 20-1720 Center Pivot Rod
9. 20-1716 Latch End Interface
10. 57-4120 O-Ring 2-226 Viton
11. 57-0207 Urethane Compression Spring 3/16" ID
12. 20-1725A Air Tube Interface
13. 57-2106 O-Ring 2-223 Buna
14. 20-1722A Nose Liner Retainer
15. 57-2258 O-Ring 2-216 Viton
16. 59-0480 Tube Insulation (2)
17. 59-0471 Compression Connector 1-1/4" EMT (2)
18. 20-1719 Fixed Liner Tube
19. 57-2834 O-Ring 2-218 Viton
20. 20-1713 Inside Liner Tube
21. 20-1734A Pusher Nose
22. 20-1731A Pusher Rod (Minilathe Only)
23. 51-0095 Radial Ball Bearing
24. 20-1732 Fixed Pusher Rod
25. 57-0019 O-Ring 2-117 Buna (2)
26. 20-1738 Pusher Switch Body
27. 57-0209 Cup Seal 1" X 1/2"
28. 20-0938 Compression Nut Liner 7K
29. 29-0940 Adapter Flange 7K
30. 20-0993 Universal Liner
31. 20-0939 Spacer Pucks (Drill 1.05") (9)
32. 20-1737A Pusher Rod (SL-10 Only)
33. 25-4486 Control Gage Mount
34. 30-4049 Bar 100 Control Assembly
35. 25-4499 Inside Switch Bracket
36. 61-2025 Limit Switch
37. 25-4500 Outside Switch Bracket
38. 25-4505 Collector Door (Minilathe Only)
    25-4705 Collector Door (SL-10 Only)
39. 25-4504 Collector Extension (Minilathe Only)
    25-4704 Collector Extension (SL-10 Only)
40. 20-1730 Latch Handle
41. 20-1726 Top Wear Strip (2)
42. 20-1727 Bottom Wear Strip
43. 25-4502 Latch Rail Support
44. 25-4485 Base Alignment Plate (Minilathe Only)
45. 25-4704 Base Alignment Plate (SL-10 Only)
46. 20-1723 Front Tube Support
47. 25-4487 Stock Tray
48. 99-0212 Adhesive Backed Rule 1/16" X 6 Ft.
49. 59-0482 Stock Tray Front Insulation
50. 59-0483 Stock Tray Rear Insulation
51. 20-1724 Bar 100 Center Support
52. 59-0470 Isolation Pad
53. 25-4503 Height Adjust Pivot

Detailed Bar Feeder Parts

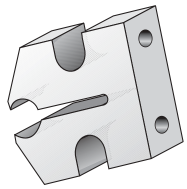
Current Parts

Previous Revision Parts



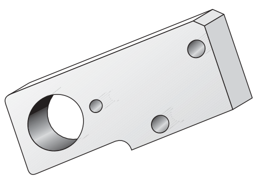
20-1033

Push Rod End Clamp



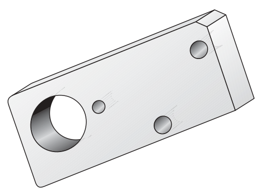
20-6483

Push Rod Connector Adapter



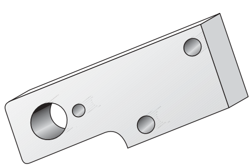
20-1034

Push Rod Control Bushing Holder 3/4"



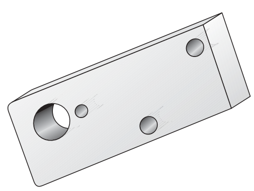
20-6032

Push Rod Control Bushing Holder 3/4"



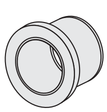
20-1035

Push Rod Control Bushing Holder 3/8"



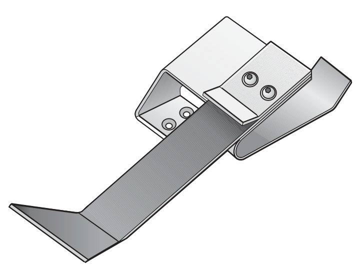
20-6044

Push Rod Control Bushing Holder 3/8"



20-0357
Push Shaft
Bushing 3/4"

51-0055
Nylon Flange
Bushing 3/8"



Switch Hold Down Assembly
P/N 30-1336