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

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

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

Only an authorized Haas Factory Outlet distributor should service or repair a Haas machine that is protected by the original factory warranty. Servicing by any other party automatically voids the factory warranty.
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<tr>
<th>Abbreviation</th>
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<td>AC</td>
<td>Alternating Current</td>
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<td>AMP</td>
<td>Ampere</td>
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<td>APC</td>
<td>Automatic Pallet Changer</td>
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<td>APL</td>
<td>Automatic Parts Loader</td>
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<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
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<td>ATC</td>
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<td>American Wire Gauge</td>
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<td>BHCS</td>
<td>Button Head Cap Screw</td>
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<td>CAD</td>
<td>Computer Assisted Design</td>
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<td>CAM</td>
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<td>CB</td>
<td>Circuit Breaker</td>
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<td>CC</td>
<td>Cubic Centimeter</td>
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<td>CCW</td>
<td>Counter Clock Wise</td>
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<td>CFM</td>
<td>Cubic Feet per Minute</td>
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<td>CNC</td>
<td>Computerized Numeric Control</td>
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<td>CNCR SPINDLE</td>
<td>Concurrent Spindle with axis motion</td>
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<td>CRC</td>
<td>Cyclic Redundancy Check digit</td>
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<td>Dynamic Host Configuration Protocol</td>
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<td>DIR</td>
<td>Directory</td>
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<td>Direct Numerical Control</td>
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<td>Disk Operating System</td>
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<td>Data Terminal Equipment</td>
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<td>Enable Conveyor</td>
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<td>End Of File</td>
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<td>Horizontal Series of Machining Centers</td>
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<td>ID</td>
<td>Inside Diameter</td>
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<td>IGBT</td>
<td>Isolated Gate Bipolar Transistor</td>
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<td>IN</td>
<td>Inch</td>
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<td>IOPCB</td>
<td>Input Output Printed Circuit Board</td>
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<td>Local Area Network</td>
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<td>Motor Interface</td>
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<td>Numerical Control</td>
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<td>NC NO</td>
<td>Normally Closed Normally Open</td>
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<td>OD</td>
<td>Outside Diameter</td>
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<td>OPER</td>
<td>Operator</td>
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<td>Pounds per Square Inch</td>
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<td>PWM</td>
<td>Pulse Width Modulation</td>
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<td>RAM</td>
<td>Random Access Memory</td>
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<td>REPT RIG TAP</td>
<td>Repeat Rigid Tap</td>
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<td>Return</td>
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<td>Serial Key Board Inter Face PCB</td>
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<td>SP</td>
<td>Spindle</td>
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<td>Tool number</td>
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<td>TIR</td>
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<td>Verein Deutscher Ingenieure</td>
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<td>VMC</td>
<td>Vertical Machining Center</td>
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<tr>
<td>WAN</td>
<td>Wide Area Network</td>
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1. TROUBLESHOOTING

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

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

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

BEFORE YOU BEGIN:

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

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

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

Machine Not Running

Machine cannot be powered on.

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

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

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

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

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

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

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

Constant E-Stop Condition (will not reset)

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

Vibration is a subjective evaluation with perceptions varying among individuals, making it difficult to determine in mild cases if there is an actual problem. Because the VF Series uses a gear head, it will be noisier than a direct drive or belt system. In obvious cases, it is a matter of determining the source - which is not easy, since all parts rotate together and sound can be transferred readily. Vibrations also need to be distinguished from noise such as a bad bearing. We will assume that vibrations would be something that could be felt by putting your hand on the spindle covers. One crude method of measurement would be to take an indicator on a magnetic base extended 10 inches between the table and spindle housing and observe the reading of the indicator. A reading of more than .001 would indicate excessive vibration. The two common sources of noise are the spindle and axis drives. Most complaints about vibration, accuracy, and finish can be attributed to incorrect machining practices such as poor quality or damaged tooling, incorrect speeds or feeds, or poor fixturing. Before concluding that the machine is not working properly, ensure that good machining practices are being observed. These symptoms will not occur individually (Ex. A machine with backlash may vibrate heavily, yielding a bad finish.). Put all of the symptoms together to arrive at an accurate picture of the problem.

Machine vibrates while jogging the axis with the hand wheel.

- The HAAS control uses very high gain accelerations curves. This vibration as you jog is simply the servos quickly trying to follow the handle divisions. If this is a problem, try using a smaller division on the handle. You will notice the vibration more at individual clicks than when you are turning the handle faster. This is normal.

The machine vibrates excessively in a cut.

- This is a tough one to call because machining practices come into play. Generally speaking, the least rigid element of a cut is the tool because it is the smallest part. Any cutter will vibrate if pushed beyond its tensile strength. In order to eliminate the machine as the source of the problem, you need to check the spindle and the backlash of the axes as described in the following sections. Once machining practices have been eliminated as the source of vibration, observe the machine in both operation and "cutting air." Move the axes (individually) without the spindle turning and then turn the spindle without moving the axes. Isolate whether the vibration comes from the spindle head or from an axis. Isolate the source of vibration per "Spindle", "Servo Motors/Leadscrews", and "Gearbox and Spindle Motor" sections.
Accuracy

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

- Ensure that the machine has been sufficiently warmed up before cutting parts. This will eliminate mispositioning errors caused by thermal growth of the leadscrews (see "Thermal Growth" section).
- **Do not** use a wiggler test indicator for linear dimensions. They measure in an arc and have sine/cosine errors over larger distances.
- **Do not** use magnetic bases as accurate test stops. The high accel/decel of the axis can cause them to move.
- **Do not** attach magnetic base to the sheet metal of the spindle head or table.
- **Do not** mount the magnetic base on the spindle dogs.
- **Do not** check for accuracy/repeatability using an indicator with a long extension.
- Ensure that test indicators and stops are absolutely rigid and mounted to machined casting surfaces (e.g. spindle head casting, spindle nose, or the table).
- **Do not** rapid to position when checking accuracy. The indicator may get bumped and give an inaccurate reading. For best results, feed to position at 5-10 inches per minute.
- Check a suspected error with another indicator or method for verification.
- Ensure that the indicator is parallel to the axis being checked to avoid tangential reading errors.
- Center drill holes before using jobber length drills if accuracy is questioned.
- Once machining practices have been eliminated as the source of the problem, determine specifically what the machine is doing wrong.

**Machine will not interpolate a round hole.**

- Check that the machine is level (see "Installation" section).
- Check for backlash ("Servo Motors/Leadscrews" section).

**Bored holes do not go straight through the workpiece.**

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

**Machine bores holes out-of-round.**

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

**Bored holes are out of round or out of position.**

- Check for thermal growth of the leadscrew (see "Thermal Growth" section).
- The spindle is not parallel to the Z axis. Check the spindle sweep to the table and the squareness of the Z axis with a cylinder square. If available use a spindle master bar and indicate the spindle to the Z axis.
Machine mis-positions holes.

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

Machine leaves large steps when using a shell mill.

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

Boring depth inaccurate

- Check for thermal growth of the leadscrew (see "Thermal Growth" section).
- Check the hydraulic counterbalance system. Check for:
  - abnormal noises from counterbalance system,
  - oil leaks (esp. at fittings and at filter at top of cylinder),
  - bound cylinder.

Finish

Machining yields a poor finish.

- Check for gearbox vibration.
- Check for backlash ("Accuracy/Backlash" section)
- Check the condition of the tooling and the spindle.
- Check spindle
- Check the condition of the servo motors.
- Check that the is machine level.

Thermal Growth

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

**NOTE:** On machines equipped with linear scales, thermal growth will not affect machine positioning or accuracy. However, it is still recommended that the machine be warmed up before cutting parts.

**NOTE:** The leadscrew will always expand away from the motor end.
VERIFY THERMAL GROWTH

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

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

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

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

4. Enter the following program. It will start at the new zero position, rapid 10 inches in the X direction, feed the final .25 inches at 10 inches/min., and then repeat the X movement.
   
   G00  G90  G110  X0  Y0;
   X10.0;
   G01  X10.25  F10. ;
   M99;

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

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

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

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

SOLUTIONS

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

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

Not Turning

Spindle not turning.

- If there are any alarms, refer to "Alarms" section.
- Check that the spindle turns freely when machine is off.
- If motor turns but spindle does not, see "Belt Assembly" and "Spindle Motor & Transmission" sections.
- Command spindle to turn at 1800 RPM and check spindle drive display. If display blinks “bb”, check spindle orientation switch ("Spindle Orientation" section). If spindle drive does not light the RUN LED, check forward/reverse commands from IOPCB ("Electrical Service").
- Check the wiring of analog speed command from MOTIF PCB to spindle drive (cable 720).
- If spindle is still not turning, replace MOCON PCB ("Electrical Service").
- If spindle is still not turning, replace spindle drive ("Electrical Service").
- Check for rotation of the gearbox (if applicable) or the motor. If the motor or gearbox operates, check the drive belt ("Belt Assembly" section).
- Disconnect the drive belt. If the spindle will not turn, it is seized and must be replaced ("Spindle Assembly" section).

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

Noise

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

**Excessive noise coming from the spindle head area.**

On VF-1 through 6 models, first determine if the noise is related to the RPM of the motor or the RPM of the spindle. For example: If the noise appears at 2000 RPM in high gear, listen for a similar noise at 500 RPM in low gear. If the same noise persists, the problem lies with the gearbox. If the noise disappears, the problem could be either the gearbox or the spindle, and further testing is necessary.

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

- Remove the head covers and check the machine’s drive belt tension ("Tension Adjustment" section).
  - If the noise persists, turn the drive belt over on the pulleys. If the noise is significantly different, the belt is at fault. Replace the belt ("Belt Assembly" section).
  - If the noise does not change, remove the belt and go on to the next step.
TROUBLESHOOTING

• Check the pulleys for excessive runout (more than 0.003” axial or radial).

• Run the motor or the gearbox with the drive belt disconnected. If the noise persists, the problem lies with the gearbox/motor. If it disappears, go on to the next step.

• Check for the correct amount of lubrication to the spindle bearings (0.5-1.0 cc every two hours) in an air mist-lubricated spindle.
  • If the spindle is not getting lubrication, correct the problem per the lube and air diagram at the back of this manual and replace the spindle (“Spindle Assembly” section).
  • If the spindle is getting lubrication, replace the spindle (“Spindle Assembly” section).

Note: Haas Automation does not honor warranty requests for gearbox or spindles without vibration analyzer signatures.

OVERHEATING

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

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

N100  S300  M03
G04  P900.
M05
G04  P900.
G04  P900.
N200  S1000  M03
G04  P900.
M05
G04  P900.
N500  S4000  M03
G04  P900.
N800  S7500  M03
M05
N300  S2000  M03
G04  P900.
G04  P900.
N600  S5000  M03
G04  P900.
M05
G04  P900.
G04  P900.
N400  S3000  M03
G04  P900.

NOTE: This program will step the spindle speed from 300 RPM up to 7500 RPM at regular intervals of time, stop the spindle and allow it to cool to room temperature, then restart it so the temperature can be monitored.
**Alternate Spindle Run-in Program**

Run program #O02021 with the air pressure to the spindle set to 30 psi. (for all spindles). Program time is approximately 2 hours. If possible run the program overnight by changing M30 to M99 so it can repeat. Adjust spindle speed override depending on maximum spindle speed of machine: Set override 50% for 5,000 RPM machines; Set at 100% for 7,500 and 10,000 RPM machines; Set at 150% for 15,000 RPM machines.

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

- If at any time during this procedure the spindle temperature rises above 150 degrees (120 degrees for 50 Taper), start the procedure over from the beginning and follow the steps below.

---

**NOTE:** Once run-in program is complete reset the air pressure back to 17psi. (20psi. for 15K spindles, 25psi. Mini-Mill) prior to checking spindle temperature.

If the spindle fails this test for any reason, check the following:

- Check for correct amount of lubrication.

---

**NOTE:** Over lubrication is a common source of overheating. Check the oil flow carefully.

- Check the drive belt tension. Belts that are too tight will cause heating of the top bearing in the spindle housing.

- Ensure that the correct oil is being used (refer to "Maintenance Schedule").
**Stalling / Low Torque**

Generally, complaints of stalling or low torque relate to incorrect tooling or machining practices. A spindle that is tending to seize will yield a poor finish machining, run very hot and very loud. Investigate machining problems before concluding the problem exists with the spindle or spindle drive.

**Spindle Drive**

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

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

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

**Vector Drive**

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

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

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

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

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

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

3. Disconnect cable 490 at terminals 2 and 3 of the Vector Drive and from the servo amplifiers. With a multimeter in the diode mode, place the red meter lead to the +HV terminal and the black meter lead to the -HV terminal of each amplifier. The meter should read open.
4. Reverse the leads: Place the red meter lead on the -HV terminal and the black lead on the +HV terminal. The meter should read .7 ohms in both instances. If not, replace the faulty amplifier.

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

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

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

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

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

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

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

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

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

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

Non Vector Drive
• Check the orientation ring for tightness. Ensure the shaft on which the ring mounts is clean and is free of grease and oil.
• Check the orientation ring for cracks near the bolt holes or near the balancing holes.
  • If there are cracks, replace the ring.
• Check the shot pin on the gearbox for binding, damage, and proper operation. Replace it if it is damaged.

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

Tools Sticking In Taper

Tool sticking in the taper causes ATC to be pulled up; accompanied by a popping noise as the tool holder pops out of the spindle taper.

NOTE: This problem may occur after loading a cold tool into a hot spindle (a result of thermal expansion of the tool holder inside the spindle taper). It may also occur due to heavy milling, milling with long tooling, or cuts with heavy vibration. This also is the result of thermal expansion.

If sticking only occurs during these situations, check your application to ensure proper machining techniques are being used; check the feeds and speeds for the tools and material being used. If a tool is pulled out of the extractors due to a tool stuck in the taper then the unclamp switch is not adjusted correctly or the switch could be bad.

NOTE: In a proper working system the spindle will pop slightly during a tool change. This popping does not create flex in the carousel or the need to remove the tool with a mallet.

• Check the condition of the tooling, verifying the taper on the tooling is ground and not turned. Look for damage to the taper caused by chips in the taper or rough handling. If the tooling is suspected, try to duplicate the symptoms with known-to-be-good tooling.
• Check the condition of the spindle taper. Look for damage caused by chips or damaged tooling. Also, look for damage such as deep gouges in the spindle taper caused by tool crashing.
• Duplicate the cutting conditions under which the deflection occurs, but do not execute an automatic tool change. Try instead to release the tool using the tool release button on the front of the spindle head. If sticking is observed, the deflection is not caused by improper ATC adjustment, but is a problem in the spindle head on the machine.
• Ensure the spindle is not running too hot (140° or above).
• Check air supply. Max air pressure drop of 10psi. during a tool change is allowed.
• Check drawbar height adjustment.
• Does the tool tip to the spindle gauge line exceed 3.5”?
• Are the correct pull studs being used?

**Tool Holder / Spindle Fretting**

Is fretting present on the tool holder or spindle?

Fretting is the result of sideways movement of a tool holder in the spindle. Fretting can leave a wave pattern on the mating surfaces and will affect the fit and finish of both the tool holder and the spindle.

• If light fretting is present, check the application to ensure proper machining techniques are being used; check the feeds and speeds for the tools and material being used.
• Light fretting and rust may be cleaned from the tool holder with a fine scotchbrite hand pad and solvent. If scotchbrite is used, clean the tool holder and spindle taper thoroughly after use with an alcohol pad. Apply a thin coat of light oil to the taper of the tool holder. Grease the pull stud.
1.3 SERVO MOTORS / LEADScrews

NOT OPERATING

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

Servo motor is not functioning.

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

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

NOISE

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

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

Servo motor noise.

- Disconnect the servo motor from the lead screw and rotate by hand. If the noise persists, replace the motor assembly (“Axis Motor Removal/Installation” section).
- Noise is caused by motor brushes (VF-E only). Remove and inspect brushes. Blow out brush dust and inspect the armature.
Lead screw noise.

- Ensure oil is getting to the lead screw through the lubrication system (See Air and Oil Diagrams). Look for a plugged metering valve.
- Check for damage to the bearing sleeve.

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

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

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

### Accuracy / Backlash

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

**Poor mill table-positioning accuracy.**

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

Turn the VMC ON, ZERO RET the machine and move the mill table to the approximate center of its travel in the X and Y directions. Move the spindle head to approximate center of the Z-axis travel, also.

CHECKING X-AXIS:

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

![Figure 1-1. Dial indicator in position to check X-axis.](image)

2. Set dial indicator and the “Distance to go” display in the HANDLE JOG mode to zero as follows:
   • Zero the dial indicator.
   • Press the MDI button on the control panel.
   • Press the HANDLE JOG button on the control panel.
   The “Distance to go” display on the lower right hand corner should read: X=0 Y=0 Z=0

3. Set the rate of travel to .001 on the control panel and jog the machine .010 in the positive (+) X direction. Jog back to zero (0) on the display. The dial indicator should read zero (0) ± .0001.

4. Repeat Step 3 in the negative (-) direction.

**TOTAL DEVIATION BETWEEN THE DIAL INDICATOR AND THE CONTROL PANEL DISPLAY SHOULD NOT EXCEED .0002.**

An alternate method for checking backlash is to place the dial indicator as shown in Fig. 1-1 and manually push on the mill table in both directions. The dial indicator should return to zero after releasing the table.

**NOTE:** The servos must be on to check backlash by this method.
CHECKING Y-AXIS:

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

![Figure 1-2. Dial indicator in position to check Y-axis.](image)

2. Set dial indicator and the “Distance to go” display in the HANDLE JOG mode to zero as follows:
   • Zero the dial indicator.
   • Press the MDI button on the control panel.
   • Press the HANDLE JOG button on the control panel.
   The “Distance to go” display on the lower right hand corner should read: X=0 Y=0 Z=0.

3. Set the rate of travel to .001 on the control panel and jog the machine .010 in the positive (+) Y direction. Jog back to zero (0) on the display. The dial indicator should read zero (0) ± .0001.

4. Repeat Step 3 in the negative (-) direction.

**TOTAL DEVIATION BETWEEN THE DIAL INDICATOR AND THE CONTROL PANEL DISPLAY SHOULD NOT EXCEED .0002.**

An alternate method for checking backlash is to place the dial indicator as shown in Fig. 1-2 and manually push on the mill table in both directions. The dial indicator should return to zero after releasing the table.

---

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

CHECKING Z-AXIS:

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

2. Manually push up and down on the spindle head while listening for a ‘clunk’. Also, watch for any rapid change in the dial indicator. Either of these indicate possible backlash.

---

**NOTE:** Servos must be on to check for backlash in the Z-axis.

**NOTE:** Do not mistake deflection for backlash in the system.
If backlash is found in the system, check for the following possible causes:

- Loose SHCS attaching the ball nut to the nut housing. Tighten the SHCS as described in Mechanical Service.
- Loose SHCS attaching the nut housing to the mill table, spindle head, or saddle, depending on the axis. Tighten the SHCS as described in Mechanical Service.
- Loose clamp nut on the bearing sleeve. Tighten the SHCS on the clamp nut.
- Loose motor coupling. Tighten as described in Mechanical Service.
- Broken or loose flex plates on the motor coupling.
- Loose SHCS attaching the bearing sleeve to the motor housing. Tighten as described in "Lead Screw Removal and Installation".
- Defective thrust bearings in the bearing sleeve. Replace the bearing sleeve as outlined in "Bearing Sleeve Removal and Installation".
- Loose SHCS attaching the axis motor to the motor housing. If the SHCS are found to be loose, inspect the motor for damage and if none is found, tighten as described in "Axis Motor Removal/Installation". If damage is found, replace the motor.
- Incorrect backlash compensation number in the parameter in the machine. Check Parameters 13, 27, and 41.
- Worn lead screw.

NOTE: The coupling cannot be serviced in the field and must be replaced as a unit if it is found to be defective.
**Vibration**

Excessive servo motor vibration.

- Swap the suspected bad servo motor with a known good driver and check to see if there is a driver problem. If needed, replace the DRIVER PCB ("Electrical Service" section).
- Check all Parameters of the suspected axis against the Parameters as shipped with the machine. If there are any differences, correct those and determine how the Parameters were changed.
- A bad motor can cause vibration if there is an open or short in the motor. A short would normally cause a GROUND FAULT or OVERCURRENT alarm; check the ALARMS. An ohmmeter applied to the motor leads should show between 1 and 3 ohms between leads, and over 1 megohm from leads to chassis. If the motor is open or shorted, replace.

**Overheating**

Servo motor overheating.

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

**Following Errors**

FOLLOWING ERROR (Brush Machines only) or SERVO ERROR TOO LARGE alarms 103-106, 187 occur on one or more axes sporadically.

- Check DC bus voltage on diagnostics page #2 (brush machines only). Verify this voltage on the drive cards in the control panel. If it is at the low side of the recommended voltages, change the transformer tap to the next lower voltage group as explained in the Installation Manual.
- Check motor wiring for a short.
- Check driver card ("Electrical Service").
- Check servo motor ("Axis Motor Removal/Installation").
- Check encoder (brush machines only)

**Drive Fault / Overcurrent**

Z-axis motor overcurrent.

- Alarm not cleared
- Low counterbalance pressure
- Check Z axis parameters
- Check the lead screw for binding
- Check motor and cable for shorts
- Check amplifier (drive card on a VF-E)
VF-6 with Z axis brake only

- Brake power fuse blown
- Brake power transformer blown
- Brake power rectifier blown
- Cabling pinched
- Brake failed

**Lead Screws - Visual Inspection**

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

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

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

**Loss of Lubrication:**

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

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

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

**Contamination:**

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

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

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

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

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

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

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

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

Cleaning

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

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

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

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

Deflection

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

During a tool change, ATC appears to be pushed down.

- Check to see if pull studs on the tool holder are correct and tight.
- Check the adjustment of the “Z” offset (“Setting Parameter 64”).

**NOTE:** If the offset is incorrect a tool changer crash can occur and a thorough inspection of the ATC will be necessary.

- Check the adjustment of the “Z” offset. Check parameters 71, 72, and 143 against the values that are in the documentation sent with the machine.
- Ensure the tool holders are held firmly in place by the extractor forks.
- Ensure the balls on the drawbar move freely in the holes in the drawbar when the tool release button is pressed. If they do not move freely, the ATC will be pushed down about 1/4” before the tool holder is seated in the taper, resulting in damage to the roller bolts on the ATC shuttle. Replace the drawbar.
- Check Drawbar height adjustment.
- If TSC, check for excessive coolant tip wear.

Tool holder sticking in the spindle taper causes the ATC to be pulled up as the spindle head is travelling the distance specified in parameter 71; accompanied by a popping noise as the tool holder pops out of the spindle taper.

**NOTE:** This problem may occur after loading a cold tool into a hot spindle (a result of thermal expansion of the tool holder inside the spindle taper. It may also occur in cuts with heavy vibration. This also is the result of thermal expansion. If sticking only occurs during these situations, check your application to ensure proper machining techniques are being used. If tool is pulled out of extractors due to a tool being stuck in the taper then the unclamp switch is not adjusted correctly or the switch could be bad.

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

• Check air supply pressure it should be 85 psi (min). An air pressure drop of no more than 10 psi during tool release is acceptable. An air pressure drop greater than 10 psi is caused by a supply line restriction or an undersize supply line. Use of quick couplers (1/4") can cause restriction. Directly connecting the air hose to a barb fitting can help.

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

• Check the adjustment of the “Z” offset ("Setting Parameter 64" section).

NOTE: If the offset is incorrect, a tool changer crash can occurred, and a thorough inspection of the ATC will be necessary.

• Ensure the roller bolts on the shuttle of the ATC are tight against the V-guides on the ATC holding arm. If the lower right roller bolt is loose against the V-guide, the upper right bolt is probably bent. See the following section ("ATC Crashing") or "Roller Bolt Replacement", for roller bolt replacement.

NOTE: Bent roller bolts are a symptom of another problem with the ATC. Repair the bent roller bolt and then isolate the ATC problem.

• Check Parameter 71 against the values that are in the documentation sent with the machine.

• Ensure the balls on the drawbar move freely in the holes in the drawbar when the tool release button is pressed. If they do not move freely, the ATC will be pushed down about ¼" before the tool holder is seated in the taper, resulting in damage to the roller bolts on the ATC shuttle. Replace drawbar.

Tool holders twist against extractor fork during a tool change.

• Check the alignment of the ATC in the X and Y axes ("Automatic Tool Changer Alignment" section).

Tool holders spin at all pockets of the ATC when the ATC shuttle retracts.

• ATC is misaligned in the “Y” axis. Realign ATC ("Automatic Tool Changer Alignment" section).

NOTE: Observe the direction the tool holder rotates, as this will be the direction in which the “Y” axis of the ATC needs to be moved.

Tool holders spin only at certain pockets of the ATC when the ATC shuttle retracts.

• Check all the extractor forks to ensure they are centered in the pocket of the ATC. Also, see above. See "Extractor Fork Replacement" section, if necessary.

NOTE: If the ATC shows the problem as described here, each extractor fork must be checked and centered to eliminate the possibility of the ATC being aligned against an incorrectly-centered fork.
C R A S H I N G

The most common ATC crashes are outlined as follows:

**Shuttle crashes into spindle when a tool change is commanded (tool holder is in the pocket facing the spindle head).**

* Rotate the carousel to an empty pocket. Refer to the Programming and Operation manual for correct operation.

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**NOTE:** This crash is fairly common and is a result of operator error. If the ATC is stopped in the middle of tool change cycle, the operator must command the ATC to an empty pocket before the machine will operate correctly. Repeated crashes of this type can damage the I/O board, the slip clutch, and the shuttle motor in the ATC.

**During a tool change spindle crashes into top of the tool holder after a turret rotation.**

When the spindle head moves down over the top of the tool holder during a tool change, the pull stud will bind inside the drawbar bore of the spindle, forcing the ATC down, breaking the carousel. Bending the upper right roller bolt on the ATC shuttle or completely breaking it off is also possible. Tool holder is not held correctly in the extractor fork, possibly held only in one side of the extractor and at an odd angle.

* Check all of the extractor forks on the ATC.

**During a tool change spindle crashes into top of the tool holder after a turret rotation.**

The balls in the drawbar do not move freely, causing the ATC to be forced down far enough to break the carousel. Bending the upper right roller bolt on the ATC shuttle or completely breaking it off is also possible.

* Ensure the balls on the drawbar move freely in the holes in the drawbar when the tool release button is pressed. If this failure occurs, check all of the extractor forks on the ATC for damage and repair the spindle drawbar.

* Check drawbar height and set according to the appropriate section, if necessary.

**ATC properly deposits a tool holder in the spindle, but the tools are dropped onto the machine table when the shuttle retracts.**

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

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

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

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

**Side Mount Tool Changer Recovery Flow Chart**

1. **Tool Change Restore Indicating pressing "F10" button**
   - Yes
   - No

2. Is there a tool in the arm on the spindle vote?
   - Yes
   - No

3. Will the arm prevent any tool in the spindle or the pocket from being removed?
   - Yes
   - No

**THE TOOL MAY FALL DURING THE TOOL RECOVERY PROCESS. PLACE SOMETHING SOFT, LIKE FOAM, TO CATCH IT AS IT MAY FALL DAMAGING THE TOOL AND MACHINE. PROTECT NO OCCUPANCY SERVICES SHOULD YOU ATTEMPT TO USE YOUR HANDS TO CATCH THE TOOL DURING THIS PROCESS. PRESS "Y" TO CONTINUE THE PROCESS.**

4. Wait until "..." before continuing.

5. **Use the following commands until you can remove all the tools from the spindle and the arm: CANCEL, CANCEL TOU.**
   - MOVE 
   - ROTATE ARM PM/AR
   - MOVE TOOL TO LOAD (I, O)
   - UNLOAD (I, O)
   - MOVE ARM UP OR DOWN (I, O)
   - MOVE ARM UP OR DOWN (I, O)
   - ORIENT SPINDLE
   - SPINDLE ORIENTATION

   **Note:** If you want to move the spindle up or down, the arm must be at Origin, and you must cancel tool changer recovery.

6. Are you finished using commands (Y)?
   - Yes
   - No

7. Orient spindle.
   - Yes
   - No

8. **Remove all tools from arm and spindle.**
   - Use tool release button while holding tool to remove any tool from spindle.
   - Suspend tool change and release stud on arm while holding tool and side tool out.

9. Are all the tools removed (Y)?
   - Yes
   - No

10. **Use a tool cancel tool to cancel.**
    - Orient spindle.
    - N or Y
    - Ok

11. At Origin, continue to restore (Y)?
    - The "ok" return can still move arm of this time, cnc waits for "y" before continuing.

12. **Select between pockets. Please wait.**
    - Yes
    - No

13. C-Hack current carousel pocket. Enter current pocket number. Then press the enter key.

14. Tool change recovery complete.
    - Press "Y" to continue.
    - Please update pocket & tool page.

15. **Start page with pockets displayed.**

**End**
**Breakage**

Breakage of the ATC is caused by either very hard and repeated crashes or excessive TSC coolant tip wear.

**ATC shuttle is broken off of the holding plate.**

- Carefully inspect the bosses on the shuttle casting (where the roller bolts mount) for damage to the threads or cracks. If any of the bosses are cracked, replace the casting. Realign the tool changer after repairing the machine.

**ATC extractor forks are damaged after breakage.**

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

**Noisy Operation**

To isolate noise(s) in the ATC, carefully observe the ATC in operation and look for the following:

**ATC makes noise as the shuttle moves.**

- Check the adjustment of the roller bolts on the ATC ("Roller Bolt Replacement" section). Loose roller bolts can cause the ATC to make a clunking noise when the shuttle is commanded to move. Tight roller bolts can cause the shuttle motor to labor excessively, possibly damaging the motor or the I/O board. In this case, the shuttle may also move too slowly.
- Check for damage to the trap door on the ATC cover. See appropriate section for trap door replacement.
- Check for missing plastic riders on the ATC shutter. See "ATC Trap Door Replacement" for shutter replacement.
- Ensure the guide pin mounted to the holding plate is not bent and does not scrape the ATC cover during movement. See "ATC Trap Door Replacement" for guide pin replacement.
- Listen for damage to the gear train in the shuttle motor. If the motor is found to be the source of the noise, replace the motor ("Shuttle Motor Removal" section). DO NOT try to repair the motor or to further isolate the noise in the motor.
- Check to ensure the Geneva driver on the turret motor is tight and properly adjusted ("Shuttle Motor Removal" section). If the Geneva driver is found to be loose, check for damage to the Geneva star. Any roughness in the slots will require that it be replaced ("Geneva Star Replacement" section).
- Check the adjustment of the Geneva driver in relation to the Geneva star ("Geneva Star Replacement" section). If the adjustment is too loose, the carousel will vibrate heavily and make a loud clanking noise during carousel rotation. If the adjustment is too tight, the turret motor will labor excessively and the carousel may appear to move erratically.

**NOTE:** If the turret motor adjustment is tight for extended periods, the turret motor, Geneva star, and the I/O board may be damaged. If the adjustment of the Geneva star appears tight at some pockets and loose at others, the problem lies with the Geneva star. Check the concentricity of the star relative to the bearing housing on the carousel assembly. If the concentricity of the star is proven to within specification and the problem still persists, the Geneva star must be replaced ("Geneva Star Replacement" section).
• Ensure the screws holding the turret motor to the mounting plate are tight ("Turret Motor Removal" section).
• Ensure the screws attaching the motor mounting plate to the shuttle casting are tight.
• Check for excessive noise in the gear train of the turret motor. See appropriate section for turret motor replacement.

NOTE: If the motor is found to be the source of noise, replace the motor assembly (motor, mounting plate, and Geneva driver). DO NOT attempt to repair the motor or to further isolate the problem in the motor.

**Spindle Orientation**

A switch is used to sense when the pin drops in to lock the spindle. When the pin drops the switch opens, indicating orientation is complete. The normally-closed side of this switch is wired to the spindle drive and commands it into the COAST STOP condition. This is done to make sure that the spindle motor is not powered when the pin is locking the spindle. If, during a tool change, the dogs on the spindle shaft do not align with the keys on the ATC carousel, the spindle orientation may be at fault.

The orientation of the spindle is as follows:

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

**ATC out of orientation with the spindle. Incorrect spindle orientation will cause the ATC to crash as the shuttle moves. Alarm 113 will be generated.**

• Check the orientation of the spindle.

**ATC will not run.**

• In all cases where the tool changer will not run, an alarm is generated to indicate either a shuttle in/out problem or a turret rotation problem. These alarms will occur either on an attempt to change tools (ATC FWD) or ZERO RETURN the machine (AUTO ALL AXES). Use the appropriate alarm to select one of the following problems:

**ATC shuttle will not move; shuttle is getting power (Command a tool change and check for power being applied to the shuttle motor).**

• Disconnect the slip clutch arm from the ATC shuttle and ensure the shuttle can move freely. If not, appropriate section for shuttle adjustment.
• Command a tool change with the shuttle disconnected.
  • If the shuttle cycles, check the slip clutch on the ATC. See "Shuttle Installation" section for slip clutch replacement.

NOTE: The slip clutch should move the shuttle with a fair amount of force, but not so much that the shuttle cannot be made to slip when holding it back by hand. If the slip clutch is frozen, replace it. It cannot be rebuilt in the field.

  • If the ATC shuttle does not cycle, the motor has failed and must be replaced. Turn the motor by hand and feel for binding in the gear train in the motor.

NOTE: The motor uses a large amount of gear reduction and should be hard to turn by hand.

ATC shuttle will not move; shuttle is not getting power.

• Command a tool change check for power being applied to the shuttle motor.
• Check that the TC IN/TC OUT LED on the I/O PCB is illuminated when a tool change takes place.
  • If the LED lights, check the fuse FU5 on the POWER PCB or FU1 on the I/O PCB. Otherwise, check the I/O PCB ("Electrical Service").
  • If the LED does not light, check cables I/O-P65-510 and I/O-P64-520.
• Check ATC shuttle relay

ATC turret will not rotate; turret motor is getting power.

• Command a tool change check for power being applied to the turret motor.
• If power is applied but the output shaft on the motor does not turn, check for binding between the turret motor assembly and the Geneva star ("Automatic Tool Changer" section). Check for damage to the Geneva star or the Geneva driver. Check for a broken turret motor ("Turret Motor Removal" section).

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

ATC turret will not rotate; turret motor is not getting power.

• Command a tool change check for power being applied to the turret motor.
• Check that the TC CW/ TC CCW LED on the I/O PCB is illuminated when a tool change takes place.
  • If the LED lights, check the fuse FU5 on the POWER PCB or FU1 on the I/O PCB. Otherwise, replace the I/O PCB (Electrical Service).
  • If the LED does not light, check cables I/O-P65-510 and I/O-P64-520.
• Check ATC turret relay.
1.5 Gearbox and Spindle Motor

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

Noise

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

Excessive or unusual noise coming from the gearbox and/or spindle motor.

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

• If the noise only occurs in one gear throughout the entire RPM range of that gear position, the problem lies with the gearbox, and it must be replaced ("Spindle Motor & Transmission" section).

• If the noise occurs in both gear positions, disconnect the drive belt and repeat the previous step. If the noise persists, the gearbox is damaged and must be replaced, ("Spindle Motor & Transmission" section).

• With the drive belt disconnected, run the machine at 1000 RPM in high gear. Command a change of direction and listen for a banging noise in the gearbox as the machine slows to zero RPM and speeds back up to 1000 RPM in reverse. If the noise occurs, the motor has failed and the gearbox must be replaced.

Gears Will Not Change

Machine will not execute a gear change.

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

When a gear change is performed, the following sequence of events occurs:

1. If the spindle is turning, it is commanded to stop,
2. Pause until spindle is stopped,
3. Gear change spindle speed is commanded forward,
4. Pause until spindle is at speed,
5. Command high or low gear solenoid active,
6. Pause until in new gear or reversal time,
7. Alarm and stop if max. gear change time elapsed,
8. If not in new gear, reverse spindle direction,
9. Turn off high and low gear solenoids.

• Check air supply pressure. If pressure is too low, the gears will not change.

• Check the air solenoid assembly on the solenoid bracket (rear of gearbox). If the solenoid operates properly and the limit switches on the gearbox operate properly, the problem lies with the gear change piston. Replace the gearbox ("Spindle Motor & Transmission" section).

• Check contactor CB4.
Low Pressure Alarm

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

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

Coolant Overflow

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

Coolant pouring out of spindle head covers.
- Check the customer’s tooling for through holes in the pull stud, holder and tool.
- Check for seal failure. If failure is found, replace the seal housing (30-3286A). Refer to the appropriate steps in “TSC-Tool Release Piston Replacement” section for procedure.
- Check that the TSC drain and purge lines are intact. If necessary, replace with 5/32” O.D. nylon tubing.
- Check for coolant flowing from a failed fitting or check valve.
- Check precharge pressure in accordance with TSC “Pressure Regulator Adjustment” section and reset if necessary. Low precharge pressure can cause coolant to dump into the spindle head.
- Check the coolant pump pressure (should be 300 psi for high pressure TSC, and 140 psi for old system), with a standard (non-TSC) tool holder in spindle. If pump pressure is above 310 psi (above 140 psi for old system), reset the pump relief valve in accordance with the “Setting TSC Pump Relief Valve” section.

Excessive coolant flow out of drain line.
Pulsating flow through tool and drain line.
- Check precharge pressure in accordance with TSC “Pressure Regulator Adjustment” section. Reset precharge pressure if necessary. Low precharge pressure will cause heavy or pulsating flow from the drain line.
- Ensure the coolant pump relief valve has not been tampered with (yellow paint band is intact). Check the coolant pump pressure (should be 300psi for high pressure TSC, and 140 psi for old system), with a standard (non-TSC) tool holder in spindle. If pump pressure is above 310 psi (above 140 psi for old system), reset pump relief valve in accordance with “Setting Pump Relief Valve” section.
**Low Coolant**

**Alarm 151, "Low Thru Spindle Coolant"

- Check coolant tank level.
- Check for slow coolant drainage from machine enclosure.
- Read the filter gauges and check the intake strainer to ensure there is no clogging. Read gauges with TSC running with no tool in spindle. Check coolant lines for any clogging or kinking. Clean or replace as needed.
- If received at start-up, check that the breaker hasn't tripped and that the pump is turning. Check the electrical continuity of cables.
- Check for overheating TSC motor. Single phase motors have a built in thermal cut out. Three phase TSC motors have a thermal circuit that interrupts power to the relay coil.
- For old TSC system, if the drawbar was replaced, check that the hole through the drawbar is 0.156 dia. not 0.190 dia. Replace if it is 0.190.
- Check for pressure switch failure (refer to "Testing the Coolant Pressure Switch" section), and replace if necessary. Check "LO CLNT" bit in the diagnostics display (0 = pressure on, 1= pressure off). Leaking pressure switches can also give intermittent alarms.
- Check the pump pressure with TSC running and no tool in the spindle. Normal pressure is 75-95 PSI. Replace the pump if pressure is 60 psi or less.
- Another alarm generated during TSC operation can cause this alarm.

**Coolant Tip Wear**

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

Coolant tip is wearing quickly and needs frequent replacement.

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

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

Alarm 198, "Precharge Failure"

**NOTE:** This alarm only applies to the TSC system. This alarm does not apply to 50 taper spindle machines. If this alarm is received on a 50 taper TSC machine, check that parameter 235 is set to zero. A non-zero value will cause the control to act as a 40 taper TSC.

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

Chip conveyor does not turn

- Check that Parameter 209 bit switch ENA CNVR is enabled.
- Check that the front enclosure door is completely closed and door switches function properly.
- Check that hub is connected to auger with bolt.
- Check that all conveyor fuses are intact. [Single phase motor uses 2 fuses (VF-1/2); Three phase motor uses 3 fuse (VF-3,4,6,8)]
- Check thermal reset button on conveyor motor body.

**NOTE:** Thermal reset indicates further problems: Ensure conveyor is not jammed, all necessary fuses are intact, check motor connector and I/O Board conveyor relays.

Chip conveyor is moving in the wrong direction

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

Chip conveyor reverses, then shuts down

- Check that the conveyor is free of obstruction.
- Check that Parameters are at Default settings.
- Check that Discrete Input CNVYR (conveyor overload) cycles from 0 - 1 or 1 - 0 (0 means overload condition).

**NOTE:** If it does cycle check the motor for burnout or binding. If it does not cycle check the I/O board.
1.8 **Hydraulic Counterbalance**

A reference table is listed below indicating top of travel pressure and switch setting pressure for each machine.

<table>
<thead>
<tr>
<th>Machine</th>
<th>Top of Travel Pressure (PSI)</th>
<th>Switch Setting Pressure (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VF-1,2</td>
<td>750</td>
<td>600</td>
</tr>
<tr>
<td>VF-3, 4</td>
<td>1150</td>
<td>900</td>
</tr>
<tr>
<td>VF-5/40</td>
<td>875</td>
<td>750</td>
</tr>
<tr>
<td>VF-5/50</td>
<td>1100</td>
<td>1000</td>
</tr>
<tr>
<td>VF-6/40 – 11/40</td>
<td>750</td>
<td>600</td>
</tr>
<tr>
<td>VF-6/50, 7/50, 10/50</td>
<td>1150</td>
<td>900</td>
</tr>
<tr>
<td>VF-8/50, 9/50, 11/50</td>
<td>1550</td>
<td>1400</td>
</tr>
<tr>
<td>VR-11</td>
<td>1100</td>
<td>1000</td>
</tr>
<tr>
<td>VB-1</td>
<td>1550</td>
<td>1400</td>
</tr>
<tr>
<td>HS-1, 15AXT, 1R, 1RP</td>
<td>600</td>
<td>450</td>
</tr>
<tr>
<td>HS-3, 3R</td>
<td>1150</td>
<td>1000</td>
</tr>
</tbody>
</table>
Troubleshooting

The table below lists observable machine conditions and their probable cause. Find the appropriate corrective action step to fix the observed faults.

<table>
<thead>
<tr>
<th>Machine Condition</th>
<th>Possible Problem(s)</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine alarms, pressure reading low.</td>
<td>- Cylinder leaks</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- Fitting leaks</td>
<td>2</td>
</tr>
<tr>
<td>Machine alarms, pressure reading ok, alarm does not reset.</td>
<td>- I/O board failure</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>- Bad cable or dirty contacts</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>- Switch setting too high and/or system is under-pressurized due to inaccurate gauge.</td>
<td>3</td>
</tr>
<tr>
<td>No alarm, pressure reading low (at or below switch setting).</td>
<td>- Cylinder leaks</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- Fitting leaks</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>- Shorted cable</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>- Switch setting too low and/or system has an inaccurate gauge.</td>
<td>7</td>
</tr>
<tr>
<td>Spindle head drifts up.</td>
<td>- Over-pressurized due to inaccurate gauge.</td>
<td>8</td>
</tr>
<tr>
<td>Spindle head drifts down, no alarm.</td>
<td>- Cylinder leaks</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- Fitting leaks</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>- Switch setting too low and/or system under-pressurized due to inaccurate gauge.</td>
<td>2</td>
</tr>
</tbody>
</table>

Corrective Action

Tools Required

Hand tools.
Charge/Discharge Kit P/N 35-4050A
Hydraulic Hand Pump Kit P/N 93-0206

1. Check for sufficient oil in system: Block spindle head at top of travel. Attach charge/discharge kit to schrader valve, slowly turn t-handle clockwise to begin releasing pressure and make one of the following observations:

   a) If oil is immediately present stop discharging, there is sufficient oil in the system. There are two courses of action at this point; add nitrogen to system to obtain top of travel pressure specification. This step may last indefinitely depending on the severity of the leak, or what caused it. The second course of action is to proceed to Corrective Action 2 if it is felt that the leak is substantial.

   b) If nitrogen gas is immediately present stop discharging and proceed to Corrective Action 2. There is not enough oil in the system.
2. Block spindle head at bottom of travel (if the cylinder is to be replaced block the head in the lowest position that will permit access to the rod attachment).
   a) Carefully drain remaining gas and oil.
   b) Replace faulty component(s). (SAE straight thread o-ring fittings are to be lubricated with a film of hydraulic oil prior to install) Note that machines built after August, 1999 use straight thread fittings with o-rings, and sealed connectors on the switch wires. Earlier machines have pipe thread connections. Replacing older style components with newer style requires that all components of the counter balance system be changed as well as the cable back to the control.
   c) Pump new Mobil DTE-25 oil (see chart for qty.) into system using Hydraulic Hand Pump Kit. (see “Hydraulic Hand Pump Instructions” below).

<table>
<thead>
<tr>
<th>Machine</th>
<th>Quarts of Mobile DTE-25</th>
<th># of Pump Strokes</th>
</tr>
</thead>
<tbody>
<tr>
<td>VF-1-11, VR-11, HS-1</td>
<td>2 per tank</td>
<td>93</td>
</tr>
<tr>
<td>VB-1, HS-3</td>
<td>3 per tank</td>
<td>0140</td>
</tr>
</tbody>
</table>
   d) Pressurize with nitrogen using charge/discharge kit to spec. at top of travel.

3. Add 50 psi of nitrogen to the system at top of travel.
   Does the alarm clear?
   Yes: Now check if the head drifts up more than 1” upon E-stop at the bottom of travel. If it does then replace the switch as described in corrective action 2.
   No: Add another 50 psi to the system at top of travel. If the alarm still does not clear replace the switch as described in corrective action 2. If the alarm clears check if the head drifts up more than 1” upon E-stop at the bottom-of-travel. If it does then replace the switch as described in corrective action 2.

4. If the counter balance system pressure is ok and there is an E-stop alarm that won’t reset check the cable for dirty contacts. Loose connections or broken wire can be tested by disconnecting the cable at the switch and adding a jumper across the connector pins of the cable and clear the alarm. If the alarm does not clear the cable is defective. Repair or replace the cable if necessary.

5. Check I/O board and replace if necessary.

6. Test for short in cable. Repair or replace if necessary.

7. Does spindle head drift down from top of travel upon E-stop?
   Yes: Replace switch as described in corrective action 2.
   No: Replace pressure gauge as described in corrective action 2.

8. Invert tank to bleed about 50 psi of nitrogen gas. Re-evaluate machine condition.
**Leak Failures**

Leaks can occur at any fitting connection, at the hydraulic cylinder's rod seal (where the rod enters the cylinder), at the cylinder's piston seal, or through hose failures. Inspections for leaks are visual although rod seal leaks may be inconclusive because of way oil spatter. Piston seal leaks, if advanced, exit the top end of the cylinder and oil can be seen at the vent area. Early piston leaks accumulate over time on top of the piston to about \( \frac{3}{4} \)" high before they are pushed out the cylinder at top of travel. Leaks are normally very slow and machines can operate until the pressure switch sends an E-stop alarm.

**Mechanical Diagnosis**

**Important!** Hydraulic counterbalance oil contains red dye for easier recognition.

**Noise in the system**

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

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

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

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

**Over Current alarms**

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

If any linear scale faults (alarms 279-290) are detected, contact the Haas service Department.

The following information is needed in order to properly diagnose the machine:
- List of the faults and the dates
- Any pertinent information on the conditions and circumstances surrounding the fault
- All machine parameters
- Software version
- Machine serial number

Do not attempt to adjust or inspect the scale without notifying the service department.

1.10 Automatic Pallet Changer

Checking pallet repeatability on to the receiver.
- Maximum tolerance is ±0.005.
- Pallets are not considered repeatable from one to the other. Pallets should use separate offsets.
- If pallet is out of tolerance check the alignment pins on the receiver base and bushings on the bottom side of the clamp rails for damage.
- Check the height of the alignment pins on the receiver base, the top of the pin should be .450 to .490 above the receiver base.
- If the alignment pins are out of the receiver body, check the depth of the hole. Depth should be .510 to .550.

Sticking Pallet.
- Check for chips around the alignment pins or pallet clamp rail bushings.
- Check the torque on the bolts that fasten the clamp rails to the pallet. If the bolts are loose realign the pallet according to the instructions in the APC section of Mechanical Service.

APC not responding to controller commands.
- If the APC does not run but the mill does, check the APC control cable.
- Make sure the E-Stop jumper is removed and that the APC control cable is plugged into the 5th axis port tightly.
Recovery from an E-Stop initiated during a pallet change

Troubleshooting a Power Outage or E-Stop condition with a Pallet in transition between the Receiver and the APC.

CAUTION!
With the pallet stopped between the APC and receiver the drive pin on the chain will be engaged with the pallet drive arm. Severe damage may occur if the "X" or "Y" axes are moved automatically.

1. Power ON?
   ** NO **
   Power ON the VMC.
   Do not push Power Up Restart.
   Do not Zero Return, auto all axes.
   Do not Zero a single axis. Do not Jog or otherwise move the X and Y axes.

   YES

2. Has power been turned off since the pallet motion was stopped?
   NO

   YES

3. Is the receiver Unclamped?
   ** NO **
   Run M18 to close the door and clamp the receiver.

   YES

4. Is the pallet stopped between the APC and receiver?
   ** NO **
   Run M17 to open the door and unclamp the receiver.

   YES

5. Manual move the pallet to a known location, either on the receiver, or on the APC to engage the associated switch (see Figure 1). Verify alignment of pin and bushing (see Figure 2).

If needed, rotate the chain to a known location that compliments the pallet locations. Use the sprocket rotation tool to move the chain (see Figure 3).

Run M18 to close the door and clamp the receiver.

Run M50 to complete a pallet cycle. The completed M50 will clear the Pallet Change Incomplete variable.

Run M50 to complete a pallet cycle. The completed M50 will clear the Pallet Change Incomplete variable.

There are 5 switches involved in the location of the pallets and chain.
1 pallet switch on the receiver (Pallet Clamp Switch).
2 pallet switches on the APC (Pallet Home Switches).
2 chain switches on the APC (Pin Clear Switches).

If the power to the VMC has been shut down either intentionally or by power outage, damage may occur to the APC pallet, the receiver, or the drive chain if the X or Y axes are moved in the VMC at power ON.

At power ON the VMC will investigate the pallet and chain location and alarm if either an unknown chain location or unknown pallet location are detected.

At the beginning of the APC M50, a Pallet Change Incomplete variable is set to 1 and reset to 0 at the end. The VMC will not operate properly if a pallet change (M50) has not been completed.
Figure 1
Pallet known locations. Pallet 1 is on the receiver and engaging the Pallet Clamped switch. Pallet 2 is on the APC and engaging the Pallet Home Switch under the control panel.

Figure 2
Alignment Pin and Bushing alignment must be verified when manually positioning a pallet on the receiver.
Figure 3

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

Figure 4

Press and hold the solenoid actuation buttons to keep air pressure flowing to unclamp the receiver and hold the door open. If the buttons are released the door will close and the receiver will clamp.
**1.11 Electrical Troubleshooting**

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

---

**Electrical Alarms**

**Axis Drive Fault Alarm**
- Blown amplifier - indicated by a light at bottom of amplifier when power is on. Replace amplifier.
- Amplifier or MOCON is noise sensitive. If this is the case, the alarm can be cleared and the axis will run normally for a while. To check an amplifier, switch the motor leads and control cables between the amplifier and the one next to it. If the same problem occurs with the other axis, the amplifier must be replaced. If the problem stays on the same axis, either the MOCON or control cable. The problem could also be the axis motor itself, with leads either shorted to each other or to ground, which is very rare.
- Amplifier faulting out for valid reason, such as overtemp, overvoltage, or +/-12 volt undervoltage condition. This usually results from running a servo intensive program, or unadjusted 12 volt power supply. Replace amplifier. Overvoltage could occur if regen load is not coming on, but this does not usually happen. The problem could also be the axis motor itself, with leads either shorted to each other or to ground, which is very rare.

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

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

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

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

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

Alarm 101, "MOCON Comm. Failure"

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

Alarm 157, "MOCON Watchdog Fault"

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

Alarm 222, “C Phasing Error”

- If this alarm occurs on a VB-1, it is probably because parameter 176 bit 3 (SP AXIS DISABLED) is set to 0. It should be set to 1.

Rotary CRC Error Alarm 261

- This alarm is normally the result of an incomplete software installation. To correct this error, Change Setting 30 to any selection but OFF (note the original selection). Then go to parameter 43 and change one of the bits from 1 to 0 or vice versa and press WRITE (The bit must be changed from its original value to its alternate value). Simply changing the Setting and Parameter bit from one value to another and then back again corrects the fault, and will clear any further occurrences of the alarm. Change the bit and Setting 30 back to their original values. Press Reset to clear the alarms or cycle power to the machine.

Alarm 354 - Aux Axis Disconnected

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

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

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

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

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

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

WO6 Air or limit switch or motor overheat. Check that the motor is not hot. Check for any binding in the motor. Check for overweight tooling.
WO7  Z channel fault. Either the encoder or the cable is bad. Change the encoder first, as it is easier to change than the cable. If the problem persists, change the cable.

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

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

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

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

**Processor Stack Diagnostic**

(DISCONNECT CABLES FROM A NORMAL OPERATING SYSTEM)

Remove low voltage cable from the Video & Keyboard PCB
  - Processors LED's are normal
  - Runs fine and the CRT is Normal
  - No keypad beep

Remove low voltage cable from the MOTIF PCB
  - Processors LED's are normal then RUN goes out
  - No screen

Remove the Data & or Address buss from the Video & Keyboard PCB
  - Processors LED's Normal - then Run goes out

Remove the Data & or Address buss from the MOTIF PCB
  - Processors LED's Normal - then Run goes out

Remove the Data & or Address buss from the Micro Processor PCB
  - Processors LED's - CRT and Run are out
## Keyboard Diagnostic

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

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<td>POWER UP</td>
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<td>RESET</td>
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<td>TOOL RELEASE</td>
<td>+Z</td>
<td>JOG LOCK</td>
<td>-Z</td>
<td>+10</td>
<td>+10</td>
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<td>I</td>
<td>O</td>
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<td>EDB</td>
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<td>J</td>
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<td>V</td>
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<td>INSERT</td>
<td>SINGLE BLOCK</td>
<td>COOLNT</td>
<td>.0001 1</td>
<td>AUTO ALL AXES</td>
<td>SELECT PROG</td>
<td>E</td>
<td>K</td>
<td>Q</td>
<td>W</td>
<td>)</td>
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<td>22</td>
<td>ALTER</td>
<td>DRY RUN</td>
<td>ORIENT SPINDLE</td>
<td>.0001 1</td>
<td>ORIGIN</td>
<td>SEND RS232</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>CANCEL</td>
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<td>23</td>
<td>DELETE</td>
<td>OPT OPT</td>
<td>STOP</td>
<td>ATC FWD</td>
<td>.01 10.</td>
<td>ZERO SINGL AXES</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>24</td>
<td>UNDO</td>
<td>BLOCK DELETE</td>
<td>ATC REV</td>
<td>.01 100.</td>
<td>HOME G28</td>
<td>ERASE PROG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### KEYBOARD GRID

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

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

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

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

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

**ETHERNET**

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

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

To fix this error first verify the following:

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

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

1. On the Ethernet boot disk, edit the protocol.ini file in the NETI directory.
2. Find the line FRAME=ETHERNET_802.2 and change it to FRAME=ETHERNET_802.3
3. Save the file
4. Insert the boot disk back into the CNC and cycle the power.
If an Error 53 is still present, restore the protocol.ini file to its previous state and do the following to the NT server:

1. Open the control panel
2. Double click on the Network icon
3. Select the Protocols tab.
5. Select properties.
7. Click on Add.
8. Select Ethernet 802.2
9. Click on Add.
10. Click OK.
11. Close all windows and reboot the NT server.

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

Mill code will not work

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

**CRT Test Pattern**

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

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

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

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

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

**Alarm number and text:** Possible causes:

<table>
<thead>
<tr>
<th>Alarm number</th>
<th>Alarm text</th>
<th>Possible causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>Comm. Failure with MOCON</td>
<td>During a self-test of communications between the MOCON PCB and main processor, the main processor does not respond, one of them is possibly bad. Check cable connections and boards.</td>
</tr>
<tr>
<td>102</td>
<td>Servos Off</td>
<td>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.</td>
</tr>
<tr>
<td>103</td>
<td>X Servo Error Too Large</td>
<td>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.</td>
</tr>
<tr>
<td>104</td>
<td>Y Servo Error Too Large</td>
<td>Same as alarm 103.</td>
</tr>
<tr>
<td>105</td>
<td>Z Servo Error Too Large</td>
<td>Same as alarm 103.</td>
</tr>
<tr>
<td>106</td>
<td>A Servo Error Too Large</td>
<td>Same as alarm 103.</td>
</tr>
<tr>
<td>107</td>
<td>Emergency Off</td>
<td>EMERGENCY STOP button was pressed. After the E-STOP is released, the RESET button must be pressed once to correct this and clear the E-STOP alarm. This alarm will also be generated if there is a low pressure condition in the hydraulic counterbalance system. In this case, the alarm will not reset until the condition has been corrected.</td>
</tr>
<tr>
<td>108</td>
<td>X Servo Overload</td>
<td>Excessive load on X-axis motor. This can occur if the load on the motor is large enough to exceed the continuous rating of the motor. This could be period of several seconds or even minutes. The servos will be turned off when this occurs. This can be caused by running into the mechanical stops. It can also be caused by anything that causes a very high load on the motors.</td>
</tr>
<tr>
<td>Alarm No.</td>
<td>Description</td>
<td>Details</td>
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<tr>
<td>----------</td>
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</tr>
<tr>
<td>109 Y Servo Overload</td>
<td>Same as alarm 108.</td>
<td></td>
</tr>
<tr>
<td>110 Z Servo Overload</td>
<td>Same as alarm 108.</td>
<td></td>
</tr>
<tr>
<td>111 A Servo Overload</td>
<td>Same as alarm 108.</td>
<td></td>
</tr>
<tr>
<td>112 No Interrupt</td>
<td>Electronics fault. Call your dealer.</td>
<td></td>
</tr>
<tr>
<td>113 Shuttle In Fault</td>
<td>Tool changer is not completely to right. During a tool changer operation the tool in/out shuttle failed to get to the IN position. Parameters 62 and 63 can adjust the delays. This alarm can be caused by anything that jams the motion of the slide or by the presence of a tool in the pocket facing the spindle. A loss of power to the tool changer can also cause this. Check relays K9-K12, and fuse F1 on IOPCB.</td>
<td></td>
</tr>
<tr>
<td>114 Shuttle Out Fault</td>
<td>Tool changer not completely to left. During a tool change operation the tool in/out shuttle failed to get to the OUT position. Parameters 62 and 63 can adjust the time-out times. This alarm can be caused by anything that jams the motion of the slide or by the presence of a tool in the pocket facing the spindle. A loss of power to the tool changer can also cause this. Check relays K9-K12, and fuse F1 on IOPCB.</td>
<td></td>
</tr>
<tr>
<td>115 Turret Rotate Fault</td>
<td>During a tool changer operation the tool turret failed to start moving, failed to stop moving or failed to stop at the right position. Parameters 60 and 61 can adjust the delays. This alarm can be caused by anything that jams the rotation of the turret. A loss of power to the tool changer can also cause this. Check relays K9-K12, and fuse F1 on IOPCB.</td>
<td></td>
</tr>
<tr>
<td>116 Spindle Orientation Fault</td>
<td>Spindle did not orient correctly. This is either a vector drive problem or a mechanical problem on machines without a vector drive. During a spindle orientation function, the spindle is rotated until the lock pin drops in; but the lock pin never dropped. Parameters 66, 70, 73, and 74 can adjust delays and spindle orient speeds. This can be caused by a trip of circuit breaker CB4, a lack of air pressure, or too much friction with the orientation pin.</td>
<td></td>
</tr>
<tr>
<td>117 Spindle High Gear Fault</td>
<td>Gearbox did not shift into high gear. During a change to high gear, the spindle is rotated slowly while air pressure is used to change gears but the high gear sensor was not detected in time. Parameters 67, 70 and 75 can adjust the delays. Check the air pressure, circuit breaker CB4, the circuit breaker for the air pressure solenoids, and the spindle drive.</td>
<td></td>
</tr>
<tr>
<td>118 Spindle Low Gear Fault</td>
<td>Gearbox did not shift into low gear. During a change to low gear, the spindle is rotated slowly while air pressure is used to change gears but the low gear sensor was not detected in time. Parameters 67, 70 and 75 can adjust the delays. Check the air pressure, the solenoid’s circuit breaker CB4, and the spindle drive.</td>
<td></td>
</tr>
<tr>
<td>119 Over Voltage</td>
<td>Incoming line voltage is above maximum. The spindle, tool changer, and coolant pump will stop. If this condition persists, an automatic shutdown will begin after the time specified by parameter 296.</td>
<td></td>
</tr>
<tr>
<td>120 Low Air Pressure</td>
<td>Air pressure dropped below 80 PSI for a period defined by Parameter 76. The LOW AIR PR alarm will appear on the screen as soon as the pressure gets low, and this alarm appears after some time has elapsed. Check your incoming air pressure for at least 100 PSI and ensure that the regulator is set at 85 PSI.</td>
<td></td>
</tr>
</tbody>
</table>
121 Low Lube or Low Pressure
Way lube is low or empty or the lube pressure is too high or low. Check tank at rear of mill and below control cabinet. Also check connector on the side of the control cabinet. Check that the lube lines are not blocked.

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

123 Spindle Drive Fault
Failure of spindle drive, motor or regenerative load. This can be caused by a shorted motor, overvoltage, overcurrent, undervoltage, failure of drive, or shorted or open regen load. Undervoltage and overvoltage of DC bus are also reported as alarms 160 and 119, respectively.

124 Low Battery
Memory batteries need replacing within 30 days. This alarm is only generated at power on and indicates that the 3.3 volt Lithium battery is below 2.5 volts. If this is not corrected within 30 days, you may lose your stored programs, parameters, offsets, and settings.

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

126 Gear Fault
Transmission is out of position when a command is given to start a program or rotate the spindle. This means that the two speed transmission is not in either high or low gear but is somewhere in between. Check the air pressure, the solenoid’s circuit breaker CB4, and the spindle drive. Use the POWER UP/RESTART button to correct the problem.

127 No Turret Mark
Tool carousel motor not in position. This alarm is only generated at power-on. The AUTO ALL AXES button will correct this but be sure that the pocket facing the spindle afterwards does not contain a tool.

129 M Fin Fault
M-code relays were active at power on. Check the wiring to your M code interfaces. This test is only performed at power-on.

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

131 Tool Not Clamped
When clamping or powering up the machine, the Tool Release Piston is not HOME. This is a possible fault in the air solenoids, relays on the 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 Power Interface card on power supply assembly, relays on the I/O assembly, and the main contactor K1.

133 Spindle Locked
Shot pin did not release. This is detected when spindle motion is commanded. Check the solenoid that controls the air to the lock, relay K16, the wiring to the sense switch, and the switch.
134 Tool Clamp Fault
When UNCLAMPING, the tool did not release from spindle when commanded. Check air pressure and solenoid circuit breaker CB4. Can also be caused by misadjustment of drawbar assembly.

135 X Motor Over Heat
Servo motor overheat. The temperature sensor in the motor indicates over 150 degrees F. This can be caused by an extended overload of the motor such as leaving the axis at the stops for several minutes.

136 Y Motor Over Heat
Same as alarm 135.

137 Z Motor Over Heat
Same as alarm 135.

138 A Motor Over Heat
Same as alarm 135.

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

140 Y Motor Z Fault
Same as alarm 139.

141 Z Motor Z Fault
Same as alarm 139.

142 A Motor Z Fault
Same as alarm 139.

143 Spindle Not Locked
Vector drive orientation lost or spindle shot pin not fully engaged when a tool change operation is being performed. Check air pressure and solenoid circuit breaker CB4. This can also be caused by a fault in the sense switch that detects the position of the lock pin.

144 Time-out- Call Your Dealer
Time allocated for use prior to payment exceeded. Call your dealer.

145 X Limit Switch
Axis tripped the limit switch or switch disconnected. This is not normally possible as the stored stroke limits will stop the axis before they reach the limit switches. Check the wiring to the limit switches and connector P5 at the side of the main cabinet. Can also be caused by a loose encoder shaft at the back of the motor or coupling of motor to the screw.

146 Y Limit Switch
Same as alarm 145

147 Z Limit Switch
Same as alarm 145

148 A Limit Switch
Normally disabled for rotary axis.

149 Spindle Turning
Spindle not at zero speed for tool change. A signal from spindle drive indicating that the spindle drive is stopped is not present while a tool change operation is going on.

150 Z and Tool Interlocked
Changer not at home and either the Z or A or B axis (or any combination) is not at zero. If RESET, E-STOP, or POWER OFF occurs during tool change, Z-axis motion and tool changer motion may not be safe. Check the position of the tool changer and remove the tool if possible. Re-initialize with the AUTO ALL AXES button but be sure that the pocket facing the spindle afterwards does not contain a tool.
<table>
<thead>
<tr>
<th>Alarm</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>151</td>
<td>Low Thru Spindle Coolant</td>
</tr>
<tr>
<td>152</td>
<td>Self Test Fail</td>
</tr>
<tr>
<td>153</td>
<td>X-axis Z Ch Missing</td>
</tr>
<tr>
<td>154</td>
<td>Y-axis Z Ch Missing</td>
</tr>
<tr>
<td>155</td>
<td>Z-axis Z Ch Missing</td>
</tr>
<tr>
<td>156</td>
<td>A-axis Z Ch Missing</td>
</tr>
<tr>
<td>157</td>
<td>MOCON Watchdog Fault</td>
</tr>
<tr>
<td>158</td>
<td>Video/Keyboard PCB Failure</td>
</tr>
<tr>
<td>159</td>
<td>Keyboard Failure</td>
</tr>
<tr>
<td>160</td>
<td>Low Voltage</td>
</tr>
<tr>
<td>161</td>
<td>X-Axis Drive Fault</td>
</tr>
<tr>
<td>162</td>
<td>Y-Axis Drive Fault</td>
</tr>
<tr>
<td>163</td>
<td>Z-Axis Drive Fault</td>
</tr>
<tr>
<td>164</td>
<td>A-Axis Drive Fault</td>
</tr>
<tr>
<td>165</td>
<td>X Zero Ret Margin Too Small</td>
</tr>
<tr>
<td>166</td>
<td>Y Zero Ret Margin Too Small</td>
</tr>
<tr>
<td>167</td>
<td>Z Zero Ret Margin Too Small</td>
</tr>
<tr>
<td>168</td>
<td>A Zero Ret Margin Too Small</td>
</tr>
<tr>
<td>169</td>
<td>Spindle Direction Fault</td>
</tr>
<tr>
<td>170</td>
<td>Phase Loss</td>
</tr>
</tbody>
</table>

For machines with Through the Spindle Coolant only. This alarm will shut off the coolant spigot, spindle and pump, and purge the system. Check for low coolant tank level, any filter or intake strainer clogging, or for any kinked or clogged coolant lines. If no problems are found with any of these, and none of the coolant lines are clogged or kinked, call your dealer. Verify proper pump and machine phasing.

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.

Z reference signal from encoder was not received as expected. Likely encoder contamination or parameter error.

Same as alarm 153.

Same as alarm 153.

Same as alarm 153.

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

Internal circuit board problem. This could also be caused by a short in the front panel membrane keypad. Call your dealer.

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

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

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.

Same as alarm 161.

Same as alarm 161.

Same as alarm 161.

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.

Same as alarm 165.

Same as alarm 165.

Same as alarm 165.

Problem with rigid tapping hardware. The spindle started turning in the wrong direction.

Problem with incoming line voltage. This usually indicates that there was a transient loss of input power to the machine.
<table>
<thead>
<tr>
<th>Alarm</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>173</td>
<td>Spindle Ref Signal Missing</td>
</tr>
<tr>
<td></td>
<td>The Z channel pulse from the spindle encoder is missing for hard tapping</td>
</tr>
<tr>
<td></td>
<td>synchronization.</td>
</tr>
<tr>
<td>174</td>
<td>Tool Load Exceeded</td>
</tr>
<tr>
<td></td>
<td>The tool load monitor option is selected and the maximum load for a tool</td>
</tr>
<tr>
<td></td>
<td>was exceeded in a feed. If the tool load monitor function is installed in</td>
</tr>
<tr>
<td></td>
<td>your machine.</td>
</tr>
<tr>
<td>175</td>
<td>Ground Fault Detected</td>
</tr>
<tr>
<td></td>
<td>A ground fault condition was detected in the 115V AC supply. This can be</td>
</tr>
<tr>
<td></td>
<td>caused by a short to ground in any of the servo motors, the tool change</td>
</tr>
<tr>
<td></td>
<td>motors, the fans, or the oil pump.</td>
</tr>
<tr>
<td>176</td>
<td>Over Heat Shutdown</td>
</tr>
<tr>
<td></td>
<td>An overheat condition persisted longer than the interval specified by</td>
</tr>
<tr>
<td></td>
<td>parameter 296 and caused an automatic shutdown.</td>
</tr>
<tr>
<td>177</td>
<td>Over Voltage Shutdown</td>
</tr>
<tr>
<td></td>
<td>An overvoltage condition persisted longer than the interval specified by</td>
</tr>
<tr>
<td></td>
<td>parameter 296 and caused an automatic shutdown.</td>
</tr>
<tr>
<td>178</td>
<td>Divide by Zero</td>
</tr>
<tr>
<td></td>
<td>Software Error; Call your dealer.</td>
</tr>
<tr>
<td>179</td>
<td>Low Pressure Transmission Oil</td>
</tr>
<tr>
<td></td>
<td>Spindle coolant oil is low or low pressure condition in lines.</td>
</tr>
<tr>
<td>180</td>
<td>Pallet Not Clamped</td>
</tr>
<tr>
<td></td>
<td>The APC pallet change was not completed, pressing E-stop, reset, or</td>
</tr>
<tr>
<td></td>
<td>feedhold, and an attempt was made to run the spindle. Run M50 pallet</td>
</tr>
<tr>
<td></td>
<td>change to reset the machine.</td>
</tr>
<tr>
<td>182</td>
<td>X Cable Fault</td>
</tr>
<tr>
<td></td>
<td>Cable from X-axis encoder does not have valid differential</td>
</tr>
<tr>
<td></td>
<td>signals.</td>
</tr>
<tr>
<td>183</td>
<td>Y Cable Fault</td>
</tr>
<tr>
<td></td>
<td>Same as alarm 182.</td>
</tr>
<tr>
<td>184</td>
<td>Z Cable Fault</td>
</tr>
<tr>
<td></td>
<td>Same as alarm 182.</td>
</tr>
<tr>
<td>185</td>
<td>A Cable Fault</td>
</tr>
<tr>
<td></td>
<td>Same as alarm 182.</td>
</tr>
<tr>
<td>186</td>
<td>Spindle Not Turning</td>
</tr>
<tr>
<td></td>
<td>Status from spindle drive indicates it is not at speed when expected.</td>
</tr>
<tr>
<td>187</td>
<td>B Servo Error Too Large</td>
</tr>
<tr>
<td></td>
<td>Same as alarm 103.</td>
</tr>
<tr>
<td>188</td>
<td>B Servo Overload</td>
</tr>
<tr>
<td></td>
<td>Same as alarm 108.</td>
</tr>
<tr>
<td>189</td>
<td>B Motor Overheat</td>
</tr>
<tr>
<td></td>
<td>Same as alarm 135.</td>
</tr>
<tr>
<td>190</td>
<td>B Motor Z Fault</td>
</tr>
<tr>
<td></td>
<td>Same as alarm 139.</td>
</tr>
<tr>
<td>191</td>
<td>B Limit Switch</td>
</tr>
<tr>
<td></td>
<td>Same as alarm 148.</td>
</tr>
<tr>
<td>192</td>
<td>B Axis Z Ch Missing</td>
</tr>
<tr>
<td></td>
<td>Z reference signal from encoder was not received as expected. Likely</td>
</tr>
<tr>
<td></td>
<td>encoder contamination or parameter error.</td>
</tr>
<tr>
<td>193</td>
<td>B Axis Drive Fault</td>
</tr>
<tr>
<td></td>
<td>Same as alarm 161.</td>
</tr>
<tr>
<td>194</td>
<td>B Zero Ret Margin Too Small</td>
</tr>
<tr>
<td></td>
<td>Same as alarm 165.</td>
</tr>
<tr>
<td>195</td>
<td>B Cable Fault</td>
</tr>
<tr>
<td></td>
<td>Same as alarm 182.</td>
</tr>
<tr>
<td>196</td>
<td>Coolant Spigot Failure</td>
</tr>
<tr>
<td></td>
<td>Vertical mills only. Spigot failed to achieve commanded location after</td>
</tr>
<tr>
<td></td>
<td>two (2) attempts.</td>
</tr>
<tr>
<td>197</td>
<td>100 Hours Unpaid Bill</td>
</tr>
<tr>
<td></td>
<td>Call your dealer.</td>
</tr>
<tr>
<td>198</td>
<td>Precharge Failure</td>
</tr>
<tr>
<td></td>
<td>During TSC operation, the precharge failed for greater than 0.1 seconds.</td>
</tr>
<tr>
<td></td>
<td>It will shut off the feed, spindle and pump all at once. If received,</td>
</tr>
<tr>
<td></td>
<td>check all air lines and the air supply pressure.</td>
</tr>
<tr>
<td>Alarm Number</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>199</td>
<td>Negative RPM</td>
</tr>
<tr>
<td>201</td>
<td>Parameter CRC Error</td>
</tr>
<tr>
<td>202</td>
<td>Setting CRC Error</td>
</tr>
<tr>
<td>203</td>
<td>Lead Screw CRC Error</td>
</tr>
<tr>
<td>204</td>
<td>Offset CRC Error</td>
</tr>
<tr>
<td>205</td>
<td>Programs CRC Error</td>
</tr>
<tr>
<td>206</td>
<td>Internal Program Error</td>
</tr>
<tr>
<td>207</td>
<td>Queue Advance Error</td>
</tr>
<tr>
<td>208</td>
<td>Queue Allocation Error</td>
</tr>
<tr>
<td>209</td>
<td>Queue Cutter Comp Error</td>
</tr>
<tr>
<td>210</td>
<td>Insufficient Memory</td>
</tr>
<tr>
<td>211</td>
<td>Odd Prog Block</td>
</tr>
<tr>
<td>212</td>
<td>Program Integrity Error</td>
</tr>
<tr>
<td>213</td>
<td>Program RAM CRC Error</td>
</tr>
<tr>
<td>214</td>
<td>No. of Programs Changed</td>
</tr>
<tr>
<td>215</td>
<td>Free Memory PTR Changed</td>
</tr>
<tr>
<td>216</td>
<td>EPROM Speed Failure</td>
</tr>
<tr>
<td>217</td>
<td>X Axis Phasing Error</td>
</tr>
<tr>
<td>218</td>
<td>Y Axis Phasing Error</td>
</tr>
<tr>
<td>219</td>
<td>Z Axis Phasing Error</td>
</tr>
<tr>
<td>220</td>
<td>A Axis Phasing Error</td>
</tr>
<tr>
<td>221</td>
<td>B Axis Phasing Error</td>
</tr>
<tr>
<td>222</td>
<td>C Axis Phasing Error</td>
</tr>
<tr>
<td>223</td>
<td>Door Lock Failure</td>
</tr>
<tr>
<td>Alarm Code</td>
<td>Alarm Description</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>224</td>
<td>X Transition Fault Illegal transition of encoder count pulses in X axis. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON or MOTIF PCB.</td>
</tr>
<tr>
<td>225</td>
<td>Y Transition Fault Same as alarm 224.</td>
</tr>
<tr>
<td>226</td>
<td>Z Transition Fault Same as alarm 224.</td>
</tr>
<tr>
<td>227</td>
<td>A Transition Fault Same as alarm 224.</td>
</tr>
<tr>
<td>228</td>
<td>B Transition Fault Same as alarm 224.</td>
</tr>
<tr>
<td>229</td>
<td>C Transition Fault Same as alarm 224.</td>
</tr>
<tr>
<td>231</td>
<td>Jog Handle Transition Fault Illegal transition of encoder count pulses in jog handle encoder. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors.</td>
</tr>
<tr>
<td>232</td>
<td>Spindle Transition Fault Illegal transition of encoder count pulses in spindle encoder. This alarm usually indicates that the encoder has been damaged and encoder position data is unreliable. This can also be caused by loose connectors at the MOCON.</td>
</tr>
<tr>
<td>233</td>
<td>Jog Handle Cable Fault Cable from jog handle encoder does not have valid differential signals.</td>
</tr>
<tr>
<td>234</td>
<td>Spindle Enc. Cable Fault Cable from spindle encoder does not have valid differential signals.</td>
</tr>
<tr>
<td>235</td>
<td>Spindle Z Fault Same as alarm 139.</td>
</tr>
<tr>
<td>236</td>
<td>Spindle Motor Overload The spindle motor is overloaded.</td>
</tr>
<tr>
<td>237</td>
<td>Spindle Following Error The error between the commanded spindle speed and the actual speed has exceeded the maximum allowable (as set in Parameter 184).</td>
</tr>
<tr>
<td>238</td>
<td>Door Fault The safety switch was not tripped or released when the door was commanded open or closed.</td>
</tr>
<tr>
<td>239</td>
<td>Unknown Mocon Alarm Mocon has reported an alarm to the current software. The current version of software was unable to identify the alarm. See mocon software release notes for additional diagnostics.</td>
</tr>
<tr>
<td>240</td>
<td>Empty Prog or No EOB DNC program not found, or no end of program found.</td>
</tr>
<tr>
<td>241</td>
<td>Invalid Code RS-232 load bad. Data was stored as comment. Check the program being received.</td>
</tr>
<tr>
<td>242</td>
<td>No End Check input file for a number that has too many digits</td>
</tr>
<tr>
<td>243</td>
<td>Bad Number Data entered is not a number.</td>
</tr>
<tr>
<td>244</td>
<td>Missing ) Comment must end with a &quot; ) &quot;.</td>
</tr>
<tr>
<td>245</td>
<td>Unknown Code Check input line or data from RS-232. This alarm can occur while editing data into a program or loading from RS-232. See MESSAGE PAGE for input line.</td>
</tr>
<tr>
<td>246</td>
<td>String Too Long Input line is too long. The data entry line must be shortened.</td>
</tr>
<tr>
<td>247</td>
<td>Cursor Data Base Error Software Error; Call your dealer.</td>
</tr>
</tbody>
</table>
248 Number Range Error
Number entry is out of range.

249 Prog Data Begins Odd
Possible corrupted program. Save all programs to floppy disk, delete all, then reload.

250 Program Data Error
Same as alarm 249.

251 Prog Data Struct Error
Same as alarm 249.

252 Memory Overflow
Same as alarm 249.

253 Electronics Overheat
The control box temperature has exceeded 135 degrees F. This can be caused by an electronics problem, high ambient temperature, or clogged air filter.

254 Spindle Overheat
The motor driving the spindle is too hot. The spindle motor temperature sensor sensed a high temperature for greater than 1.5 seconds.

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

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

257 Program Data Error
Possible corrupted program. Save all programs to floppy disk, delete all, then reload. Possible processor board problem.

258 Invalid DPRNT Format
Macro DPRNT statement not structured properly.

259 Language Version
Possible processor board problem.

260 Language CRC
Indicates FLASH memory has been corrupted or damaged. Possible processor board problem.

261 Rotary CRC Error
Rotary table saved parameters (used by Settings 30, 78) had a cyclic redundancy check (CRC) error. Indicates a loss of memory, possible processor board problem.

262 Parameter CRC Missing
RS-232 or disk read of parameter did not have a cyclic redundancy check (CRC) when loading from disk or RS-232.

263 Lead Screw CRC Missing
Lead screw compensation tables did not have a cyclic redundancy check (CRC) when loading from disk or RS-232.

264 Rotary CRC Missing
Rotary table parameters did not have cyclic redundancy check (CRC) when loading from disk or RS-232.

265 Macro Variable File CRC Error
Macro variable file has a cyclic redundancy check (CRC) error. Indicates a loss of memory. Possible processor board problem.

266 Tool Changer Fault
The tool changer did not return to the proper starting position. Run Toolchnger Recovery.
### ALARMS

<table>
<thead>
<tr>
<th>Alarm Code</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>267</td>
<td>Tool Door Out of Position</td>
<td>Horizontal mills only. Alarm will be generated during a tool change when parameter 278 TC DR SWITCH is set to 1, and the tool carousel air door and the tool carousel air door switch indicates that the door is open after commanded to be closed, or closed after it was commanded to be open. This alarm will most likely be caused by a stuck or broken switch.</td>
</tr>
<tr>
<td>268</td>
<td>Door open @ M95 Start</td>
<td>Generated whenever an M95 (Sleep Mode) is encountered and the door is open. The door must be closed in order to start sleep mode.</td>
</tr>
<tr>
<td>269</td>
<td>TOOLARM FAULT</td>
<td>The toolchanger arm is not in position. Run Toolchanger Recovery.</td>
</tr>
<tr>
<td>270</td>
<td>C Servo Error Too Large</td>
<td>Same as alarm 103.</td>
</tr>
<tr>
<td>271</td>
<td>C Servo Overload</td>
<td>Same as alarm 108.</td>
</tr>
<tr>
<td>272</td>
<td>C Motor Overheat</td>
<td>Same as alarm 135.</td>
</tr>
<tr>
<td>273</td>
<td>C Motor Z Fault</td>
<td>Same as alarm 139.</td>
</tr>
<tr>
<td>274</td>
<td>C Limit Switch</td>
<td>Same as alarm 145.</td>
</tr>
<tr>
<td>275</td>
<td>C Axis Z Ch Missing</td>
<td>Same as alarm 153.</td>
</tr>
<tr>
<td>276</td>
<td>C Axis Drive Fault</td>
<td>Same as alarm 161.</td>
</tr>
<tr>
<td>277</td>
<td>C Zero Ret Margin Too Small</td>
<td>Same as alarm 165.</td>
</tr>
<tr>
<td>278</td>
<td>C Cable Fault</td>
<td>Same as alarm 182.</td>
</tr>
<tr>
<td>279</td>
<td>X Axis Linear Scale Z Fault</td>
<td>Encoder marker pulse count failure. This alarm usually indicates that the Z Fault encoder has been damaged and encoder position data is unreliable. This can also be caused by loose scale connectors.</td>
</tr>
<tr>
<td>280</td>
<td>Y Axis Linear Scale Z Fault</td>
<td>Same as alarm 279.</td>
</tr>
<tr>
<td>281</td>
<td>Z Axis Linear Scale Z Fault</td>
<td>Same as alarm 279.</td>
</tr>
<tr>
<td>282</td>
<td>A Axis Linear Scale Z Fault</td>
<td>Same as alarm 279.</td>
</tr>
<tr>
<td>283</td>
<td>X Axis Linear Scale Z CH Missing</td>
<td>Broken wires or encoder contamination. All servos are turned off. This Z Channel Missing can also be caused by loose scale connectors.</td>
</tr>
<tr>
<td>284</td>
<td>Y Axis Linear Scale Z CH Missing</td>
<td>Same as alarm 279.</td>
</tr>
<tr>
<td>285</td>
<td>Z Axis Linear Scale Z CH Missing</td>
<td>Same as alarm 279.</td>
</tr>
<tr>
<td>286</td>
<td>A Axis Linear Scale Z CH Missing</td>
<td>Same as alarm 279.</td>
</tr>
<tr>
<td>287</td>
<td>X Axis Linear Scale Cable Fault</td>
<td>Cable from X-axis scale does not have valid differential signals.</td>
</tr>
<tr>
<td>288</td>
<td>Y Axis Linear Scale Cable Fault</td>
<td>Cable from Y-axis scale does not have valid differential signals.</td>
</tr>
<tr>
<td>289</td>
<td>Z Axis Linear Scale Cable Fault</td>
<td>Cable from Z-axis scale does not have valid differential signals.</td>
</tr>
<tr>
<td>290</td>
<td>A Axis Linear Scale Cable Fault</td>
<td>Cable from A-axis scale does not have valid differential signals.</td>
</tr>
<tr>
<td>291</td>
<td>Low Air Volume/Pressure During ATC</td>
<td>An automatic tool change was not completed due to insufficient volume or pressure of compressed air. Check air supply line.</td>
</tr>
</tbody>
</table>
292 320V Power Supply Fault  
Incoming line voltage is above maximum. The servo will be turned off and the spindle, tool changer, and coolant pump will stop. If this persists, an automatic shutdown will begin after the interval specified by parameter 296.

293 Invalid Chamfer or Corner Rounding Distance in G01  
This alarm supports the corner rounding and chamfering feature.

294 No End Move for G01 Chamfer Corner Rounding  
This alarm supports the corner rounding and chamfering feature. A chamfer or corner rounding move was requested in a G01 command, but no end move was commanded.

295 Move Angle Too Small in G01 Corner rounding  
This alarm supports the corner rounding and chamfering feature. Tangent of half angle is zero. Move Angle must be greater than 1 deg.

296 Invalid Plane Selection in G01 Chamfer or Corner Rounding  
This alarm supports the corner rounding and chamfering feature. Chamfer or corner rounding move and end move must be in the same plane as the beginning move.

297 ATC Shuttle Overshoot  
The ATC shuttle has failed to stop within the standby position window during a tool change. Check for a loose drive belt, damaged or over heated motor, sticking or damaged shuttle standby switch or shuttle mark switch, or burned ATC control board relay contacts. Use tool changer restore to recover the ATC, then resume normal operation.

298 ATC Double Arm Out of Position  
The ATC double arm mark switch, CW position switch or CCW position switch is in an incorrect state. Check for sticking, misaligned or damaged switches, mechanism binding, damaged motor, or debris build up. Use tool changer restore to recover the ATC, then resume normal operation.

299 ATC Shuttle Out of Position  
The ATC shuttle mark switch is in an incorrect state. Check for a sticking, misaligned, or damaged switch, mechanism binding, damaged motor, or debris build up. Use tool changer restore to recover the ATC, then resume normal operation.

302 Invalid R In G02 or G03  
Check your geometry. R must be greater than or equal to half the distance from start to end within an accuracy of 0.0010 inches.

303 Invalid X, Y, or Z In G02 or G03  
Check your geometry.

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

305 Invalid Q In Canned Cycle  
Q in a canned cycle must be greater than zero.

306 Invalid I, J, K, or Q In Canned Cycle  
I, J, K, and Q in a canned cycle must be greater than zero.

307 Subroutine Nesting Too Deep  
Subprogram nesting is limited to nine levels. Simplify your program.

309 Exceeded Max Feed Rate  
Use a lower feed rate.

310 Invalid G Code  
G code not defined and is not a macro call.

311 Unknown Code  
Program contained a line of code that is not understood.

312 Program End  
End of subroutine reached before M99. Need an M99 to return from subroutine.
313 No P Code In M97, M98, or G65
   In M97, M98 or G65 a subprogram number must be put in the P code. G47 must have P0 for text engraving or P1 for sequential serial numbers.

314 Subprogram or Macro Not In Memory
   Check that a subroutine is in memory or that a macro is defined.

315 Invalid P Code In M97, M98 or M99
   The P code must be the name of a program stored in memory without a decimal point for M98 and must be a valid N number for M99. G47 must have P0 for text engraving or P1 for sequential serial numbers.

316 X Over Travel Range
   Commanded X-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user’s program or improper offsets.

317 Y Over Travel Range
   Same as alarm 316.

318 Z Over Travel Range
   Same as alarm 316.

319 A Over Travel Range
   Commanded A-axis move would exceed the allowed machine range. Machine coordinates are in the negative direction. This condition indicates either an error in the user’s program or improper offsets.

320 No Feed Rate Specified
   Must have a valid F code for interpolation functions.

321 Auto Off Alarm
   Occurs in debug mode only.

322 Sub Prog Without M99
   Add an M99 code to the end of program called as a subroutine.

324 Delay Time Range Error
   P code in G04 is greater than or equal to 1000 seconds (over 999999 milliseconds).

325 Queue Full
   Control problem; call your dealer.

326 G04 Without P Code
   Put a Pn.n for seconds or a Pn for milliseconds.

327 No Loop For M Code Except M97, M98
   L code not used here. Remove L Code.

328 Invalid Tool Number
   Tool number must be between 1 and the value in Parameter 65.

329 Undefined M Code
   That M code is not defined and is not a macro call.

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

331 Range Error
   Number too large.

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

333 X-Axis Disabled
   Parameters have disabled this axis. Not normally possible in VF Series Mills.

334 Y-Axis Disabled
   Same as alarm 333.

335 Z-Axis Disabled
   Same as alarm 333.

336 A-Axis Disabled
   An attempt was made to program the A-axis while it was disabled (DISABLED bit in Parameter 43 set to 1) or invisible (INVIS AXIS bit in Parameter 43 set to 1).
337  GOTO or P line Not Found
Subprogram is not in memory, or P code is incorrect, or a P value is not found.

338  Invalid IJK and XYZ in G02 or G03
There is a problem with circle definition; check your geometry.

339  Multiple Codes
Only one M, X, Y, Z, A, Q etc. allowed in any block, or only one G code in the same group.

340  Cutter Comp Begin With G02 or G03
Select cutter compensation earlier. Cutter comp. must begin on a linear move.

341  Cutter Comp End With G02 or G03
Disable cutter comp later.

342  Cutter Comp Path Too Small
Geometry not possible. Check your geometry.

343  Display Queue Record Full
Software error. Call your dealer.

344  Cutter Comp With G18 and G19
Cutter comp only allowed in XY plane (G17).

346  Illegal M Code
There was an M80 or M81 commanded. These commands are not allowed while Setting 51 DOOR HOLD OVERRIDE is OFF. Also check Setting 131 for Auto Door and Parameter 57 for DOOR STOP SP.

347  Invalid or Missing E Code
All 5-axis canned cycles require the depth to be specified using a positive E code.

348  Motion Not Allowed In G93 Mode
This alarm is generated if the mill is in Inverse Time Feed mode, and a G12, G13, G70, G71, G72, G150, or any Group 9 motion command is issued.

349  Prog Stop W/O Cancel Cutter Comp
An X/Y cutter compensation exit move is required before a program stop.

350  Cutter Comp Look Ahead Error
There are too many non-movement blocks between motions when cutter comp is being used. Remove some intervening blocks.

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

352  Aux Axis Power Off
Aux C, U, V, or W axis indicate servo off. Check auxiliary axes. Status from control was OFF.

353  Aux Axis No Home
A ZERO RET has not been done yet on the aux axes. Check auxiliary axes. Status from control was LOST.

354  Aux Axis Disconnected
Aux axes not responding. Check auxiliary axes and RS-232 connections.

355  Aux Axis Position
Mismatch between machine and aux axes position. Check aux axes and Mismatch interfaces. Make sure no manual inputs occur to aux axes.

356  Aux Axis Travel Limit
Aux axes are attempting to travel past their limits.

357  Aux Axis Disabled
Aux axes are disabled.

358  Multiple Aux Axis
Can only move one auxiliary axis at a time.

359  Invalid I, J, or K In G12 or G13
Check your geometry.

360  Tool Changer Disabled
Check Parameter 57. Not a normal condition for VF Series Mills.

361  Gear Change Disabled
Check Parameter 57. Not a normal condition for VF Series Mills.
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<tr>
<th>Alarm Code</th>
<th>Message</th>
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<td>362</td>
<td>Tool Usage Alarm RESET. Tool life limit was reached. To continue, reset the usage count in the Current Commands display and press</td>
</tr>
<tr>
<td>363</td>
<td>Coolant Locked Off Override is off and program tried to turn on coolant.</td>
</tr>
<tr>
<td>364</td>
<td>No Circ Interp Aux Axis Only rapid or feed is allowed with aux axes.</td>
</tr>
<tr>
<td>365</td>
<td>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.</td>
</tr>
<tr>
<td>367</td>
<td>Cutter Comp Interference G01 cannot be done with tool size.</td>
</tr>
<tr>
<td>368</td>
<td>Groove Too Small Tool too big to enter cut.</td>
</tr>
<tr>
<td>369</td>
<td>Tool Too Big Use a smaller tool for cut.</td>
</tr>
<tr>
<td>370</td>
<td>Pocket Definition Error Check geometry for G150.</td>
</tr>
<tr>
<td>371</td>
<td>Invalid I, J, K, OR Q Check G150.</td>
</tr>
<tr>
<td>372</td>
<td>Tool Change In Canned Cycle Tool change not allowed while canned cycle is active.</td>
</tr>
<tr>
<td>373</td>
<td>Invalid Code in DNC A code found in a DNC program could not be interpreted because of DNC restrictions.</td>
</tr>
<tr>
<td>374</td>
<td>Missing XYZA in G31 or G36 G31 skip function requires an X, Y, Z, or A move.</td>
</tr>
<tr>
<td>375</td>
<td>Missing Z or H in G37 G37 automatic tool length measurement function requires H code, Z value, and tool offset enabled. X, Y, and A values not allowed.</td>
</tr>
<tr>
<td>376</td>
<td>No Cutter Comp In Skip Skip G31 and G37 functions cannot be used with cutter compensation.</td>
</tr>
<tr>
<td>377</td>
<td>No Skip in Graph/Sim Graphics mode cannot simulate skip function.</td>
</tr>
<tr>
<td>378</td>
<td>Skip Signal Found Skip signal check code was included but skip was found when it was not expected.</td>
</tr>
<tr>
<td>379</td>
<td>Skip Signal Not Found Skip signal check code was included but skip was not found when it was expected.</td>
</tr>
<tr>
<td>380</td>
<td>X, Y, A, or G49 Not Allowed in G37 G37 may only specify Z-axis and must have tool offset defined.</td>
</tr>
<tr>
<td>381</td>
<td>G43 or G44 Not Allowed in G36 or G136 Auto work offset probing must be done without tool offset.</td>
</tr>
<tr>
<td>382</td>
<td>D Code Required in G35 A Dnnn code is required in G35 in order to store the measured tool diameter.</td>
</tr>
<tr>
<td>383</td>
<td>Inch Is Not Selected G20 was specified but settings have selected metric input.</td>
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<tr>
<td>384</td>
<td>Metric Is Not Selected G21 was specified but settings have selected inches.</td>
</tr>
<tr>
<td>385</td>
<td>Invalid L, P, or R G10 was used to change offsets but L, P, or R code is missing or Code In G10 invalid.</td>
</tr>
<tr>
<td>386</td>
<td>Invalid Address Format An address A...Z was used improperly.</td>
</tr>
<tr>
<td>387</td>
<td>Cutter Comp Not Allowed With G103 If block buffering has been limited, Cutter comp cannot be used.</td>
</tr>
<tr>
<td>388</td>
<td>Cutter Comp Not Allowed With G10 Coordinates cannot be altered while cutter comp is active. Move G10 outside of cutter comp enablement.</td>
</tr>
<tr>
<td>389</td>
<td>G17, G18, G19 Illegal in G68 Planes of rotation cannot be changed while rotation is enabled.</td>
</tr>
<tr>
<td>Alarm Code</td>
<td>Description</td>
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<tr>
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<td>-------------</td>
</tr>
<tr>
<td>390</td>
<td>No Spindle Speed. S code has not been encountered. Add an S code.</td>
</tr>
<tr>
<td>391</td>
<td>Feature Disabled. An attempt was made to use a control feature not enabled by a parameter bit. Set the parameter bit to 1.</td>
</tr>
<tr>
<td>392</td>
<td>B Axis Disabled. An attempt was made to program the B-axis while it was disabled (DISABLED bit in Parameter 151 set to 1) or invisible (INVIS AXIS bit in Parameter 151 set to 1).</td>
</tr>
<tr>
<td>393</td>
<td>Invalid Motion In G74 or G84. Rigid Tapping can only be in the Z minus G74 or G84 direction. Make sure that the distance from the initial position to the commanded Z depth is in the minus direction.</td>
</tr>
<tr>
<td>394</td>
<td>B Over Travel Range. Same as alarm 316.</td>
</tr>
<tr>
<td>395</td>
<td>No G107 Rotary Axis. A rotary axis must be specified in order to perform cylindrical mapping. Specified (G107).</td>
</tr>
<tr>
<td>396</td>
<td>Invalid G107 Rotary Axis Specified. The rotary axis specified is not a valid axis, or has been disabled.</td>
</tr>
<tr>
<td>397</td>
<td>Aux Axis In G93 Block. This alarm is generated if a G-code block specifies any form of interpolated motion that involves BOTH one or more of the regular axes (X, Y, Z, A, B, etc...) AND one or more of the auxiliary axes (C, U, V, W).</td>
</tr>
<tr>
<td>398</td>
<td>Aux Axis Servo Off. Aux. axis servo shut off due to a fault.</td>
</tr>
<tr>
<td>400</td>
<td>Skip Signal During Restart. A skip signal G-code (G31, G35, G36, G37, G136) was found during program restart.</td>
</tr>
<tr>
<td>403</td>
<td>RS-232 Too Many Progs. Cannot have more than 200 programs in memory.</td>
</tr>
<tr>
<td>404</td>
<td>RS-232 No Program Name. Need name in programs when receiving ALL; otherwise has no way to store them.</td>
</tr>
<tr>
<td>405</td>
<td>RS-232 Illegal Prog Name. Check files being loaded. Program name must be Onnnnn and must be at beginning of a block.</td>
</tr>
<tr>
<td>406</td>
<td>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.</td>
</tr>
<tr>
<td>407</td>
<td>RS-232 Invalid Code. Check your program. The program will be stored but the bad data is turned into a comment.</td>
</tr>
<tr>
<td>408</td>
<td>RS-232 Number Range Error. Check your program. The program will be stored but the bad data is turned into a comment.</td>
</tr>
<tr>
<td>409</td>
<td>RS-232 Invalid N Code. Bad Parameter or Setting data. User was loading settings or parameters and something was wrong with the data.</td>
</tr>
<tr>
<td>410</td>
<td>RS-232 Invalid V Code. Bad parameter or setting data. User was loading settings or parameters and something was wrong with the data.</td>
</tr>
<tr>
<td>411</td>
<td>RS-232 Empty Program. Check your program. Between % and % there was no program found.</td>
</tr>
<tr>
<td>412</td>
<td>RS-232 Unexpected End of Input. Check Your Program. An ASCII EOF code was found in the input data before program receive was complete. This is a decimal code 26.</td>
</tr>
<tr>
<td>413</td>
<td>RS-232 Load Insufficient Memory. Program received does not fit. Check the space available in the LIST PROG mode and possibly delete some programs.</td>
</tr>
<tr>
<td>Alarm Code</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
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</tbody>
</table>
| 414        | RS-232 Buffer Overflow
Data sent too fast to CNC. This alarm is not normally possible as this control can keep up with 115200 bits per second. Computer sending data may not respond to X-OFF. |
| 415        | RS-232 Overrun
Data sent too fast to CNC. This alarm is not normally possible as this control can keep up with 115200 bits per second. |
| 416        | RS-232 Parity Error
Data received by CNC has bad parity. Check parity settings, number of data bits and speed. Also check your wiring. |
| 417        | RS-232 Framing Error
Data received was garbled and proper framing bits were not found. One or more characters of the data will be lost. Check parity settings, number of data bits and speed. |
| 418        | RS-232 Break
Break condition while receiving. The sending device set the line to a break condition. This might also be caused by a simple break in the cable. |
| 419        | Invalid Function For DNC
A code found on input of a DNC program could not be interpreted. |
| 420        | Program Number Mismatch
The O code in the program being loaded did not match the O code entered at the keyboard. Warning only. |
| 421        | No Valid Pockets
Pocket Table is full of dashes. |
| 422        | Pocket Table Error
If the machine is equipped with a 50 taper spindle there must be 2 dashes between L's (large tools). L's must be surrounded by dashes. |
| 429        | Disk Dir Insufficient Memory
Disk memory was almost full when an attempt was made to read the disk directory. |
| 430        | Disk Unexpected End of Input
Check your program. An ASCII EOF code was found in the input data before program receive was complete. This is a decimal code 26. |
| 431        | Disk No Prog Name
Need name in programs when receiving ALL; otherwise has no way to store them. |
| 432        | Disk Illegal Prog Name
Check files being loaded. Program must be Onnnnn and must be at the beginning of a block. |
| 433        | Disk Empty Prog Name
Check your program. Between % and % there was no program found. |
| 434        | Disk Load Insufficient Memory
Program received does not fit. Check the space available in the LIST PROG mode and possibly delete some programs. |
| 435        | Disk Abort
Could not read disk. |
| 436        | Disk File Not Found
Could not find disk file. |
| 501        | Too Many Assignments In One Block
Only one assignment macro assignment is allowed per block. Divide block into multiple blocks. |
| 502        | [ Or = Not First Term In Exppressn
An expression element was found where it was not preceded by “[” or “=”, that start expressions. |
| 503        | Illegal Macro Variable Reference
A macro variable number was used that is not supported by this control, use another variable. |
| 504        | Unbalanced Brackets In Expression
Unbalanced brackets, “[” or “]”, were found in an expression. Add or delete a bracket. |
505 Value Stack Error  The macro expression value stack pointer is in error. Call your dealer.

506 Operand Stack Error  The macro expression operand stack pointer is in error. Call your dealer.

507 Too Few Operands On Stack  An expression operand found too few operands on the expression stack. Call your dealer.

508 Division By Zero  A division in a macro expression attempted to divide by zero. Reconfigure expression.

509 Illegal Macro Variable Use  See "MACROS" section for valid variables.

510 Illegal Operator or Function Use  See "MACROS" section for valid operators.

511 Unbalanced Right Brackets  Number of right brackets not equal to the number of left brackets.

512 Illegal Assignment Use  Attempted to write to a read-only macro variable.

513 Var. Ref. Not Allowed With N Or O  Alphabetic addresses N and O cannot be combined with macro variables. Do not declare N#1, etc.

514 Illegal Macro Address Reference  A macro variable was used incorrectly with an alpha address. Same as 513.

515 Too Many Conditionals In a Block  Only one conditional expression is allowed in any WHILE or IF-THEN block.

516 Illegal Conditional Or No Then  A conditional expression was found outside of an IF-THEN, WHILE, or M99 block.

517 Exprsn. Not Allowed With N Or O  A macro expression cannot be linked to N or O. Do not declare O[#1], etc.

518 Illegal Macro Exprsn Reference  An alpha address with expression, such as A[#1+#2], evaluated incorrectly. Same as 517.

519 Term Expected  In the evaluation of a macro expression, an operand was expected and not found.

520 Operator Expected  In the evaluation of a macro expression an operator was expected and not found.

521 Illegal Functional Parameter  An illegal value was passed to a function, such as SQRT[ or ASIN[.

522 Illegal Assignment Var Or Value  A variable was referenced for writing. The variable referenced is read only.

523 Conditional Req'd 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.
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<th>Details</th>
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<td>Parameter Precedes G65</td>
<td>On G65 lines all parameters must follow the G65 G-code. Place parameters after G65.</td>
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<tr>
<td>529</td>
<td>Illegal G65 Parameter</td>
<td>The addresses G, L, N, O, and P cannot be used to pass parameters.</td>
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<tr>
<td>530</td>
<td>Too Many I, J, or K's In G65</td>
<td>Only 10 occurrences of I, J, or K can occur in a G65 subroutine call. Reduce the I, J, or K count.</td>
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<tr>
<td>531</td>
<td>Macro Nesting Too Deep</td>
<td>Only four levels of macro nesting can occur. Reduce the amount of nested G65 calls.</td>
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<tr>
<td>532</td>
<td>Unknown Code In Pocket Pattern</td>
<td>Macro syntax is not allowed in a pocket pattern subroutine.</td>
</tr>
<tr>
<td>533</td>
<td>Macro Variable Undefined</td>
<td>A conditional expression evaluated to an UNDEFINED value, i.e. #0. Return True or False.</td>
</tr>
<tr>
<td>534</td>
<td>DO Or END Already In Use</td>
<td>Multiple use of a DO that has not been closed by and END in the same subroutine. Use another DO number.</td>
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<tr>
<td>535</td>
<td>Illegal DPRNT Statement</td>
<td>A DPRNT statement has been formatted improperly, or DPRNT does not begin block.</td>
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<tr>
<td>536</td>
<td>Command Found On DPRNT Line</td>
<td>A G-code was included on a DPRNT block. Make two separate blocks.</td>
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<td>537</td>
<td>RS-232 Abort On DPRNT</td>
<td>While a DPRNT statement was executing, the RS-232 communications failed.</td>
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<tr>
<td>538</td>
<td>Matching END Not Found</td>
<td>A WHILE-DO statement does not contain a matching END statement. Add the proper END statement.</td>
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<td>539</td>
<td>Illegal Goto</td>
<td>Expression after GOTO not valid.</td>
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<tr>
<td>540</td>
<td>Macro Syntax Not Allowed</td>
<td>A section of code was interpreted by the control where macro syntax is not permitted.</td>
</tr>
<tr>
<td>541</td>
<td>Macro Alarm</td>
<td>This alarm was generated by a macro command in a program.</td>
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<tr>
<td>600</td>
<td>U Over Travel Range</td>
<td>Same as alarm 316.</td>
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<tr>
<td>601</td>
<td>V Over Travel Range</td>
<td>Same as alarm 316.</td>
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<tr>
<td>602</td>
<td>W Over Travel Range</td>
<td>Same as alarm 316.</td>
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<tr>
<td>603</td>
<td>U Limit Switch</td>
<td>Same as alarm 145.</td>
</tr>
<tr>
<td>604</td>
<td>V Limit Switch</td>
<td>Same as alarm 145.</td>
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<tr>
<td>605</td>
<td>W Limit Switch</td>
<td>Same as alarm 145.</td>
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<tr>
<td>609</td>
<td>U Servo Error Too Large</td>
<td>Same as alarm 103.</td>
</tr>
<tr>
<td>610</td>
<td>V Servo Error Too Large</td>
<td>Same as alarm 103.</td>
</tr>
<tr>
<td>611</td>
<td>W Servo Error Too Large</td>
<td>Same as alarm 103.</td>
</tr>
<tr>
<td>612</td>
<td>U Servo Overload</td>
<td>Same as alarm 108.</td>
</tr>
<tr>
<td>613</td>
<td>Command Not Allowed In Cutter Comp.</td>
<td>A command (M96, for example) in the highlighted block cannot be executed while cutter comp. Is invoked.</td>
</tr>
<tr>
<td>614</td>
<td>V Servo Overload</td>
<td>Same as alarm 108.</td>
</tr>
<tr>
<td>615</td>
<td>W Servo Overload</td>
<td>Same as alarm 108.</td>
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</tbody>
</table>
Service Manual

ALARMS

June 2002

616 U Motor Over Heat  Same as alarm 135.
617 V Motor Over Heat  Same as alarm 135.
618 W Motor Over Heat  Same as alarm 135.
619 U Motor Z Fault  Same as alarm 139.
620 C Axis Disabled  Parameters have disabled this axis
621 C Over Travel Range  C-axis will exceed stored limits. This is a parameter in negative direction and is machine zero in the positive direction. This will only occur during the operation of a user's program.

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

622 Tool Arm Fault  This alarm supports the side mount tool changers. It is generated if the arm is not at the Origin position, or the arm motor is already on when a tool change process is started.
623 Side Mount Carousel Error  This alarm supports the side mount tool changers. It is generated if the carousel motor is still on when the tool pocket is unlocked and lowered prior to a tool change.
624 Invalid Tool  This alarm is generated by a side mount tool changer if the tool specified by the G-code program is not found in the POCKET-TOOL table, or the searching pocket is out of range.
625 Carousel Positioning Error  This alarm is generated by a side mount tool changer if conditions are not correct when:
- The carousel or tool arm was started and one or more of the following incorrect conditions existed:
  - The carousel or arm motor already on, arm not at Origin, tool carousel not at TC mark.
  - The tool carousel was in motion and Tool One Mark was detected but the current pocket facing the spindle was not at pocket one, or the current pocket was at pocket one but Tool One Mark was not detected.
626 Tool Pocket Slide Error  This alarm is generated by a side mount tool changer. It is generated if the tool pocket has not moved to its commanded position (and settled) within the total time allowed by parameters 306 and 62.
627 ATC Arm Position Timeout  This alarm supports the side mount tool changers. It is generated if the tool arm has not moved after the allowed time or has not stopped after the allowed time. Refer to Parameter 309 MOTOR COAST TIME.
628 ATC ARM Positioning Error  This alarm supports the side mount tool changers. It is generated if:
- The arm was being moved from the ORIGIN position to the CLAMP position and it coasted past the MOTOR STOP point or could not get to the CLAMP point.
- The arm was being moved from the CLAMP position to the UNCLAMP position and it coasted past the MOTOR STOP point or could not get to the UNCLAMP point (same physical point as CLAMP).
- The arm was being moved back to the ORIGIN position and it coasted past the MOTOR STOP point or could not get to the ORIGIN point.
629 Carousel Position Timeout

This alarm supports the side mount tool changers. It is generated if the tool carousel has not moved after the allowed time or has not stopped after the allowed time specified by parameter 60 TURRET START DELAY and parameter 61 TURRET STOP DELAY, respectively.

630 Apc-door Sw Fault-switch Not Equal To Solenoid

The APC Door Switch indicates the door is open but the solenoid shows the door has been commanded to close. Either the door failed to close and is stuck or the switch itself is broken or stuck. Also, the door switch wiring may have a fault. Check switch then cable. After correcting the condition, run an M50 to continue machining.

631 APC-Pallet Not Clamped or Home

DO NOT ATTEMPT TO MOVE X OR Y AXES OF MILL UNTIL APC IS IN SAFE CONDITION. CAUTION—The APC is not in a safe operating condition. One pallet is at home but the other pallet is neither clamped nor at home. Locate the unclamped pallet and return to home if possible. If drive pin is engaged or pallet is partially clamped, go to the lub/air panel at rear of mill and continuously press both white buttons in center of solenoid air valves while assistant pulls the pallet off the receiver. After correcting the condition, run an M50 to continue machining.

632 APC-Unclamp Error

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

633 APC-Clamp Error

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

634 APC-Mislocated Pallet

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

635 APC PAL num Conflict Rec and CH

The pallet number conflict receiver and Pallet changer: The pallet number in memory does not agree with the actual pallet in use. Run an M50 to reset this variable.

636 APC-Switch Missed Pal 1

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

637 APC-Switch Missed Pal 2

Pallet #2 did not return from the receiver to the APC in the allowable amount of time. This can be caused by the chain switch block missing the limit switch, or from another mechanical problem, such as clutch slippage. After correcting the condition, run an M50 to continue machining.
638 APC-Door Not Open
The automatic door did not open (in the allowable time), or may have fallen during an APC function. This can be caused by a bad air solenoid, a blocked or kinked air line, or a mechanical problem. After correcting the condition, run an M50 to continue machining.

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

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

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

642 APC-Incorrect Chain Location
Chain not in position to load or unload pallets when necessary. To correct this, the mislocated pallet must be moved back into the proper position by hand. After correcting the condition, run an M50 to continue machining.

643 RP-Index Station Unlocked...
The index station is not in the correct orientation for a pallet change or the front doors are open. Check whether the handle is in the fully up position, close the front doors, check the function of the front door switches. After correcting the condition, the M50 must be re-run to continue machining.

644 RP-Pallet Changer Will Not Raise...
The pallet did not begin to lift within a reasonable time after command, or did not complete lifting within a reasonable time. Verify air supply to the pallet changer valve assembly, verify proper adjustment of the lift cylinder regulator (40 PSI), verify the function of the lift cylinder air valve and solenoid, verify the operation of the lift cylinder position sense switches. After correcting the condition, run an M50 to continue machining.

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

646 RP-CW/CCW Switch Illegal Condition
Both of the switches that sense the rotational position of the pallet changer are indicating the impossible condition that the pallet changer is rotated CW and CCW at the same time. Only one switch should be tripped at a time. Check the function of the rotational sense switches, their connectors, and their wiring. After correcting the condition, run an M50 to continue machining.
647 RP-UP/DOWN Switch Illegal Condition, Lift Cylinder
The switches that sense the lifted and lowered position of the pallet changer are indicating the impossible condition that the pallet changer is both lifted and lowered at the same time. Check the function of the lift and lower sense switches, check the adjustment of the top switch, check both switch electrical connections and their wiring. After correcting the condition, run an M50 to continue machining.

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

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

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

651 Z Axis Is Not Zeroed
The Z-axis has not been zeroed. In order to continue the Toolchanger Recovery the Z-axis must be zeroed. Once the Z-axis has been zeroed, continue with the Toolchanger Recovery.

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

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

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

655 U CABLE FAULT
Same as alarm 182.

656 V CABLE FAULT
Same as alarm 182.

657 W CABLE FAULT
Same as alarm 182.

658 U PHASING ERROR
Same as alarm 217.
<table>
<thead>
<tr>
<th>Alarm Number</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>659</td>
<td>V PHASING ERROR</td>
<td>Same as alarm 217.</td>
</tr>
<tr>
<td>660</td>
<td>W PHASING ERROR</td>
<td>Same as alarm 217.</td>
</tr>
<tr>
<td>661</td>
<td>U TRANSITION FAULT</td>
<td>Same as alarm 224.</td>
</tr>
<tr>
<td>662</td>
<td>V TRANSITION FAULT</td>
<td>Same as alarm 224.</td>
</tr>
<tr>
<td>663</td>
<td>W TRANSITION FAULT</td>
<td>Same as alarm 224.</td>
</tr>
<tr>
<td>664</td>
<td>U AXIS DISABLED</td>
<td>Same as alarm 336.</td>
</tr>
<tr>
<td>665</td>
<td>V AXIS DISABLED</td>
<td>Same as alarm 336.</td>
</tr>
<tr>
<td>666</td>
<td>W AXIS DISABLED</td>
<td>Same as alarm 336.</td>
</tr>
<tr>
<td>667</td>
<td>U AXIS LINEAR SCALE Z FAULT</td>
<td>Same as alarm 279.</td>
</tr>
<tr>
<td>668</td>
<td>V AXIS LINEAR SCALE Z FAULT</td>
<td>Same as alarm 279.</td>
</tr>
<tr>
<td>669</td>
<td>W AXIS LINEAR SCALE Z FAULT</td>
<td>Same as alarm 279.</td>
</tr>
<tr>
<td>670</td>
<td>TT OVER TRAVEL RANGE</td>
<td>Same as alarm 316.</td>
</tr>
<tr>
<td>671</td>
<td>TT LIMIT SWITCH</td>
<td>Same as alarm 145.</td>
</tr>
<tr>
<td>672</td>
<td>TT SERVO ERROR TOO LARGE</td>
<td>Same as alarm 103.</td>
</tr>
<tr>
<td>673</td>
<td>TT SERVO OVERLOAD</td>
<td>Same as alarm 108.</td>
</tr>
<tr>
<td>674</td>
<td>TT MOTOR OVER HEAT</td>
<td>Same as alarm 135.</td>
</tr>
<tr>
<td>675</td>
<td>TT MOTOR Z FAULT</td>
<td>Same as alarm 273.</td>
</tr>
<tr>
<td>676</td>
<td>TT AXIS Z CH MISSING</td>
<td>Same as alarm 275.</td>
</tr>
<tr>
<td>677</td>
<td>TT AXIS DRIVE FAULT</td>
<td>Same as alarm 161.</td>
</tr>
<tr>
<td>678</td>
<td>TT ZERO RET MARGIN TOO SMALL</td>
<td>Same as alarm 168.</td>
</tr>
<tr>
<td>679</td>
<td>TT CABLE FAULT</td>
<td>Same as alarm 182.</td>
</tr>
<tr>
<td>680</td>
<td>TT PHASING ERROR</td>
<td>Same as alarm 217.</td>
</tr>
<tr>
<td>681</td>
<td>TT TRANSITION FAULT</td>
<td>Same as alarm 224.</td>
</tr>
<tr>
<td>682</td>
<td>TT AXIS DISABLED</td>
<td>Same as alarm 336.</td>
</tr>
<tr>
<td>683</td>
<td>TT AXIS LINEAR SCALE Z FAULT</td>
<td>Same as alarm 279.</td>
</tr>
<tr>
<td>684</td>
<td>V MOTOR Z FAULT</td>
<td>Same as alarm 273.</td>
</tr>
<tr>
<td>685</td>
<td>W MOTOR Z FAULT</td>
<td>Same as alarm 273.</td>
</tr>
<tr>
<td>686</td>
<td>U MOTOR Z FAULT</td>
<td>Same as alarm 273.</td>
</tr>
<tr>
<td>687</td>
<td>U AXIS Z CH MISSING</td>
<td>Same as alarm 275.</td>
</tr>
<tr>
<td>688</td>
<td>V AXIS Z CH MISSING</td>
<td>Same as alarm 275.</td>
</tr>
<tr>
<td>689</td>
<td>W AXIS Z CH MISSING</td>
<td>Same as alarm 275.</td>
</tr>
<tr>
<td>690</td>
<td>U AXIS DRIVE FAULT</td>
<td>Same as alarm 161.</td>
</tr>
<tr>
<td>691</td>
<td>V AXIS DRIVE FAULT</td>
<td>Same as alarm 161.</td>
</tr>
</tbody>
</table>
693  W AXIS DRIVE FAULT  Same as alarm 161.

694  ATC SWITCH FAULT  Conflicting switch states detected, such as shuttle at spindle and shuttle at chain simultaneously. Check for damaged or sticking switches, damaged wiring, or debris build up.

695  ATC AIR CYLINDER TIME OUT  The ATC double arm did not complete extending or retracting within the time allowed by Parameter 61. Check for proper spindle orientation, correct alignment of the double arm with the chain or spindle, adequate air supply, mechanism binding, air leakage, excessive tool weight, debris build up, adequate chain tension, and correct chain guide strip adjustment. Use tool changer restore to recover the ATC, then resume normal operation.

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

697  ATC MOTOR FAULT  The ATC shuttle motor or double arm motor was on unexpectedly. Use tool changer restore to recover the ATC, then resume normal operation.

698  ATC PARAMETER ERROR  The ATC type cannot be determined. Check Parameter 278, bit 10, HS3 HYD TC, or Parameter 209, bit 2, CHAIN TC, as appropriate for the installed tool changer.

900  Par No xxx Has Changed. Old Value Was xxx.
    When the operator alters the value of a parameter, alarm 900 will be added to the alarm history. When the alarm history is displayed, the operator will be able to see the parameter number and the old value along with the date and time the change was made. Note that this is not a resetable alarm, it is for information purposes only.

901  Parameters Have Been Loaded By Disk
    When a file has been loaded from floppy disk, alarm 901 will be added to the alarm history along with the date and time. Note that this is not a resetable alarm, it is for information purposes only.

902  Parameters Have Been Loaded By RS-232
    When a file has been loaded from RS-232, alarm 902 will be added to the alarm history along with the date and time. Note that this is not a resetable alarm, it is for information purposes only.

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

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

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

906  INVALID P CODE IN M14, M15, M36
    The P code must be the pallet number of a valid pallet without a decimal point, and must be a valid integer number.
907 APC-SWITCH MISSED PAL 3  Pallet #3 did not return from the receiver to the APC in the allowable amount of time. This can be caused by the chain switch block missing the limit switch, or from another mechanical problem, such as clutch slippage.

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

909 APC-PROGRAM NOT LISTED  The control attempted to run a program that is not listed in the Pallet Schedule Table. To run the program enter the program name into the Pallet Schedule Table, column Program Number, for the pallet you want to operate on. Verify that the program and the pallet are compatible.

910 APC-PROGRAM CONFLICT  The current program is not assigned to the loaded pallet in the Pallet Schedule Table. To run the program enter the program name into the Pallet Schedule Table, column Program Number, for the pallet you want to operate on. Verify that the program and the pallet are compatible.

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

912 ATC-NO P CODE OR Q CODE FOR M46  M46 must have a P code and a Q code. The P code must be the name of a program stored in memory. The Q code is the number of the pallet to run the program on.

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

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

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

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

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

The following alarms only apply to horizontal mills with a pallet changer:

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

1002 Pallet Locked Down  The pallet did not begin to lift within two seconds of command, or did not complete lifting within six seconds.
<table>
<thead>
<tr>
<th>Alarm Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1003</td>
<td>Pallets Jammed</td>
</tr>
<tr>
<td>1004</td>
<td>CW/CCW Switch Illegal Condition</td>
</tr>
<tr>
<td>1007</td>
<td>Up/Down Switch Illegal Condition</td>
</tr>
<tr>
<td>1008</td>
<td>Main Drawbar Locked In Up Position</td>
</tr>
<tr>
<td>1009</td>
<td>Main Drawbar Locked In Down Position</td>
</tr>
<tr>
<td>1010</td>
<td>Main Drawbar Switch Illegal Condition</td>
</tr>
<tr>
<td>1011</td>
<td>Main Drawbar Unclamp Timeout</td>
</tr>
<tr>
<td>1012</td>
<td>Main Drawbar Clamp Timeout</td>
</tr>
</tbody>
</table>

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

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

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

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

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

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

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

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

RECOMMENDED TORQUE VALUES FOR MACHINE FASTENERS

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

<table>
<thead>
<tr>
<th>DIAMETER</th>
<th>TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 - 20</td>
<td>15 ft. lb.</td>
</tr>
<tr>
<td>5/16 - 18</td>
<td>30 ft. lb.</td>
</tr>
<tr>
<td>3/8 - 16</td>
<td>50 ft. lb.*</td>
</tr>
<tr>
<td>M10 - 100</td>
<td>50 ft. lb.</td>
</tr>
<tr>
<td>M12 - 65</td>
<td>100 ft. lb.</td>
</tr>
<tr>
<td>1/2 - 13</td>
<td>80 ft. lb.</td>
</tr>
<tr>
<td>3/4 - 10</td>
<td>275 ft. lb.</td>
</tr>
<tr>
<td>1 - 8</td>
<td>450 ft. lb.</td>
</tr>
</tbody>
</table>

* 3/8-16 SHCS used on tool release piston torqued to 35 ft. lb.

3.1 HEAD COVERS REMOVAL / INSTALLATION

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

REMOVAL -

NOTE: This procedure is for the VF-3/4. However, the procedure varies only slightly for other models.

1. Zero return (ZERO RET) all axes, then HANDLE JOG to center X- and Y-axes under spindle. Protect table surface with a piece of cardboard.

2. Remove the top and rear covers.

Figure 3.1-1 View of VF-3/4 head covers.
3. Pull front cover from the bottom until you can disconnect the tool release cable (quick disconnect), then remove cover.

4. Remove the side covers. Jog Z-axis as necessary to make screw removal easier.

**INSTALLATION -**

1. Protect table surface with a piece of cardboard.

2. Replace each side cover from the top. Jog Z-axis as necessary to make access to screws easier.

3. Reconnect tool release cable, if equipped, then replace front cover from the bottom.

4. Replace rear cover and top cover.
3.2 Tool Release Piston (TRP) Assembly

Please read this section in its entirety before attempting to replace tool release piston assembly.

Overview

The Tool Release Piston is actuated by air. It forces the Tool Draw Bar down against the spring stack, releasing the old tool and permitting the new tool to be inserted. Normally the piston is in the upper, retracted position. During a tool change cycle the piston is forced down by air pressure, pushing the draw bar down until the pull stud on the top of the tool is released.

As the piston finishes its downward stroke a hole in the side of the Tool Release Shaft comes clear of the Cylinder Housing and is exposed to the compressed air within the cylinder. The air flows down through the Shaft to the Tool Release Nut at the lower end of the shaft. This nut presses on the end of the Tool Draw Bar and the air flows through a central hole drilled through both the Tool Release Nut and the Tool Drawbar to blow any chips out of the tapered area of the Spindle Shaft.

The Spring Retainer captures the compression spring that returns the Tool Change Piston and Shaft to the normal position when the air is released from the cylinder. The Upper and Lower Limit Switches are actuated by the Spring Retainer. The position of these switches is monitored by the computer control system during the tool change cycle.

There is different tool release piston for the 40 and 50 taper spindles. In addition The tool change pistons have different subassemblies that will need to be adjusted, or may need replacing. The section(s) that follow the installation instructions must be completed as well or serious damage to the machine could result.

40 Taper Spindle TRP Removal

1. If machine is equipped with Through the Spindle Coolant (TSC), place a tool holder in the spindle.
2. Remove cover panels from the headstock area.
3. Remove the four 3/8-16 x 1¾" SHCS holding the tool release piston assembly to the head casting.
4. Disconnect the air line at the lube/air panel.
5. Disconnect the clamp/unclamp cables (quick disconnect) and the assembly’s solenoid wiring located on the solenoid bracket.
6. Remove the tool release air hose and precharge hose at the fitting shown in Fig. 3.2-1 If machine is equipped with TSC, also remove the coolant hose.
7. Remove entire tool release piston assembly.

NOTE: Steps 8 and 9 apply only to machines with TSC.

8. Remove the drain and purge lines from the seal housing.
9. Remove the seal housing from the TRP.
Figure 3.2-1 Tool Release Piston with Optional TSC fitting.

Figure 3.3-2 Mounting location for tool release piston assembly.
**40 Taper Spindle TRP Installation**

The following sections must be completed after installation:

- Set Pre-Charge
- Adjust the Tool Clamp/Unclamp Switches
- Set the Drawbar Height

1. Ensure drive belt has been properly replaced as described in "Belt Assembly" section.

2. Verify spindle sweep adjustment is correct (as shown in "Spindle Assembly" section) before proceeding. If not correct, re-shim as necessary.

3. Reinstall tool release piston assembly loosely if the machine is equipped with TSC. Otherwise tighten the four mounting bolts securely.

4. Reconnect the air hoses at the applicable fittings on the tool release piston assembly.

5. Reconnect the clamp/unclamp cables and solenoid wire to the sides of the solenoid bracket.

6. Connect the 5/32” drain line and 5/32” purge line to the seal housing and install the seal housing on the TRP (use Loctite on the screws). The drain line connector should point toward the rear of the machine.

   **NOTE:** The drain line must run straight through the cable clamp guide on the transmission, and must not interfere with the pulley or belts.

   **NOTE:** Steps 6, 7 and 8 apply only to machines with TSC.

7. Apply precharge pressure several times to allow the seal to center itself with the drawbar. While holding down precharge, tighten the bolts.

8. Install the coolant hose. A wrench must be used, tighten snug. **Do not overtighten!!**

9. Adjust the clamp/unclamp switches in accordance with the appropriate section.

**Setting Pre-Charge**

   **NOTE:** Do not perform this procedure on machines equipped with Through the Spindle Coolant (TSC). It will damage the machine. Refer to the "Precharge Regulator Adjustment" section and perform those adjustments.

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

   **NOTE:** At "0" pressure on the precharge regulator, the adjustment knob is out as far as it will turn.
11. Ensure Parameter 149, Precharge DELAY, is set to 300. If not, set it at this time.

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

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

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

14. Replace the head covers.

**Tool Clamp/Unclamp Switch Adjustment - Initial Preparation**

Please read this section in its entirety before adjusting clamp/unclamp switches or setting drawbar height.

**TOOLS REQUIRED**

- Machined aluminum block (2" x 4" x 4")
- 6" flexible ruler or .020" shim
- 1" diameter pipe (approx. 1' long)

1. Remove cover panels, as described in "Head Covers Removal".

2. Place a sheet of paper under the spindle for table protection, then place a machined block of aluminum (approximately 2" x 4" x 4") on the paper.
3. Power on the VMC.

4. Insert a tool holder WITHOUT ANY TYPE OF CUTTER into the spindle taper.

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

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

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

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

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

1. Press MDI and turn hand wheel to zero (0).

2. Press HANDLE JOG button and set increments to .01. Jog the Z-axis in the positive (+) direction 0.100".

3. Press and hold the TOOL RELEASE button, grasp the block and try to move it. The block should be tight at .100 and loose at .110. If block moves at .100, jog the Z-axis in the negative (-) direction one increment at a time. Press the TOOL RELEASE button and check for movement between increments until block is tight.

   **NOTE:** The increments jogged in the Z negative (-) direction are the amount of shim washers that must be added to the tool release bolt (or coolant tip for TSC). Refer to the "Shim Washers" section.

4. If the block is tight at .110, move the Z-axis in the positive (+) direction one increment at a time. Press the TOOL RELEASE button and check movement between increments until block is loose. The increments jogged in the Z positive (+) direction are the amount of shim washers that must be removed. (Refer to the "Shim Washers" section).

**Shim Washers**

1. To add or subtract shim washers, remove tool release piston assembly ("Tool Release Piston" section) from head casting.

2. Check the condition of the tool release coolant tip and the draw bar. Repair or replace these items before setting the drawbar height.

   **NOTE:** Shims may need to be added or removed when spindle cartridge, tool release piston assembly, or drawbar is replaced. If none have been replaced, skip this section.

![Figure 3.2-5 Tool release piston assembly (TSC shown).](image)
3. Remove tool release bolt. If machine is equipped with TSC, loosen the three set screws and remove the TSC coolant tip.

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

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

6. Install tool release piston assembly in accordance with the "Tool Release Piston - Installation" section and recheck settings. If within specifications, continue; if not, readjust.

**Adjustment of Switches**

**Lower (Unclamp) Switch -**

1. Drawbar height must be set properly before adjusting switches. Add or subtract shim washers to the tool release piston until proper height is achieved.

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

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

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

5. Press the tool release button and hold it in. Adjust the switch in or out until the switch just trips (DB OPN =1).
6. Check the adjustment. The switch must trip (DB OPN =1) at 0.06" above the block and not trip (DB OPN =0) at 0.05" above the block.

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

8. Set the pressure regulator back to 85PSI.

**UPPER (CLAMP) SWITCH -**

1. Remove the tool holder from the spindle.

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

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

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

5. Press CYCLE START.

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

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

Checking with the 0.04" shim assures that the switch is not backed off too far. If switch is all the way in, this check is not needed.

![Figure 3.2-7 Placement of shim before checking switch adjustment.](image-url)
50 Taper Spindle TRP Removal

1. For TSC equipped machines, place a tool holder in the spindle.

2. Remove cover panels from the headstock area in accordance with "Head Covers Removal and Installation".

3. For TSC equipped machines the rotary union and extension tube must be removed before proceeding. They both have left handed threads.

4. Disconnect the air line at the lube/air panel.

5. Disconnect the clamp/unclamp cables (quick disconnect) and the assembly’s solenoid wiring located on the solenoid bracket.

6. Remove the three tool release air hoses.

7. Remove the four shoulder screws holding the tool release piston assembly to the head casting. Make sure to keep all the washers and shims.

8. Remove entire tool release piston assembly, by sliding it forward then lifting it upward. The assembly is heavy so use great care when removing it.

TRP Disassembly

1. Loosen the shaft clamp and remove. It may be necessary to use a punch and mallet to break the clamp loose.

2. Remove the switch trip and compression spring.

3. Remove the 50T upper spacer.

4. Push the TRP shaft down.

5. Remove the 8 bolts holding the TRP assembly together.

6. Separate and remove the upper half of the housing.

7. Remove the upper TRP piston.

8. Remove the lower half of the TRP housing.

9. Remove the TRP lower spacer.

10. Remove the lower TRP 50T piston.

11. Remove the TRP sub plate.
O' Ring Replacement

1. Remove and replace the 4 O'rings (57-0027) on the TRP 50T shaft.
2. Remove and replace the 2 O'rings (57-0092) on the TRP 50T piston, 1 O'ring per piston.
3. Remove and replace the 3 O'rings (57-0095). 2 in the center of the TRP 50T housings and 1 in the center of the TRP 50T sub plate.

TRP Assembly

1. Place the TRP sub plate over the TRP shaft.
2. Place the lower TRP piston, grooved side up, over the TRP shaft.
3. Place the TRP lower spacer over the TRP shaft.
4. Place the lower TRP housing over the TRP shaft.
5. Place the upper TRP piston, grooved side up, over the TRP shaft.
6. Place upper TRP housing over the TRP shaft.
7. Replace the 8 bolts holding the TRP assembly together. Pattern torque to 100 ft. lbs.
8. Place the TRP upper spacer over the TRP shaft.
9. Push the TRP shaft up from the bottom, using the mallet handle. The shaft will bottom out with approximately 1/4” of the shaft still showing.
10. Place the switch trip and compression spring over the TRP shaft.
11. Tighten the shaft clamp on the TRP shaft, then the shaft clamp locking bolt.

50 Taper Spindle TRP Installation

The following sections must be completed after installation:

• Tool Push-Out Adjustment
• Setting TRP Switches
• Extension Tube Installation (if equipped with TSC)
1. Place the TRP on the machine. The TRP will rest on the spindle lift fork. **Caution:** Be careful of the spindle lift fork. Place the assembly toward the front of the machine before lowering it. The assembly is heavy so use great care when replacing it.

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

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>30-0013A (NEW)</th>
<th>30-0013 (OLD STYLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fork:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(45-0014)</td>
<td>0.010 Shim Washer</td>
<td>1 ea.</td>
<td>None</td>
</tr>
<tr>
<td>(45-0015)</td>
<td>0.018 Shim Washer</td>
<td>7 ea.</td>
<td>5 ea.</td>
</tr>
<tr>
<td>TRP</td>
<td>0.093 Nylon Washer</td>
<td>1 ea.</td>
<td>1 ea.</td>
</tr>
<tr>
<td>Spacers:</td>
<td>0.010 Shim Washer</td>
<td>1 ea.</td>
<td>1 ea.</td>
</tr>
<tr>
<td>(45-0017)</td>
<td>0.010 Shim Washer</td>
<td>2 ea.</td>
<td>2 ea.</td>
</tr>
<tr>
<td>(45-0018)</td>
<td>0.015 Shim Washer</td>
<td>3 ea.</td>
<td>2 ea.</td>
</tr>
</tbody>
</table>

**NOTE:** TRP Spacers: the nylon washer goes on top of the shims.

3. If the machine is equipped with TSC, re-install the Extension Tube and Rotating Union in the following manner. Otherwise, skip this step.

**NOTE:** If the Spindle, Drawbar or Extension Tube has been replaced the Extension Tube Runout **must** be adjusted.
a) Put a tool holder in the Spindle (this is absolutely required!).

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

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

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

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

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

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

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

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

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

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

4. Plug the 3 air hoses in the TRP.

5. Plug in the clamp and unclamp switches.

6. Set the main air regulator to 85 psi.

**NOTE:** Tool Push Out Adjustment and Setting TRP Switches must be completed.
TOOL PUSH OUT ADJUSTMENT

1. Put tool holder in spindle.

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

3. Jog Z-Axis down until tool holder is about 0.030 above the aluminum block. Switch to 0.001 increments. Jog down one increment at a time until no movement can be felt in the block. This is our zero point. Do not press the tool release button now, this can cause a Z-Axis overload!
4. The Tool Push-out adjustment is 0.060 +/-0.010. Add or remove shims from the tool release fork to make adjustments. The shims come in 0.010 and 0.018 thicknesses. Jog upward 0.060. Press and hold the tool release button, and feel for movement in the aluminum block.
   - If the block is tight when the button is pressed, shims may have to be ADDED to the tool release fork.
   - If the block is loose when the button is pressed, shims may have to be REMOVED from the tool release fork.
   (This is the opposite of 40 taper adjustment.)
   - If the aluminum block is tight at 0.060, release the button and jog the Z-Axis up 0.001 and press the tool release button again. Feel for movement in the aluminum block. Repeat this until movement is felt. Note the last position where the block was tight. If the position is 0.070 or more, add shims to the tool release fork.
   - If the aluminum block is loose at 0.060, jog the Z-Axis downward 0.001 at a time and check for movement in the aluminum block. If the position where the block becomes tight is 0.050 or less, remove shims from the tool release fork.

5. If shims were added to the TRP fork, add half that amount to the TRP spacers supporting the TRP. This will keep the two clearance gaps between the TRP and the rotating Spindle equal (approximately 0.095 each). If shims were removed from the TRP fork, remove half that number of shims from the TRP spacers.

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

Figure 3.2-11 TRP shim location
SETTING TRP SWITCHES

1. Setting the upper switch (Tool Clamped). Push the switch in slowly until it trips, then push it a little farther. Lock down the screws. Double-Check the switch by turning on the TRP a few times. The bit in the Diagnostics Page should always turn on (1) when the TRP is completely retracted.

2. Setting the lower switch (Tool Unclamped). Use the air pressure regulator on the back of the machine or an extra regulator placed in line.
   a) Jog the Z-Axis to 0.030 above the aluminum block.
   b) Put a jumper across the air switch to prevent a low pressure alarm.
   c) Back off the air pressure to around 65 psi (75 psi for old style TRP's).
   d) Press the tool release and check for movement in the aluminum block. Adjust the air pressure until the block is loose at 0.030 +/-0.005.
   e) While holding the Tool Release Button push the switch in until it just trips (the bit on the Diagnostics Page should change to “1”). Lock down the screws. Double-check the switch by turning the TRP on and off a few times.
   f) Back off the air pressure until the block is loose at 0.020 +/-0.005. Press the tool release button, the Tool Unclamped bit in Diagnostics should remain “0”. If not, repeat the above steps.

3. Restore air pressure to 85 psi and remove jumper.
**Coolant Union**

**CAUTION:** Do not remove pipe connectors from the coolant union!! Removing any pipe connector from the union will void your warranty on the union.

Use wrenches only on the SAE hose connector and the bottom nut of the Coolant Union. See arrows below:

---

**Coolant Union Removal**

1. Loosen the SAE hose connector at the Check Valve Assembly with a wrench (right arrow in diagram). Do not use a wrench on the pipe connector attached to the Coolant Union; the Union will be damaged and the Warranty voided.

2. Carefully cut off the clear plastic Drain Hose at the side of the Coolant Union. It is safest to use scissors or snips. Cut it close to the connector, since the hose will be re-used on the replacement union. Do not cut the Black coolant hose. (Note: If you are not replacing the Union, leave the Drain Hose attached to the union.)

3. Remove the coolant union from the Extension Tube (bottom arrow in diagram) using two wrenches (7/8 and 15/16). THIS IS A LEFT HAND THREAD.

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

**Coolant Union Installation**

1. Thread the Coolant Union onto the end of the Extension Tube (it has left hand threads). DO NOT USE LOCTITE. Tighten the threads snugly using two wrenches.

2. Attach the clear plastic Drain Hose to the barb connector on the side of the union. Use a hose clamp if one is available. The hose must travel downward (below the union) to drain off collected coolant. The union will be damaged if coolant collects inside the union.

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

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

1) Place a Tool Holder in the Spindle.
2) Remove the Rotating Union.
3) Remove the old Extension Tube (It has left hand threads).
4) Remove the Tool Release Piston, and lay it on its side with the air connectors facing up.
5) Insert a 5/8 Allen wrench into the lower end of the piston shaft. Loosen off the 1/4-20 screw in the clamp collar on top of the piston shaft. Insert a large flat blade screwdriver into the slot in the clamp collar, and twist the collar off.
6) Screw the Bearing Holder (20-7655) onto the piston shaft, and tighten using a large wrench or pliers.
7) Wipe clean the hole in the end of the Drawbar.
8) Replace the Tool Release Piston.
9) Apply a light layer of Molybdenum Grease to the inside of the Bearing Holder. Insert the Wave Spring (59-0176) into the Bearing Holder.
10) Lightly grease the O-Ring on the end of the Extension Tube Assy (30-1242). Apply blue Loctite to the thread on the end. Insert the Extension Tube down into the Drawbar. Tighten by hand as far as possible (It has left hand threads).

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

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

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

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

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

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

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

Belt Removal

NOTE: For easier removal, place transmission in high gear before beginning.

1. Remove cover panels from headstock area in accordance with "Head Covers Removal and Installation".

![Figure 3.3-1 Spindle head casting disconnect points.](image)

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

3. Remove the six SHCS holding the transmission to the head casting and pull the transmission forward enough (½" to ¾" max.) to allow the drive belt to be pulled upward over the spindle pulley.

**Note:** On direct drive machines, remove the four SHCS holding the mounting plate to the spindle head casting. Slide the assembly forward enough to allow the drive belt to be pulled up over the spindle pulley.
4. Remove the inspection cover from the bottom of the spindle head casting and carefully slide the drive belt between the sump tank and the web in the casting.

5. First, pull the belt up over the spindle pulley, then push the other end down to clear the shifter and pull out.

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

---

**Belt Installation**

1. Slide the replacement belt(s) under the sump tank and onto the pulley.

**NOTE:** DO NOT wrap the belts over the pulley. The pulley can be rather sharp, and may cut the belts. DO NOT bend or kink the belt in any way; damage to the fibers in the belt may result, and the belt will fail soon after installation.

2. Ensuring the belt is properly seated, push the transmission back, tightening the belt. Pull belt forward from rear of head casting. Pull belt over spindle pulley.

3. Tighten the drive belt in accordance with the following section.

4. Set the spindle orientation in accordance with appropriate section.

**NOTE:** The following step is necessary only if the spindle or transmission was exchanged prior to belt replacement.
5. Double-check the spindle sweep to assure that nothing has moved during the previous steps. If sweep is within tolerance, continue; if not, sweep must be readjusted.

**NOTE:** Drive belt tension must be adjusted after every installation.

---

**TENSION ADJUSTMENT**

**NOTE:** The drive belt tension should be adjusted after every service on the transmission or spindle of the machine.

1. Turn the machine ON. Jog the spindle head down to a level that will allow you to work on the drive belt comfortably.

2. Remove the cover panels from the head stock area as shown in "Head Covers Removal" section.

3. Remove the tool release piston assembly in accordance with appropriate section.

**FOR THE VF-1 THROUGH 9**

4. Loosen the six SHCS holding the transmission to the spindle head casting.

**NOTE:** Ensure the transmission is broken free by moving it slightly by hand.

5. Set the belt tension tool in place as shown in Figure 3.3-3. Mount it to the head casting by inserting the two SHCS into the two front TRP mounting holes. Tighten the SHCS finger tight.

6. Turn the handle until the tool is flat against the transmission casting.

**NOTE:** Ensure the transmission is straight, and not cocked, before tensioning belt.

7. Turn the handle until the edge of the tool’s plunger and the outer tube are flush. This will set the belt at the proper tension.

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

8. Check if the belt is too loose or too tight. If the belt is set too tight, the belt will whine excessively when the assembly is at speed; and if it is set too loose, it will vibrate during accelerations and decelerations.

9. With the tool still in place, tighten the six SHCS holding the transmission to the spindle head casting.

10. Loosen the two SHCS and remove the belt tension tool.
FOR DIRECT DRIVE MACHINES:

1. Loosen the four SHCS holding the motor mounting plate to the head casting.

   NOTE: Ensure the motor is broken free by moving it slightly by hand.

2. Set the belt tension tool in place as shown in Figure 3.3-3. Mount it to the head casting by inserting the two SHCS into the two front TRP mounting holes. Tighten the SHCS finger tight.

3. Turn the handle until the tool is flat against the motor mounting plate.

   NOTE: Ensure the motor is straight, and not cocked, before tensioning belt.

4. Turn the handle until the edge of the tool's plunger and the outer tube are flush, and then 1/2 turn more. This will set the belt at the proper tension.

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

5. Check if the belt is too loose or too tight. If the belt is set too tight, the belt will whine excessively when the assembly is at speed; and if it is set too loose, it will vibrate during accelerations and decelerations.

6. With the tool still in place, tighten the four SHCS holding the mounting plate to the head casting.

7. Loosen the two SHCS and remove the belt tension tool.

---

Figure 3.3-3 Belt tension tool.
3.4 Spindle Assembly

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

WARNING!

The current pulley is shrink-fitted onto the spindle and is not field-serviceable. It is identified by many holes on top of the spindle pulley. Should any attempt to remove the pulley damage the spindle or its components, the service warranty will be voided.

NOTE: The drive belt's tension should be adjusted after every transmission or spindle service.

Spindle Cartridge Removal

NOTE: VMCs equipped with a 15K Spindle must remove the spindle and drawbar as a unit. Do not remove the drawbar separately.

1. Ensure the VMC is ON. You will need to raise and lower the head stock to remove the spindle. Place the cardboard on the mill table to protect the surface.

2. Put the tool into the spindle.

3. Remove cover panels from head stock area as described in "Head Covers Removal" section.

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

5. Remove the spindle drive belt from the spindle pulley as shown in previous section. It is not possible to completely remove the belt at this time.

6. Drawbars are held in the spindle shaft by a spiral ring (newer assemblies). Remove the spiral ring with a small screwdriver. Wedge the tip of the screwdriver to take out one end of the ring from the shaft groove. Force the ring end to stay open and simultaneously rotate the screwdriver all the way around so the entire ring comes out of the groove.

7. Put the tool release piston on and remove the tool.

8. First disconnect the oil line from the fitting at the oil injection cover, then remove the brass fitting.

NOTE: When replacing a new design spindle in any vertical machine, it is important to note that the cavity between the housing and the spindle cartridge will be filled with either oil or grease. An oil filled spindle is identified by the oil fill hole to the left side of the spindle head near the spindle bore as viewed from the top.

9. Ensure oil plug is inserted into oil injection port of spindle before removing spindle or oil may spill into the spindle cartridge.

10. With the 5/16" hex wrench, loosen approximately two turns the six SHCS holding the spindle to the underside of the head casting.

11. Place the block of wood (minimum 6" thick) on the table directly under the spindle.
Figure 3.4-1. Position wood block under spindle.

12. At the panel, go to the JOG mode and choose Z-axis. Slowly jog in the negative (-) direction until the spindle rests on the block, then remove the screws that were previously loosened (step 7).

13. Jog Z-axis in the positive (+) direction until spindle is half way out of the head casting.

14. Grasp spindle with one hand and continue to jog in Z in the positive (+) direction until it is completely free of the casting.
**Spindle Cartridge Installation**

1. Thoroughly clean all mating surfaces of both the cartridge and the head casting, lightly stone if necessary to remove burrs or high spots.

2. Place spindle on wood block making sure both spindle dogs contact the block. Align the two 10-32 holes located on the spindle lock so they are approximately 90 degrees from the front of the spindle on the right side.

3. Slowly jog the Z-axis in the negative (-) direction until the top portion of spindle is inside of head casting. At this point, align spindle to spindle bore. While performing this operation, you must make sure the spindle cartridge is straight to the spindle bore.

*Figure 3.4-2. Spindle cartridge.*

*Figure 3.4-3 Underside view of spindle cartridge.*
4. If the spindle moves to one side, use a rubber mallet and/or jog in the X or Y directions to straighten it. The spindle must go in easy. If it does not, check your alignment. Do not force it!

5. Install and torque the six SHCS.

6. Reattach the brass fitting to the oil injection cover and connect the oil line to the fitting.

---

CAUTION! Do not overtighten the fittings when replacing on the oil injection cover. Overtightening may result in damage to the spindle cartridge.

---

NOTE: If replacing copper tubing to spindle, thoroughly clean out with filtered air.

7. Fill the cavity between the housing and the spindle cartridge with oil. The oil fill hole is to the left side of the spindle head near the spindle bore, as viewed from the top.

   **WARNING!**
   Never pour oil into the spindle housing.

8. Reinstall the drive belt and adjust the tension as needed.

9. Reinstall the tool release piston assembly.

10. Remove the tool release piston. Carefully install the spiral ring on the spindle shaft. Feed one end of the spiral ring into the shaft groove. Rotate the ring until the entire ring is in the groove.

11. Check the spindle sweep, as described later in this section. Check the clamp/unclamp switch adjustment.

---

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

---

**Drawbar Replacement - 40 Taper**

**REMOVAL -**

NOTE: VMCs equipped with a 15K Spindle must remove the spindle and drawbar as a unit. Do not remove the drawbar separately.

1. Place a tool holder with no cutter in the spindle.

2. Remove head cover panels as shown in "Head Covers Removal".

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

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

5. Reinstall the tool release piston.

6. Remove the tool holder from the spindle.

7. Remove bolts from the transmission and use 2"x4" blocks of wood, placed underneath the front of the housing, to keep it from falling forward.
8. Angle the transmission back and remove the drawbar from the spindle.

**NOTE:** Direct drive machines do not require movement of the drive assembly to access/remove the drawbar.

**INSTALLATION -**

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

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

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

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

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

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

12. The tool release piston will have to be reinstalled at this time.

13. Install a tool holder with no cutter into the spindle taper.

14. Remove the tool release piston.

15. Install the spiral ring on the spindle shaft.

16. Reinstall the tool release piston.

17. Set the drawbar height, and clamp and unclamp switches as described in the following section.

18. Reinstall the head covers.

19. Test-run the machine and perform the necessary ATC adjustments in the "Automatic Tool Changer" section.
**Drawbar Replacement - 50 Taper**

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

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

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

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

5. Remove the drawbar.

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

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

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

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

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

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

9. Install the drawbar.

10. Reinstall the tool release piston.

**Spindle Sweep Adjustment**

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

1. To check spindle sweep, place a .0005 indicator on a suitable holder, place on spindle nose and jog the Z-axis in the negative (-) direction enough so that you can adjust the indicator to sweep a 5" radius from the center of X and Y axes' travels. Slowly jog Z-axis in the negative (-) direction to zero out indicator.

2. Establish reference zero at rear of the table. Sweep the three remaining points (left, front, and right) and record the reading.
3. Shim the spindle if necessary to correct the spindle sweep to specifications.

4. Recheck sweep. It must be within .0005 in both X/Z and Y/Z planes, as stated in the inspection report supplied with the VMC.

5. Replace the Tool Release Piston Assembly in accordance with the "Tool Release Piston Assembly Installation" and "Setting Pre-Charge" sections.
3.5 Spindle Orientation

Please read this section in its entirety before attempting to orient the spindle.

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

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

**Orientation - Spindle Drive with Shot Pin Orientation**

1. Remove cover panels from the head stock area (“Head Covers Removal”), and tool changer front cover.

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

3. Loosen the four 1/4"-20 bolts on the orientation ring. Remove two of these bolts and insert them into the two threaded holes on the ring. Evenly tighten these two bolts until the taper lock is broken.

4. Remove the two 1/4"-20 bolts and place them into their original holes. Tighten them finger tight, then 1/2 of a turn more. Ensure that the orientation ring is snug, but not tight.

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

5. Set up a magnetic base with a 0.0005" indicator on the table. Zero the indicator on the spindle dog in the X-plane.

6. Jog the indicator across the spindle dogs and note the indicator reading. The spindle dogs should be parallel to the X axis within 0.030".

![Top view of spindle orientation components.](image-url)
7. There is a 0.015”-0.030” backlash in the spindle system when it is oriented. Be certain to compensate for this backlash when performing the adjustment.

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

9. Disconnect the main air line to the machine.

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

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

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

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

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

---

**Orientation - Vector Drive**

1. Place the machine in low gear.

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

   For 50 taper mills with an offset tool changer, add 5 degrees of offset (111 encoder steps) to Parameter 257 to match the tool changer arm offset.
3.6 Setting Parameter 64 (Tool Change Offset)

Please read this section in its entirety before attempting to set Parameter 64.

**NOTE:** Setting 7 must be "unlocked" before setting Parameter 64.

1. **WITHOUT** a tool in the spindle taper, initiate a tool change and stop the tool changer using the EMERGENCY STOP button (when the Z-axis moves above the carousel, but before the carousel rotates). Insert a tool holder into the pocket facing the spindle.

2. Using a .0005 indicator and suitable 18" mag base, zero off of bottom left edge “A” of tool holder (looking directly into pocket). Move indicator to bottom right edge “B” of tool holder. Any difference between these edges should be equally divided. For example: if a difference of .002 from left side to right side edge, adjust indicator dial so that indicator reads .001 when it is on either edge. This gives you the tool offset reference.

3. Carefully (so as not to disturb relative position) move the indicator to one side. Remove tool from the tool changer and place it in the spindle.

4. Press Z SIGL AXIS to zero return the Z-axis only.

5. Carefully (so as not to disturb relative position) place indicator under spindle and indicate on bottom left edge of the tool holder.

   If spindle head is too far in the negative (-) or the positive (+) direction, go to JOG mode and choose Z-axis. Jog Z-axis in the necessary direction until it reads zero (0).

6. Push the help button twice. This will put the machine in the calculator mode.
7. Take the number in the Z-axis machine display (center left of page) and multiply it by Parameter 33, which is Z RATIO (STEPS/UNIT).

   If Z-axis work display is negative (-), add the number to the number that you calculated to Parameter 64. If the number is positive (+), subtract it from Parameter 64.

8. To insert the calculated new number, place the cursor at Parameter 64, type in new number and push WRITE key. ZERO RET Z-axis to initialize the new Parameter 64.

9. Recheck the offset with the indicator (Steps 1-5).

10. Insert tool holder in spindle taper and initiate a tool change.

**When the Parameter 64 is changed, the tool offsets must be reset.**
3.7 Spindle Motor & Transmission

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

**NOTE:** The drive belt tension should be adjusted after every service on the transmission or spindle.

**Motor Removal (Direct Drive)**

1. Ensure the VMC is ON. You will need to raise and lower the head stock to remove the transmission. At this time, raise the Z-axis to the full up position.

2. Remove the cover panels from head stock area (“Head Stock Removal” section).


4. Press the POWER OFF button on the control panel and turn the main breaker off. If there is an external breaker box, turn it off and lock it out.

5. Disconnect the air supply from the back panel of the machine.

6. Disconnect all of the electrical and pneumatic lines from the solenoid bracket on top of the spindle motor assembly. Mark any connections that have not been previously labeled for reassembly.

7. Remove the two SHCS holding the cable carrier to the solenoid bracket and position the cable carrier so as to not interfere with removal of the motor. It may be necessary to tie the cable carrier back to the Z-axis motor to keep it in place.

8. If machine is equipped with Through the Spindle Coolant option, remove the pressure regulator and bracket from the old transmission and install them on the new transmission.

![Figure 3.7-1 Direct Drive with lifting eyeholes.](image-url)
9. Remove the four SHCS and carefully lift the spindle motor assembly off the spindle head. Take care to not damage the drive pulley during removal.

**NOTE:** It is recommended that the HAAS Transmission Hoist be used in this operation (Refer to the "Hoist Pre-Assembly" section for assembly and setup).

---

**Installation (Direct Drive)**

1. Carefully lower the motor assembly down to just above the spindle head casting, taking care not to damage the drive pulley or pinch the drive belt.

2. Place the drive belt on the motor's drive pulley and lower the motor down onto the spindle head casting.

3. Insert and tighten down the four SHCS attaching the motor to the spindle head casting. Adjust the drive belt as noted in "Belt Assembly" before tightening down completely.

4. Refer to the appropriate section and set the spindle orientation.

5. Check for proper orientation of the machine and be aware of any unusual noises or vibration that may occur because of incorrect belt tension.

6. Reattach the cable carrier to the solenoid bracket and reconnect all electrical and fluid lines. Replace any leaking or damaged lines at this time, if necessary.

**NOTE:** Ensure the orient ring has an adequate layer of grease around the circumference before starting operation.
**Hoist Pre-Assembly**

1. Attach the mast support to the support base, using the four 3/8-16 x 1 1/4" SHCS, four 3/8" flat washers, four split washers, and the four 3/8-16 hex nuts. Ensure the bolts are securely tightened.

2. Attach the boom modification plates to the mast using the three 1/2-13 x 4 1/2" HHB, three 1/2" split washers, three 1/2-13 hex nuts, and the three spacers.

![Figure 3.7-2 Support base/mast support assembly.](image1)

![Figure 3.7-3 Exploded view of boom modification plate components.](image2)
3. Assemble the boom assembly as follows:
   A. Lubricate the components of the assembly:
      1) Using a grease brush, apply grease to the through-hole and the side surface of the
         pulley wheel.
      2) Wipe a thin coat of oil on the entire cable.
      3) Lubricate all clevis pins with a thin layer of grease.
      4) Oil all bearings on the winch and apply grease to the gear teeth.

   B. Place the pulley wheel inside the cable guide and place this subassembly into the end of the
      boom. Ensure the clevis pin through-hole is toward the top of the boom and the rounded end of
      the cable guide is toward the outside. Slide the clevis pin through the hole and fasten with the 1/8"
      x 1" cotter pin.

   C. Attach the winch base to the boom with the two 3/8-16x1" SHCS, two 3/8" lock washers, and
      the two 3/8" hex nuts. See owner's manual for mounting of left-or right-handed operation.
   D. Feed the free end of the cable (without hook) between the pulley and cable guide and through
      the inside of the boom.

   E. Attach the cable to the winch as follows:
      1) FOR LEFT-HAND OPERATION -
         Pass the cable under the winch drum and through the hole in the drum flange. Form a loop
         of cable and securely anchor it in place using the tie-down clasp, carriage bolt, and hex
         nut. The cable must be underwound on the winch drum.
      2) FOR RIGHT-HAND OPERATION -
         Pass the cable between the frame rod and the countershaft of the winch, over the winch
         drum, and through the hole in the drum flange. Form a loop of cable and securely anchor it
         in place using the tie-down clasp, carriage bolt, and hex nut. The cable must be over
         wound on the winch drum.

   F. Ensure all hex nuts and cap nuts are securely tightened and all cotter pins are properly bent
      to secure them in place. Make sure all pivots and rotation points are well-lubricated and refer to the
      winch owner's manual for proper lubrication before operating.

4. Place the transmission lift fixture on top of the transmission, with the rod at each end in the two
   lifting eyeholes of the transmission. Tighten the fixture onto the transmission by turning the handle
   at the end. Do not overtighten.
Figure 3.7-5 View of transmission lift fixture.

**Transmission Removal**

**NOTE:** This procedure is not for direct drive machines.

1. Ensure the VMC is ON. You will need to raise and lower the head stock to remove the transmission. At this time, raise the Z-axis to the full up position.

2. Remove the cover panels from head stock area (“Head Covers Removal” section).

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


5. Loosen the six SHCS holding the transmission to the head casting. Slide the transmission forward enough to release the drive belt from the transmission and spindle pulleys.

6. Press the POWER OFF button on the control panel and turn the main breaker off. If there is an external breaker box, turn it off and lock it up.

7. Disconnect all electrical lines and air lines from the transmission solenoid bracket. Disconnect the electrical and oil lines from the oil pump. Plug the oil lines to prevent contamination. Most of the lines should be marked and identified. If not marked, do so as it is removed.
8. Remove the two SHCS holding the cable carrier to the solenoid bracket and position the cable carrier so as not to interfere with the transmission removal. It may be necessary to tie the cable carrier back to the Z-axis motor to keep it in place.

9. Remove the protective cardboard from the mill table and install the support base assembly on the table, using the four SHCS, four ½" flat washers, and the four T-nuts.

CAUTION! Ensure the protective rubber pads on the bottom of the mounting base are in place and in good condition, or damage to the mill table may result.
10. With the boom modification plate in place, insert the mast into the mast support. Using the two clevis pins, attach the boom to the mast.

![Diagram of boom assembly to mast]

*Figure 3.7-8 Mounting boom assembly to mast.*

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

![Diagram of fully assembled hoist in position]

*Figure 3.7-9 Fully assembled hoist in position*

12. Remove the six SHCS holding the transmission to head casting. Raise the transmission, ensuring the hoist is being lifted in the locking position, clearing the enclosures. Swing the boom toward the front of the machine and lower onto the wood blocks.
13. For VF-1-4: Place the hoist hook in the bar's lifting eye and place the two hooks on either end of the bar into diagonally opposite lifting holes in the motor shroud. Lift just enough to ensure the hooks are seated properly, then carefully lift the motor and transmission assembly up enough to clear the VMC. Swing the boom toward the front of the machine and lower onto the wood blocks.

### Transmission Installation

1. If machine is equipped with Through the Spindle Coolant option, reinstall the pressure regulator, check valve assembly, and bracket. Install two cable ties on the replacement transmission as follows:
   - Place one cable tie around the limit switch cable.
   - Place the second cable tie through the first one, forming a loop.
   - Tighten the first cable tie. **NOTE:** The loop of the second cable tie must allow the drain line to slip through.

2. Place cradle under new transmission and lift just enough to put tension on the cables.

3. Ensure new transmission is seated securely and lift. Only lift high enough to clear the enclosure and to swing into place.

4. Slowly swing boom around to center the cradle and transmission over the spindle head.

**NOTE:** Inspect the gearbox isolators to ensure the spacer is flush with the bushing on the underside of the housing.

5. Lower the transmission carefully to just above the spindle head. Place the drive belt onto the transmission pulley.

6. Lower the transmission into the spindle head, taking care not to crush or bind the drive belt as you lower.
7. Insert and tighten down the six SHCS attaching the transmission to the spindle head. If these screws include gearbox isolators, ensure the 3/8" fender washer is **NOT** touching the gearbox housing.

![Figure 3.7-11 Gearbox isolators.](image)

8. Adjust the drive belt tension as noted in "Belt Assembly" section before tightening screws down completely.

9. Reattach the cable carrier to the solenoid bracket and reconnect all electrical and fluid lines. Replace any leaking lines at this time, if necessary.

10. Fill the transmission.

**NOTE:** The hoist must be disassembled before removing from the mill table. Break down the hoist by removing the boom assembly, then the mast. It will not be necessary to completely break down the hoist after the first assembly.

**NOTE:** Ensure the positioning ring has an adequate layer of grease around the circumference before starting operation.
Transmission and Motor Replacement - 50 Taper

Removal

1. Lower the Z-axis travel to its full negative value (full down). Position the mill table so that it is centered on the X-axis and as close to the doors as possible (full -Y). This will allow the best working surface.

2. Clean the mill table of any grease, coolant, or chips. You will be standing on the mill table during this procedure and need firm footing.

3. Power OFF the machine. Remove all air and power service from the machine.

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

5. Remove the TRP assembly. Refer to the "50 Taper Spindle TRP Removal" section.

   CAUTION! The TRP assembly is very heavy. When moving, ensure you have a place to set the assembly when removed.

   NOTE: Make sure you collect all washers and spacers from beneath the TRP assembly. Keep these separated in sets.

6. Remove the TSC extension tube if the machine is equipped with Through the Spindle Coolant option. Refer to the "Through The Spindle Coolant System" section.

   NOTE: The TSC union and extension shaft are reverse thread.

7. If your machine is equipped with TSC, remove the 3/16" SHCS that attach the TSC valve bracket to the right side of the motor. Let the TSC valve bracket hang off the right side of the spindle head, ensuring that the hoses do not get kinked.

8. Remove the SHCS that attach the TRP solenoid assembly to the top of the motor lift plate. Cable tie the assembly to the rear sheetmetal or column to prevent damage while removing the transmission/motor assembly.

9. Remove the quick-disconnect electrical plug panel from the rear of the motor. This is attached by four 3/16" SHCS. Gently push the plug panel behind the motor and cable tie it to the rear sheetmetal or column.

10. Remove the plug for the gear change solenoid.

11. Remove the Encoder-to-Transmission Shaft belt. This can most easily be accomplished by removing the four SHCS that attach the Encoder bracket to the spindle head (located inside the spindle head cavity between the drive belts). Use a universal swivel joint and hex-head socket for these SHCS.

12. Break loose the four large SHCS that attach the transmission mount plate to the spindle head. Remove the SHCS and set aside. Pull the transmission/motor assembly towards the front of the machine slightly. This will remove the tension on the drive belts.
13. Remove the Encoder belt and the drive belts.

**CAUTION:** Measure the distance between the bottom of the Z-axis motor and the ballscrew anchor mount. Cut a wood block to the proper length and put in place. This is necessary to counteract the Hydraulic Counterbalance mechanism when the transmission/motor assembly is lifted off the machine.

14. Mark and remove the power cables from the motor.

15. Attach a heavy chain to the lifting eyeholes of the top motor plate using hooks or C-clips of appropriate weight rating (approximately 250 lbs.).

**CAUTION:** Before proceeding, make sure you have appropriate lifting equipment to safely lift 250 lbs., room to maneuver it, and a stable place to set the transmission/motor assembly once it is removed.

16. Lift off the transmission/motor assembly.

**Installation**

**CAUTION:** Before proceeding, make sure you have appropriate lifting equipment to safely lift 250 lbs. and room to maneuver.

1. Lift the transmission/motor assembly into place. The next five steps (2-6) can be performed with the transmission/motor assembly turned slightly to ease installation of accessory parts.

2. Connect the power wires.

3. Attach the electrical plug panel to the rear of the motor. Reattach any Molex plugs to the panel, if removed during the previous procedure.

4. Slide on the drive belts.

5. Place and secure the TRP solenoid assembly to the top of the motor lift plate using the removed SHCS.

6. Place and secure the TSC valve bracket to the right side of the motor lift plate using the removed SHCS (if equipped).

7. Properly orient the transmission/motor assembly, if necessary. Insert the four SHCS that attach the transmission mount plate to the spindle head.

8. Use a Belt Tensioning Tool to tighten drive belts. Do not overtighten the drive belts!


10. Replace the TRP assembly. See “50 Taper Spindle TRP Installation”.

11. Replace the TSC union and extension shaft. Refer to the “Through The Spindle Coolant System” section.

**NOTE:** The TSC union and extension shaft are reverse thread.
12. Lubricate any new or removed parts if necessary. Remove the wood spacer (if used). Check to make sure all connections are secure.

13. Reconnect air and power services. If equipped with TSC, check drawbar for runout. See the "Adjusting Extension Tube Runout" section.

14. Replace sheetmetal.

15. Set spindle orientation. Refer to the "Spindle Orientation" section.

16. Check Toolchanger function.
3.8 Axis Motor Removal / Installation

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

Tool Required
- Z-Axis: Cylinder shaft stop (P/N 99-7562 - VF-1 through 4, P/N 93-9962 - VF-6 through 11)

X-Axis Motor Removal

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

2. Move the table to the far left position. Loosen the SHCS and remove the right way cover.
3. Move the table to the far right position. Loosen the SHCS and remove the left way cover.
4. Remove the side enclosure panels.
5. On the motor housing, remove the four BHCS and remove the cover plate.
6. Loosen the SHCS on the motor coupling at the lead screw.
7. Turn the machine power OFF.
8. On the motor housing, loosen the four SHCS and remove the motor from the housing.
9. Disconnect all wiring from the motor.

Figure 3.8-1 X-axis motor and components.
INSTALLATION -

1. Slide motor into motor housing, inserting the end of the lead screw in the motor coupling.

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

3. Reconnect the motor wiring.

4. Visually inspect the coupler flex plates to ensure they are parallel to the coupling halves.

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

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

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

6. Move the table to the far right position. Replace the left way cover with the SHCS.

7. Move the table to the far left position. Replace the right way cover with the SHCS.

8. Reinstall the side enclosures.

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

Y-Axis Motor Removal

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

2. Move the table to the farthest forward position. Using a 5/32" hex wrench, remove the SHCS on the way cover at the rear of the saddle.

3. Slide the way cover back against the machine. Remove the two roller brackets from the base. Pull the way cover forward and off of the base.

4. If the bearings are to be serviced, move the table to the rear of its travel and remove the SHCS holding the front way covers to the saddle. Slide the way cover to the forward position.

Figure 3.8-3 Y-axis motor and components.

Removing Lube / Air Panel -

5. Turn the machine off and disconnect all air lines to panel.

6. Disconnect the spindle air/lube line.

7. Using a 3/8" open-end hex wrench, disconnect the oil line connecting the base to the lubrication system panel.

8. Disconnect the two air lines from the panel (quick-disconnect fittings) by hand.

9. Disconnect the three connections labeled 'limit switches' and remove the cords from the panel.

10. Disconnect the limit switch connection and the Y-axis connection at the side of the control panel.
11. While holding the lube/air panel assembly at the bottom edge, loosen the two SHCS and remove the panel assembly.

**CAUTION!** On machines with only two SHCS, remove one screw at a time. Replace the screw to hold the cabinet in place before removing the other screw. Failure to do this will result in damage to the cabinet.

12. On the motor housing, remove the four BHCS and remove the cover plate.

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

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

![Figure 3.8-4 Lube/Air Panel.](image)

**INSTALLATION -**

1. Slide motor into motor housing, inserting the end of the lead screw in the motor coupling.

2. Replace and tighten down the four SHCS that hold the motor to the housing and reconnect the cables to the motor.

3. Visually inspect the flex plates to ensure they are parallel to the coupling halves.

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

Tighten the SHCS on the motor coupling at the lead screw. (Place a drop of blue Loctite® on the screw before inserting.)
4. Replace the cover plate and fasten with the four BHCS.
5. Replace the lube system panel with the two SHCS that mount it.
6. Plug in the limit switch connection and Y-axis connection at the side of the control panel.
7. Reconnect the three connections labeled "limit switches" to the panel.
8. Reconnect the two air lines to the panel, and the solenoid to the front of the panel.
9. Reconnect the oil line that connects the lube system panel to the base.
10. If the front way cover was removed, slide it back into position, and replace the SHCS that holds it to the saddle.
11. Move the table to the fully forward position. Replace the rear way cover.
12. Replace the two roller brackets onto the base.
13. Slide the way cover back into place, and attach to the saddle with the SHCS.
14. Check for backlash in the Y-axis lead screw (Troubleshooting section) or noisy operation.
15. Zero return the Y axis and set grid offset according to section.

**Z-Axis Motor Removal**

Machines are currently equipped with either a hydraulic counterbalance system or an electric brake motor. Care must be taken, in either case, to avoid damaging the machine or severely injuring yourself. Heed all warnings and cautions and read all the steps of the procedure before starting any disassembly.

**WARNING! MACHINES WITHOUT A COUNTER BALANCE**

If debug is on and the Z-axis is disabled the spindle head will fall. This is extremely dangerous and should be avoided at all costs.

**CAUTION!** Always block the hydraulic cylinder with shaft stop block before servicing any Z-axis components.

1. Turn the machine power ON. Zero return (ZERO RET) all axes and put the machine in HANDLE JOG mode.
2. Loosen the six SHCS that attach the rear head cover to the side covers, and remove from the spindle head.

**NOTE:** If machine is equipped with a hydraulic counterbalance, remove entire spindle head cover for VF-1/2, VCE 700/750, or right side spindle head cover for VF-3/4, VCE 1000/1250.

3. Remove the SHCS attaching the Z-axis way cover to the spindle head and slide the cover to the bottom position. VF 1-4 remove the rear spindle head cover.
4. Lower the spindle head to its lowest position.
5. a. If the machine is equipped with a hydraulic counterbalance, install cylinder shaft stop (See Fig. 3.8-6). HANDLE JOG Z-axis up until shaft stop blocks axis.

b. Machine with Brake motors: Position table under the spindle head and insert a 4" x 4" x 14" wood block under the spindle head and lower head casting on to it. Emergency stop the machine.

6. At the motor housing, loosen the four BHCS and remove the cover plate.

7. Visually check the motor coupling. Align the coupler so that SHCS on the lead screw can be easily accessed. This can be done by turning the ball screw manually.
8. Disconnect electrical power. Caution: If the machine is equipped with a Z-axis brake motor the spindle head may drop slightly.

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

10. Disconnect the Z-axis connection from the control panel.

11. Remove cableing from the motor.

INSTALLATION -

1. Slide motor into motor housing, inserting the end of the lead screw in the motor coupling.

2. Replace and tighten down the four 5/16-18 x 1¼" SHCS that hold the motor to the housing and connect cables to the motor.

3. Visually inspect the flex plates to ensure they are parallel to the coupling halves.

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

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

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

5. Reconnect electrical power.

6. Remove shaft stop, if necessary.

7. If the front way cover was removed, slide it back into position, and replace the 10-32x3/8" SHCS that holds it to the saddle.

8. Move the table to the fully forward position. Replace the rear way cover.

9. Replace the two roller brackets onto the base.

10. Slide the way cover back into place, and attach to the saddle with the 10-32x3/8" SHCS.

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

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

**WARNING! MACHINES WITHOUT A COUNTER BALANCE**

If debug is on and the Z-axis is disabled the spindle head will fall. This is extremely dangerous and should be avoided at all costs.

1. Remove the axis motor in accordance with "Axis Motor Removal/Installation" section.

2. Loosen the 10-32 x ½" SHCS on the two coupling rings and remove the coupling.

3. For installation: Visually inspect the flex plates to ensure they are parallel to the coupling halves. Slide the new coupling onto the motor shaft until the coupling half is flush to the end of the shaft.

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

4. Reinstall the axis motor.

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

---

*Figure 3.8-7 Motor coupling.*
Please read this section in its entirety before attempting to remove or replace the lead screws.

**TOOLS REQUIRED**

- Spanner wrench (32 mm or 40/50 mm)
- 2" x 4" wood block (21”-23½” long)
- Shaft lock (32 mm or 40/50 mm)
- Torque tester
- Z-Axis: Cylinder shaft stop (P/N 99-7562 - VF-1 through 4, P/N 93-9962 - VF-6 through 10)

**NOTE:** Certain steps in the following procedures apply only to 40 and 50 mm lead screws.

**X-Axis Lead Screw Removal**

1. Turn the machine ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.
2. Remove the side enclosures.
3. Loosen the SHCS and remove the chip tray from the mill table.
4. Jog the table to the far right position. Loosen the SHCS and remove the right way cover.
5. Jog the table to the far left position. Loosen the SHCS and remove the left way cover.
6. If applicable, remove the hard stop from the bearing housing on the lead screw.
7. Disconnect the oil line from the ball nut.

*Figure 39-1. X-axis lead screw and components.*
8. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the lead screw support bearing end.

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

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

10. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the lead screw in the motor housing.

11. **For 32 mm lead screws:**
   - Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the lead screw to loosen.
   - Push the mill table towards the motor end until the lead screw clears the bearing support. Remove the SHCS from the ball nut and remove the lead screw by pulling from the bearing support end.

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

**For 40 and 50 mm lead screws:**
- Loosen the SHCS that mount the bearing support to the saddle, and remove. Remove the pull pins from the bearing support.
- Loosen the five SHCS in the ball nut and remove the lead screw by pulling from the bearing support end.
THIS PROCEDURE ASSUMES THAT THE NUT AND MOTOR HOUSING WILL NOT BE REMOVED.

INSTALLATION -

1. Center the mill table on the saddle.

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

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

3. Insert the lead screw through the nut housing and motor housing (See Fig. 3.9-3), taking care not to make contact with the screw threads, which will cause possible damage.

4. If 40 or 50 mm lead screw:
   • Mount the bearing support to the saddle with six SHCS, but do not tighten completely.
   • Replace the pull pins in the bearing support.
   • Install the spacer ring on the motor end of the lead screw.
   • Insert the 5/16-18 x 3/4" (or M10 x 25 mm) SHCS, attaching the ball nut to the nut housing, but do not tighten completely. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

5. Place the bearing sleeve in the motor housing as shown. (It may be necessary to align the bearings in the sleeve to facilitate mounting on the lead screw.)

Figure 3.9-3 Install lead screw from right side.
6. Insert the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten to torque specification.

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

7. Move mill table as far right as possible. Insert, but **DO NOT TIGHTEN**, the five ¼-20 x 1" (or ¼-20 x ¾") SHCS attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

**CAUTION!** Do not run mill table pads past the end of the linear guides! If this occurs, cease all operations and contact the manufacturer at once.

8. The following sequence is important to ensure proper installation of the lead screw:
   • Tighten the clamp nut, hand tight, on the motor end.
   • Install and tighten clamp nut on bearing support. Ensure the nut **does not** touch the support bearing.
   • Install the shaft lock onto the bearing support end of the lead screw. This will keep the lead screw from turning while torquing the clamp nut.
   • Place a spanner wrench on the clamp nut at the motor end of the assembly.
   • Torque the clamp nut to 15 FT-LBS.

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

   • Tighten the clamp nut screw and mark with yellow paint on motor support end.
   • Remove the shaft lock.
   • Torque support mounting bolts to proper specifications.
   • Loosen the clamp nut screw and clamp nut at the bearing support end and tighten to 4 IN-LBS against the bearing. Retighten the clamp screw.
9. **For 40 and 50 mm lead screws only:**
   - Move the table all the way to the right. Tighten down completely the SHCS that mount the bearing support to the saddle.
   - Loosen the clamp nut on the bearing support end. Adjust the nut until it seats on the bearing. Retighten the clamp nut hand-tight, then 1/8 turn more (If you have a torque screwdriver, torque the clamp nut to 4 in-lbs).

10. Reinstall the motor according to "Axis Motor Removal and Installation".

11. Torque the SHCS attaching the ball nut to the nut housing.

12. Reconnect oil line to the ball nut.

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

14. Reinstall the way covers and chip tray. If applicable, replace the hard stop.

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


### Y-Axis Lead Screw Removal

1. Turn the machine ON. ZERO RETURN all axes and put the machine in HANDLE JOG mode.
2. If applicable, remove the hard stop from the lead screw support bearing end of the lead screw.
3. Disconnect the oil line at the ball nut.
4. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the lead screw bearing support end.

![Figure 3.9-5 Y-axis lead screw and components.](image-url)
5. Remove the motor in accordance with "Y-Axis Motor Removal".

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

6. Loosen the 10-32 x 1/2" SHCS and remove the clamp nut on the lead screw in the motor housing.

7. **For 32 mm lead screws:**
   • Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the lead screw to loosen.
   
   **CAUTION!** Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or lead screw will result.

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

**For 40 and 50 mm lead screws:**

• Loosen the SHCS that mount the bearing support to the saddle, and remove. Remove the pull pins from the bearing support.
• Loosen the five SHCS in the ball nut and remove the lead screw by pulling from the bearing support end.

![Diagram](image-url)  
*Figure 3.9-6 Pull lead screw forward around bearing support...*
...push back into the machine, then pull out forward.

THIS PROCEDURE ASSUMES THAT THE NUT AND MOTOR HOUSING WILL NOT BE REMOVED.

INSTALLATION -

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

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

2. Slide the motor end of the lead screw under the saddle, taking care not to damage the screw threads. Position the lead screw to the right side of the nut housing and slide toward the rear of the machine as far as it will go.

3. Pull the lead screw forward until it is against the front way covers. Place the motor end of the lead screw through the nut housing and push the lead screw toward the back of the machine until the ball nut is seated in the nut housing.

4. **If 40 or 50 mm lead screw:**
   - Mount the bearing support to the saddle with six SHCS, but do not tighten completely. Replace the pull pins in the bearing support.
   - Install the spacer ring on the motor end of the lead screw.
   - Insert the 5/16-18 x 3/4" (or M10 x 25 mm) SHCS, attaching the ball nut to the nut housing, but do not tighten completely. (Place a drop of blue Loctite® on each of the SHCS before inserting.).
   - Skip to Step 8.
5. Place the bearing sleeve in the motor housing as shown. (It may be necessary to align the bearings in the sleeve to facilitate mounting on the lead screw.)

6. Insert the six ½-20 x 1" SHCS attaching the bearing sleeve to the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten to torque specifications.

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

7. Move mill table as far forward as possible. Insert, but DO NOT TIGHTEN, the five 1/4-20 x 1" (or 1/4-20 x 3/4") SHCS attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

CAUTION! Do not run mill table pads past the end of the linear guides! If this occurs, cease all operations and contact the manufacturer at once.

8. The following sequence is important to ensure proper installation of the lead screw:
   • Tighten the clamp nut, hand tight, on the motor end.
   • Install and tighten clamp nut on bearing support. Ensure the nut does not touch the support bearing.
   • Install the shaft lock onto the bearing support end of the lead screw. This will keep the lead screw from turning while torquing the clamp nut.
   • Place a spanner wrench on the clamp nut at the motor end of the assembly.
   • Torque the clamp nut to 15 FT-LBS.

   NOTE: The 40/50 mm leadscrew clamp nut should be torqued to 50 FT-LBS.
   • Tighten the clamp nut screw and mark with yellow paint.
   • Remove the shaft lock.
   • Torque support mounting bolts to proper specifications.
   • Loosen the clamp nut screw and clamp nut at the bearing support end and tighten to 4 IN-LBS. against the bearing. Retighten the clamp screw.

9. Move the mill table to the far back position (motor end). Tighten down completely the five SHCS attaching the ball nut to the nut housing.

10. For 40 and 50 mm lead screws only:
   • Move the table all the way forward. Tighten down completely the SHCS that mount the bearing support to the base.
   • Loosen the clamp nut on the bearing support end. Adjust the nut until it seats on the bearing. Retighten the clamp nut hand-tight, then 1/8 turn more (If you have a torque screwdriver, torque the clamp nut to 4 in-lbs).

11. Reinstall the motor according to "Axis Motor Removal and Installation". If applicable, replace the hard stop from the lead screw support bearing end of the lead screw.

12. Reconnect oil line to the ballnut.

13. Check lead screw torque at bearing support end with torque tester. Jog the table all the way to the front. Check the lead screw torque again. It should be the same as the previous reading.
14. Check for backlash in the lead screw ("Accuracy/Backlash" section) or noisy operation.


**Z-Axis Lead Screw Removal**

Machines are currently equipped with either a hydraulic counterbalance system or an electric brake motor. Care must be taken, in either case, to avoid damaging the machine or severely injuring yourself. Heed all warnings and cautions, and read all the steps of the procedure before starting any disassembly.

**WARNING!**

IF THE MACHINE IS EQUIPPED WITH A HYDRAULIC CYLINDER, A SHAFT STOP BLOCK MUST BE USED TO SECURE THE SPINDLE HEAD.

DO NOT MOVE THE SPINDLE DURING LEAD SCREW SERVICE.

**WARNING! MACHINES WITHOUT A COUNTER BALANCE**

If debug is on and the Z-axis is disabled the spindle head will fall. This is extremely dangerous and should be avoided at all costs.

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

2. Loosen the six SHCS that attach the rear cover to the side covers, and remove from the spindle head. Remove the three SHCS attaching the Z-axis way cover to the spindle head and slide the cover to the bottom position.

3. **a.** Machines with hydraulic counter balance cylinders: Lower the spindle head to its lowest position. Install cylinder shaft stop. Handle jog Z-axis up until the shaft stop blocks the axis.

   **b.** Machine with Brake motors: Remove the rear Y-axis way cover and brace the spindle head up with a 4" x 4" x 14" block of wood.

4. Disconnect electrical power.

5. If applicable, remove the hard stop from the bearing housing on the lead screw.

6. Disconnect the oil line at the ball nut.

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

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

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

9. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the lead screw in the motor housing.

10. **For 32 mm lead screws:**

    • Loosen the six ¼-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the opposite end of the lead screw to loosen.

   **CAUTION!** Do not pry the bearing sleeve away from the housing. Damage to the sleeve, bearing, or lead screw will result.
• Hand-turn the lead screw to move the screw up until the bottom end clears the support bearing by approximately six inches (6").
• Remove the SHCS from the ball nut and lower the lead screw down and to the right of the support bearing, past the Z-axis way cover. For the VF-6, remove the lead screw from top of column.

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

For 40 and 50 mm lead screws:
• Loosen the SHCS that mount the bearing support to the column, and remove. Remove the pull pins from the bearing support.
• Loosen the five SHCS in the ball nut and remove the lead screw by pulling from the bearing support end.

![Figure 3.9-7 Z-axis lead screw and components.](image)

INSTALLATION -

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

CAUTION! Mating surfaces must be clean or misalignment may occur, seriously affecting the proper operation of the machine.
2. **If 40 or 50 mm lead screw:**
   - Insert the lead screw into the bearing support. Screw the clamp nut on a few turns.
   - Insert the lead screw, with the bearing support attached, into place on the column. Ensure the lead screw goes through the ball nut housing and the bearing sleeve.
   - Mount the bearing support to the column with SHCS, but do not tighten completely. Replace the pull pins in the bearing support.
   - Install the spacer ring on the motor end of the lead screw.
   - Hand-turn the ball nut until it comes into contact with the nut housing mounting surface. If necessary, turn the lead screw to correctly position lube fitting of the ball nut. Insert, but DO NOT TIGHTEN, the 5/16-18 x 3/4" (or M10 x 25 mm) SHCS, attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)
   - Skip to Step 7.

3. Slide the lead screw up into the nut housing and gently lower it until it is resting in the support bearing.

4. Place the bearing sleeve in the motor housing as shown. (It may be necessary to align the bearings in the sleeve to facilitate mounting on the lead screw.)

5. Insert the six ¼-20 x 1" SHCS attaching the bearing sleeve to the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

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

6. Hand-turn the ball nut until it comes into contact with the nut housing mounting surface. If necessary, turn the leadscrew to correctly position lube fitting of the ball nut. Insert, but DO NOT TIGHTEN, the five ¼-20 x 1" (or ¼-20 x ¾") SHCS attaching the ball nut to the nut housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)
7. The following sequence is important to ensure proper installation of the lead screw:
   • Tighten the clamp nut, hand tight, on the motor end.
   • Install and tighten clamp nut on bearing support. Ensure the nut does not touch the support bearing. It will be used to hold the lead screw while the other end is tightened.
   • Install the shaft lock onto the bearing support end of the lead screw. This will keep the lead screw from turning while torquing the clamp nut.
   • Place a spanner wrench on the clamp nut at the motor end of the assembly.
   • Torque the clamp nut to 15 FT-LBS.

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

   • Tighten the clamp nut screw and mark with yellow paint.
   • Remove the shaft lock.
   • Torque support mounting bolts to proper specifications.
   • Loosen the clamp nut screw and clamp nut at the bearing support end and tighten to 4 IN-LBS (32 mm lead screws) against the bearing. Retighten the clamp screw.

8. Tighten down completely the five SHCS attaching the ball nut to the nut housing.

9. Reinstall the motor according to "Z-Axis Motor Removal and Installation". Reinstall the hard stop at the support bearing end of the lead screw.

10. Reconnect the oil line to the ball nut.

11. Reconnect electrical power.

12. a. Machines with counterbalances: Jog the spindle down and remove the cylinder shaft stop.

   b. Machines with brake motors: Jog the spindle up slightly, just above the block of wood and push Emergency stop. Watch to see if the spindle head drops. If it does, check motor installation and electrical connections, and make proper repair.

13. For 40 and 50 mm lead screws only:
   • Jog the spindle head towards the bearing support end.
   • Tighten down completely the SHCS that mount the bearing support to the column.
   • Loosen the clamp nut on the bearing support end. Adjust the nut until it seats on the bearing. Retighten the clamp nut hand-tight, then torque the clamp nut to 10 ft-lbs).

14. Check lead screw torque at bearing support end with torque tester. Jog the spindle head to its highest position. Check the lead screw torque again. It should be the same as the previous reading.

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

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

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

1. Use a standard ballscrew support bearing assembly to prevent the leadscrew for sagging, and to allow the use of the shaft lock for tightening the clamp nut at the motor end. Use only one screw to fasten the support bearing assembly (no dowel pins are necessary) to prevent it from rotating while the shaft lock is in place and tighten the clamp nut at the motor end.

2. Remove the fastener from the support bearing assembly to allow it to float on its support surface. Position the leadscrew nut toward the motor end to allow it to self align to the motor housing bearing assembly.

3. Tightening the five screws to the nut housing.

4. Install the leadscrew bumpers.

5. Install the shaft lock on the clamp nut at the motor end and allow it to wedge itself in the coupler cavity. Torque the clamp nut to 15 ft-lbs.
3.10 BEARING SLEEVE REMOVAL AND INSTALLATION

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

TOOLS REQUIRED
- Spanner wrench
- Pre-load fixture
- Wood block (16" long)
- Z-Axis: Cylinder shaft stop (P/N 99-7562 - VF-1 through 4, P/N 93-9962 - VF-6 through 10)

NOTE: For machines equipped with 40 or 50 mm lead screws, the lead screw must be removed in order to remove the bearing sleeve. Refer to the "Lead Screw Removal/Installation" section for instructions.

X-AXIS BEARING SLEEVE REMOVAL

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

2. Loosen the SHCS and remove the chip tray from the mill table.

3. Jog the table to the left and remove the right way cover

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

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

5. Loosen the 10-32 x ½" SHCS and remove the clamp nut on the lead screw in the motor housing.
6. Loosen the six ¼-20 x 1” SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the lead screw to loosen.

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

**INSTALLATION -**

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

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

2. Move mill table to the far right.

3. Place the bearing sleeve in the motor housing as shown. (It may be necessary to align the bearings in the sleeve to facilitate mounting.)

4. Insert the six ¼-20 x 1” SHCS, attaching the bearing sleeve to the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.) Tighten down completely.

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

5. Start the clamp nuts on both ends of the lead screw. Do not tighten.

6. Hand-turn the mill table to the far left position.
7. Loosen the six \( \frac{3}{4} \)-20 x 1" SHCS attaching the bearing sleeve to the motor housing and retighten completely. DO NOT SKIP THIS STEP. It ensures the lead screw is installed and runs parallel and flat to the linear guides and the saddle.

**NOTE:** For the angular contact design bearing, no pre-load is necessary. Do the following:

- Tighten the clamp nut on the motor housing to 15 foot-pounds.
- Tighten the SHCS on the clamp nut.
- Tighten the clamp nut on the support bearing end of the lead screw until it contacts the bearing, then tighten further approximately 1/8 of a turn.
- Tighten the SHCS on the clamp nut.

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

9. Reinstall the way covers and chip tray.

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


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**Y-Axis Bearing Sleeve Removal**

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

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

3. Remove the hard stop from the bearing housing on the lead screw.

4. Loosen the 10-32 x \( \frac{3}{8} \)" SHCS and remove the clamp nut from the bearing support end of the lead screw.

5. Loosen the six \( \frac{3}{4} \)-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Push on the mill table or the opposite end of the lead screw to loosen.

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

---

**INSTALLATION -**

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

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

2. Slide the bearing sleeve into the motor housing and start all six \( \frac{3}{4} \)-20 x 1" SHCS into the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

**CAUTION!** Do not use more than one drop of Loctite®. An excessive amount will cause a film between the sleeve and housing, which could result in backlash.
3. Move the table to the rear of its travel.

4. Tighten the six ¼-20 x 1" SHCS that attach the bearing sleeve to the motor housing.

5. Loosely install the clamp nut on the lead screw at the motor housing end

---

**NOTE:** For the angular contact design bearing, no pre-load is necessary (follow the procedure in "X-axis bearing sleeve" section).

6. Reinstall the axis motor.

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


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**Z-Axis Bearing Sleeve Removal**

**WARNING!**

**ALWAYS BLOCK THE HYDRAULIC CYLINDER WITH SHAFT STOP BLOCK BEFORE SERVICING ANY Z-AXIS COMPONENTS.**

---

1. Turn the machine power ON. Zero return (ZERO RET) all axes and put the machine in HANDLE JOG mode.

2. Loosen the six SHCS that attach the rear cover to the side covers, and remove from the spindle head.

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**NOTE:** If machine is equipped with a hydraulic counterbalance, remove entire spindle head cover for VF-1/2, VCE 550/700/750, or right side spindle head cover for VF-3/4, VCE 1000/1250.

3. If the bearings are to be serviced, remove the three SHCS attaching the Z-axis way cover to the spindle head and slide the cover to the bottom position.

4. Remove the hard stop from the bearing housing on the lead screw.

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

6. Raise the spindle head until the bottom edge is approximately sixteen inches (16") above the mill table.

7. Install cylinder shaft stop. HANDLE JOG Z-axis up until shaft stop block axis.

8. Place the wood block beneath the spindle head and lower the spindle head until it is resting on the block.
9. Perform Steps 6-10 of "Z-Axis Motor Removal".

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

10. Loosen the 10-32 x ½" SHCS and remove the clamp nut from the motor housing end of the lead screw.

11. Loosen the six ¾-20 x 1" SHCS and remove the bearing sleeve from the motor housing. Hand-turn the lead screw in an upward direction to push the bearing sleeve out of the motor housing.

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

**INSTALLATION -**

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

**CAUTION!** MATING SURFACES MUST BE CLEAN OR MISALIGNMENT MAY OCCUR, SERIOUSLY AFFECTING THE PROPER OPERATION OF THE MACHINE.

2. Slide the bearing sleeve into the motor housing and start all six ¾-20 x 1" SHCS into the motor housing. (Place a drop of blue Loctite® on each of the SHCS before inserting.)

**CAUTION!** Do not use more than one drop of Loctite®. An excessive amount will cause a film between the sleeve and housing, which could result in backlash.
3. Tighten the six \( \frac{3}{4} \)-20 x 1" SHCS that attach the bearing sleeve to the motor housing.

4. Loosely install the clamp nut on the lead screw at the motor housing end.

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

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

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

7. Remove shaft stop.

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

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

1. Toolchanger Trap Door
2. Loc Nut Elastic
3. Washer
4. Nylon Washer
5. Vertical Axle
6. 2 Pin Geneva Star
7. Bearing Housing
8. Extractor Key
9. Extractor Spring
10. Extractor Finger
11. 20 Pocket Carousel
12. Toolchanger Door Spring
13. Sliding Panel
14. Sliding Panel Cover
15. Number Ring
16. Cap, Toolchanger
Carriage Casting Replacement

Tools Required

- Two-jaw puller
- Hydraulic jack
- 1-2-3 Block
- Cardboard

NOTE: If the carriage casting is damaged in a crash, it must be replaced. Look specifically for broken bosses where the roller bolts mount to the casting. If the carriage casting is broken off of the holding plate but not damaged, only the roller bolts need be replaced.

1. Turn the machine power off.
2. Remove the left side enclosure panel of the machine.
3. Disconnect all cables from the carriage casting and remove any bolts holding the ATC to the holding plate.

NOTE: If the carriage casting has been damaged, replacement is necessary; move the ATC to a bench and remove all components from the damaged carriage casting and place in the new casting. Skip to Step 6 for replacement.

4. Place a piece of cardboard over the machine's table, and carefully lower the carriage casting (with carousel) onto the machine table.
5. If the carriage casting has crashed and/or has been broken off of the holding plate, it should be inspected for damage before going any further.
6. Remove any damaged roller bolts from the carriage casting. Replace with new bolts.
7. With a lifting device, carefully lift the ATC assembly up and onto the holding plate.

NOTE: Ensure the cam follower on the slip clutch engages the slot on the carriage casting.

8. With the ATC assembly securely supported, install the lower roller bolts and adjust in accordance with "Roller Bolt Replacement".
9. Repair or replace any cables damaged and adjust the ATC. Align the ATC assembly in accordance with the following sections, and set Parameter 64 in accordance with "Spindle Motor and Transmission" section.

Roller Bolt Replacement

1. Remove the shuttle motor cover from the back of the machine (VF-1, VF-2).
2. Place a support under the center of the carousel.
3. Loosen the eccentric locks on the bottom roller bolts.

CAUTION! Ensure the ATC is securely supported, otherwise it may fall when an upper roller bolt is removed.
4. Carefully remove the damaged roller bolt from the ATC shuttle and replace with a new bolt.

**NOTE:** REPLACE ONLY ONE ROLLER BOLT AT A TIME. Carefully inspect the V-groove rollers for roughness or damage, and replace if necessary.

5. Tighten the eccentric locks on the bottom rollers until there is no play between the rollers and the V-guide on the ATC holding plate.

6. Set the tool change offset (Parameter 64) in accordance with "Setting Parameter 64" section.

7. Verify the ATC alignment in accordance with the following section.

8. Reinstall the shuttle motor cover (VF-1, VF-2).

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**Automatic Tool Changer (ATC) Alignment**

1. Verify that the spindle orientation is correct (Refer to appropriate section).

2. Command an automatic tool change, and press EMERGENCY STOP when the shuttle is in the full in position.

3. Verify that the spindle dog lines up to the alignment key in the ATC, in the Y plane.

**NOTE:** If the spindle dog and alignment key do not line up, loosen the four HHB that hold the ATC holding arm to the column.

---

*Figure 3.11-1. Underside showing centering measurements.*
4. Move the entire tool changer until the tool alignment key lines up with the spindle dog. Tighten the four HHB.

**NOTE:** Parameter 64 must be checked, and adjusted if necessary, when the ATC is aligned.

5. Make at least 50 tool changes after the alignment is complete. Verify that the tools are being picked up squarely.

**SHUTTLE STROKE ADJUSTMENT**

6. Move the ATC away from the spindle and loosen the four HHBs in the ATC holding arm in the X-axis plane.

7. Push the cam follower to its full upward stroke, then push the entire ATC assembly in by pushing on the tool changer holding plate until ATC is fully engaged on the tool holder.

8. Ensure the extractor is making full contact on the tool flange.

*Figure 3.11-2 Automatic Tool Changer - Mechanical Assembly (Side View)*
Extractor Fork Replacement

NOTE: Extractor forks that do not hold the tool holders firmly, or forks that are bent, must be replaced. Damage to the ATC will result if not replaced.

1. With no tool holders in the spindle or in the ATC, command “ATC FWD” until the extractor fork needing replacement is facing the spindle.

2. Command “ATC FWD” again, but press the EMERGENCY STOP after the spindle head lifts up off the carousel.

NOTE: At this point, the shuttle should be in and the spindle should be about 4½” above the carousel.

3. Loosen the SHCS that attach the damaged extractor fork to the ATC carousel.

4. With the extractor fork removed, inspect the alignment key mounted under the extractor. If it is damaged due to improper spindle orientation, replace it and correct the orientation (Refer to appropriate section) after the extractor fork has been replaced.

5. Put a drop of blue Loctite on each of the SHCS and attach the new extractor fork to the ATC with the SHCS. DO NOT OVER-TORQUE! Ensure the distance from the edge of the extractor fork to the edge of the pocket in the carousel is the same on both sides in accordance with the following section.

6. Test run the ATC to ensure proper operation.
**Sliding Cover Replacement**

**NOTE:** If any of the sliding covers on the ATC do not slide freely or are bent in a crash, they must be replaced.

1. Loosen the four screws that attach the sliding panel cover to the carousel. Be careful to not lose the spring that holds the sliding cover closed or the number plate on the ATC carousel.

2. Inspect the cover for any galling or damage. Inspect the spring for damage.

3. Loosely install the two innermost screws that attach the number plate and the cover to the carousel and slide the spring into position in the slot in the ATC carousel.

4. Put the replacement sliding panel in place, making certain that the tongue on the panel pushes on the end of the spring.

5. Tighten the two rear screws completely and install the two front screws.

6. Ensure the sliding panel moves freely.

**NOTE:** If the sliding door is bent, determine the cause before resuming normal operation.

**Shuttle Motor Removal**

1. Turn the VMC off.

2. Remove the cover from the tool carriage casting.

3. Remove the hex bolt that attaches the cam follower to the slip clutch (see Fig. 3.11-2).

4. Push the tool changer in as far as it will go.

5. Loosen the set screw that secures the slip clutch assembly to the shuttle motor (see Fig. 3.11-3).

6. Using a small two-jaw puller, pull the slip clutch assembly (see Fig. 3.11-3) off the shuttle motor shaft.

7. Remove the SHCS attaching the cover to the holding arm casting on the tool changer.

8. Remove the cover from the wire channel inside the holding arm casting and unplug the shuttle motor from the wiring harness.
9. Remove the four FHCS attaching the shuttle motor to the holding plate on the tool changer. The FHCS are visible from the front of the VMC. Do not remove the HHBs holding the shuttle motor gear box together.

**SHUTTLE MOTOR INSTALLATION**

1. Install the new motor on the tool changer holding plate using the four 10-32 x ¾” FHCS. Before inserting the FHCS, place a drop of blue Loctite® on each screw.

2. Reattach the shuttle motor connection to the wiring harness in the holding arm casting.

3. Replace the cover on the holding arm casting.

Figure 3.11-4 Wiring harness for shuttle motor.

Figure 3.11-5 Front view of holding plate showing FHCS location.
4. Reattach the slip clutch assembly to the shuttle motor shaft. Before placing on the shaft, put two or three drops of red Loctite® on the slip clutch hub.

5. Insert and tighten down the set screw holding the slip clutch assembly to the shuttle motor shaft. Before inserting the set screw, put a drop of blue Loctite® on the set screw.

6. Ensure the actuating arm on the slip clutch assembly contacts the shuttle IN and OUT limit switches.

7. Ensure the hub of the slip clutch assembly does not interfere with the face plate on the shuttle motor.

8. Start the VMC and go through a performance check consisting of at least 30 tool changes, assuring correct operation.

**TURRET MOTOR REMOVAL**

1. Power on the VMC and put it in MDI mode.

2. Zero Return all axes (ZERO RET - AUTO ALL AXES).

3. Press ATC FWD then the EMERGENCY STOP after the spindle head has moved during the tool change cycle. At this time, the tool changer should be at the full in position and the spindle head should be above the tool changer.

4. Turn the VMC power OFF.

5. Remove the 10-32 SHCS from the carriage casting cover and remove the cover.

6. Tag both limit switch connections for reassembly, then unplug the limit switches and the power connections at the carriage casting.

7. Remove the four SHCS attaching the turret motor and mounting plate to the tool carriage casting.

![Figure 3.11-6 Carriage casting with cover removed.](image-url)
8. Carefully lift the turret motor assembly off of the tool carriage casting.

NOTE: The gear motor should never be disassembled and is not field-serviceable. All gear motors should be returned to Haas for evaluation and rebuilding.

INSTALLATION -

1. Grease the locking element and drive pin on the Geneva driver. Also, grease the teeth on the Geneva star.

2. Rotate the Geneva driver until the cam depresses the limit switch on the turret motor assembly.

3. Place a narrow strip of paper around the locking element of the Geneva driver and install the turret motor assembly onto the casting. Be certain that the locking element of the Geneva driver is seated against the star with the paper strip acting as a shim.
4. Attach the turret motor assembly to the carriage casting with the four SHCS.

5. Reconnect the power and limit switch lines to the turret motor.

6. Power on the VMC and ZERO RETURN all axes (ZERO RET - AUTO ALL AXES).

7. Go to MDI mode and press "T - 1 - ATC FWD".

   NOTE: The machine may alarm at this time (Alarm 115 or 127). If this occurs, ZERO RETURN the Z-axis (ZERO RET - SINGL AXIS) and repeat step 8. This step may need to be repeated two times to clear all possible alarms.

8. Press "T - 9 - ATC FWD". The tool changer should go to tool nine. If the tool changer travels to tool seven, the turret motor is wired backwards. Reverse motor leads and repeat steps 7-10. Also, the turret should run quietly with no strain in the motor, banging, or vibration.

9. Reinstall the tool carriage casting cover.

10. Test the tool changer for proper operation.
**Geneva Star Replacement**

**NOTE:** If the ATC Geneva star is damaged or worn in its driven slots, it must be replaced.

1. Turn the machine power off.
2. Remove the cover from the front of the ATC shuttle.
3. Remove the turret motor assembly (Refer to previous section).
4. Place a support for the ATC under the center of the carousel.
5. Loosen the nut inside the carriage casting that attaches the ATC carousel assembly to the casting. There is a socket head in the top of the shaft to hold it stationary while loosening the nut.
6. Place the cardboard over the mill table and carefully lower the carousel until it rests on the table.
7. Remove the six SHCS that attach the Geneva star to the bearing housing on the ATC carousel.
8. Install the Tool #1 standoff on the replacement Geneva star.
9. Install the replacement Geneva star. Check the concentricity of the star to the shaft on the carousel assembly; it must be within 0.005". If the star is not within tolerance, loosen the SHCS and adjust the alignment until it is acceptable.
10. Installation is reverse of removal. Be certain to grease the perimeter of the star before installation and readjust the ATC in accordance with "Alignment Preparation" and "Shuttle Stroke Adjustment", if necessary.

**ATC Trap Door Replacement**

**NOTE:** If the ATC trap door is damaged in a crash, it must be replaced.

1. Turn the machine power off.
2. Remove the turret motor assembly in accordance with the previous section.
3. Place a support for the ATC under the center of the carousel.
4. Loosen the nut inside the carriage casting that attaches the ATC carousel assembly to the casting. There is a socket head in the top of the shaft to hold it stationary while loosening the nut.
5. Place the cardboard over the mill table and carefully lower the carousel until it rests on the table.
6. Remove the two SHCS that attach the guide pin for the ATC trap door to the ATC holding plate and remove the guide pin.
7. Slide the trap door from between the carousel cover and the shuttle casting. Be careful to not lose the two nylon washers that sandwich the trap door between the carousel cover and the shuttle casting.
8. Installation is reverse of removal. When installing the guide pin, ensure the mounting slot is approximately central to the mounting screws and be certain the pin does not interfere with the top of the ATC carousel cover. Grease the carousel cover where the plastic standoffs ride, the slot in the ATC shutter, the guide pin, and the nylon washers where the shutter pivots. The position of the ATC may need to be readjusted after installation.
Grid Offset Calculation

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

GUIDELINES -

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

In ZERO RETURN mode, the DISTANCE TO GO is the amount the encoder rotated from when the switch was released until it found the Z channel signal. The ideal amount for the DISTANCE TO GO is .118 (This equals 1/8 of a revolution of the encoder).

SETTING THE OFFSET -

1. Set the grid offset to zero. (Parameter 125, 126, 127, 128, or 170, depending on the axis being set.) Setting #7 (PARAMETER LOCK) must be OFF to reset grid offset.
2. Press ZERO RET and ZERO SINGL AXIS the axis you are setting (X, Y, Z, A, or B).
3. Calculate the grid offset using the following formula, and write the result in Parameter 125, 126, 127, 128, or 170 (depending on the axis being set).

\[(\text{DISTANCE TO GO} - .118) \times \text{Ratio} = \text{Grid Offset}\]

The Ratio (steps/unit) for the X, Y, Z, A, and B axes are the values in Parameters 5, 19, 33, 47, and 155, respectively.

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

NOTE: If Z-axis grid offset is reset, Parameter 64 should be checked and adjusted accordingly.

Setting the Offset using the Grid Feature

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

1) Turn the machine off and back on. This will un-zero all the axes.
2) Select the ALARMS screen and enter DEBUG mode.
3) Perform a ZERO SINGLE AXIS on each of the desired axes individually. Ignore any ZERO RET MARGIN TOO SMALL alarms. Note: if a SERVO ERROR TOO LARGE alarm was generated, this indicates that a GRID OFFSET parameter is out of range (make sure it is -138718 to +138718.)
4) Select the Positions screen, enter GRID and press ENTER. The message GRID OFFSET DONE should appear and the GRID OFFSET parameters for the homed axes will have been updated. If the message “NO ZERO” appears, this indicates that none of the axes had been zeroed.
5) Perform AUTO ALL AXIS and verify that the DIST TO GO value for each of the selected axes is now close to 0.118".
Special Tools Required:

- Lifting Device (1000lb capacity for ATC removal)
- Spanner Wrench
**40 Taper Carousel Removal and Installation**

**Removal:**

1. Power Off machine.
2. Unscrew the BHCS from the carousel number disc and remove. Refer to Figure 3.12-1.
3. Using a spanner wrench, remove nut on the center shaft of the carousel.
4. Carefully pull carousel assembly from the ATC center shaft. Lift carousel away from the machine and carefully avoid hitting the sheet metal covers. Place assembly in service area.

   **CAUTION!** Be careful not to bend the tool pocket orientation tabs when storing the carousel assembly.

5. Unscrew the FHCS for each tool pocket. Remove the tool pocket holders from carousel. Refer to Figure 3.12-3.
Installation:

1. Carefully lift and place carousel on to the center shaft.

2. Install new carousel retaining nut on to the ATC center shaft and torque to 85 ft-lbs (place the locking portion of the nut towards the end of the shaft). Remove the pocket stop and slider.

3. Install each tool holder through the spindle. Attach the tool pocket to the carousel. Apply blue loctite to the Torx and torque to 15 ft-lbs (1/4-20) / 23 ft-lbs (5/16-18). Manually rotate the carousel for each tool pocket installation. Re-install the pocket stop and slider. Refer to Figure 3.12-3. The carousel can be rotated by manually rotating the carousel pulley by hand. See Figure 3.12-4

4. Re-attach the carousel number disc with the BHCS. Apply blue loctite to the BHCS and tighten.

5. Re-check slider adjustment. Refer to section on tool pocket slider adjustment.
50 Taper Carousel Removal and Installation

Removal

CAUTION! Do not attempt to remove the carousel with the pockets installed.

1. Remove sheetmetal disc covering the carousel. Press <TOOL CHANGER RESTORE>. Press <Y> three times to enter Tool Changer Recover Mode.

2. Remove all tool changer pockets. See the 50 Taper SMTC Pocket Removal and Installation in this section.

NOTE: The carousel can be manually rotated by turning the carousel drive motor by hand while in <E-STOP>.

3. Remove the center bearing nut using Haas tool P/N #1357.

4. Remove the carousel using a suitable lifting device.

CAUTION! The carousel is extremely heavy. Ensure you have an appropriate lifting device and straps capable of lifting the carousel weight.

Installation

1. Using a suitable lifting device, place the carousel onto the tool changer body.

2. Use a new bearing nut and thread onto the carousel shaft. Torque to 80 ft./lbs.

3. Install pockets into the carousel following the 50 Taper SMTC Pocket Removal and Installation section.

4. Rotate the carousel by hand to the next pocket. Line up the pocket mounting finger with the actuator shaft (or micro switch) on the flat spot on the carousel cam.

ATC Assembly Removal / Installation

Removal:

1. Power Off machine.

2. Remove all ATC assembly sheet metal covers and fasteners.

3. Remove the tool changer amphenol connection at the control box and tool pocket air line at the top of the carousel. Wrap and tie the amphenol connector to the top of the carousel cam box.

4. Insert an eye-bolt into the threaded 1/2-13 hole at the top of the carousel housing. Attach the lifting device to the eye-bolt and support the ATC assembly (Refer to Figure 3.12-5). Remove the five carousel mounting SHCS from the ATC mounting bracket and move ATC assembly away from the column (Refer to Figure 3.12-6).

5. Carefully raise the ATC assembly until it is out of the machine. Avoid catching the double-arm on other machine parts.
6. Lower the ATC assembly with the back side of the cam box towards the ground. See Figure 3.12-5.

installation:

1. Power Off machine.

2. Clean mounting surfaces of the ATC mounting bracket and the ATC.

3. Align the ATC with the mounting bracket and attach with SHCS. Only snug the SHCS.

4. Reconnect the tool changer amphenol connector to the control and re-attach the air line to the carousel assembly.

5. Align the ATC assembly according to section on ATC alignment.

6. Torque the SHCS to 100 ft-lbs.

7. Replace all carousel sheet metal covers and fasteners. Apply blue loctite to all fasteners and tighten.
This procedure is for a newly mounted ATC assembly without the double-arm installed.

Cam Box to Tool Pocket Alignment:

1. Remove all cam box sheet metal fasteners and covers. Place protective covers on the machine table.

2. Power Up machine. Raise Z-axis to top of travel. Set the machine control to Tool Change Recovery Mode (TCR).

3. Push the ARROW DOWN button, to activate the tool pocket down (insure proper tool pocket operation). Refer to figure 3.12-7.

4. POWER OFF the machine. Disconnect the air supply line at the rear of the machine. The tool pocket will raise once the air is disconnected.

5. At the top of the ATC assembly, reverse the two air lines going from the solenoid valve to the air cylinder. See Figure 3.12.8. Reconnect the air supply line at the rear of the machine. (The tool pocket holder in the tool change position should move down)
6. At the top of the ATC assembly, manually rotate the cam box pulley clockwise until the output shaft is lowered and just before it begins to rotate 180\degree.

7. Align the double-arm underneath the tool pocket and the spindle with the unlocking finger buttons facing upward. Place the double-arm on to the shaft and snug the lock ring on the bottom of the double-arm with the SHCS.

8. Place an empty tool holder without a pull stud into the double arm end beneath the tool pocket. Depress the tool release button on top of the double-arm and insert a tool holder. Slightly push the double-arm in the clockwise direction to remove backlash in the drive assembly. Refer to Figure 3.12-9.

**Radial alignment of Double Arm to Carousel:**

9. Rotate the cam box pulley counter-clockwise to raise the double-arm into the tool pocket holder. Visually check the centerline alignment of the tool holder to the centerline of the tool pocket.

10. In order to adjust the radial alignment of the tool pocket holder to the double arm, loosen the lock ring SHCS and adjust the double-arm. Refer to Figure 3.12-9.

11. If the double arm is not aligned in the y-axis with the centerline of the tool pocket holder, loosen the four cam box SHCS and insert a pry-bar between the slots. Adjust the cam box until the centerline of tool holder is aligned with the centerline of the tool pocket.

12. Torque the cam box SHCS to 100 ft-lbs.
Figure 3.12-9 Cam Box / Double Arm Alignment, top view.

Checking Parallelism of Double-arm to Table:

13. Rotate the cam box pulley clockwise to lower the double arm. Remove the tool holder from the double arm.

14. Rotate the cam box pulley counter-clockwise to raise the double arm back to its home position.

15. Remove the air supply line from the rear of the machine. **Switch the inlet and outlet airlines back to their original positions at the top of the ATC assembly.** Re-attach the air supply line (the tool pocket holder should retract to its home position).

16. POWER ON the machine and enter TCR mode. For more information on TCR mode refer to the TCR flow chart located in the Technical Reference section.

17. Press the ATC FORWARD button until the arm lowers and is parallel to the x-axis. Insert a short tool holder into the double arm by pressing the tool release button located near the shaft. Refer to Figure 3.12-9

Place a magnetic base and indicator on to the machine table. Measure the bottom of the tool holder to the nearest .001.”

18. Move the tool holder and indicator setup to the other end of the double-arm. Measure the bottom of the tool holder to the nearest .001.” The maximum allowable height tolerance between the two ends is .030.” Adjust the alignment as necessary. Repeat this test with the arm rotated 180°.

19. Remove the tool holder from the double-arm. Return the double-arm to the home position.

Setting the Double-arm Height:

20. Press the DOWN ARROW to command the tool pocket down. Place a tool holder **with** a pull stud into the tool pocket. In TCR mode, rotate the double arm near the tool pocket.

21. Visually check the height alignment of the double arm to the V-groove on the tool holder. If necessary loosen the lock ring SHCS and adjust the height of the double arm. Torque the lock ring SHCS to 7 ft-lbs.

22. Repeat steps 9 & 10 to re-check radial alignment.
23. Return the double-arm to the home position.

**Double-Arm to Spindle Alignment:**

1. **ZERO RETURN** the Z-axis.

2. In TCR mode, lower the double arm and re-insert the short tool holder without pull stud into the double arm. Orient the spindle dogs for a tool change. (If the orientation has changed reset Parameter 257. Refer to section on setting spindle orientation). If spindle dogs are not aligned with the tool holder slot, manually rotate the spindle dogs.

3. Raise and lower the double-arm to move the tool in and out of the spindle. Check for alignment. Refer to Figure 3.12-10.

4. Check the X-axis alignment of the tool holder to the spindle center. Refer to Figure 3.12-10.

![Figure 3.12-10 Double Arm to Spindle Center Alignment, along the Y-axis.](image)

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

![Figure 3.12-11 ATC Assembly X-axis alignment](image)  ![Figure 3.12-12 ATC Assembly Y-axis alignment](image)
6. Insert a pry-bar between the locating pins and the ATC mounting bracket. Adjust the bracket to align the tool holder in the double arm to the center of the spindle in the X-axis. Refer to Figure 3.12-11.

7. Torque the SHCS to 80 ft-lbs.

8. Check the Y-axis alignment of the tool holder to the spindle.

9. If necessary, loosen the five ATC SHCS (Refer to Figure 3.12-12). Insert a small pry bar between the locating pins and the mounting bracket. Adjust the ATC along the mounting slots and align the tool and spindle’s center.

10. Check the spindle tool change height. If the spindle tool change height has changed, reset Parameter 64 (section 3.6).

11. Return to normal operation. Insert tool holders through the spindle and perform several tool changes. Observe the tool changer during operation and make any adjustments if necessary.

12. Torque the ATC mounting SHCS to 100 ft-lbs. Replace all cam box sheet metal covers and fasteners. Apply blue loctite to the fasteners and tighten.

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**SETTING SPINDLE ORIENTATION**

1. POWER UP machine. Go to PARAMETERS. Unlock PARAMETERS and change the value under PARAMETER 257 to "0."

2. Place a tool into the spindle. Enter TCR mode. Align the spindle dogs to the double-arm key (refer to Figure 3.12-13). Press the ATC FORWARD button until the double arm engages the tool (manually rotate the spindle dogs if necessary).

3. Enter DEBUG mode. Record the encoder value under "spindle orientation position". Refer to Figure 3.12-13.

4. Return to Parameter 257. Enter the spindle orientation value from DEBUG and lock parameters.

5. In TCR mode, press the ATC REVERSE button until the double arm is in the home position. Return to normal operation mode.

6. Manually insert tools into spindle and perform several tool changes. Observe for any misalignment.

7. Adjust the PARAMETER 257 setting value if necessary.
Removal

1. In TCR mode, lower the double arm. POWER OFF machine.

2. Underneath the double-arm, loosen the six SHCS from the lock ring. Insert four new jack screws into the lock ring (Coat the jack screw threads and tips with moly grease).

3. Slowly tighten the jack screws in order to push the double-arm away from the lock ring. If necessary, tap the center of the double arm from underneath with a soft mallet until the double-arm breaks free.

4. Once the double-arm is loose, pull the double arm assembly off the shaft.

Figure 3-12-14 Removal of the Double Arm
Installation

1. Place the double-arm onto output shaft. Align the double-arm to the home position, then slide the lock ring onto the shaft.

2. Reattach the lock ring to the double-arm with six (6) SHCS. Verify the slides are correctly adjusted on the double arm with the following procedure:

With the double arm lowered, and a tool inserted into the double arm, a 0.020 feeler gauge should fit between the slide and the tool flange O.D. The plunger should be able to rise fully to the locked position with the gauge between the tool holder and the plunger.

The plunger will not return reliably to the fully raised locked position when the tool is inserted, if there is insufficient clearance. The toolholder will be excessively loose in the doublearm if there is too much clearance.

To adjust the clearance, remove the slide and the cover by removing the cover plate and lifting the slide out at an angle. Be careful not to lose the spring. Loosen the locknut and adjust the clearance. Apply blue Locktite and retighten. Grease the spring and the slide assembly and reinstall them both. Reattach the cover plate and recheck the clearance. Both ends of the double arm are separately adjusted.

3. Re-align the double-arm to the spindle and tool pocket. Refer to section on ATC alignment.
**Removal**

1. Turn the machine on and rotate the carousel to the pocket you want to change. Remove the sheetmetal in order to gain access to pocket limit switches. Remove the sheetmetal disc covering the carousel.

2. Press `<Tool Changer Restore>`. Press `<Y>` three times.

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

![Pocket Stop](image1.png)

4. Remove the shoulder bolt from the back of the pocket slide.

   **NOTE:** The machine must be in Tool Changer Recovery Mode to perform the next step.

5. Press `<v>` to retract the air cylinder shaft. Manually lower the pocket and remove the pocket retaining screw. See the following figure:

![Pocket Retaining Screw](image2.png)

6. Remove the tool changer pocket by carefully maneuvering the pocket out of the carousel, taking care not to drop the pocket slide.

**NOTE:** If the carousel is to be replaced, skip to the Carousel Removal and Installation section.
Installation

7. Replace the damaged pocket with a new one. Apply grease to the shaft. Install the pocket slide and pocket into the carousel. Apply a drop of Red Loctite to the pocket retaining screw and install. Torque to 14 ft./lbs.

8. Clear all alarms. Return to Tool Changer Recovery Mode and press <^>. This will extend the air cylinder shaft. Install the pocket slide shoulder bolt, taking care not to pinch the microswitch roller. Ensure that the microswitch roller rests on the shoulder bolt head.

9. Install the pocket stop, using Blue Loctite and torquing the four SHCS to 40 ft./lbs. Activate the pocket up and down several times. Restore the machine to automatic mode and perform a tool change by pressing <MDI> and then <ATC FWD>. Check for any binding or interference of installed parts.

50 TAPER SMTC POCKET REMOVAL AND INSTALLATION

Removal

1. Turn the machine on and rotate the carousel to the pocket you want to change. Remove the sheetmetal disc covering the carousel.

2. Press <Tool Changer Restore>. Press <Y> three times.

3. Remove the four SHCS that hold the pocket stop. See the Figure below:

   ![Diagram](image)

   **NOTE:** Do not remove the set screws. Doing so will change the pocket slide and groove alignments.

4. Manually rotate the carousel to the affected pocket by manually rotating the carousel motor and disconnect air from the machine. Remove the pocket retaining screw. See the Figure below:

5. Remove the tool changer pocket by carefully maneuvering the pocket out of the pocket slide fingers, taking care not to drop the pocket.

   **NOTE:** If the carousel is to be replaced, skip to the Carousel Removal and Installation section.
Installation

1. Replace the damaged pocket with a new one. Apply grease to the shaft. Install the pocket into the pocket slide fingers. Apply a drop of Blue Loctite to the pocket retaining screw and install. Torque to 23 ft./lbs. Reconnect air to the machine.

2. Press <^>. This will extend the air cylinder shaft and raise the pocket.

3. Install the pocket stop, using Blue Loctite and torquing the four SHCS to 45 ft./lbs. Activate the pocket up and down several times. Restore the machine to automatic mode and perform a tool change. Check for any binding or interference of installed parts.

4. Raise the pocket and verify that the pocket slide groove matches the casting groove. See the following figure.

---

**Tool Pocket Slider Adjustment**

The slider set-screw is used to adjust the tool pockets' end-of-stroke with the circular path on the carousel housing.

1. Rotate carousel by turning the carousel cam pulley by hand. Refer to Figure 3.12-4.

2. Visually check for mis-alignment (tool pockets should move smoothly). Refer to Figure 3.12-15

3. If necessary, loosen the set-screw nut. Adjust the set-screw in or out until the tool pocket is aligned with the circular path on the carousel housing. Advance the tool pocket and observe for proper alignment.
4. Tighten set-screw lock nut.

![Diagram of tool pocket orientation and set-screw adjustment](image1)

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

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**Proximity Switch Removal / Installation**

**Removal**

1. Power Off machine. Remove the carousel number disc and the top cover plate.
2. Remove the 1/4"NPT plug near the cam box output shaft and drain the cam box oil.
3. Disconnect the proximity switch connector from the bracket on the top of the assembly.
4. Loosen the double nuts retaining the proximity switch. Carefully remove the proximity switch from the cam box assembly. Refer to Figure 3.12-16.

![Diagram of proximity switch location](image2)

**Figure 3.12-16 Proximity Sensor Switch Location**
Installation

The proximity trigger disk inside the cam box determines the sensor operation. The sensor must be approximately .030" away from a flat surface on the disk to function properly. An L.E.D. light will come on at the back of the sensor when it is triggered.

1. Look through the sensor hole and rotate the cam box pulley by hand until the groove is not visible.

2. Screw two nuts to the threaded section of the proximity switch. Snug the two nuts together and apply thread sealant to the threads. Carefully screw the switch into the cam box. Connect the proximity switch connector to the plug on the switch bracket. Refer to Figure 3.12-17.


4. Screw the proximity sensor into the cam box an additional 1/8 turn after the L.E.D light comes on. Loosen both nuts then re-tighten the inner nut against the cam box housing. Tighten the outer nut against the inner nut.

5. Repeat this procedure for each proximity sensor switch.

6. Refill the cam box with oil (Penzgear 320) to the fill level line. See Figure 3.12-16.

7. Check for correct operation of the tool changer and alignment. Adjust as necessary.

8. Replace the carousel disc and top cover plate. Apply blue loctite to the fasteners and tighten.
Setting Parameter 64

On a Vertical mill: For Z-axis; displacement from home switch to tool change position and machine zero. On machines equipped with 40 taper or 50 taper side mount tool changers this distance is:

\[(\text{Distance from Home in Inches}) \times (\text{Line Encoder Constant}) = \text{Z-axis tool change position setting}\]

Example:
\[.625 \times 1378718 = 861699\]

To reset Parameter 64 (Z-axis tool change position) if an ATC assembly has been installed or replaced.

1. Enter PARAMETERS page and record original Parameter 64 setting value.
2. (Make sure there are no tools in the spindle head or tool pocket positions). Command the spindle head to its tool change height. Enter DEBUG and record Z-axis spindle height value.
3. Enter TCR mode. Press the DOWN ARROW, command a tool pocket down. Manually insert a tool into the tool pocket.

![Figure 3.12-18 Setting Parameter 64, indicator reference measurement.](image)

4. Place a 0.0005” indicator with an extended arm base on to the machine table. Indicate the bottom of the tool with the indicator to the nearest 0.001.” Record the measurement.
5. Remove indicator from the table and the tool holder from the tool pocket. Insert the tool into the spindle head position. Place the measurement indicator under the spindle head.
6. Enter DEBUG. Jog handle the Z-axis up or down until the end of the tool is at the same height as the measured value found when the tool was placed in the tool pocket. Record the Z-axis spindle height value. Refer to Figure 3.12-18.
7. Take the difference in the spindle height values found in DEBUG mode and add the encoder count value to the original value for PARAMETER 64 setting.
Example: 40 Taper SMTC

(Difference in Z-axis encoder counts) + (Old Z-axis Tool Change Setting) = New Z-axis Tool Setting

20681 + 861699 = 882380

8. Enter PARAMETERS page. UNLOCK settings and write new setting value for Parameter 64. LOCK parameter settings.

9. Perform a tool change and observe for misalignment. Adjust the PARAMETER 64 setting if necessary.
3.13 Enclosure Replacement

Please read this section in its entirety before attempting to replace the doors or windows.

TOOLS REQUIRED
• Trim installation tool (dull-edged knife or caulking spatula)

Door Replacement

CAUTION! If possible, have two people performing this operation, as the weight of the doors may be a factor in removal.

Removal -
1. Turn the machine power off.
2. Slide the doors to the full open position.
3. Remove the tension springs (2) connecting the two swivel roller brackets at the top and bottom of the door.
4. Slide the door to the fully closed position. Loosen the two upper roller hex nuts, and disengage the upper swivel roller brackets from the top roller guide.
5. Lift the door from the bottom roller guide and remove.

Installation -
6. Ensure that the lower roller hex fasteners are wrench tight and the upper roller fasteners are finger tight in the middle of their adjusting slots. Place the door into the enclosure, and position with the lower rollers resting on the lower roller guide.
7. Rotate the door to the upright position, and engage the top rollers onto the top roller guide.
8. Replace the tension springs onto the upper and lower roller swivel brackets. Tighten the upper roller fasteners.
9. Verify that the door travels smoothly. If it does not:
   • Check that all roller wheels are seated and roll on their tracks.
   • If all roller wheels are seated on their tracks, it will be necessary to adjust the door travel by loosening the upper and lower roller hex fasteners.
DOOR ADJUSTMENTS -

10. Close both doors and check that the vertical gap between them is uniform. If it is not:
    • Determine which door must be adjusted.
    • Loosen the door's outer lower roller attachment and pivot the door on the inner lower roller wheel.
    • When the door is in the desired position (the vertical gap is uniform), tighten the lower outer roller fastener.
11. Check the gap between the door and the front panel flange, and verify it is 5/8" throughout the travel of the door. If it is not:
   • Loosen the door’s upper roller fasteners and tilt the door forward or back, as necessary, to adjust door position.

   ![Door Gap Diagram]

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

**SWITCH ADJUSTMENT -**

12. Move the door to the fully closed position. Go to the "Diagnostics" page on the control panel, and ensure "DOOR S" reads "0". Move the door to the open position, and ensure "DOOR S" reads "1". If either reading is incorrect:
   • Loosen the SHCS that mounts the switch actuator bracket to the top of the door. (NOTE: It is possible to access this bracket from the side window.)
   • Move the bracket in its slot to the proper position and tighten the SHCS.

**WINDOW REPLACEMENT**

**REMOVAL -**

1. Turn the machine power off.

2. Move the door to the fully closed position so the window is accessible. Use a trim installation tool to pull the locking tab out of the inside of the window seal (the tab is a part of the seal).

3. Remove the window panel from the seal. The tool can be placed between the window panel and the seal to aid in removing the window panel.

4. Remove the seal from the enclosure’s cutout.
INSTALLATION -

1. Replace the seal around the enclosure's cutout, with the locking tab facing the inside of the machine.

2. Replace the window panel into the seal. The tool can be placed between the window panel and the seal to aid in replacing the window panel into the seal.
### 3.14 Hydraulic Counterbalance

**TOOLS REQUIRED**

• (1) 4 x 4 x 14” head support block

• Hydraulic counterbalance service kit, consists of:
  • Pressure tank with manifold assembly, prefilled with (2) quarts DTE-25 hydraulic oil
  • Hydraulic cylinder with hose attached (if necessary)

**Hydraulic Tank Replacement**

**REMOVAL -**

---

**CAUTION!** While performing this procedure, the spindle head may drop if the control loses power or alarms.

1. Raise spindle head by HANDLE JOG up to 14.5” above table. Insert wood block and lower head casting onto it. EMERGENCY STOP the machine. Head should rest securely on table block. Power OFF VMC.

**NOTE:** Do not lower spindle onto block.

2. Disconnect the two-pin end of the pressure sensor cable(s) to the pressure sensor(s), if tank is equipped with sensor.

---

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

3. Remove cap to Schrader filler valve.

4. Ensure T-handle of the gas chuck is turned completely counterclockwise. Attach charge/discharge kit by tightening gas chuck to the Schrader valve finger tight, then wrench lightly to tighten (see Figure 3.14-1).
5. Place the CGA 580 end of charge/discharge kit into a bucket to contain the hydraulic oil while discharging the system.

6. Slowly turn the T-handle clockwise until the system begins to discharge. Complete discharge may take up to 10 minutes. Verify tank gauge reads 0 psi.

7. Turn the T-handle completely counterclockwise and remove the charge/discharge kit from the Schrader valve.

8. Disconnect the hydraulic hose from the tank assembly.

9. Remove the tank assembly from the column by removing the four SHCS from the tank mount.

**INSTALLATION -**

1. Connect the hose to the tank before mounting the tank in the inverted position. This prevents hydraulic oil from spilling.

   **NOTE:** For a positive seal, ensure the hose-to-tank connection is straight, and not skewed.

2. Mount the tank assembly to the column with the tank mount and four SHCS. Ensure the hydraulic hose is not twisted.

3. Connect the two-pin end of the pressure sensor cable(s) to the pressure sensor(s).

4. Use cable ties to secure the cable to the hydraulic hose.

   **NOTE:** For this step, use regulated dry nitrogen gas (welding grade acceptable) that accepts a right-hand thread CGA 580 fitting.

5. Attach the CGA 580 fitting end of the charge/discharge kit to the source pressure. Ensure T-handle of the gas chuck is turned completely counterclockwise. Attach charge/discharge kit by tightening gas chuck to the Schrader valve finger tight, then wrench lightly to tighten. Pressurize the system to required pressure as listed in Figure 3.14-2.

   **NOTE:** For VF-6/8 follow installation procedure for each hydraulic tank.

   **NOTE:** • Do not use compressed air, oxygen or flammable gas.
   • Refer to the table below and verify pressure according to machine and spindle head position.
   • Verify cylinder is seated in counterbore.

<table>
<thead>
<tr>
<th>Machine at top of travel</th>
<th>VF-3/4</th>
<th>VF-6-11</th>
<th>VF-6/7/10 w/50T Spindle</th>
<th>VF-8/9/11 w/40T Spindle</th>
<th>VF-5 w/50T Spindle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1150 psi</td>
<td>750 psi</td>
<td>1150 psi</td>
<td>1550 psi</td>
<td>875 psi</td>
<td>1100 psi</td>
</tr>
</tbody>
</table>

   *Figure 3.14-2 Tank pressure requirements.*

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

   **NOTE:** If there is an E-stop alarm that will not reset, check for correct system pressure and the correct tank assembly.
HYDRAULIC CYLINDER REPLACEMENT

REMOVAL-

1. Remove the hydraulic tank as described in previous section.

2. To gain access to the cylinder rod, remove the three SHCS holding the Z-axis way cover to the spindle head.

3. Remove the cotter pin and lock nuts from the threaded end of the cylinder rod.

NOTE: For VF-6/8 loosen jam nut from clevis then remove the cotter pin, clevis pin, clevis and jam nut.
4. Remove the band clamp that holds the cylinder to the stabilizer bracket. Loosen the two SHCS that attach the bracket to the column.

5. Remove the hydraulic cylinder from the top of the column.

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

Fig. 3.14-5 VF-Series hydraulic counterbalance view - left side view.
NOTE: Do not disassemble unit. Keep the hose attached to the cylinder.

6. Return complete assembly to HAAS Automation.

INSTALLATION-

1. Install cylinder with cylinder rod extended from top of column.

   NOTE: Cylinder rod should pass through column bracket and spindle head bracket. Cylinder body must rest in column bracket counterbore.

2. Orient cylinder body with hydraulic hose facing away from lead screw.

   NOTE: For VF-6/8 orient cylinder bodies with hydraulic hose facing the lead screw.

3. Install lock nuts, at threaded end of cylinder rod, wrench tight. Install safety cotter pin.

   NOTE: For VF-6/8 install jam nut and clevis at end of cylinder rod then attach to spindle head bracket with clevis pin. Install safety cotter pin and lock the clevis by tightening jam nut.

4. Install the hydraulic tank as described in the previous section, but DO NOT power up the machine.

5. Power on the machine and zero return (ZERO RET) Z-axis only. Observe cylinder body for motion or abnormal noises. Check for fluid at manifold, cylinder hose connection and cylinder rod. Verify tank pressure at top of travel. Remove charging system and replace valve cap.

6. Install the band clamp and tighten the two SHCS that attach the stabilizer bracket to the column.

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

8. Cycle Z-axis, using the following program, for five minutes and check for oil leaking at top of cylinder and cylinder rod.
   
   G28, G54, Z-14.
   M99
   50% Rapid

9. If Z-axis overcurrents alarm during travel, verify and correct system pressure.

   NOTE: If Z-axis overcurrent alarm at top or bottom of travel, call HAAS Automation Service Department immediately for assistance.
   • If fluid leaks from hydraulic fittings, check that fittings are tight.
   • If leaking continues, call HAAS Automation Service Department for assistance.

10. Reinstall Z-axis way cover with three SHCS that hold it to the spindle head.
3.15 Through the Spindle Coolant System - Adjustments

Tools Required
- Tool holder with small TSC drill or restrictor (with a small orifice #T-1461)
- TSC Gauge Kit (P/N 93-9011), includes:
  - 0-15 PSI Precharge pressure gauge
  - 0-160 PSI Purge pressure gauge (Not used on newer TSC machines)
  - 0-600 Coolant pressure gauge
  - Ball valve

Precharge Regulator Adjustment

1. **CAUTION!** Extreme care must be taken in making this delicate adjustment. Insert a short piece of 1/4" plastic tubing into the 0-15 psi pressure gauge. Insert the short tube into the precharge pressure regulator (located on top of the transmission) and connect the plastic precharge tube (leading to the TRP) to the pressure gauge.

2. Manually turn on the precharge air by pushing the plunger on the precharge solenoid valve.

3. Hold down the precharge solenoid valve for at least 20 seconds to allow the pressure reading to stabilize, then set the precharge pressure to 4.0 psi (±0.4 psi). Release the solenoid and hold it down again for 20 seconds and re-check the precharge pressure. Repeat this a few times to ensure the pressure setting remains stable. Be sure the regulator adjustment knob is securely locked in place.

4. Remove the pressure gauge and short 1/4" hose. Reattach the precharge tube to the regulator.

Priming the TSC System

**Note:** When machine is ready to operate, with coolant in the coolant tank, prime the Through the Spindle Coolant (TSC) system according to the following procedure. This procedure should also be performed whenever the pump has sucked in air (e.g. low coolant).

50 Taper TSC (old system)

1. With no tool in the spindle, switch to MDI mode.
2. Close the programmable coolant (P-Cool) and lock line shut-off valves.
3. Press the COOLNT key to turn on the main coolant pump; this will prime the TSC pump.
4. Wait 20-30 seconds for the TSC pump to fill.
5. Press the AUX CLNT key to turn on the TSC. Wait for coolant to flow from the spindle at full force.
6. Press the reset key to shut off the system. The TSC system will continue to hold its prime.

High pressure TSC 40 and 50 taper

1. With no tool in the spindle, switch to MDI mode.
2. Press the AUX CLNT button to turn on TSC. Wait for coolant to flow from the spindle.
3. Allow coolant to flow for at least one minute.
4. Press the AUX CLNT button again to turn off TSC.
**CHECKING PUMP PRESSURE**

**NOTE:** If the coolant pressure with no tool in the spindle is 60 psi or less, replace the pump assembly (30-3281A). Old TSC system uses pump head (93-3280B).

1. Insert the 0-600 psi coolant pressure gauge into the coolant line between the coolant filters and the TSC pump hose. Use wrenches to tighten the fittings snug. DO NOT OVERTIGHTEN!!

2. With no tool in the spindle, prime the TSC system as described above.

3. Insert a standard (no through hole in pull stud) tool holder into the spindle.

4. Turn on TSC.

5. Check for leaks while TSC is still running. Shut off TSC.

6. Remove pressure gauge and reconnect the pump to the machine.

**If the pump relief valve has been changed, adjust the relief valve in the following manner:**

1. Remove the sealing cap from the pump relief valve. Loosen the lock nut.

2. Start with the pressure below 300 psi. Adjust the pressure relief valve until the pressure on the gauge rises to 300 psi. Tighten the lock nut, and replace the sealing cap. Setting range is 280-300 psi.

3. Mark across the pump and sealing cap with a paint marker. This will indicate any future tampering.

**TESTING THE COOLANT PRESSURE SWITCH**

1. Insert the ball valve and pressure gauge into the TSC pump outlet. The ball valve must be between the pump and pressure gauge. Connect the other end to the machine. For high pressure TSC, the connectors must be tightened snug with wrenches. DO NOT OVERTIGHTEN.

2. Run TSC system for one minute to purge air.

3. Insert a TSC type tool holder (with a small TSC drill or restrictor) in the spindle. **CAUTION!** Changing tools after running TSC can cause coolant to spray out. Wear safety glasses.

**WARNING!**

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

4. Set Parameter 236 to 100.

5. Turn on TSC. Test low coolant pressure switch by slowly shutting off the ball valve in the coolant line (pump should shut off at 40 psi +/- 5 psi). If the switch is outside this range, replace the switch.

**NOTE:** Test the electrical continuity of the pressure switch cable and the control function by shorting the leads of the cable. The “LO CLNT” bit on the Diagnostics page should change from “1” to “0”. Check this before replacing the pressure switch.

6. Reset Parameter 236 to 1000.
### 3.16 Air / Oil Line Diagram

**VF, 40 Taper Air Line & Oil Line Diagram**

- **Compressed Air Line**
- **Lubricating Oil Line**
- **NOT USED ON VACUUM DRIVE MACHINES**

- **Located at ATR Reg & Lube Back Panel**
  - Oil Tank & Pump
  - Oil Filter
  - Pressure Switch

- **Located at Base Assembly**
  - Linear Guide Rail
  - Ball Screw (Ball Nut)
  - Oil Resistor

- **Located at Column Assembly**
  - Linear Guide Rail
  - Ball Screw (Ball Nut)
  - Oil Resistor

- **Located at Saddle Assembly**
  - Linear Guide Rail
  - Ball Screw (Ball Nut)
  - Oil Resistor
TSC SYSTEM WARNING!

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

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

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

Machining of ceramics and the like voids all warranty claims for wear and is done entirely at customer's risk. Increased maintenance schedules are absolutely required with abrasive swarf. The coolant must be changed more often and the tank thoroughly cleaned of sediment on the bottom. An auxiliary coolant tank is recommended.

### THROUGH SPINDLE COOLANT SYSTEM FLOW DIAGRAM

#### THROUGH SPINDLE COOLANT (TSC) WARNINGS:

1. **TSC Requires Tool Holder With Through Hole in Full Stud and Tool, Failure to Do So Can Flood Spindle Head With Coolant.**
2. **Do Not Run TSC with Low Coolant Level in Tank.**

#### THROUGH SPINDLE COOLANT ALARMS:

1. **Low Thru Spindle Coolant (Alarm 151):**
   - Cause: Coolant Pressure in System Fell Below 40 PSI.
   - A) Check For Low Coolant in Tank, B) Check Dirt Indicators On Both Filters, C) Press Reset and Run TSC Again to Purge Air From System.
2. **Pre-Charge Failure (Alarm 196):**
   - Causes: Tool Release Piston Did Not Move Down When Commanded Or It Moved Up During TSC Operation, Or Another Alarm Occurred During TSC Operation.
   - A) Check For Low Air Supply Pressure, B) Check For T.R.P. Failure.

#### THROUGH SPINDLE COOLANT (TSC) MAINTENANCE SCHEDULE:

1. **Top-Off Coolant Tank Daily (Every 8 Hour Shift) During Heavy TSC Usage.**
2. **Check Gage (G2) On 100 Micron Filter With TSC System Running and No Tool In Spindle. Change Element When The Indicator Reaches the Red Zone. Use 100 Micron Filter Element (56-6145) Or Commercially Available Equivalent.**
3. **Clean Pump Intake Filter When Indicator (G1) Is In Red Zone. Reset With Button.**

Special instructions: After changing or cleaning filter elements, run TSC system with no tool in spindle for at least one minute to purge air.

**Adjustable TSC Parameter:** Parameter 237 (TSC Clnt Line Purge)

Minimum (Default) Value Is 250k, No Minimum Limit.
TSC SYSTEM WARNING!

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

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

WHEN MACHINING CASTINGS, SAND FROM THE CASTING PROCESS AND THE ABRASIVE PROPERTIES OF CAST ALUMINUM AND CAST IRON WILL SHORTEN PUMP LIFE UNLESS A SPECIAL FILTER IS USED IN ADDITION TO THE 100 MESH SUCTION FILTER. CONTACT HAAS FOR RECOMMENDATIONS.

MACHINING OF CERAMICS AND THE LIKE VOIDS ALL WARRANTY CLAIMS FOR WEAR AND IS DONE ENTIRELY AT CUSTOMER'S RISK. INCREASED MAINTENANCE SCHEDULES ARE ABSOLUTELY REQUIRED WITH ABRASIVE SWARF. THE COOLANT MUST BE CHANGED MORE OFTEN AND THE TANK THOROUGHLY CLEANED OF SEDIMENT ON THE BOTTOM. AN AUXILIARY COOLANT TANK IS RECOMMENDED.

THROUGH THE SPINDLE COOLANT SYSTEM FLOW DIAGRAM - 50 TAPER SPINDLE OPTIION

THROUGH SPINDLE COOLANT (TSC) WARNINGS:

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

THROUGH SPINDLE COOLANT ALARMS:

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

THROUGH SPINDLE COOLANT (TSC) MAINTENANCE SCHEDULE:

1. TOP OFF COOLANT TANK BEFORE EACH SHUT DOWN DURING HEAVY TSC USAGE.
2. CHECK GAGE (G2) ON TSC FILTER WITH NO TOOL IN SPINDLE AND TSC RUNNING. CHANGE ELEMENT WHEN THE INDICATOR IS IN THE YELLOW ZONE. USE 20 MICRON FILTER ELEMENT (58-6948) OR COMMERCIAL AVAILABLE EQUIVALENT.
3. CLEAN INTAKE FILTER WHEN SUCTION GAGE (G1) IS IN THE RED ZONE.

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

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

**Pallet Replacement**

**TOOLS REQUIRED:**
- Hoist
- Straps or Chains
- Eyebolts (2)

**CAUTION!** Be careful when changing out pallets, each pallet weighs approx. 300lbs.

**NOTE:** Pallets that have been replaced must be re-aligned to the receiver. Pallets shipped with the VMC from the factory have been machined perpendicular to the spindle. It is recommended that replacement pallets be machined after aligning them to the receiver.

1. Remove the old pallet from the APC using the supplied eyebolts and a hoist.
2. Set the new pallet on the APC, aligning the roller grooves on the bottom of the pallet with the rollers on the APC.
3. Loosen the clamp rail bolts on the new pallet (the bolts should be snug and not overtighten).
4. Run new pallet into the receiver. Clamp and unclamp the pallet a few times (this will allow the pallet to center on the guide pins). Torque the clamp rail bolts to 50 FT-LB while the pallet is clamped to the receiver.

**Figure 3.17-1 Pallet Replacement**

**IMPORTANT!** New pallets should be machined on the VMC in order for them to be perpendicular to spindle.
Pallet Clamp Rail Replacement

Tools Required:
- Hoist
- Straps or Chains
- Eyebolts (2)

Note: This procedure must be performed with the pallets on the APC.

1. Loosen the clamp rail bolts.
2. Screw the eyebolts into place and lift the pallet carefully.
3. Remove the clamp rails from the pallets.

Figure 3.17-2

4. Verify the condition of the wipers and determine if they need replacing.
5. Re-install the new rails leaving the bolts loose.
6. Carefully place the pallet back onto the APC using the hoist.
7. Position the pallet back onto the receiver and clamp/unclamp the pallet several times to allow the rails to center themselves on to the guide pins.
8. Finish torquing the clamp rail bolts.
ALIGNMENT PIN REPLACEMENT

TOOLS REQUIRED:
• Hoist
• Straps or Chains
• Eyebolts (2)

CAUTION! Be careful when changing out pallets, each weighs approx. 300lbs.

NOTE: The receiver must be removed in order to access the alignment pins.

1. Both pallets must be on the APC in order to access the receiver.
2. Position the receiver to the front of the machine.
3. Disconnect the air from the machine.

4. Remove the six (6) receiver mounting bolts.
5. Use a hoist and the two eyebolts supplied with the APC, lift the receiver off the table.
6. Use a punch to remove the alignment pins.
7. Install the new pins using a brass hammer. The pins should bottom out in the holes. Pin height from the base of the receiver to the top of the pin should be within .450 to .490.
8. Position the receiver back onto the table.
9. Install the six mounting bolts.

Figure 3.17-3 Alignment Pin Removal
9. Reconnect the air to the machine.

10. Position a pallet onto the receiver and clamp/unclamp the pallet to the receiver several times. Check for the pallets sticking during this process. If the pallets are sticking, loosen the clamp rail bolts and clamp/unclamp the pallet several times to center the alignment pin to the rails.

NOTE: Because the receiver has been removed from the VMC, any tooling on the pallets must be re-aligned.

**Drive Pin Replacement**

NOTE: If the drive pin assembly is damaged due to a crash or from excessive wear, all components should be checked for damage and replaced.

NOTE: The chain must be loosened in order to remove the entire drive pin assembly.

1. Power off the machine.
2. Remove the drive pin retaining clip.
3. Remove 5/16" washer.
4. The cam follower is lightly pressed onto the pin. The spacer should slide off easily.
LOOSENING THE CHAIN

5. Remove the two screws that mount the coverplate over the sprocket located at the far end of the APC as shown.

6. Loosen the 4 bolts that mount the sprocket bracket to the casting.

7. Loosen the chain sprocket tensioner screw slightly.

8. At this point there should be enough slack in the chain to slide the drive pin out.

9. Re-assemble the drive pin assembly according to the assembly drawing.

10. Re-tension the chain in the reverse order.
APC Pallets

There are two different designs of pallets for use with the APC. This difference in design is for locating the pallet on to the receiver. The earlier method uses two friction blocks to slow the pallet and locate it correctly as it enters the machine (part number 20-0053, or 20-0579 for a metric pallet). The current design uses a pin and latch to locate the pallet (part number 20-0053A, or metric 20-0579A). Current method pallets can be used on earlier machines by replacing the location stub (part number 20-1082), with a friction block (part number 20-1081). See the following figures.

![Pallet Part number 20-0053 (metric 20-0579)](image1)

![Pallet Part number 20-0053a (metric 20-0579a)](image2)

The spare pallet, P/N – PAL40, will come with two filler blocks (20-1081) and one APC Location Stub (20-1082). If the machine has an existing pallet with part number 20-0053 (Metric 20-0579), then the two filler blocks (20-1081) will be used and the Location Stub (20-1082) will not be used. See the figures.

If the machine has an existing pallet with a part number 20-0053A (Metric 20-0579A), then one filler block (20-1081) will be used, one Location Stub (20-1082) will be used, and one filler block (20-1081) will not be used. See the figures.

**NOTE:** The bolts used for the filler block are – 40-1712 SHCS 5/16-18 X ½ (QTY 4). Torque to 35 ft-lb.
The bolts for the Location Stub are – 40-16385 SHCS 5/16-18 X ¾ (QTY 4). Torque to 35 ft-lb.
**AIR LUBRICATION PANEL**

![Air Lube Panel Diagram]

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**AIR REGULATOR SERVICING**

**CAUTION:** Disconnect or shut off air supply and exhaust the primary and secondary pressure before servicing unit. Turning the adjustment knob counterclockwise Does Not vent downstream pressure. Downstream pressure must be vented before servicing the regulator.

**NOTE:** Use mineral based grease or oil ONLY. Do Not use synthetics or silicones.

**NOTE:** After servicing unit, turn on air supply and adjust regulator to the desired downstream pressure. Check for leaks. If leakage occurs, Do Not operate – conduct repairs.

**SERVICING THE FILTER ELEMENT & CLEANING THE BOWL ASSEMBLY:**

Use the pictures on the following page to assist with the following steps.

1. Unscrew the bottom threaded Collar and remove the Bowl Assembly. Use care as not to loose the O-ring (a).

2. Unscrew the Baffle and then remove the Element.

3. Clean the internal parts and Bowl Assembly before reassembling. To clean the Bowl Assembly use mild soap and water ONLY! Do Not blow with air as loss or damage may occur to O-rings.
   
a. Remove the Drain Nut from the Dump Valve and remove it from the Bowl Assembly. Use care as not to loose the O-ring (b).
b. Soak the Dump Valve in a mild soap and water mix to clean. Rinse in water and allow to air dry.

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

4. Install the New Element.

5. Attach the Baffle and finger tighten firmly.

6. Inspect/Replace O-ring (a). Lightly lubricate O-ring (a) to assist with retaining it in position.

7. Install the Bowl Assembly into the body and tighten the Collar; hand tight, plus ¼ turn.
Make sure the circuit breaker is locked in the off position before attempting any electrical work to avoid possible shock.

4.1 Solenoids

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

**Air Solenoid Assembly**

**REMOVAL** -

1. Turn machine power on and raise spindle head to uppermost position. Turn power off.
2. Remove spindle head covers (Mechanical Service).
3. Remove air supply from machine.
4. Disconnect all air lines going to and from the air solenoid assembly on the bottom rear of the solenoid bracket. Do not remove the fittings --- remove the lines from the fittings.
5. Disconnect the two leads to the low air pressure sensor.
6. Unplug the wiring leading to the plug marked on the solenoid bracket as "880 FROM I/O PCB TO SOLENOID VALVES" and the plug marked "SPARE".
Figure 4.1-1 Air solenoid assembly.

7. Remove the SHCS holding the assembly to the bracket and remove the assembly.

INSTALLATION:
1. Replace the air solenoid assembly and attach to the bracket with the SHCS previously removed. Tighten securely.
2. Reconnect all air lines at this time, ensuring that all connections are tight and do not leak.
3. Reconnect the two leads to the low air pressure sensor.
4. Reconnect the wiring to the plugs on the solenoid bracket (see Step 6).
5. Reconnect air supply to the machine.

**Tool Release Piston Assembly Air Solenoid**

1. Turn machine power on and raise spindle head to uppermost position. Turn power off.
2. Remove spindle head covers (See the procedure in the Mechanical Service section).
3. Remove air supply from machine.
4. Remove the tool release piston assembly (See the procedure in the Mechanical Service section).
5. Unscrew the air solenoid assembly from the tool release piston assembly, taking care to not disturb the position of the clamp/unclamp switches.
6. Unscrew the air solenoid from the air solenoid assembly.
7. Install the new air solenoid on the air solenoid assembly. Reinstall the air solenoid assembly onto the tool release piston assembly. Take care to not disturb the position of the clamp/unclamp switches.

8. Reinstall the tool release piston assembly (Mechanical Service).

9. Ensure all air lines are reconnected to their proper fittings.
**Spindle Lube Air Solenoid**

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

![Figure 4.1-3 Front side of lube/air panel.](image)

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

3. Unplug the electrical leads at the quick-disconnect. You will have to slide the wiring channel cover back to disconnect the leads.

![Figure 4.1-4 Top view of spindle lube/air solenoid assembly.](image)

4. Unscrew the assembly from the T-fitting.
Figure 4.1-5 Top view of spindle lube/air solenoid assembly.

5. Replace the assembly, ensuring it is approximately horizontal to the floor, and tighten fittings securely.

6. Reconnect all air lines.

7. Reconnect wiring leads at the quick-disconnect in the wiring channel. Slide cover back into place.

8. Restore air supply to the machine.
4.2 Line Voltage Adjustments

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

TOOLS REQUIRED
- Large flat tip screwdriver
- Digital voltmeter

ADJUSTING VOLTAGE -

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

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

WARNING!

The electrical panel should be closed and the three screws on the door should be secured at all times except during installation and service. At those times, only qualified electricians should have access to the panel. When the main circuit breaker is on, there is high voltage throughout the electrical panel (including the circuit boards and logic circuits) and some components operate at high temperatures. Therefore extreme caution is required.
Figure 4.2-1 Control cabinet general overview.

**Electrical Connections**

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

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

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

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

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

2. After the line voltage is connected to the machine, make sure that main circuit breaker (at top-right of rear cabinet) is OFF (rotate the shaft that connects to the breaker counterclockwise until it snaps OFF). Turn ON the power at the source. Using an accurate digital voltmeter and appropriate safety procedures, measure the voltage between all three pair phases at the main circuit breaker and write down the readings. The voltage must be between 195 and 260 volts (354 and 488 volts for high voltage option).

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

   **CAUTION!** Make sure that the main breaker is set to OFF and the power is off at your supply panel BEFORE you change the transformer connections. Make sure that all three black wires are moved to the correct terminal block and that they are tight.
3. Check the connections on the transformer at the bottom-right corner of the rear cabinet. The three black wires labeled 74, 75, and 76 must be moved to the terminal block triple which corresponds to the average voltage measured in step 2 above. There are four positions for the input power for the 260 volt transformer and five positions for the 480 volt transformer. The labels showing the input voltage range for each terminal position are as shown in the following illustrations:

4. Transformer T5 supplies 24VAC used to power the main contactor. There are two versions of this transformer for use on 240 and 400V machines (32-0964B and 32-0965B, respectively). The 240V transformer has two input connectors located about two inches from the transformer, which allow it to be connected to either 240V or 200V. Users that have 220V-240V RMS input power should use the connector labeled 200V. Users with the External High Voltage Option should use the 240V connector if they have 420V-510V 60Hz power or the 200V connector if they have 50Hz power. Failure to use the correct input connector may result in either overheating of the main contactor or failure to reliably engage the main contactor.

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

WARNING!

Through the Spindle Coolant (TSC) pump is a three phase pump and must be phased correctly! Improper phasing will cause damage to the TSC pump and void the warranty. Refer to the TSC start up section IF YOUR MACHINE IS EQUIPPED WITH TSC.
6. After the power is on, measure the voltage across the upper terminals on the contactor K1 (located below the main circuit breaker). It should be the same as the measurements where the input power connects to the main breaker. If there are any problems, check the wiring.

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

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

![PHASE DETECT](image)

**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:

<table>
<thead>
<tr>
<th>Input Voltage Range</th>
<th>Tap</th>
</tr>
</thead>
<tbody>
<tr>
<td>493-510</td>
<td>1 (504)</td>
</tr>
<tr>
<td>481-492</td>
<td>2 (492)</td>
</tr>
<tr>
<td>469-480</td>
<td>3 (480)</td>
</tr>
<tr>
<td>457-468</td>
<td>4 (468)</td>
</tr>
<tr>
<td>445-456</td>
<td>5 (456)</td>
</tr>
<tr>
<td>433-444</td>
<td>6 (444)</td>
</tr>
<tr>
<td>420-432</td>
<td>7 (432)</td>
</tr>
</tbody>
</table>

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 settings 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.

<table>
<thead>
<tr>
<th>Input Voltage Range</th>
<th>Tap</th>
</tr>
</thead>
<tbody>
<tr>
<td>423-440</td>
<td>1 (504)</td>
</tr>
<tr>
<td>412-422</td>
<td>2 (492)</td>
</tr>
<tr>
<td>401-411</td>
<td>3 (480)</td>
</tr>
<tr>
<td>391-400</td>
<td>4 (468)</td>
</tr>
<tr>
<td>381-390</td>
<td>5 (456)</td>
</tr>
<tr>
<td>371-380</td>
<td>6 (444)</td>
</tr>
<tr>
<td>355-370</td>
<td>7 (432)</td>
</tr>
</tbody>
</table>
4.3 Fuse Replacement

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

**Overvoltage Fuse**

**WARNING!**

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

1. Turn machine power off.

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

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

4. On the POWER SUPPLY board there are three fuses located in a row at the upper right of the board; these are the overvoltage fuses. An orange light will be on to indicate the blown fuse(s).
5. Using a flat tip screwdriver, turn the fuse(s) counterclockwise to remove and replace the blown fuse(s) with ones having the same type and rating (½ amp, type AGC, 250V).

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

---

**Servo Driver Fuses**

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

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

3. On the SERVO DRIVE ASSEMBLY, there are three individual fuses on each of the SERVO DRIVE boards (See Fig. 4.3-3; the F3 fuses are not shown).
4. On each of the SERVO DRIVER boards, the fuses (F1, F2, F3) may be replaced by simply pulling out the fuses by hand and replacing with fuses of the same type and rating (F1, F2: 20 amp, type ABC, 250V; F3: 10 amp, type ABC, 250V).

Figure 4.3-3 Servo Drive Assembly: fuse locations
4.4 PCB Replacement

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

Microprocessor, MOCON (MOTIF) & Video/Keyboard

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

WARNING!

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

MOCON (or MOTIF) BOARD -

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

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

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

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

VIDEO / KEYBOARD -

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

8. Remove the MOCON (or MOTIF) board as described in Steps 1-5.
9. Disconnect all leads to the Video / Keyboard. Ensure all cables are properly labeled for reconnecting later. The following illustration shows all cable numbers and the locations on the Video / Keyboard.

10. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.

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

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

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

   PROCESSOR BOARD -

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

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

14. Disconnect all leads to the Processor (68020) board. Ensure all cables are properly labeled for reconnecting later. The following illustration shows all cable numbers and the locations on the 68030 board.

15. After all cables have been disconnected, unscrew the standoffs, taking care to hold the board in place until all standoffs have been removed.

16. Replace the Processor (68030) board, attaching it to the electrical cabinet (beneath the 68030 board) with the standoffs.

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

   **Servo Driver**

   **WARNING!**

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

   1. Turn machine power off.
   2. Turn the main switch (upper right of electrical cabinet) to the off position.
   3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel. Wait until the red CHARGE light on the servo drive assembly goes out before beginning any work inside the electrical cabinet.
SERVO DRIVER BOARDS -

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

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

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

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

4. Disconnect all leads to the Servo Driver (DRIVER) board that you wish to replace. Ensure all cables are properly labeled for reconnecting later.

**NOTE:** When replacing any DRIVER board, it will be necessary to disconnect all leads on all DRIVER boards in order to remove or replace the board.

5. Remove the board by first removing the two screws that fasten it to the cabinet. Take care to hold the board in place until both screws have been removed.

6. Replace the DRIVER board, attaching it to the cabinet with the two screws previously removed.

7. Reconnect all leads to all boards at this time. Ensure the red and black leads go to the appropriate connections.

---

I/O Board

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

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

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

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

4. Disconnect all leads to the Input/Output board and move aside for removal. Ensure all cables are properly labeled for reconnecting later. The illustration in the Cable Locations section shows all cable numbers and their locations on the I/O board.

5. Remove the board by first removing the twelve screws that fasten it to the cabinet. Take care to hold the board in place until all screws have been removed.

6. Replace the I/O board, attaching it to the cabinet with the twelve screws previously removed.

7. Reconnect all leads to the I/O board at this time.
POWER & LOW VOLTAGE SUPPLY

POWER BOARD -

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

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

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

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

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

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

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

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

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

LOW VOLTAGE POWER SUPPLY -

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

9. Disconnect all leads to the Low Voltage Power Supply (LVPS) board. Ensure all cables are properly labeled for reconnecting later. The illustration in the Cable Locations section shows all cable numbers and their locations on the LVPS board.

10. After all cables have been disconnected, unscrew the two standoffs at the bottom of the board. Unscrew the remaining two screws at the top of the LVPS board, taking care to hold the board in place until all screws have been removed.

11. Replace the LVPS board, attaching it to the cabinet with the two screws and two standoffs previously removed.

12. Replace the POWER board as described in Steps 6-7.
**RS-232 PCB**

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

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

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

3. Using a large flat tip screwdriver, loosen the three screws on the cabinet door and then open the door enough to safely work on the electrical panel.

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

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

5. To remove the RS-232 board, unscrew the two hex screws (on the exterior of the cabinet) holding the connector to the cabinet. From the inside of the cabinet, pull the connector through the panel, and disconnect the cable.

6. Replace the RS-232 board by first connecting the appropriate cable to the board (850 to SERIAL PORT #1, 850A to SERIAL PORT #2, then inserting the board (cable side up) through the left side panel. Attach with the two hex screws previously removed. Ensure the board for Serial Port #1 is the upper connector and the board for Serial Port #2 is the lower connector.

7. Replace the Serial Keyboard Interface (KBIF) board, using the four screws previously removed, starting at the top right. Attach the screw and standoff loosely, then all other screws and standoffs, until all are mounted. Tighten down completely.

8. Reconnect all cables to the Serial KBIF board at their proper locations.

* Serial interface replaces cable 700 with cable 700B.

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

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

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

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

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

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

RS-232 Remote Command Mode

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

RS-232 Line Noise

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

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

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

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

**CRT Assembly Replacement**

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

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

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

![Figure 4.5-1 Interior of control panel (rear).](image-url)
8. Plug the black cable and white cable into the matching cables. Feed the white cable through the opening in the top of the control panel.

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

### Jog Handle Replacement

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

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

1. Turn the machine power off.

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

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

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

![Figure 4.5-2 Jog handle encoder.](image-url)
5. Remove the three screws holding the jog handle encoder to the control panel and remove.

6. Replacement is reverse of removal. Keep in mind the important notice in Step 3.

**Switch Replacement**

**NOTE:** This section is applicable for the POWER ON, POWER OFF, EMERGENCY STOP, CYCLE START, and FEED HOLD switches.

1. Turn the machine power off.

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

3. Disconnect all leads to the switch’s connectors. Ensure all leads are properly marked for reconnecting later. Refer to Fig. 4.5-1 for proper locations.

4. Unscrew the two small set screws, one on top and one on the bottom, and turn the switch counterclockwise to loosen. Separate from the front portion and pull out.

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

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

6. Reconnect all leads to the correct switch.

7. Replace the back panel of the pendant.
**Spindle Load Meter Replacement**

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

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

3. Disconnect the two leads at the back of the spindle load meter assembly. Ensure the two leads are properly marked for reconnecting later.

4. Unscrew the four screws that hold the spindle load meter assembly to the control panel. Take care to hold the assembly in place until all screws have been removed. Remove the assembly.

5. Installation is reverse of removal. Ensure leads go to the correct location.

**Keypad Replacement**

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

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

3. Unplug the keypad’s 24-pin ribbon cable from the Keyboard Interface board.

4. Remove the screws from the front of the control panel. Take care to hold the front cover panel in place until all screws have been removed. Remove the pieces and set aside in a safe place.

5. Using a flat, blunt tool, such as putty knife, pry the keypad away from the control panel. Pull the ribbon cable through the opening in the control to remove.

6. To replace, first put the bezel spacer in place and fasten temporarily with screws in the top corners.

*Figure 4.5-5. Keypad installation.*
7. Insert the ribbon cable through the opening in the control panel. Expose the adhesive strip on the back of the keypad and press the keypad in place in the upper right corner of the keypad recess. Press to the control panel to mount. Plug the ribbon cable into the Keyboard Interface board, taking care to not bend the pins on the board.

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

**Serial Keyboard Interface (KBIF)**

---

**NOTE:** Refer to “Cable Locations” for a diagram of this board.

1. Follow all precautions noted previously before working in the control cabinet (See warning at beginning of Section 5).

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

3. Remove the screws on the back of the control box, then remove the cover panel. Take care to hold the panel in place until all screws have been removed.

4. Disconnect all leads to the Serial Keyboard Interface (KBIF) board. Ensure all cables are properly labeled for reconnecting later.

5. After all cables have been disconnected, unscrew the four screws holding the Serial KBIF board to the control box. Take care to hold the board in place until all screws have been removed. Place the screws and standoffs aside for later use.

6. Replace the Serial KBIF board, using the four screws previously removed, starting at the top right. Attach the screw and standoff loosely, then all other screws and standoffs, until all are mounted. Tighten down completely.

7. Reconnect all cables to the Serial KBIF board at their proper locations.
4.6 Spindle Encoder Replacement

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

Removal

1. Turn machine power on. Raise or lower spindle head to a position that will allow you to easily work on the encoder (must be above the enclosures). Turn machine off.

2. Remove head covers (See the procedure in the Mechanical Service section).

3. Disconnect the encoder cable at the top of the encoder.

4. Unscrew and remove the four 10-32 screws holding the encoder to the four standoffs (VF-1, VF-2, VF-3, VF-4) or mounting bracket (direct drive machines). Remove the encoder, leaving the belt on the pulley at the orient ring.

Installation

If you wish to install an encoder on a machine start at step 5; if this is just a replacement, skip to step 13. Please note the differences in installation between the VF-1, VF-2, and the VF-3, VF-4.

1. For the VF-1, VF-2, and VF-3, VF-4, put some blue Loctite on the threads of the four set screws and screw approximately halfway into the standoffs. Screw the hex end of the set screws into the standoffs.

2. Screw the standoffs into the four holes located at the rear of the transmission’s top plate.

3. On direct drive machines, place the mounting bracket in place. Fasten to the top plate with the four screws and four lock washers.

4. Place the 18-tooth pulley onto the pulley bushing and tighten down. Place the SHCS through the center axis of the pulley.

5. Screw this assembly into the spindle orientation ring.

Figure 4.6-1 Spindle encoder installation (VF-1/VF-2).
5. Place the 36-tooth pulley onto the encoder, making the top of the pulley flush with the end of the shaft. Tighten down with the 5/64" hex wrench.

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

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

8. Place the belt on the 36-tooth pulley, then loop over the 18-tooth pulley. Place the encoder assembly on the four standoffs (mounting bracket on the direct drive machines) and attach with the four 10-32 SHCS, placing the #10 lock washers between the socket head and the encoder base.

9. Connect the encoder cable to the encoder assembly.
5. TECHNICAL REFERENCE

5.1 TOOL CHANGER

Tools are always loaded through the spindle and should never be installed directly in the carousel in order to avoid crashes. The pocket open to the spindle must always be empty in the retracted position.

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

**WARNING**

AN INADEQUATE AIR SUPPLY WILL CAUSE TOOL CHANGER FAULTS

FOLLOW THESE GUIDELINES:
- MINIMUM AIR SUPPLY PRESSURE TO MACHINE IS 100 PSI.
- OBSERVE GAGE DURING TOOL CHANGE - 10 PSI MAX. DROP.
- USING THE AIR GUN DURING TOOL CHANGES MAY CAUSE FAULTS IF THE AIR SUPPLY TO THE MACHINE IS MARGINAL.
- ALLOW 2 HP OF AIR COMPRESSOR PER MACHINE.
- (I.E., 5 MACHINES REQUIRE A 10 HP AIR COMPRESSOR).
- USE MINIMUM 3/8 ID HOSE FOR 40 TAPER MACHINES.
- MINIMUM 1/2 ID HOSE FOR 50 TAPER & HS MACHINES.
- AVOID QUICK DISCONNECTS IN SUPPLY LINES - THEY ARE RESTRICTIVE.

If the shuttle should become jammed, the control will automatically come to an alarm state. To correct this, push the EMERGENCY STOP button and remove the cause of the jam. Push the RESET key to clear any alarms. Press "Tool Changer Restore" button, to automatically reset the tool changer after a crash. Never put your hands near the tool changer when powered unless the EMERGENCY STOP button is pressed.

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

**CAUTION!** Never put your hands near the tool changer when powered unless the EMERGENCY STOP button is pressed.
CAUTION! Do not exceed the Maximum Specifications given below!

### SIDE-MOUNT TOOL CHANGER SPECIFICATIONS

<table>
<thead>
<tr>
<th>Tool Diameter</th>
<th>40-Taper VF 0-4</th>
<th>40-Taper VF 5-11</th>
<th>50-Taper VF 5</th>
<th>50-Taper VF 6-11,VS-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>with all pockets full</td>
<td>3”</td>
<td>3”</td>
<td>4”</td>
<td>4”</td>
</tr>
<tr>
<td>if tool is declared oversized</td>
<td>5”</td>
<td>6”</td>
<td>7”</td>
<td>10”</td>
</tr>
<tr>
<td>from gauge line</td>
<td>13”</td>
<td>16”</td>
<td>16”</td>
<td>16”</td>
</tr>
<tr>
<td>Maximum Tool Weight</td>
<td>12 lb</td>
<td>12 lb</td>
<td>30 lb</td>
<td>30 lb</td>
</tr>
<tr>
<td>Tool Capacity</td>
<td>25 (41 opt VF 3/4)</td>
<td>25 (41 optional)</td>
<td>31 tools</td>
<td>31 tools</td>
</tr>
<tr>
<td>Number of Tool Pockets</td>
<td>24 (40 opt VF 3/4)</td>
<td>24 (40 optional)</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

### SHUTTLE TOOL CHANGER SPECIFICATIONS

<table>
<thead>
<tr>
<th>Tool Capacity</th>
<th>20-Pocket</th>
<th>32-pocket (16 pocket)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Tool Weight</td>
<td>12 lb</td>
<td>12 lb</td>
</tr>
<tr>
<td>Maximum Total Tool Weight</td>
<td>120 lb</td>
<td>200 lb</td>
</tr>
</tbody>
</table>

CAUTION!
- Extremely heavy tool weights should be distributed evenly.
- Ensure there is adequate clearance between tools in the tool changer before running an automatic operation. This distance is 3.6” for the 20 pocket, 3.4” for the 32 pocket, 6” for the 16 pocket.

When a tool change operation is performed, the following sequence of events occurs:
1) Z axis moves up to machine zero,
2) If the spindle is turning, it is commanded to stop; coolant stopped,
3) Spindle oriented to Tool Changer,
4) Turn TSC pump off, (optional)
5) Turn purge on and off (optional)
6) Pre-charge is on (40 taper spindle only),
7) Tool unclamps,
8) Z axis moves up,
9) Tool Changer rotates,
10) Z axis moves down,
11) Tool clamps,
12) Pre-charge off (40 taper spindle only),

**TOOL CHANGER LUBRICATION**

Place lubricating grease on the outside edge of the guide rails of the tool changer and run through all tools.

**SHUTTLE IN/OUT MOTOR**

A DC brush motor is used to move the tool changer assembly towards and away from the spindle. This is called the shuttle. The motor is geared down to a low RPM and then connected to an arm that rotates through 180° and pushes the shuttle in and out.

**NOTE:** This motor should never be disassembled.
**Turret Rotation Motor**

A DC brush motor is used to rotate the tool turret between tool changes. This motor is geared down to a low RPM and connected to a Geneva mechanism. Each 1/2 revolution of the Geneva mechanism moves the tool turret one tool position forward or backward.

NOTE: This motor should never be disassembled.

**Side Mount Tool Changers**

The tool changer is controlled with a single axis control mounted inside the control.

**Carousel Rotation Motor**

A DC brush motor is used to rotate the carousel between tool changes. The motor has an encoder and is driven by the single axis control mounted inside the control.

NOTE: This motor should never be disassembled.

**Tool Changer Position Switches**

Two switches are used to sense the position of the tool changer carousel. One switch is activated when the carousel is moved full travel inward and one is activated when it is full travel outward. These switches are normally closed so that both will be closed between in and out. The diagnostic display will show this status of this input switch. A “1” indicates the associated switch is activated or open.
5.2 Tool Clamp/Unclamp

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

Tool Clamp/Unclamp Air Solenoids

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

Tool Clamp/Unclamp Sense Switches

There are two switches used to sense the position of the tool clamping mechanism. They are both normally closed and one will activate at the end of travel during unclamping and the other during clamping. When both switches are closed, it indicates that the drawbar is between positions.

A tool change operation will wait until the unclamped switch is sensed before the Z-axis pulls up from the tool. This prevents any possibility of breaking the tool changer or its support mounts.

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

The Precharge and Through the Spindle Coolant system applies low air pressure and releases the clamped switch (with 40 taper spindle only).

Remote Tool Unclamp Switch

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

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

Spindle speed functions are controlled primarily by the S address code. The S address specifies RPM in integer values from 1 to maximum spindle speed (Parameter 131). NOT TO BE CHANGED BY USER! When using the Through the Spindle Coolant option, the maximum spindle speed is 7500 RPM (5000 RPM for 50 taper spindles).

Speeds from S1 to the Parameter 142 value (usually 1200) will automatically select low gear and speeds above Parameter 142 will select high gear. Two M codes, M41 and M42 can be used to override the gear selection. M41 for low gear and M42 for high gear. Low gear operation above S1250 is not recommended. High gear operation below S100 may lack torque or speed accuracy. Spindle speed accuracy is best at the higher speeds and in low gear.

If there is no gear box in your machine (VF-0/E/0E) the gear box is disabled by parameters, it is always in high gear, and M41 and M42 commands are ignored.

The spindle is hardened and ground to the precise tool holder dimensions providing an excellent fit to the holder.

Spindle Warm-Up Program

All spindles, which have been idle for more than 4 days, must be thermally cycled prior to operation above 6,000 RPM. This will prevent possible overheating of the spindle due to settling of lubrication. A 20-minute warm-up program has been supplied with the machine, which will bring the spindle up to speed slowly and allow the spindle to thermally stabilize. This program may also be used daily for spindle warm-up prior to high-speed use. The program number is O02020 (Spindle Warm-Up).

O02020 (Spindle Warm-Up)
S500M3;
G04 P200.;
S1000M3;
G04 P200.;
S2500M3;
G04 P200.;
S5000M3;
G04 P200.;
S7500M3;
G04 P200.;
S10000M3;
G04 P200.;
M30;

Spindle Run-In Program

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

These programs can be used for all spindle types. Adjust spindle speed override depending on maximum spindle speed of machine: Set override at 50% for 5,000 RPM machines; Set at 100% for 7,500 and 10,000 RPM machines; Set at 150% for 15,000 machines.
**Spindle Orientation**

Orientation is performed electrically and no shot pin or solenoid is required for locking the motor in place. Orientation of the spindle is automatically performed for tool changes and can be programmed with M19 commands. Orientation is performed by turning the spindle until the encoder reference is reached, the spindle motor holds the spindle locked in position. If the spindle is orientated and locked, commanding spindle forward or reverse will release the lock.

**Spindle Orientation Sequence**

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

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

**15K High Speed Spindle**

**Non-Serviceable, Anti-Rotation Drawbar**

The drawbar and the spindle are not serviceable as separate items on the 15K Spindle. The 15K Spindle comes with TSC and an extra high clamp drawbar and may be used in both TSC and non-TSC applications. If there is a need to replace the spindle or the drawbar the entire spindle must be replaced.

**NOTE:** The spindle and the drawbar are balanced at the factory as a matched assembly.

The anti-rotation drawbar does not allow the drawbar to turn in the spindle shaft. By not changing the position of the drawbar changes in vibration output of the spindle are minimized. The balance is also retained when the drawbar does not turn.

**Oil Flow**

The specification for oil flow is 0.15–0.18 cc per 0.5 hour when measured from the spindle restrictor with no airflow. This oil flow is measured on each machine. The flow rate is adjusted by changing the restrictor used and by changing the total output of the pump. The pump nominally puts out 3cc per 0.5 hour. The pump has a 0.5 hour cycle time. The pump runs only when the spindle is running or one of the axes is moving. Different sized restrictors are used to control flow. A 3/0 restrictor has twice the flow of a 4/0, which has twice the flow of a 5/0 restrictor.
**Spindle Air Pressure**

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

**15K Spindle**

The air pressure for the 15K Spindle is 20 psi. The 15K Spindle requires higher pressure to slightly reduce the amount of oil and speed the delivery of the oil to the bearings.

**A, B Axis Re-Alignment**

Gimbaled head mills only

If trammimg the A/B axes is neccessary, sweep a 10” diameter circle on the table with a dial indicator mounted to the spindle.

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

The display will indicate which axis is enabled. It is recommended that when jogging the A and B axes, the operator use only the .0001, .0010, or .0100 increments.

The rule of thumb is that for every .001” out of position, you **add or subtract** 100 from the appropriate parameter. This will re-calibrate the distance from the A/B axes home switch. Parameters 212 and 213 are the tool change offset parameters for the A and B-axis. These parameters also control the tram of the A-axis and B-axes. It is advised that you record the factory set values before changing parameters 212 and 213 in the event that you enter an invalid number and have to start over.

When adjusting the tram, it is recommended that you use same feedrate to home the A/B axes between checking the sweep. This will allow the machine to repeat more accurately. The A-axis and B-axis should be trammed individually to reduce the possibility of error.
5.4 Control Cabinet

Control cabinet general overview.

Connectors on side of control cabinet.
5.5 Servos Brush / Brushless

Servo Encoders

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

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

The motor controller board has a dedicated processor which does all the servo control algorithm.

There is no servo distribution board anymore, therefore there is no CHARGE light present. Care should still be taken however, since there are high voltages present on the amplifiers, even when power is shut off. The high voltage comes from the spindle drive, which does have a CHARGE light.

The servo drive cards are replaced by Brushless Servo Amplifiers, and are controlled differently.

A low voltage power supply card is added to the servo drive assembly to supply the low voltage requirement to the amplifiers.

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

Servo Amplifiers

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

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

The user should never attempt to replace these fuses.

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

The connectors on the amplifiers are:

+H.V. +320 volts DC
-H.V. 320 volts return
A motor lead phase A
B motor lead phase B
C motor lead phase C
J1 Three pin Molex connector used for +/-12 and GND.
J2 Eight pin Molex connector used for input signals.
5.6 Input/Output Assembly

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

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

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

The Input/Output Assembly consists of a single printer circuit board called the IOPCB.
5.7 Two-Speed Gear Transmission

The spindle head contains a two-speed gear transmission. The spindle motor is directly coupled to the transmission and the transmission is cog belt-coupled to the spindle.

Gear Box Lubrication

Gear Box: Mobil DTE 25 oil.

The gear box uses an oil sump and is cooled by gear oil. The VF-0/E/0E does not have a gearbox and is air-cooled.

Gear Box Air Solenoids

There is a double solenoid valve controlling air to the gear box shifter. This solenoid sends air to select either the high gear or the low gear. When power is removed from the solenoids, the valve remains in its last state. Air is always required to ensure the gears are held in either high or low gear. A circuit breaker will interrupt power to these solenoids. Power is left on the solenoid which is commanded last.

On machines equipped with a 50 taper spindle, an electric motor drives the gearbox shifter into high or low gear.

Gear Box Sense Switches

There are two switches in the gear box used to sense the position of the gears. One switch indicates HIGH by opening and the other indicates LOW by opening (50 Taper machines indicate high or low gear by opening). Between gears, both switches are closed indicating a between-gear condition. The diagnostic display shows the status of these switches and the CURNT COMDS display shows which gear is selected. If the switches indicate that the gear box is between gears, the display will indicate “No Gear”.

Gear Change Sequence

When a gear change is performed, the following sequence of events occurs:

1) If the spindle is turning, it is commanded to stop,
2) Pause until spindle is stopped,
3) Gear change spindle speed is commanded forward,
4) Pause until spindle is at speed,
5) Command high or low gear solenoid active,
6) Pause until in new gear or reversal time,
7) Alarm and stop if max gear change time elapsed,
8) If not in new gear, reverse spindle direction,
9) Turn off high and low gear solenoids
5.8 Control Pendant

Jog Handle

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

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

Power On/Off Switches

The POWER ON switch engages the main contactor. The on switch applies power to the contactor coil and the contactor thereafter maintains power to its coil. The POWER OFF switch interrupts power to the contactor coil and will always turn power off. POWER ON is a normally open switch and POWER OFF is normally closed. The maximum voltage on the POWER ON and POWER OFF switches is 24V AC and this voltage is present any time the main circuit breaker is on.

Spindle Load Meter

The Load meter measures the load on the spindle motor as a percentage of the rated continuous power of the motor. There is a slight delay between a load and the actual reflection of the meter. The eighth A-to-D input also provides a measure of the spindle load for cutter wear detection. The second page of diagnostic data will display % of spindle load. The meter should agree with this display within 5%. The spindle drive display #7 should also agree with the load meter within 5%.

There are different types of spindle drive that are used in the control. They are all equivalent in performance but are adjusted differently.

Emergency Stop Switch

The EMERGENCY STOP switch is normally closed. If the switch opens or is broken, power to the servos will be removed instantly. This will also shut off the tool changer, spindle drive, and coolant pump. The EMERGENCY STOP switch will shut down motion even if the switch opens for as little 0.005 seconds.

Be careful of the fact that Parameter 57 contains a status switch that, if set, will cause the control to be powered down when EMERGENCY STOP is pressed.

You should not normally stop a tool change with EMERGENCY STOP as this will leave the tool changer in an abnormal position that takes special action to correct.

Note that tool changer alarms can be easily corrected by first correcting any mechanical problem, pressing RESET until the alarms are clear, selecting ZERO RETURN mode, and selecting “AUTO ALL AXES”.

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

There is a beeper inside the control panel that is used as an audible response to pressing keyboard buttons and as a warning beeper. The beeper is a 2.3 kHz signal that sounds for about 0.1 seconds when any keypad key, CYCLE START, or FEED HOLD is pressed. The beeper also sounds for longer periods when an auto-shut down is about to occur and when the “BEEP AT M30” setting is selected.

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

**5.9 Microprocessor Assembly**

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

**Microprocessor PCB (68ECO30)**

The Microprocessor PCB contains the 68ECO30 processor running at 40 MHz, one 128K EPROM; between 1MB and 16MB of CMOS RAM and 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:

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

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

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

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

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

- **CRT** CRT/VIDEO initialization complete. (Normally On)
  If this light does not come on, there is a problem communicating with the VIDEO PCB. Check the buss connectors and ensure the VIDEO PCB is getting power.
PGM  Program signature found in memory. (Normally On)
If this light does not come on, it means that the main CNC program package was not found in
memory or that the auto-start switch was not set. Check that switch S1-1 is on and the EPROM
is plugged in.

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

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

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

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

**Memory Retention Battery**

The memory retention battery is initially soldered into the processor PCB. This is a 3.3V Lithium battery that
maintains the contents of CMOS RAM during power off periods. Prior to this battery being unusable, an alarm
will be generated indicating low battery. If the battery is replaced within 30 days, no data will be lost. The
battery is not needed when the machine is powered on. Connector J6 on the processor PCB can be used to
connect an external battery.

**Video Keyboard with Floppy**

The VIDEO and KB PCB generates the video data signals for the monitor and the scanning signals for the
keyboard. In addition, the keyboard beeper is generated on this board. There is a single jumper on this board
used to select inverse video.

**Motor Interface PCB (MOTIF) Optional**

The Motor Interface PCB is used to interface with linear scale encoders.

**Motor Controller (MOCON) - Brushless**

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

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

The spindle drive is located in the main cabinet on the right side and halfway down. It operates from three-phase 200 to 240V AC. It has a 10 (or 20) H.P. continuous rating, and a 15 (or 30) H.P. one-minute rating. The spindle drive is protected by CB1. Never work on the spindle drive until the small red CHARGE light goes out. Until this light goes out, there are dangerous voltages inside the drive, even when power is shut off.

For all other data on the spindle drive, refer to the supplied documentation for your drive.

Haas Vector Drive

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

5.11 Resistor Assembly

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

Spindle Drive Regen Resistor

A resistor bank is used by the spindle drive to dissipate excess power caused by the regenerative effects of decelerating the spindle motor. If the spindle motor is accelerated and decelerated again in rapid succession repeatedly, this resistor will get hot. In addition, if the line voltage into the control is above 255V, this resistor will begin to heat. This resistor is overtemp protected at 100°C. At that temperature, an alarm is generated and the control will begin an automatic shutdown. If the resistor is removed from the circuit, an alarm may subsequently occur because of an overvoltage condition inside the spindle drive.

Servo Drive Regen Resistor

A 25-ohm, 300-watt resistor is used by the brush-type servo drives to dissipate excess power caused by the effects of decelerating the servo motors. If the servo motors are accelerated and decelerated again in rapid succession repeatedly, this resistor will get hot. In addition, if the line voltage into the control is above 255V, this resistor will begin to heat. This resistor is overtemp protected at 100°C. At that temperature, an automatic control shutdown is begun. If that resistor is removed from the circuit, an alarm may subsequently occur because of an overvoltage condition for the servo buss.

Overheat Sense Switch

There is an over-temperature sense switch mounted near the above-mentioned regen resistors. This sensor is a normally-closed switch that opens at about 100°C. It will generate an alarm and all motion will stop. After the time period, specified by parameter 297, of an overheat condition, an automatic shutdown will occur in the control.
5.12 Power Supply Assembly

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

Main Circuit Breaker CB1

Circuit breaker CB1 (see chart for ratings) is primarily used to protect the spindle drive and to shut off all power to the control. The locking On/Off handle on the outside of the control cabinet will shut this breaker off when it is unlocked. A trip of this breaker indicates a SERIOUS overload problem and should not be reset without investigating the cause of the trip. The full circuit breaker ratings are listed in the following chart.

<table>
<thead>
<tr>
<th>HP RATING</th>
<th>195-260 VAC</th>
<th>354-488 VAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 - 15</td>
<td>40 AMP</td>
<td>20 AMP</td>
</tr>
<tr>
<td>40 - 30</td>
<td>80 AMP</td>
<td>40 AMP</td>
</tr>
</tbody>
</table>

Main Contactor K1

Main contactor K1 is used to turn the control on and off. The POWER ON switch applies power to the coil of K1 and after it is energized, auxiliary contacts on K1 continues to apply power to the coil. The POWER OFF switch on the front panel will always remove power from this contactor.

When the main contactor is off, the only power used by the control is supplied through two ½ amp fuses to the circuit that activates the contactor. An overvoltage or lightning strike will blow these fuses and shut off the main contactor.

The power to operate the main contactor is supplied from a 24V AC control transformer that is primary fused at ½ amp. This ensures that the only circuit powered when the machine is turned off is this transformer and only low voltage is present at the front panel on/off switches.

Low Voltage Power Supply

The low voltage power supply provides +5V DC, +12V DC, and -12V DC to all of the logic sections of the control. It operates from 115V AC nominal input power. It will continue to operate correctly over a 90V AC to 133V AC range.

Power PCB (PSUP)

The low voltage power distribution and high voltage fuses and circuit breakers are mounted on a circuit board called the PSUP PCB.
**Secondary Circuit Breakers**

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

**CB2** controls the 3-phase 115volt distribution. It can be tripped only if there is a short in the control cables or on the IOPCB.

**CB3** controls the power to coolant pump only. It can be blown by an overload of the coolant pump motor or a short in the wiring to the motor.

**CB5** Controls power to the TSC coolant pump only. It can be tripped by an overload of the TSC coolant pump motor or a short in the wiring to the motor.

**CB6** is a single phase 115V protected output for the user. It may be used on Horizontal mills and lathes with a barfeeder.

**Power-Up Low Voltage Control Transformer (T5)**

The low voltage control transformer, T5, supplies power to the coil of the main contactor K1. It guarantees that the maximum voltage leaving the Power Supply assembly when power is off is 12V AC to earth ground. It is connected via P5 to the POWER PCB.
5.13 Power Transformer Assembly (T1)

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

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

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

Primary Connection to T1

Input power to T1 is supplied through CB1, the 40 amp three-phase main circuit breaker. Three-phase 230 to T1 is connected to the first three terminals of TB10.

Voltage Selection Taps

There are four labeled plastic terminal blocks. Each block has three connections for wires labeled 74, 75, and 76. Follow the instructions printed on the transformer.

Secondary Connection to T1

The secondary output from T1 is 115VAC three-phase. CB2 protects the secondary of transformer T1 and is rated at 25 amps.
All machines will get the 45KVA transformer.

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

<table>
<thead>
<tr>
<th>Input Voltage Range</th>
<th>Tap</th>
</tr>
</thead>
<tbody>
<tr>
<td>493-510</td>
<td>1 (504)</td>
</tr>
<tr>
<td>481-492</td>
<td>2 (492)</td>
</tr>
<tr>
<td>469-480</td>
<td>3 (480)</td>
</tr>
<tr>
<td>457-468</td>
<td>4 (468)</td>
</tr>
<tr>
<td>445-456</td>
<td>5 (456)</td>
</tr>
<tr>
<td>433-444</td>
<td>6 (444)</td>
</tr>
<tr>
<td>420-432</td>
<td>7 (432)</td>
</tr>
</tbody>
</table>

Optional 480V 50Hz Transformer

<table>
<thead>
<tr>
<th>Input Voltage Range</th>
<th>Tap</th>
</tr>
</thead>
<tbody>
<tr>
<td>423-440</td>
<td>1 (504)</td>
</tr>
<tr>
<td>412-422</td>
<td>2 (492)</td>
</tr>
<tr>
<td>401-411</td>
<td>3 (480)</td>
</tr>
<tr>
<td>391-400</td>
<td>4 (468)</td>
</tr>
<tr>
<td>381-390</td>
<td>5 (456)</td>
</tr>
<tr>
<td>371-380</td>
<td>6 (444)</td>
</tr>
<tr>
<td>355-370</td>
<td>7 (432)</td>
</tr>
</tbody>
</table>

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.

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

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:

M21
M-FIN
Discrete Input 1009
CNC is: Running
Waiting for M-fin
Waiting for end M-fin
Running

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

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

M FUNCTION RELAYS

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

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

M-FIN DISCRETE INPUT

The M-FIN discrete input is a low voltage circuit. When the circuit is open, there is +12V DC at this signal. When this line is brought to ground, there will be about 10 milliamps of current. M-FIN is discrete input #1009 and is wired from input #1009 on the I/O PCB. The return line for grounding the circuit should also come from that PCB. For reliability, these two wires should be routed in a shielded cable where the shield is grounded at one end only. The diagnostic display will show this signal a “1” when the circuit is open and a “0” when this circuit is grounded.
**TURNING M FUNCTIONS ON AND OFF**

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

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

**WIRING THE RELAYS**

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

**WARNING!**

Power circuits and inductive loads must have snubber protection.

---

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

The lubrication system is a resistance type system which forces oil through metering units at each of the 16 lubricating points within the machine. The system uses one metering unit at each of the lubricating points: one for each linear guide pad, one for each lead screw and one for spindle lubrication. A single oil pump is used to lubricate the system. The pump is powered only when the spindle and/or an axis moves. Once powered the pump cycles approximately 3.2 cc of oil every 30 minutes throughout the oil lines to the lube points. Every lube point receives approximately 1/16 of oil. The control monitors this system through an internal level switch in the reservoir and external pressure switch on the lube panel.

Low Lubrication and Low Pressure Sense Switches

There is a low lube sense switch in the oil tank. When the oil is low, an alarm will be generated. This alarm will not occur until the end of a program is reached. There is also a lube pressure switch that senses the lube pressure. Parameter 117 controls the lube pressure check. If Parameter 117 is not zero, the lube pressure is checked for cycling high within that period. Parameter 117 has units of 1/50 seconds; so 30 minutes gives a value of 90000. Parameter 57, bit "Oiler on/off", indicates the lube pump is only powered when the spindle fan is powered. The lube pressure is only checked when the pump is on.
5.17 Switches

Lamp On/Off Switch

An on/off switch is supplied for the operator’s lamp. It is located on the side of the operator’s pendant.

Door Open Sense Switch

The DOOR OPEN sense switch is a magnetic reed switch type and consists of two switches; one on each half of the enclosure front doors. These switches are normally closed and wired in series. When the doors open, one or both of these switches will open and the machine will stop with a “Door Hold” function. When the door is closed again, operation will continue normally.

The wiring for the door switches is routed through the front panel support arm and down through the top of the enclosure.

If the doors are open, you will not be able to start a program. Door Hold will not stop a tool change operation or a tapping operation, and will not turn off the coolant pump. Also, if the doors are open, the spindle speed will be limited to 750 RPM.

The Door Hold function can be temporarily disabled by turning Setting 51 on, if Parameter 57 bits DOOR STOP SP and SAFETY CIRC are set to zero, but this setting will return to OFF when the control is turned off.

Limit Switches

There are a number of limit switches located on the VMC, and some are difficult to reach. Ensure the problem is the switch before beginning removal procedures. The following is a list of all switches, their general location, and a functional description:

Clamp/Unclamp Switches

[Tool Release Piston Assembly (2)]
There are two switches used to sense the position of the tool clamping mechanism. They are both normally closed and one will activate at the end of travel during unclamping and the other during clamping. When both switches are closed, it indicates that the draw bar is between positions.

A tool change operation will wait until the unclamped switch is sensed before the Z-axis pulls up from the tool. This prevents any possibility of breaking the tool changer or its support mounts.

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

Spindle Orient Switch

[Top rear of transmission]

NOTE: This switch does not exist on machines that have a Vector Drive.

A normally-open switch that is held closed is used to sense when the pin drops in to lock the spindle. When the pin drops the switch opens, indicating orientation is complete.

The normally-closed side of the same switch that is held open, is wired to the spindle drive and commands it into a "Coast Stop" condition. This is done to ensure the spindle motor is not powered when the pin is locking the spindle.
X, Y, AND Z LIMIT SWITCHES

Prior to performing 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, Y, or Z. After a ZERO RETURN has been performed, the travel limits will operate unless an axis hits the limit switch. When the limit switch is hit, the zero returned condition is reset and an AUTO ALL AXES must be done again. This is to ensure that if you hit the limit switch, you can still move the servo back away from it.

The limit switches are normally closed. When a search for zero operation is being performed, the X, Y, and Z axes will move towards the limit switch unless it is already active (open); then they will move away from the switch until it closes again; then they will continue to move until the encoder Z channel is found. This position is machine zero.

Auto search for zero in the Z-axis is followed by a rapid move from the limit switch position down to the tool change position. This makes the Z-axis a little different from the other axes. The position found with the limit switch is not machine zero but is the position used to pull tools out of the spindle. Machine zero for Z is below this by Parameter 64. Be careful during the Z zero search and stay clear of that rapid move.

What Can Go Wrong With Limit Switches?

If the machine is operated without connector P5, a LOW LUBE and DOOR OPEN alarm will be generated. In addition, the Home search will not stop at the limit switch and will instead run into the physical stops on each axis.

If the switch is damaged and permanently open, the zero search for that axis will move in the negative direction at about 0.5 in/min until it reaches the physical travel stops at the opposite end of travel.

If the switch is damaged and permanently closed, the zero search for that axis will move at about 10 in/min in the positive direction until it reaches the physical stops.

If the switch opens or a wire breaks after the zero search completes, an alarm is generated, the servos are turned off, and all motion stops. The control will operate as though the zero search was never performed. The RESET can be used to turn servos on but you can jog that axis only slowly.

TOOL CHANGER POSITION SWITCHES

[Inside of Tool Carriage (2)]

GENEVA WHEEL POSITION MARK

The turret rotation mechanism has a switch mounted so that it is activated for about 30° of travel of the Geneva mechanism. When activated, this switch indicates that the turret is centered on a tool position. This switch is normally closed. The diagnostic display will show this status of this input switch as “TC MRK”. A “1” indicates the Geneva wheel is in position.

TOOL #1 SENSE SWITCH

The tool rotation turret has a switch that is activated when tool one is in position or facing towards the spindle. At POWER ON this switch can indicate that tool #1 is in the spindle. If this switch is not active at power-on, the first tool change will rotate the turret until the switch engages and then move to the selected tool. The diagnostic display will show the status of this input switch as “TOOL #1”. A “1” indicates that tool #1 is in position.
SHUTTLE IN/OUT SWITCHES

[Tool Changer Holding Plate (2)]

Two switches are used to sense the position of the tool changer shuttle and the arm that moves it. One switch is activated when the shuttle is moved full travel inward and one is activated when it is full travel outward. These switches are normally closed so that both will be closed between in and out. The diagnostic display will show this status of the input switch. A “1” indicates the associated switch is activated or open.

TRANSMISSION HIGH/LOW GEAR POSITION SWITCHES

[Bottom of Gearbox Assembly (2)]

On machines with a two-speed transmission, there are two switches in the gear box used to sense the position of the gears. One switch indicates HIGH by opening and the other indicates LOW by opening. Between gears, both switches are closed indicating a between-gear condition. The diagnostic display shows the status of these switches and the CURNT COMDS display shows which gear is selected. If the switches indicate that the gear box is between gears, the display will indicate “No Gear”.

NOTE: The Transmission High/Low Gear Position Switches are located at the bottom of the Gearbox Assembly and are extremely difficult to reach. Removal of this assembly is necessary to replace these switches. See Mechanical Service, for Spindle Motor and Transmission removal.

5.18 Z-Axis Brake Motor

The servo brake motor compensates for the weight of the spindle head on machines without a counterbalance. The brake is released when the servo motors are activated, however the disk brake engagement spline may produce a small noise when the head is in motion, this is normal.

A parameter governs the ability of the brake motor, therefore mills without counterbalances must have parameter 39, Z-Axis Torque Preload, set correctly. Check the parameters sections for the correct value.

5.19 Hydraulic Counterbalance

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

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

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

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

POWER FAILURE ALARM

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

When the machine is operating normally, a second push of the PARAM/DGNOS key will select the diagnostics display page. The PAGE UP and PAGE DOWN keys are then used to select one of two different displays. These are for diagnostic purposes only and the user will not normally need them. The diagnostic data consists of discrete input signals, discrete output relays and several internal control signals. Each can have the value of 0 or 1. In addition, there are up to three analog data displays and an optional spindle RPM display. Their number and functions are described in the following section.
The inputs/outputs that are followed by an asterisk (*) are active when equal to zero (0).

### DISCRETE INPUT

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>#</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>TC Changer In</td>
<td>1023</td>
<td>Spare 3</td>
</tr>
<tr>
<td></td>
<td>SMTC Pocket Down</td>
<td></td>
<td>APC Pin Clr #2</td>
</tr>
<tr>
<td>1001</td>
<td>TC Changer Out</td>
<td>1024</td>
<td>Tool Unclmp Rmt*</td>
</tr>
<tr>
<td></td>
<td>SMTC Pocket Up</td>
<td>1025</td>
<td>Low Phasing 115V</td>
</tr>
<tr>
<td>1002</td>
<td>Tool One In Pos.</td>
<td>1026</td>
<td>Spare 3A</td>
</tr>
<tr>
<td>1003</td>
<td>Low TSC Pressure</td>
<td></td>
<td>APC Pal #2 Home</td>
</tr>
<tr>
<td>1004</td>
<td>Tool In Position</td>
<td>1027</td>
<td>Spare 3B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>APC Pal #1 Home</td>
</tr>
<tr>
<td>1005</td>
<td>Spindle High Gear</td>
<td>1028</td>
<td>Ground Fault</td>
</tr>
<tr>
<td>1006</td>
<td>Spindle Low Gear</td>
<td>1029</td>
<td>G31 Block Skip</td>
</tr>
<tr>
<td>1007</td>
<td>Emergency Stop</td>
<td>1030</td>
<td>Spigot Position</td>
</tr>
<tr>
<td>1008</td>
<td>Door Safety Switch</td>
<td>1031</td>
<td>Conveyr Overcrnt</td>
</tr>
<tr>
<td>1009</td>
<td>M Code Finish*</td>
<td>1032</td>
<td>Spare 4A</td>
</tr>
<tr>
<td></td>
<td>APC: APC Pal Clamp</td>
<td></td>
<td>Spare 4B</td>
</tr>
<tr>
<td>1010</td>
<td>Over Voltage (Mini-Mill - P.S. Fault)</td>
<td>1033</td>
<td>Spare 3B</td>
</tr>
<tr>
<td>1011</td>
<td>Low Air Pressure</td>
<td>1034</td>
<td>Spare 5A</td>
</tr>
<tr>
<td>1012</td>
<td>Low Lube Press.</td>
<td>1035</td>
<td>Spare 5B</td>
</tr>
<tr>
<td>1013</td>
<td>Regen Over Heat</td>
<td>1036</td>
<td>Spare 6A</td>
</tr>
<tr>
<td>1014</td>
<td>Draw Bar Open</td>
<td>1037</td>
<td>Spare 6B</td>
</tr>
<tr>
<td>1015</td>
<td>Draw Bar Closed</td>
<td>1038</td>
<td>Spare 7A</td>
</tr>
<tr>
<td>1016</td>
<td>Spare</td>
<td>1039</td>
<td>Spare 7B</td>
</tr>
<tr>
<td>1017</td>
<td>Spare</td>
<td>1040</td>
<td>Spare 8A</td>
</tr>
<tr>
<td>1018</td>
<td>Spare</td>
<td>1041</td>
<td>Spare 8B</td>
</tr>
<tr>
<td>1019</td>
<td>Spare</td>
<td>1042</td>
<td>Spare 9A (SMTC: Motor stop)</td>
</tr>
<tr>
<td>1020</td>
<td>Low Trans Oil Prs</td>
<td>1043</td>
<td>Spare 9B (SMTC: Origin)</td>
</tr>
<tr>
<td>1021</td>
<td>Spare 1</td>
<td>1044</td>
<td>Spare 10A (SMTC: Clamp / Unclamp)</td>
</tr>
<tr>
<td></td>
<td>APC Door</td>
<td>1045</td>
<td>Spare 10B</td>
</tr>
<tr>
<td>1022</td>
<td>Spare 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>APC Pin Clr #1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>#</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1100</td>
<td>Powered Servos</td>
<td>1119</td>
<td>TSC Purge</td>
</tr>
<tr>
<td>1101</td>
<td>Spare</td>
<td>1120</td>
<td>Unclamp Pre-Chrg</td>
</tr>
<tr>
<td>1102</td>
<td>Spare</td>
<td>1121</td>
<td>HTC Shuttle Out (Air Drive Shuttle: Move shuttle in)</td>
</tr>
<tr>
<td>1103</td>
<td>Spare</td>
<td>1122</td>
<td>Brake 5TH Axis</td>
</tr>
<tr>
<td>1104</td>
<td>Brake 4th Axis</td>
<td>1123</td>
<td>CE Door Lock</td>
</tr>
<tr>
<td>1105</td>
<td>Coolant Pump On</td>
<td>1124</td>
<td>M21</td>
</tr>
<tr>
<td>1106</td>
<td>Auto Power Off</td>
<td>1125</td>
<td>M22</td>
</tr>
<tr>
<td>1107</td>
<td>Spind. Motor Fan</td>
<td>1126</td>
<td>M23 (Air Drive Shuttle: Move Shuttle Out)</td>
</tr>
<tr>
<td>1108</td>
<td>Move T.C. In</td>
<td>1127</td>
<td>TSC Coolant</td>
</tr>
<tr>
<td></td>
<td>APC Chain Dr Fwd</td>
<td>1128</td>
<td>Green Beacon On</td>
</tr>
<tr>
<td>1109</td>
<td>Move T.C. Out</td>
<td>1129</td>
<td>Red Beacon On</td>
</tr>
<tr>
<td></td>
<td>APC Chain Dr Rev</td>
<td>1130</td>
<td>Enable Conveyor</td>
</tr>
<tr>
<td>1110</td>
<td>Rotate T.C. CW</td>
<td>1131</td>
<td>Reverse Conveyor</td>
</tr>
<tr>
<td>1111</td>
<td>Rotate T.C. CCW</td>
<td>1132</td>
<td>M-fin</td>
</tr>
<tr>
<td>1112</td>
<td>Spindle Hi Gear</td>
<td>1133</td>
<td>Probe</td>
</tr>
<tr>
<td>1113</td>
<td>Spindle Low Gear</td>
<td>1134</td>
<td>spare</td>
</tr>
<tr>
<td>1114</td>
<td>Unclamp Tool</td>
<td>1135</td>
<td>spare</td>
</tr>
<tr>
<td>1115</td>
<td>Spare</td>
<td>1136</td>
<td>spare</td>
</tr>
<tr>
<td>1116</td>
<td>Move Spigot CW</td>
<td>1137</td>
<td>spare</td>
</tr>
<tr>
<td>1117</td>
<td>Move Spigot CCW</td>
<td>1138</td>
<td>spare</td>
</tr>
<tr>
<td>1118</td>
<td>Pal Ready Light</td>
<td>1139</td>
<td>spare</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** If the machine is equipped with an APC the following inputs and outputs will change:

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>#</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1021</td>
<td>APC CE Door</td>
<td>1101</td>
<td>Pallet Clamped</td>
</tr>
<tr>
<td>1022</td>
<td>APC Pin CLR #1</td>
<td>1108</td>
<td>APC Chain Drive Forward</td>
</tr>
<tr>
<td>1023</td>
<td>APC Pin CLR #2</td>
<td>1109</td>
<td>APC Chain Drive Reverse</td>
</tr>
<tr>
<td>1026</td>
<td>APC PAL #2 Home</td>
<td>1121</td>
<td>PAL Clamp</td>
</tr>
<tr>
<td>1027</td>
<td>APC PAL #1 Home</td>
<td>1122</td>
<td>Door</td>
</tr>
<tr>
<td>1046</td>
<td>APC Door Closed</td>
<td>1125</td>
<td>APC Motor</td>
</tr>
<tr>
<td>1047</td>
<td>Door Open</td>
<td>1126</td>
<td>Beeper</td>
</tr>
<tr>
<td>1048</td>
<td>APC Pallet Clamped</td>
<td>1137</td>
<td>APC Chain Drive Power Enable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1138</td>
<td>Air Blast</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1139</td>
<td>APC Beeper</td>
</tr>
</tbody>
</table>

The second page of diagnostic data is displayed using the PAGE UP and PAGE DOWN keys. It contains:
### INPUTS 2

<table>
<thead>
<tr>
<th>Name</th>
<th>Name</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>X Axis Z Channel</td>
<td>X Overheat</td>
<td>X Cable Input</td>
</tr>
<tr>
<td>Y Axis Z Channel</td>
<td>Y Overheat</td>
<td>Y Cable Input</td>
</tr>
<tr>
<td>Z Axis Z Channel</td>
<td>Z Overheat</td>
<td>Z Cable Input</td>
</tr>
<tr>
<td>A Axis Z Channel</td>
<td>A Overheat</td>
<td>A Cable Input</td>
</tr>
<tr>
<td>B Axis Z Channel</td>
<td>B Overheat</td>
<td>B Cable Input</td>
</tr>
<tr>
<td>X Home Switch</td>
<td>X Drive Fault</td>
<td>Spindle Z Channel</td>
</tr>
<tr>
<td>Y Home Switch</td>
<td>Y Drive Fault</td>
<td></td>
</tr>
<tr>
<td>Z Home Switch</td>
<td>Z Drive Fault</td>
<td></td>
</tr>
<tr>
<td>A Home Switch</td>
<td>A Drive Fault</td>
<td></td>
</tr>
<tr>
<td>B Home Switch</td>
<td>B Drive Fault</td>
<td></td>
</tr>
</tbody>
</table>

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

- Spindle Forward
- Spindle Reverse
- Spindle Lock
- Spindle at Speed*
- Spindle Stopped
- Spindle Fault
- Spindle Locked
- Spindle Cable Fault
- Spindle Over Heat

### DISCRETE INPUTS 2

<table>
<thead>
<tr>
<th>Name</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spare Input 4A</td>
<td>Spare Input 8A</td>
</tr>
<tr>
<td>Spare Input 4B</td>
<td>Serp. Shot Pin*</td>
</tr>
<tr>
<td>Spare Input 5A</td>
<td>Motor Stop</td>
</tr>
<tr>
<td>Spare Input 5B</td>
<td>Origin</td>
</tr>
<tr>
<td>Spare Input 6A</td>
<td>Clamp / Unclamp</td>
</tr>
<tr>
<td>Spare Input 6B</td>
<td>Serp. Cam Count</td>
</tr>
<tr>
<td>Spare Input 7A</td>
<td>Spare Input 11A</td>
</tr>
<tr>
<td>Spare Input 7B</td>
<td>Spare Input 11 B</td>
</tr>
</tbody>
</table>
DISCRETE OUTPUTS 2

<table>
<thead>
<tr>
<th>Name</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spare Output 32</td>
<td>Spare Output 44</td>
</tr>
<tr>
<td>Spare Output 33</td>
<td>Spare Output 45</td>
</tr>
<tr>
<td>Spare Output 34</td>
<td>Spare Output 46</td>
</tr>
<tr>
<td>Spare Output 35</td>
<td>Spare Output 47</td>
</tr>
<tr>
<td>Spare Output 36</td>
<td>Spare Output 48 (SMTC: Serp. ATC Enable)</td>
</tr>
<tr>
<td>TC MTR SW</td>
<td>Spare Output 49 (SMTC: Serp. ATC Rev.)</td>
</tr>
<tr>
<td>Spare Output 38</td>
<td>Spare Output 50 (SMTC: Serp. Carsl CW)</td>
</tr>
<tr>
<td>Spare Output 39</td>
<td>Spare Output 51 (SMTC: Serp. Carsl CCW)</td>
</tr>
<tr>
<td>Spare Output 40</td>
<td>Spare Output 52 (SMTC: Serp. Carsl Ena.)</td>
</tr>
<tr>
<td>Spare Output 41</td>
<td>Spare Output 53</td>
</tr>
<tr>
<td>Spare Output 42</td>
<td>Spare Output 54</td>
</tr>
<tr>
<td>Spare Output 43</td>
<td>Spare Output 55</td>
</tr>
</tbody>
</table>

ANALOG DATA

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

Five Axis Discrete Inputs / Outputs

Diagnostic data, including the discrete inputs and outputs, can be viewed by pressing the PARAM/DGNOS key twice. Descriptions of the inputs/outputs can be found in the “Technical Reference” section of the Operator’s Manual.

Two discrete outputs, “4TH BK” and “5TH BK”, control the fourth and fifth axis brakes. When motion is commanded in either the C or B axis, the brake for that axis must first be released. When the brake is released, a relay is activated; these two outputs represent the activation of the brake relays. These outputs normally will read zero (0), but if the C or B axis brakes are disengaged, these outputs will read “1”.

There are two outputs that are specific to the VB-1, and that control the air-driven tool changer shuttle. When Parameter 278 bit AIR DRV SHTL is set to 1, discrete outputs 21 and 26 will appear as “SH IN” and “SH OUT”, respectively. When “SH IN” is 1, the tool changer shuttle is in the “in” position, or in the correct position to make a tool change. When “SH OUT” is set to 1, the tool changer shuttle is in the “out” position, or out of position to make a tool change.
5.22 The Equations of Motion

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

Let:

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

The following are known:

For a circular motion:

$$a = \frac{v^2}{r} \quad (1)$$

and in motion:

$$v = b \times l \quad (2)$$

which gives:

$$b = \frac{v}{l} \quad (3)$$

and

$$e = r - \sqrt{r^2 - \frac{l^2}{4}} \quad (4)$$

which gives:

$$r^2 - 2 \times r \times e + e^2 = r^2 - \frac{l^2}{4} \quad (5)$$

and:

$$l = \sqrt{8 \times r \times e - 4 \times e^2} \quad (6)$$

Since $r >> e$, $e^2$ is small compare to $r^2$ and we can assume:

$$l = \sqrt{8 \times r \times e} \quad (7)$$

And combining we get:

$$b = \frac{\sqrt{a \times r}}{\sqrt{8 \times e}} \quad (8)$$

Or

$$b = \sqrt{\frac{a}{8 \times e}} \quad (9)$$

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

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

#### TO FIND:

**S.F.M**

**TO FIND THE SFM OF A CUTTER OR WORKPIECE**

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

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

**R.P.M.**

**TO FIND THE RPM OF A CUTTER OR WORKPIECE**

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

\[
SFM = \frac{12 \times SFM}{3.1416 \times d} = \frac{3.82 \times SFM}{d}
\]

**I.P.M.**

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

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

\[
IPM = F.P.T. \times T \times RPM
\]

#### TO FIND:

**F.P.R.**

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

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

\[
F.P.R. = \frac{I.P.M.}{R.P.M.}
\]

**F.P.T.**

**TO FIND THE FEED PER TOOTH OF A CUTTER.**

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

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

---

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

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

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

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

**Parameter List**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 X SWITCHES</td>
<td>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:</td>
</tr>
<tr>
<td>0 REV ENCODER</td>
<td>Used to reverse the direction of encoder data.</td>
</tr>
<tr>
<td>1 REV POWER</td>
<td>Used to reverse direction of power to motor.</td>
</tr>
<tr>
<td>2 REV PHASING</td>
<td>Used to reverse motor phasing.</td>
</tr>
<tr>
<td>3 DISABLED</td>
<td>Used to disable the X-axis.</td>
</tr>
<tr>
<td>4 Z CH ONLY</td>
<td>With A only, indicates that no home switch.</td>
</tr>
<tr>
<td>5 AIR BRAKE</td>
<td>With A only, indicates that air brake is used.</td>
</tr>
<tr>
<td>6 DISABLE Z T</td>
<td>Disables encoder Z test (for testing only).</td>
</tr>
<tr>
<td>7 SERVO HIST</td>
<td>Graph of servo error (for diagnostics only).</td>
</tr>
<tr>
<td>8 INV HOME SW</td>
<td>Inverted home switch (N.C. switch).</td>
</tr>
<tr>
<td>9 INV Z CH</td>
<td>Inverted Z channel (normally high).</td>
</tr>
<tr>
<td>10 CIRC. WRAP.</td>
<td>With A only, causes 360 wrap to return to 0.</td>
</tr>
<tr>
<td>11 NO I IN BRAK</td>
<td>With A only, removes I feedback when brake is active.</td>
</tr>
<tr>
<td>12 LOW PASS +1X</td>
<td>Adds 1 term to low pass filter.</td>
</tr>
<tr>
<td>13 LOW PASS +2X</td>
<td>Adds two terms to low pass filter.</td>
</tr>
<tr>
<td>14 OVER TEMP NC</td>
<td>Selects a normally closed overheat sensor in motor.</td>
</tr>
<tr>
<td>15 CABLE TEST</td>
<td>Enables test of encoder signals and cabling.</td>
</tr>
<tr>
<td>16 Z TEST HIST</td>
<td>History plot of Z channel test data.</td>
</tr>
<tr>
<td>17 SCALE FACT/X</td>
<td>If set to 1, the scale ratio is interpreted as divided by X; where X depends on bits SCALE/X LO and SCALE/XHI.</td>
</tr>
<tr>
<td>18 INVIS AXIS</td>
<td>Used to create an invisible axis.</td>
</tr>
<tr>
<td>19 ROTALM LMSW</td>
<td>Rotary alarms at the limit switch.</td>
</tr>
<tr>
<td>21 ROT TRVL LIM</td>
<td>Rotary travel limits are used.</td>
</tr>
<tr>
<td>22 D FILTER X8</td>
<td>Enables the 8 tap FIR filter. Used to eliminate high frequency vibrations, depending on the axis motor.</td>
</tr>
<tr>
<td>23 D FILTER X4</td>
<td>Enables the 4 tap FIR filter. Used to eliminate high frequency vibrations, depending on the axis motor.</td>
</tr>
</tbody>
</table>
24  TORQUE ONLY  
For HAAS diagnostic use only.

25  3 EREV/MREV  
The 2 EREV/MREV and 3 EREV/MREV bits have two definitions depending on whether one or two encoders are present. For single encoder systems, the bits are used to define the ratio between the electrical rotation of the spindle motor and the mechanical rotation of the motor. For two encoder systems, the definition is the electrical rotation of the motor to the mechanical rotation of the spindle motor encoder, which includes any pulley ratio between the motor and the motor encoder.

26  2 EREV/MREV  
The 2 EREV/MREV and 3 EREV/MREV bits have two definitions depending on whether one or two encoders are present. For single encoder systems, the bits are used to define the ratio between the electrical rotation of the spindle motor and the mechanical rotation of the motor. For two encoder systems, the definition is the electrical rotation of the motor to the mechanical rotation of the spindle motor encoder, which includes any pulley ratio between the motor and the motor encoder.

27  NON MUX PHAS  
For HAAS diagnostic use only.

28  BRUSH MOTOR  
Enables the brushless motor option.

29  LINEAR DISPL  
This bit changes the display from degrees to inches (or millimeters) on the A and B axes.

30  SCALE/X LO  
With SCALE/X HI bit, determines the scale factor used in bit SCALE FACT/X.

31  SCALE/X HI  
With SCALE/X LO bit, determines the scale factor used in bit SCALE FACT/X. See below:

<table>
<thead>
<tr>
<th>HI</th>
<th>LO</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Parameter 2  X P GAIN  
Proportional gain in servo loop.

Parameter 3  X D GAIN  
Derivative gain in servo loop.

Parameter 4  X I GAIN  
Integral gain in servo loop.

Parameter 5  X RATIO (STEPS/UNIT)  
The number of steps of the encoder per unit of travel. Encoder steps supply four (4) times their line count per revolution. Thus, an 8192 line encoder and a 6mm pitch screw give:

\[ 8192 \times 4 \times \frac{25.4}{6} = 138718 \]

(5 steps per unit inch/mm ratio)

Parameter 6  X MAX TRAVEL (STEPS)  
Max negative direction of travel from machine zero in encoder steps. Does not apply to A-axis. Thus a 20 inch travel, 8192 line encoder and 6 mm pitch screw give:

\[ 20.0 \times 138718 = 2774360 \]

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.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>MAX ERROR</td>
</tr>
<tr>
<td>10</td>
<td>FUSE LEVEL</td>
</tr>
<tr>
<td>11</td>
<td>TORQUE PRELOAD</td>
</tr>
<tr>
<td>12</td>
<td>STEPS/REVOLUTION</td>
</tr>
<tr>
<td>13</td>
<td>BACKLASH</td>
</tr>
<tr>
<td>14</td>
<td>DEAD ZONE</td>
</tr>
<tr>
<td>15</td>
<td>SWITCHES</td>
</tr>
<tr>
<td>16</td>
<td>P GAIN</td>
</tr>
<tr>
<td>17</td>
<td>D GAIN</td>
</tr>
<tr>
<td>18</td>
<td>I GAIN</td>
</tr>
<tr>
<td>19</td>
<td>RATIO (STEPS/UNIT)</td>
</tr>
<tr>
<td>20</td>
<td>MAX TRAVEL (STEPS)</td>
</tr>
<tr>
<td>21</td>
<td>ACCELERATION</td>
</tr>
<tr>
<td>22</td>
<td>MAX SPEED</td>
</tr>
</tbody>
</table>

**Parameter 9**
Max error allowed in servo loop before alarm is generated. Units are encoder steps. This is the maximum allowable error in Hz between the commanded speed and the actual speed. The purpose of this parameter is to prevent "motor runaway" in case of phasing reversal, or bad parameters. If this parameter is set to 0, it defaults to 1/4 of parameter 183 Max Frequency.

**Parameter 10**
Used to limit average power to motor. If not set correctly, this parameter can cause an "overload" alarm.

**Parameter 11**
TORQUE PRELOAD is a signed number that should be set to a value from 0 to 4095 where 4095 is the maximum motor torque. It is applied at all times to the servo in the same direction. It is used to compensate, in the vertical direction, for gravity on a machine with an axis brake instead of a counterbalance. Normally, the brake is released when the servo motors are activated. However, when an axis with the brake has been disabled, the brake must not be released at all. This feature takes care of that situation. Normally, this parameter should be set to zero on all axes. Exceptions are:
- **Mini-mills** with the axis brake instead of a counterbalance, parameter 39 Z axis TORQUE PRELOAD must be set to 300. The TORQUE PRELOAD parameter for the remaining axes must be set to zero.
- **Vertical mills** with the axis brake instead of a counterbalance, parameter 39 Z axis TORQUE PRELOAD must be set to 600. The TORQUE PRELOAD parameter for the remaining axes must be set to zero.
- **Horizontal mills** with the axis brake instead of a counterbalance, parameter 25 Y axis TORQUE PRELOAD must be set to 500. The TORQUE PRELOAD parameter for the remaining axes must be set to zero.

**Parameter 12**
Encoder steps per revolution of motor. Thus, an 8192 line encoder gives:

\[
8192 \times 4 = 32768
\]

**Parameter 13**
Backlash correction in encoder steps.

**Parameter 14**
Dead zone correction for driver electronics. Units are 0.0000001 seconds.

**Parameter 15**
See Parameter 1 for description.

**Parameter 16**
See Parameter 2 for description.

**Parameter 17**
See Parameter 3 for description.

**Parameter 18**
See Parameter 4 for description.

**Parameter 19**
See Parameter 5 for description.

**Parameter 20**
See Parameter 6 for description.

**Parameter 21**
See Parameter 7 for description.

**Parameter 22**
See Parameter 8 for description.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Y MAX ERROR</td>
</tr>
<tr>
<td>24</td>
<td>Y FUSE LEVEL</td>
</tr>
<tr>
<td>25</td>
<td>Y TORQUE PRELOAD</td>
</tr>
<tr>
<td>26</td>
<td>Y STEPS/REVOLUTION</td>
</tr>
<tr>
<td>27</td>
<td>Y BACKLASH</td>
</tr>
<tr>
<td>28</td>
<td>Y DEAD ZONE</td>
</tr>
<tr>
<td>29</td>
<td>Z SWITCHES</td>
</tr>
<tr>
<td>30</td>
<td>Z P GAIN</td>
</tr>
<tr>
<td>31</td>
<td>Z D GAIN</td>
</tr>
<tr>
<td>32</td>
<td>Z I GAIN</td>
</tr>
<tr>
<td>33</td>
<td>Z RATIO (STEPS/UNIT)</td>
</tr>
<tr>
<td>34</td>
<td>Z MAX TRAVEL (STEPS)</td>
</tr>
<tr>
<td>35</td>
<td>Z ACCELERATION</td>
</tr>
<tr>
<td>36</td>
<td>Z MAX SPEED</td>
</tr>
<tr>
<td>37</td>
<td>Z MAX ERROR</td>
</tr>
<tr>
<td>38</td>
<td>Z FUSE LEVEL</td>
</tr>
<tr>
<td>39</td>
<td>Z TORQUE PRELOAD</td>
</tr>
<tr>
<td>40</td>
<td>Z STEPS/REVOLUTION</td>
</tr>
<tr>
<td>41</td>
<td>Z BACKLASH</td>
</tr>
<tr>
<td>42</td>
<td>Z DEAD ZONE</td>
</tr>
</tbody>
</table>
Parameter 43 A SWITCHES
See Parameter 1 for description AND make sure that this parameter is set to enable the fourth axis before you try to enable the fourth axis from settings.

Parameter 44 A P GAIN
See Parameter 2 for description.

Parameter 45 A D GAIN
See Parameter 3 for description.

Parameter 46 A I GAIN
See Parameter 4 for description.

Parameter 47 A RATIO (STEPS/UNIT)
This parameter defines the number of encoder steps required to complete one full rotation of the platter. For example an HRT 210 with a 90:1 gear ratio, a final drive ratio of 2:1, and an encoder count of 2000 lines would be:

\[
2000 \times 4 \times (90 \times 2) / 360 = 4000 \text{ steps}
\]

for a brushless HRT 210 with a 90:1 gear ratio, a final drive ratio of 2:1 and an encoder count of 8192 the formula would be:

\[
8192 \times 4 \times (90 \times 2) / 360 = 16384 \text{ steps}
\]

If for example 16384 ended up being 13107.2 (non integer) the user must make sure the single bits SCALE FACT/X and the COMBINATION OF SCALE/X LO and SCALE/X HI are turned on in parameter 43. When the scale factor/x bit is 1 the scale ratio is interpreted as divide by X: where X depends on scale/x lo and scale/x hi (see parameter 1 for scale/x lo and scale/x hi values). For example:

\[
8192 \times 4 \times (72 \times 2) / 360 = 13107.2
\]

You would then turn on the scale fact/x bit and the scale/x lo bit which would give you a factor of 5 thus:

\[
13107.2 \times 5 = 65536 \text{ encoder steps}
\]

Parameter 48 A MAX TRAVEL (STEPS)
See Parameter 6 for description. Normally this parameter would not apply to the A axis, however this parameter is used on mills with a gimbaled spindle (5-axis mills). On a VR-series mill this parameter is used to limit the amount of angular movement of the spindle (A and B axes). The A and B axes are limited in movement to a distance between negative MAX TRAVEL, and positive TOOL CHANGE OFFSET. On 5-axes mills A and B axes ROT TRVL LIM must be set to 1, MAX TRAVEL and TOOL CHANGE OFFSET must be calibrated and set correctly.

Parameter 49 A ACCELERATION
See Parameter 7 for description.

Parameter 50 A MAX SPEED
See Parameter 8 for description.

Parameter 51 A MAX ERROR
See Parameter 9 for description.

Parameter 52 A FUSE LEVEL
See Parameter 10 for description.

Parameter 53 A BACK EMF
See Parameter 11 for description.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>STEPS/REVOLUTION</td>
<td>See Parameter 12 for description.</td>
</tr>
<tr>
<td>55</td>
<td>BACKLASH</td>
<td>See Parameter 13 for description.</td>
</tr>
<tr>
<td>56</td>
<td>DEAD ZONE</td>
<td>See Parameter 14 for description.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>57</td>
<td>COMMON SWITCH 1</td>
<td>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:</td>
</tr>
<tr>
<td>0</td>
<td>REV CRANK</td>
<td>Reverses direction of jog handle.</td>
</tr>
<tr>
<td>1</td>
<td>DISABLE T.C.</td>
<td>Disables tool changer operations.</td>
</tr>
<tr>
<td>2</td>
<td>DISABLE G.B.</td>
<td>Disables gear box functions.</td>
</tr>
<tr>
<td>3</td>
<td>POF AT E-STOP</td>
<td>Stops spindle then turns the power off at EMERGENCY STOP.</td>
</tr>
<tr>
<td>4</td>
<td>RIGID TAP</td>
<td>Indicates hardware option for rigid tap.</td>
</tr>
<tr>
<td>5</td>
<td>REV SPIN ENC</td>
<td>Reverses sense direction of spindle encoder.</td>
</tr>
<tr>
<td>6</td>
<td>REPT RIG TAP</td>
<td>Selects repeatable rigid tapping.</td>
</tr>
<tr>
<td>7</td>
<td>EX ST MD CHG</td>
<td>Selects exact stop in moves when mode changes.</td>
</tr>
<tr>
<td>8</td>
<td>SAFETY CIRC.</td>
<td>This enables safety hardware, if machine is so equipped.</td>
</tr>
<tr>
<td>9</td>
<td>SP DR LIN AC</td>
<td>Selects linear deceleration for rigid tapping. 0 is quadratic.</td>
</tr>
<tr>
<td>10</td>
<td>PH LOSS DET</td>
<td>When enabled, will detect a phase loss.</td>
</tr>
<tr>
<td>11</td>
<td>COOLANT SPGT</td>
<td>Enables coolant spigot control and display.</td>
</tr>
<tr>
<td>12</td>
<td>OVER T IS NC</td>
<td>Selects Regen over temp sensor as N.C.</td>
</tr>
<tr>
<td>13</td>
<td>SKIP OVERSHT</td>
<td>Causes Skip (G31) to act like Fanuc and overshoot sense point.</td>
</tr>
<tr>
<td>14</td>
<td>NONINV SP ST</td>
<td>Non-inverted spindle stopped status.</td>
</tr>
<tr>
<td>15</td>
<td>SP LOAD MONI</td>
<td>Spindle load monitor option is enabled.</td>
</tr>
<tr>
<td>16</td>
<td>SP TEMP MONI</td>
<td>Spindle temperature monitor option is enabled.</td>
</tr>
<tr>
<td>17</td>
<td>ENA ROT &amp; SC</td>
<td>Enables rotation and scaling.</td>
</tr>
<tr>
<td>18</td>
<td>ENABLE DNC</td>
<td>Enables DNC selection from MDI.</td>
</tr>
<tr>
<td>19</td>
<td>ENABLE BGEDT</td>
<td>Enables BACKGROUND EDIT mode.</td>
</tr>
<tr>
<td>20</td>
<td>ENA GRND FLT</td>
<td>Enables ground fault detector.</td>
</tr>
</tbody>
</table>
21 M19 SPND ORT  This bit makes the P and R codes a protected feature which can only be enabled with an unlock code. The unlock code will be printed on the parameter listing of all new machines. If this bit is set to 0, an M19 will orient the spindle to 0 degrees regardless of the value of any P or R code in the same block. If this is set to 1, a P code in the block will cause the spindle to be oriented to the specified angle such as P180. Alternately, a decimal R code can be used, such as R180.53. Note that the P and R codes only work on a vector drive machine.

22 ENABLE MACRO  Enables macro functions.

23 INVERT SKIP  Invert sense of skip to active low=closed.

24 HANDLE CURSR  Enable use of jog handle to move cursor.

25 NEG WORK OFS  Selects use of work offsets in negative direction.

26 TRANS OIL  Enables transmission low oil pressure detection.

27 ENA QUIKCODE  Enables conversational programming.

28 OILER ON/OFF  Enables oiler power when servos or spindle is in motion.

29 NC OVER VOLT  Inverts sense of over voltage signal.

30 SP MOTOR ENC  This parameter bit enables a second encoder that is mounted on the spindle motor and wired into the “C” axis input of the Mocon. It is required to control the vector algorithm on a belted machine when the belts slip at high load. When two encoders are present, the first is mounted on the spindle or output of the transmission, and is wired to the “spindle” input on the MOCON. Most mills use a single encoder that is mounted on either the spindle (transmission output) or spindle motor but always connected to the spindle input on the Mocon.

31 DOOR STOP SP  Enables functions to stop spindle and manual operations at door switch.

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

Parameter 59 MAXIMUM FEED  Maximum feed rate in inches per minute.

Parameter 60 TURRET START DELAY  Maximum delay allowed in start of tool turret. Units are milliseconds. After this time, an alarm is generated.

On Horizontal mills with a side mount tool changer, this parameter is used to specify the time (in milliseconds) allowed for motor driven motions of the shuttle and arm. If the motion has not completed within the time allowed by this parameter, alarm 696 ATC MOTOR TIME OUT is generated. This parameter should be set to 2000.

Parameter 61 TURRET STOP DELAY  Maximum delay allowed in motion of tool turret. Units are milliseconds. After this time, an alarm is generated.

On Horizontal mills with a side mount tool changer, this parameter is used to specify the time (in milliseconds) allowed for air-pressure driven arm in/arm out moves. If the motion has not completed within the time allowed by this parameter, alarm 695 ATC AIR CYLINDER TIME OUT is generated. This parameter should be set to 10000.

Parameter 62 SHUTTLE START DELAY  This parameter is used to specify the time (in milliseconds) needed to allow the tool pocket to settle (stop bouncing) after being lowered in preparation for a tool change.
Parameter 63 SHUTTLE STOP DELAY
This parameter is also used for vertical mills with a Side Mount Tool Changer. It is used to specify the time allowed (in milliseconds) for the tool arm motor to stop. If the arm has not stopped after the allowed time alarm 627 ATC ARM POSITION TIMEOUT is generated.

Parameter 64 Z TOOL CHANGE OFFSET
On Vertical mills: For Z-axis, displacement from home switch to tool change position and machine zero. About 4.6 inches, so for an 8192 line encoder this gives:
\[ 4.6 \times 138718 = 638103 \]
On Horizontal mills, this parameter is not used. It should be set to zero.

Parameter 65 NUMBER OF TOOLS
Number of tool positions in tool changer. This number must be set to the configuration machine. The maximum number of tool positions is 32, except Horizontal mills with a side mount tool changer. This parameter must be 60 for the HS 60 SMTC and 120 for the HS 120 SMTC.

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

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

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

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

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

Parameter 71 DRAW BAR OFFSET
Offset provided in motion of Z-axis to accommodate the tool pushing out of the spindle when unclamping tool. Units are encoder steps.

Parameter 72 DRAW BAR Z VEL UNCL
Speed of motion in Z-axis to accommodate tool pushing out of the spindle when unclamping tool. Units are encoder steps per second.

Parameter 73 SP HIGH G/MIN SPEED
Command speed used to rotate spindle motor when orienting spindle in high gear. Units are maximum spindle RPM divided by 4096. This parameter is not used in machines equipped with a Haas vector drive.

Parameter 74 SP LOW G/MIN SPEED
Command speed used to rotate spindle motor when orienting spindle in low gear. Units are maximum spindle RPM divided by 4096. This parameter is not used in machines equipped with a Haas vector drive.

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

Parameter 76 LOW AIR DELAY
Delay allowed after sensing low air pressure before alarm is generated. Alarm skipped if air pressure returns before delay. Units are 1/50 seconds.
### Parameter 77: SP LOCK SETTLE TIME
- Required time in milliseconds that the spindle lock must be in place and stable before spindle orientation is considered complete.

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

### Parameter 79: SPINDLE STEPS/REV
- Sets the number of spindle encoder steps per revolution of the spindle. This number takes into account the pulley ratio between transmission and spindle, plus transmission and encoder.

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

### Parameter 81: M MACRO CALL O9000
- M code that will call O9000. This parameter can contain a value from 1 through 98, inclusive, zero causes no call. However it is best to use a value that is not already in use (see current M code list). Using M37 the value 37 would be entered in parameter 81 (for example). A program would be written to include the M37, such as:
  ```
  G X0...
  M37
  ...
  M30
  ```
- The control would run the program until it got to the M37, it would call program O9000, run that, and then return to the point that it left, and continue the main program. Be aware that, if program O9000 contains another M37, it will call itself, and keep calling until it fills the stack (9 times) and then alarm out with 307 SUBROUTINE NESTING TOO DEEP. Note that if M33 (for example) is used, it would override the normal M33 Conveyor Stop function.

### Parameter 82: M MACRO CALL O9001
- See parameter 81 for description

### Parameter 83: M MACRO CALL O9002
- See parameter 81 for description

### Parameter 84: M MACRO CALL O9003
- See parameter 81 for description

### Parameter 85: M MACRO CALL O9004
- See parameter 81 for description

### Parameter 86: M MACRO CALL O9005
- See parameter 81 for description

### Parameter 87: M MACRO CALL O9006
- See parameter 81 for description

### Parameter 88: M MACRO CALL O9007
- See parameter 81 for description

### Parameter 89: M MACRO CALL O9008
- See parameter 81 for description

### Parameter 90: M MACRO CALL O9009
- See parameter 81 for description
Parameter 91  G MACRO CALL O9010
G code that will call O9010. This parameter can contain a value from 1 through 98, inclusive, zero causes no call. However it is best to use a value that is not already in use (see current G code list). Using G45 the value 45 would be entered in parameter 91 (for example). A program would be written to include the G45, such as:

  G X0...
  G45
  ...
  M30

The control would run the program until it got to the G45, it would call program O9010, run that, and then return to the point that it left, and continue the main program. Be aware that, if program O9010 contains another G45, it will call itself, and keep calling until it fills the stack (4 times) and then alarm out with 531 MACRO NESTING TOO DEEP.

Note that if G84 (for example) is used, it would override the normal G84 Tapping Canned Cycle.

Parameter 92  G MACRO CALL O9011
See parameter 91 for description

Parameter 93  G MACRO CALL O9012
See parameter 91 for description

Parameter 94  G MACRO CALL O9013
See parameter 91 for description

Parameter 95  G MACRO CALL O9014
See parameter 91 for description

Parameter 96  G MACRO CALL O9015
See parameter 91 for description

Parameter 97  G MACRO CALL O9016
See parameter 91 for description

Parameter 98  G MACRO CALL O9017
See parameter 91 for description

Parameter 99  G MACRO CALL O9018
See parameter 91 for description

Parameter 100  G MACRO CALL O9019
See parameter 91 for description

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

Parameter 102  IN POSITION LIMIT Y
See Parameter 101 for description

Parameter 103  IN POSITION LIMIT Z
See Parameter 101 for description

Parameter 104  IN POSITION LIMIT A
See Parameter 101 for description

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

Parameter 106  Y MAX CURRENT
See Parameter 105 for description
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>107</td>
<td><strong>Z MAX CURRENT</strong>&lt;br&gt;See Parameter 105 for description</td>
</tr>
<tr>
<td>108</td>
<td><strong>A MAX CURRENT</strong>&lt;br&gt;See Parameter 105 for description</td>
</tr>
<tr>
<td>109</td>
<td><strong>D*D GAIN FOR X</strong>&lt;br&gt;Second derivative gain in servo loop.</td>
</tr>
<tr>
<td>110</td>
<td><strong>D*D GAIN FOR Y</strong>&lt;br&gt;Second derivative gain in servo loop.</td>
</tr>
<tr>
<td>111</td>
<td><strong>D*D GAIN FOR Z</strong>&lt;br&gt;Second derivative gain in servo loop.</td>
</tr>
<tr>
<td>112</td>
<td><strong>D*D GAIN FOR A</strong>&lt;br&gt;Second derivative gain in servo loop.</td>
</tr>
<tr>
<td>113</td>
<td><strong>X ACC/DEC T CONST</strong>&lt;br&gt;Acceleration time constant. Units are 1/10000 seconds. This parameter provides for a constant ratio between profiling lag and servo velocity at the endpoint of a rapid motion.</td>
</tr>
<tr>
<td>114</td>
<td><strong>Y ACC/DEC T CONST</strong>&lt;br&gt;See Parameter 113 for description</td>
</tr>
<tr>
<td>115</td>
<td><strong>Z ACC/DEC T CONST</strong>&lt;br&gt;See Parameter 113 for description</td>
</tr>
<tr>
<td>116</td>
<td><strong>A ACC/DEC T CONST</strong>&lt;br&gt;See Parameter 113 for description</td>
</tr>
<tr>
<td>117</td>
<td><strong>LUB CYCLE TIME</strong>&lt;br&gt;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.</td>
</tr>
<tr>
<td>118</td>
<td><strong>SPINDLE REV TIME</strong>&lt;br&gt;Time in milliseconds to reverse spindle motor.</td>
</tr>
<tr>
<td>119</td>
<td><strong>SPINDLE DECEL DELAY</strong>&lt;br&gt;Time in milliseconds to decelerate spindle motor.</td>
</tr>
<tr>
<td>120</td>
<td><strong>SPINDLE ACC/DECEL</strong>&lt;br&gt;Accel/decel time constant in 200ths of a step/ms/ms for spindle motor.</td>
</tr>
<tr>
<td>121</td>
<td><strong>X PHASE OFFSET</strong>&lt;br&gt;The motor phase offset for X motor. This is arbitrary units.</td>
</tr>
<tr>
<td>122</td>
<td><strong>Y PHASE OFFSET</strong>&lt;br&gt;See Parameter 121 for description.</td>
</tr>
<tr>
<td>123</td>
<td><strong>Z PHASE OFFSET</strong>&lt;br&gt;See Parameter 121 for description.</td>
</tr>
<tr>
<td>124</td>
<td><strong>A PHASE OFFSET</strong>&lt;br&gt;See Parameter 121 for description.</td>
</tr>
<tr>
<td>125</td>
<td><strong>X GRID OFFSET</strong>&lt;br&gt;This parameter shifts the effective position of the encoder Z pulse. It can correct for a positioning error of the motor or home switch.</td>
</tr>
<tr>
<td>126</td>
<td><strong>Y GRID OFFSET</strong>&lt;br&gt;See Parameter 125 for description.</td>
</tr>
</tbody>
</table>
PARAMETERS

Parameter 127 Z GRID OFFSET
See Parameter 125 for description.

Parameter 128 A GRID OFFSET
See Parameter 125 for description.

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

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

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

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

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

Parameter 134 X EXACT STOP DIST.

Parameter 135 Y EXACT STOP DIST.

Parameter 136 Z EXACT STOP DIST.

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

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

Parameter 138 X FRICTION COMPENSATION

Parameter 139 Y FRICTION COMPENSATION

Parameter 140 Z FRICTION COMPENSATION

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

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

Parameter 143 DRAW BAR Z VEL CLMP
This parameter sets the speed of the Z-axis motion that compensates for tool motion during tool clamping. Units are in encoder steps per second.

Parameter 144 RIG TAP FINISH DIST
This parameter sets the finish tolerance for determining the end point of a rigid tapping operation. Units are encoder counts.

Parameter 145 X ACCEL FEED FORWARD
Parameter 146  Y ACCEL FEED FORWARD
Parameter 147  Z ACCEL FEED FORWARD
Parameter 148  AACCEL FEED FORWARD
These parameters set the feed forward gain for the axis servo. They have no units.
Parameter 149  Precharge DELAY
This parameter sets the delay time from precharge to tool release. Units are milliseconds.
Parameter 150  MAX SP RPM LOW GEAR
Max spindle RPM in low gear.
Parameter 151  B SWITCHES
See Parameter 1 for description.
Parameter 152  B P GAIN
See Parameter 2 for description.
Parameter 153  B D GAIN
See Parameter 3 for description.
Parameter 154  B I GAIN
See Parameter 4 for description.
Parameter 155  B RATIO (STEPS/UNIT)
See Parameter 47 for description.
Parameter 156  B MAX TRAVEL (STEPS)
See Parameter 6 for description. Normally this parameter would not apply to the A axis, however this parameter is used on mills with a gimbaled spindle (5-axes mills). On a VR-series mill this parameter is used to limit the amount of angular movement of the spindle (A and B axes). The A and B axes are limited in movement to a distance between negative MAX TRAVEL, and positive TOOL CHANGE OFFSET. On 5-axes mills A and B axes ROT TRVL LIM must be set to 1, MAX TRAVEL and TOOL CHANGE OFFSET must be calibrated and set correctly.
Parameter 157  B ACCELERATION
See Parameter 7 for description.
Parameter 158  B MAX SPEED
See Parameter 8 for description.
Parameter 159  B MAX ERROR
See Parameter 9 for description.
Parameter 160  B FUSE LEVEL
See Parameter 10 for description.
Parameter 161  B BACK EMF
See Parameter 11 for description.
Parameter 162  B STEPS/REVOLUTION
See Parameter 12 for description.
Parameter 163  B BACKLASH
See Parameter 13 for description.
Parameter 164  B DEAD ZONE
See Parameter 14 for description.
Parameter 165  IN POSITION LIMIT B
Same definition as Parameter 101.
Parameter 166  B MAX CURRENT
Same definition as Parameter 105.

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

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

Parameter 169  B PHASE OFFSET
See Parameter 121 for description.

Parameter 170  B GRID OFFSET
See Parameter 125 for description.

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

Parameter 172  B FRICTION COMPENSATION
See Parameter 138 for description.

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

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

Parameter 175  B AIR BRAKE DELAY
Delay provided for air to release from brake on B-axis prior to moving. Units are milliseconds.

**NOTE:** The C-axis parameters (176-200) are used to control the Haas Vector Drive. Parameter 278 bit HAAS VECT DR must be set to 1 for these parameters to be available.

Parameter 176  C SWITCHES
See Parameter 1 for description.

Parameter 177  C P GAIN
See Parameter 2 for description.

Parameter 178  C D GAIN
See Parameter 3 for description.

Parameter 179  C I GAIN
See Parameter 4 for description.

Parameter 180  C SLIP GAIN
The slip rate calculated depends on two other variables: speed and current.

\[
\text{Slip rate} = \text{slip gain} \times (\text{speed/\text{max speed}}) \times (\text{current/\text{max current}})
\]

The slip gain value is the value that slip rate would assume at maximum speed, and maximum current (16.384=1 Hz).

Parameter 181  C MIN SLIP
The minimum value allowed from the slip rate. From the equation:

\[
\text{Slip rate} = \text{slip gain} \times (\text{speed/\text{max speed}}) \times (\text{current/\text{max current}})
\]

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).
### Parameters

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

**Parameter 183 C MAX FREQ**
The frequency at which the motor will be run when maximum spindle RPM is commanded. Units: 0.01 Hz (two implied decimal places).

**Parameter 184 C MAX ERROR**
The maximum allowable error (in Hz) between commanded spindle speed and actual speed. If set to zero, it will default to 1/4 of Parameter 183.

**Parameter 185 C FUSE LEVEL**
See Parameter 10 for description.

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

**Parameter 187 C HIGH GEAR STEPS/REV**
This name is used when a Vector Drive is installed. This function takes on two meanings depending on how many spindle encoders are used on the machine. If only one encoder is present, it is the number of encoder steps per mechanical revolution of the spindle motor when the transmission is in high gear. (On direct drive machines, the encoder is mounted on the motor, while on others, it is on the spindle or transmission output.) N = (Encoder steps/enc rev)/(Enc pulley ratio X High Gear Ratio) For machines with a spindle and spindle motor encoder, it is the number of spindle motor encoder steps per mechanical revolution of the encoder. Its purpose is to specify the resolution of the spindle motor encoder. This parameter is used in conjunction with parameter 176 bits 25 and 26, which control the ratio between the electrical revolution of the motor to the mechanical revolution of the encoder.

If a vector drive is not installed, this parameter is called: STEPS/REVOLUTION and is not used.

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

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

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

**Parameter 191 C MAX CURRENT**
See Parameter 105 for description

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

**Parameter 193 C SPIN ORIENT MARGIN**
When a spindle orientation is done, if the actual position of the spindle is within this value (plus or minus), the spindle will be considered locked. Otherwise, the spindle will not be locked.

**Parameter 194 SPINDLE STOP FREQ**
The spindle is considered to be stopped (discrete input SP ST*=0) when the speed drops below this value. Units are encoder steps/millisecond.

**Parameter 195 C START/STOP DELAY**
This delay is used at the start of motion to magnetize the rotor before acceleration starts. When the motor comes to a stop it remains energized for this amount of time. Units are in milliseconds.
Parameter 196  C ACCEL LIMIT LOAD
This parameter is used when a Vector Drive is installed. This is the % load limit during acceleration. If the load reaches this limit during acceleration the control slows down the acceleration. If a Vector Drive is not installed, this parameter is called C axis EXACT STOP DISTANCE, and is not used.

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

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

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

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

Parameter 201  X SCREW COMP. COEF.
This is the coefficient of heating of the lead screw and is used to shorten the screw length.

Parameter 205  A SCREW COMP. COEF.
This parameter should be set to 0.

Parameter 206  SPIGOT POSITION
Vertical mills only. Maximum number of spigot positions.

Parameter 207  SPIGOT TIMEOUT (MS)
Vertical mills only. Maximum timeout allowed for spigot to traverse one spigot location.

Parameter 208  SPIN. FAN OFF DELAY
Delay for turning the spindle fan off after the spindle has been turned off.

Parameter 209  COMMON SWITCH 2
Parameter 209 is a collection of general purpose single bit flags used to turn some functions on and off. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>HORIZONTAL</td>
</tr>
<tr>
<td>1</td>
<td>RST STOPS T.C.</td>
</tr>
<tr>
<td>2</td>
<td>CHAIN TC</td>
</tr>
<tr>
<td>3</td>
<td>ENA CONVEYOR</td>
</tr>
<tr>
<td>4</td>
<td>50% RPD KBD</td>
</tr>
<tr>
<td>5</td>
<td>FRONT DOOR</td>
</tr>
<tr>
<td>6</td>
<td>TC Z NO HOME</td>
</tr>
<tr>
<td>7</td>
<td>M36 AUTO MOT</td>
</tr>
</tbody>
</table>

0 HORIZONTAL  When set to (1), the control identifies the machine as a horizontal mill. The control will then make the necessary adjustments, such as enabling the horizontal tool changer.

1 RST STOPS T.C.  Tool changer can be stopped with RESET button.

2 CHAIN TC  On all HS mills with the 60 or 120 pocket chain-style tool changer, it must be set to 1. On all other mills, it must be set to zero.

3 ENA CONVEYOR  Enables chip conveyor, if machine is so equipped.

4 50% RPD KBD  When (1) the control will support the new style keyboards with the 50% rapid traverse key. For controls without a 50% rapid keypad set this bit to (0).

5 FRONT DOOR  When enabled the control will look for an additional door switch and will generate an operator message.

6 TC Z NO HOME  In Horizontal mills only. This bit prevents Z-axis motion to machine zero prior to a tool change.

7 M36 AUTO MOT  In Horizontal only. When set to (1), an M36 rotates the A-axis after the PART READY button is pressed.
8  AUX AXIS TC  In Horizontal mills only. When enabled, means the tool changer carousel is driven by an aux. axis.
9  SPIGOT KEY INV  This bit controls the direction the spigot moves when the Coolant Up and Coolant Down buttons are pressed. Changing this bit reverses the direction the spigot moves when the buttons are pressed. It has no effect on the direction the spigot moves when commanded by the M34 and M35 codes.
12  REV CONVEYOR  Reverses the direction of the chip conveyor.
13  M27-M28 CONVYR  Usually the chip conveyor motor and direction relays are attached to the user relays M21 and M22. When this bit is set, the control expects to see the conveyor hooked up to M27 and M28.
15  GREEN BEACON  When (1) user relay M25 is used to flash a beacon. If the control is in a reset state, the beacon will be off. If the control is running normally, the beacon will be steadily on. If the control is in a M00, M01, M02, M30 feedhold, or single block state, then the beacon will flash.
16  RED BEACON  When (1) user relay M26 is used to flash a beacon. The beacon flashes if the control is experiencing an alarm or emergency stop condition.
17  CONVY DR OVRD  When (1) the conveyor will continue to run with the door open. When (0) the conveyor will stop when the door is open, but will resume when the door is closed. For safety it is recommended that the bit be set to (0).
18  DSBL CLNT IN  If set to 1 low coolant input will not be used.
19  DSC INP PR  Discrete pallet rotate/part ready; inputs enabled if set to 1.
20  RMT TOOLS RLS  If set to 1, allows use of remote tool release button on spindle head.
21  DISK ENABL  If set to 1, enables the optional disk drive.
22  TCR KEYPAD  If set to 1, enables tool changer restore button on keypad.
23  MCD RLY BRD  If set to 1, allows for M-code addressing. This adds the availability of additional outputs.
24  TSC ENABLE  When set to 1, "DSBL CLNT IN" bit is ignored, M24, M54 and M64 are disabled, and TSC will operate. When set to zero, the control functions normally.
25  AUX JOG NACC  If the jog handle is moved rapidly the auxiliary axis will not develop extremely large lags.
26  ALISM PRGRST  Alias M codes during program restart.
27  DSBL JOG TST  Disables the encoder test for the jog handle.
28  AIR DR @ M24  Used on horizontal mills only.
29  PAL ENABLE  This parameter accommodates both the APC on the vertical mill the Rotary Pallet Changer on the Horizontal mill. This parameter bit should be set to 1 if an APC is present. Otherwise, it should be set to zero. Note that this bit should be zero on Horizontal Mills as it is intended for future pallet changer software that replaces the macro program.
30  PRDY @ Y160  Used on horizontal mills only.
31  SPNDL NOWAIT  When (1), the machine will not wait for the spindle to come up to speed immediately after an M03 or M04 command. Instead, it will check and/or wait for the spindle to come up to speed immediately before the next interpolated motion is initiated. This bit does not affect rigid tapping or the TSC option.
Parameter 210 X AXIS TOOL CHANGE OFFSET
Used on the HS-2RP mill for X axis displacement from the home position to tool change position.
*If this parameter contains an incorrect value, a horizontal mill will crash when it does a tool change.*

Parameter 211 Y AXIS TOOL CHANGE OFFSET
Used on the HS-2RP mill for Y axis displacement from the home position to tool change position.
*If this parameter contains an incorrect value, a horizontal mill will crash when it does a tool change.*

Parameter 212 A TOOL CHANGE OFFSET
This parameter sets the distance between the A-axis grid offset (Parameter 128) and the spindle home position. The A-axis will be limited in movement to the area between the positive value of this parameter and the negative MAX TRAVEL.

Parameter 213 B TOOL CHANGE OFFSET
This parameter sets the distance between the B-axis grid offset (Parameter 170) and the spindle home position. The B-axis will be limited in movement to the area between the positive value of this parameter and the negative MAX TRAVEL. This parameter must be used on all mills with the 60 or 120 pocket chain-style tool changer, as opposed to parameter 215, CAROUSEL OFFSET, which is used on other side mount tool changers. Note that on a machine with a single mocon board, the T1 axis parameters are automatically copied to the B axis parameters and only the T1 axis parameters can be altered.

Parameter 214 D:Y CURRENT RATIO %. UNIT: %.
This defines the ratio between the two winding configurations. This default winding is Y, and the parameters are set for the Y winding. This number is used to adjust the parameters for the delta winding when the windings are switched.

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

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

Parameter 217 CNVYR IGNORE OC TIM
Amount of time in 1/50 seconds before overcurrent is checked after conveyor motor is turned on. Default is 50.

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

Parameter 219 CONVYR RETRY LIMIT
Number of times that the conveyor will cycle through the reverse/forward sequencing when an overcurrent is sensed before the conveyor will shut down. An overcurrent is sensed when chips jam the conveyor. By reversing and then forwarding the conveyor, the chip jam may be broken. Default is 5.

Parameter 220 CONVYR RETRY TIMEOUT
Amount of time in 1/50 seconds between consecutive overcurrents in which the overcurrents is considered another retry. If this amount of time passes between overcurrents, then the retry count is set to (0). Default is 1500, 30 seconds.

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

Parameter 222 ROTARY AXIS INCRMNT
For Horizontal mills only. This parameter sets the degrees of rotation of the A-axis at an M36 or Pallet Rotate.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>223</td>
<td>AIR TC DOOR DELAY For Horizontal mills only. This parameter sets the delay to open the tool changer door (in milliseconds). If the tool changer does not have a pneumatic door, this parameter is set to zero.</td>
</tr>
<tr>
<td>224</td>
<td>ROT AXIS ZERO OFSET This parameter shifts the zero point of A for a wheel fixture or tombstone.</td>
</tr>
<tr>
<td>225</td>
<td>MAX ROT AXIS ALLOW For Horizontal mills with a wheel fixture only. This parameter sets the maximum rotation (in degrees) allowed before stopping at front door.</td>
</tr>
<tr>
<td>226</td>
<td>EDITOR CLIPBOARD This parameter assigns a program number (nmmm) to the contents of the clipboard (for the advanced editor).</td>
</tr>
<tr>
<td>227</td>
<td>DISK DIR NAME When the disk drive is enabled and a directory is read the directory listing is placed into a program as comments. The program is then made the current program so the user can read the contents of the disk drive. This parameter designates where to write the directory listing. Program 08999 is the default value.</td>
</tr>
<tr>
<td>228</td>
<td>QUICKCODE FILE This parameter sets the program numbers to store in the Quick Code definition program. Usually, this is 9999.</td>
</tr>
<tr>
<td>229</td>
<td>X LEAD COMP 10E9 This parameter sets the X-axis lead screw compensation signed parts per billion.</td>
</tr>
<tr>
<td>230</td>
<td>Y LEAD COMP 10E9 This parameter sets the Y-axis lead screw compensation signed parts per billion.</td>
</tr>
<tr>
<td>231</td>
<td>Z LEAD COMP 10E9 This parameter sets the Z-axis lead screw compensation signed parts per billion.</td>
</tr>
<tr>
<td>232</td>
<td>A LEAD COMP 10E9 This parameter sets the A-axis lead screw compensation signed parts per billion.</td>
</tr>
<tr>
<td>233</td>
<td>B LEAD COMP 10E9 This parameter sets the B-axis lead screw compensation signed parts per billion.</td>
</tr>
<tr>
<td>235</td>
<td>TSC PISTON SEAT With the 50 TSC option, the amount of time given for the piston to seat during system start-up. The default is 500 milliseconds. If machine has a 50 Taper spindle and the TSC option, this parameter must be set to 0.</td>
</tr>
<tr>
<td>236</td>
<td>TSC LOW PR FLT After the TSC system has stabilized following start-up, Alarm 151 is generated if coolant pressure falls below 40 psi for the amount of time set in this parameter. The default is 1000 milliseconds.</td>
</tr>
<tr>
<td>237</td>
<td>TSC CLNT LINE PURGE The amount of time given for the coolant to purge when the TSC system is shut off. This parameter may be increased by the user to a higher value to help purge coolant from small orifice tooling. The minimum (default) value is 2500 milliseconds.</td>
</tr>
<tr>
<td>238</td>
<td>MAX TSC SPINDLE RPM When TSC is enabled and in use, this parameter limits the maximum spindle speed. Default value is 10000 RPM. On 50 taper machines, the maximum spindle speed is 5000 RPM</td>
</tr>
<tr>
<td>239</td>
<td>SPNDL ENC STEPS/REV This parameter sets the number of encoder steps per revolution of the spindle encoder.</td>
</tr>
</tbody>
</table>
Parameter 240 1ST AUX MAX TRAVEL
This parameter sets the maximum travel of the first auxiliary (C) axis in the positive direction.

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

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

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

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

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

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

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

Parameter 248 SMTCL RLY ON / OFF DLY
Vertical mills with sidemount tool changers only. It specifies the time needed (in milliseconds) between turning off one relay and turning on the other one, when reversing the carousel.

Parameter 249 TOOL CLAMP DELAY
This parameter provides a delay after the tool has been clamped and before retraction of the tool carousel at the end of a tool change. For most mills, this parameter should be set to zero. Units are milliseconds.

Parameter 250 TOOL UNCLAMP DELAY
This parameter provides a delay after the tool has been unclamped and before the spindle is backed away at the beginning of a tool change. For most mills, this parameter should be set to zero. Units are in milliseconds.

Parameter 251 A DOOR OPEN ERRTIME
This parameter supports the Auto-Door feature. It is used for several things:
1) It specifies the number of 50ths of a second for the motor to run to open the door.
2) The value of this parameter plus one second specifies the number of 50ths of a second for the motor to run to close the door.
3) If, at the end of the door-close time, the door has not yet reached the switch, alarm 238 DOOR FAULT is generated.
If an automatic door is installed, this parameter should be set to 5500 (5.5 seconds) nominally, otherwise it should be set to zero.

Parameter 252 GEAR MOTOR TIMEOUT
This parameter supports the Auto-Door feature. It specifies the length of time (in ms) that is allowed for the door to begin opening. If the door does not move off the door-closed switch within this amount of time, alarm 238 DOOR FAULT will be generated. This parameter should be set to 1000 (1.0 seconds) nominally.

Parameter 253 SPIGOT FWD POS DLY
This parameter is used to specify the length of a delay (units are ms) when moving the coolant spigot forward. This parameter should be set to zero on all machines.
Parameter 254  VB AIR DOOR CLEARANCE
This is a new parameter to support the VB-1 Bridge Mill tool carousel air door. The air door is a clamshell shaped door covering the tool carousel, which raises up at one side by air power to allow the spindle to access the tools. In order for it to open and close, there must be sufficient clearance between it and the spindle. This parameter must be set to the correct value (in encoder units), parameter 223 AIR TC DOOR DELAY must set to a non-zero value, parameter 267 ZERO AXIS TC must be set to 1 and parameter 278 TC DR SWITCH must be set to 1. When a tool change is commanded, the following steps are performed:
1) The Y axis is moved to the position specified by parameter 254.
2) The air door is commanded to open.
3) There is a delay specified by parameter 223 to allow the door to open fully.
4) The Y axis is moved to zero and the tool change is performed.
5) The Y axis is moved to the position specified by parameter 254.
6) The air door is commanded to close.
7) There is a delay specified by parameter 223 to allow the door to close fully.

Parameter 255  CONVEYOR TIMEOUT
The number of minutes the conveyor will operate without any motion or keyboard action. After this time, the conveyor will automatically shut off. Note that this parameter value will cause the conveyor to turn off even if the intermittent feature is functioning. Note also that if this parameter is set to zero, the chip conveyor will shut off immediately, i.e., pressing CHIP FWD or CHIP REV will not turn it on.

Parameter 256  PALLET LOCK INPUT
This parameter selects the discrete input (0 to 31) that is to be used to monitor the pallet locked status. Used in horizontal mills only.

Parameter 257  SPINDLE ORIENT OFFSET
If the machine is equipped with a spindle vector drive (as set in bit 7 of Parameter 278), this bit sets the spindle orientation offset. The offset is the number of encoder steps between the Z pulse and the correct spindle orientation position. It is used to orient the spindle properly anytime it needs to be locked, such as prior to a tool change, or orient spindle command.

Parameter 258  COLD SPINDLE TEMP
The first time Cycle Start is pressed after the machine has been turned on, the control will compare the microprocessor temperature (in degrees Fahrenheit) against the value of this parameter. If the microprocessor is colder, the control will assume that the spindle is too cold or inadequately lubricated to be run safely at high speed and the following message will be displayed:

!!!WARNING!!!
YOUR MACHINE IS COLD, RUN A WARM-UP PROGRAM BEFORE RUNNING THE SPINDLE AT HIGH SPEED OR DAMAGE MAY RESULT PRESS ‘CANCEL’ TO CONTINUE

The user must press CANCEL before continuing. It is recommended that a spindle warm-up program be run immediately. This message will only appear once each time the machine has been turned on. The initial value for this parameter is 70 (degrees F). To disable this feature, change it to zero.

Parameter 259  COLD SPINDLE DAYS
The first time Cycle Start is pressed after the machine has been turned on, the control will compare the number of days that have passed since the machine was turned off against the value of this parameter. If the machine has been off longer, the control will assume that the spindle is too cold or inadequately lubricated to be run safely at high speed and the following message will be displayed:

!!!WARNING!!!
YOUR MACHINE IS COLD, RUN A WARM-UP PROGRAM BEFORE RUNNING THE SPINDLE AT HIGH SPEED OR DAMAGE MAY RESULT PRESS ‘CANCEL’ TO CONTINUE
The user must press CANCEL before continuing. It is recommended that a spindle warm-up program be run immediately. This message will only appear once each time the machine has been turned on. The initial value for this parameter is 3 (days). To disable this feature, change it to 999999.

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

0 X LIN SCALE EN Used to enable linear scales for the X axis.
1 X INVRT LN SCL Used to invert the X-axis linear scale.
2 DSBL SCALE Z Used to disable the linear scale Z test.
3 X ZERO AXIS TC Used to return axis to zero prior to tool change (5-axes mills).
4 X 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.
5 X NEG COMP DIR Used to negate the direction of thermal compensation.
6 X DELAY AXIS 0 Used with an APL to ensure X axis is zeroed before A axis of APL.
7 X MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 X TEMP SENSOR This performs Lead Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

- 201, 132, 133 XYZ SCREW COMP. COEF. =-8000000
- 272, 273, 274 XYZ SCREW COMP. T. CONST. =-28000
- 351 TEMP PROBE OFFSET = 450000

16 SCALE Z HIST For HAAS diagnostic use only.

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

0 Y LIN SCALE EN Used to enable linear scales for the Y axis.
1 Y INVRT LN SCL Used to invert the Y-axis linear scale.
2 DSBL SCALE Z Used to disable the linear scale Z test.
3 Y ZERO AXIS TC Used to return axis to zero prior to tool change (5-axes mills).
4 Y 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.
5 Y NEG COMP DIR Used to negate the direction of thermal compensation.
6 Y DELAY AXIS 0 Used with an APL to ensure Y axis is zeroed before A axis of APL.
7 Y MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.
9  Y TEMP SENSOR  This performs Lead Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF.  =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST.  =-28000
351 TEMP PROBE OFFSET =450000

16  SCALE Z HIST  For HAAS diagnostic use only.

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

0  Z LIN SCALE EN  Used to enable linear scales for the Z axis.
1  Z INVRT LN SCL  Used to invert the Z-axis linear scale.
2  DSBL SCALE Z  Used to disable the linear scale Z test.
3  Z ZERO AXIS TC  Used to return axis to zero prior to tool change (5-axes mills).
4  Z 2ND HOME BTN  Used to move axis to coordinate specified in Work Offset G129.
5  Z NEG COMP DIR  Used to negate the direction of thermal compensation.
6  Z DELAY AXIS 0  Used with an APL to ensure Z axis is zeroed before A axis of APL.
7  Z MAX TRAVEL INP  This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9  Z TEMP SENSOR  This performs Lead Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF.  =-8000000
272, 273, 274 XYZ SCREW COMP. T. CONST.  =-28000
351 TEMP PROBE OFFSET =450000

16  SCALE Z HIST  For HAAS diagnostic use only.

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

0  A LIN SCALE EN  Used to enable linear scales for the A axis.
1  A INVRT LN SCL  Used to invert the A-axis linear scale.
2  DSBL SCALE Z  Used to disable the linear scale Z test.
3  A ZERO AXIS TC  Used to return axis to zero prior to tool change (5-axes mills).
4  A 2ND HOME BTN  Used to move axis to coordinate specified in Work Offset G129.
5  A NEG COMP DIR  Used to negate the direction of thermal compensation.
6  A DELAY AXIS 0  Used with an APL to ensure A axis is zeroed before B axis of APL.
7  A MAX TRAVEL INP  This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.
9 A TEMP SENSOR This performs Lead Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. = -8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. = -28000
351 TEMP PROBE OFFSET = 450000

16 SCALE Z HIST For HAAS diagnostic use only.

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

0 B LIN SCALE EN Used to enable linear scales for the B axis.
1 B INVRT LN SCL Used to invert the B-axis linear scale.
2 DSBL SCALE Z Used to disable the linear scale Z test.
3 B ZERO AXIS TC Used to return axis to zero prior to tool change (5-axes mills). On HS mills with the 60 or 120 pocket chain-style tool changer, this bit must be set to 1. It will cause the TOOL CHANGE OFFSET parameter to be used for tool changes.
4 B 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.
5 B NEG COMP DIR Used to negate the direction of thermal compensation.
6 B DELAY AXIS 0 Used with an APL to ensure B axis is zeroed before A axis of APL.
7 B MAX TRAVEL INP This bit is set to 1 on five axes machines. This bit indicates that there is a switch (visible through MOCON) that detects if the axis has rotated all the way round. It is used to tell the control to skip the first zero switch when zeroing so it can unwrap the cables.

9 B TEMP SENSOR This performs Lead Screw Thermal Compensation via a temperature sensor attached to the ball nut. When this bit is set to 1, the feature is activated for that axis. Note that this feature can only be used when temperature sensors are installed. The following parameters must be set appropriately:

201, 132, 133 XYZ SCREW COMP. COEF. = -8000000
272, 273, 274 XYZ SCREW COMP. T. CONST. = -28000
351 TEMP PROBE OFFSET = 450000

16 SCALE Z HIST For HAAS diagnostic use only.

Parameter 271 C SWITCHES
Parameter 271 is a collection of single-bit flags used to turn servo related functions on and off. This parameter is not used when machine is equipped with a Haas vector drive. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:

0 C LIN SCALE EN Used to enable linear scales for the C axis.
1 C INVRT LN SCL Used to invert the C-axis linear scale.
2 DSBL SCALE Z Used to disable the linear scale Z test.
3 C ZERO AXIS TC Used to return axis to zero prior to tool change (5-axes mills).
4 C 2ND HOME BTN Used to move axis to coordinate specified in Work Offset G129.
5 C NEG COMP DIR Used to negate the direction of thermal compensation.
6 C DELAY AXIS 0 Used with an APL to ensure C axis is zeroed before A axis of APL.
### 16 SCALE Z HIST
For HAAS diagnostic use only.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>272 X SCREW COMP T. CONST.</th>
<th>This parameter is the thermal compensation time constant, and is the time constant governing the rate of cool down of the screw.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
<td>273 Y SCREW COMP T. CONST.</td>
<td>This parameter is the thermal compensation time constant, and is the time constant governing the rate of cool down of the screw.</td>
</tr>
<tr>
<td>Parameter</td>
<td>274 Z SCREW COMP T. CONST.</td>
<td>This parameter is the thermal compensation time constant, and is the time constant governing the rate of cool down of the screw.</td>
</tr>
<tr>
<td>Parameter</td>
<td>275 A SCREW COMP T. CONST.</td>
<td>This parameter should be set to 0.</td>
</tr>
<tr>
<td>Parameter</td>
<td>276 B SCREW COMP T. CONST.</td>
<td>This parameter should be set to 0.</td>
</tr>
<tr>
<td>Parameter</td>
<td>278 COMMON SWITCH 3</td>
<td>Parameter 278 is a collection of general purpose single bit flags used to turn some functions on and off. This bit will cause the machine to use discrete outputs 21 and 26 to command the shuttle to move in and out. On mills with the Air Driven Shuttle it must be set to 1. On all other mills it must be set to 0. The left and right cursor arrows are used to select the function being changed. All values are 0 or 1 only. The function names are:</td>
</tr>
<tr>
<td>0</td>
<td>INVERT G.B.</td>
<td>This bit allows an alternate gearbox configuration. It inverts the sense of the gearbox inputs. Used for 50 taper option.</td>
</tr>
<tr>
<td>1</td>
<td>DPR SERIAL</td>
<td>Causes the main serial inputs/outputs to go through the disk video board.</td>
</tr>
<tr>
<td>2</td>
<td>CHECK PALLET IN</td>
<td>This bit is used on horizontal mills only.</td>
</tr>
<tr>
<td>3</td>
<td>CHECK HIDN VAR</td>
<td>This bit is used on horizontal mills only.</td>
</tr>
<tr>
<td>4</td>
<td>DISPLAY ACTUAL</td>
<td>When set to 1, displays the actual spindle speed on the Current Commands display page.</td>
</tr>
<tr>
<td>5</td>
<td>TSC PRG ENBL</td>
<td>Enables purge output on TSC option.</td>
</tr>
<tr>
<td>6</td>
<td>SNGL SW CLMP</td>
<td>This parameter enables the control to rely up on a single switch to detect the clamp position of the Side Mount Tool Changer arm. When this bit is set to zero, both the upper and the lower switches are used to detect the arm position. When it is set to one, only the lower switch will be used. This means that the control will not wait until the upper switch is tripped to conclude that the tool is clamped, so subsequent operations can begin immediately. This increases tool change speed.</td>
</tr>
<tr>
<td>7</td>
<td>SPND DRV LCK</td>
<td>This bit must be set to 1 if machine is equipped with a non-Haas vector spindle drive. This bit must be set to 1 if the machine has a 50 taper spindle or a non-Haas vector drive.</td>
</tr>
<tr>
<td>9</td>
<td>CNCR SPINDLE</td>
<td>(Concurrent Spindle) When set to 1, the spindle will be commanded to start concurrently with other commands in the same block. In the following example, with this bit set to 1, the spindle will start at the same time as the rapid move:</td>
</tr>
<tr>
<td></td>
<td>G0 X-1. S7500 M3;</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>10 HS3 HYD TC</td>
<td>This parameter bit is used with the 38 tool SMTC on the HS-3. When this is set to zero, the mill will behave normally. When it is set to 1, the control will recognize that the toolchanger is a 38-Tool SMTC.</td>
<td></td>
</tr>
<tr>
<td>11 HAAS VECT DR</td>
<td>(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.</td>
<td></td>
</tr>
<tr>
<td>12 UP ENCL TEMP</td>
<td>(Microprocessor Enclosure Temperature) When set to 1, the enclosure temperature will be displayed on INPUTS2 screen of the diagnostics display.</td>
<td></td>
</tr>
<tr>
<td>13 HAAS RJH</td>
<td>(Haas Remote Jog Handle) This bit must be set to 1 if the machine is equipped with a Haas 5-Axes Remote Jog Handle.</td>
<td></td>
</tr>
<tr>
<td>14 SP MOT OT NC</td>
<td>(Spindle Temperature Sensor Normally Closed) This bit specifies the type (normally open or normally closed) of the spindle temperature sensor. This bit should be set to 1.</td>
<td></td>
</tr>
<tr>
<td>15 AIR DRV SHTL</td>
<td>This bit will cause the machine to use discrete outputs 21 and 26 to command the shuttle to move in and out. On mills with the Air Driven Shuttle it must be set to 1. On all other mills it must be set to 0.</td>
<td></td>
</tr>
<tr>
<td>16 GIMBAL SPNDL</td>
<td>Used on 5-axes mills. This bit will cause the machine to check that the Z,A and B axes are at zero before a tool change is started. If one is not, alarm 150 will be generated. On mills with the gimbaled Spindle it must be set to 1. On all other mills it must be set to 0.</td>
<td></td>
</tr>
<tr>
<td>17 NO MFIN CKPU</td>
<td>When this bit is set, it will prevent checking of MFIN at power-up. It should be set for 1 for all machines that have the new Haas Automatic Pallet Changer attached, and 0 for all other machines.</td>
<td></td>
</tr>
<tr>
<td>18 D:Y SW ENABLE</td>
<td>(Delta Wye switch enabled). This bit is used for the Vector Drive. The bit enables the switching of spindle motor windings, provided the hardware ENABLE is installed, and the proper parameters are set. If this switch is set, but bit 19 is not, then the winding switching will only be done when the spindle is at rest, depending on the target speed of the spindle.</td>
<td></td>
</tr>
<tr>
<td>19 D:Y SW ON FLY</td>
<td>This bit enables switching on the fly, as the spindle motor is accelerating or decelerating through the switch point. If bit 18 is not set, this switch will be ignored.</td>
<td></td>
</tr>
<tr>
<td>20 5AX TOFS -X</td>
<td>This bit is used with the G143 (modal 5 axes tool length compensation) on machines with a Gimbaled Spindle. If it is set to 1, this means that when the corresponding rotary axes is moved, the sign of the X Position must be inverted. Normally, this bit should be set to 0.</td>
<td></td>
</tr>
<tr>
<td>21 5AX TOFS -Y</td>
<td>This bit is used with the G143 (modal 5 axes tool length compensation) on machines with a Gimbaled Spindle. If it is set to 1, this means that when the corresponding rotary axes is moved, the sign of the Y Position must be inverted. Normally, this bit should be set to 0.</td>
<td></td>
</tr>
<tr>
<td>22 B+C 5AXES</td>
<td>This bit is used with the G142 (modal 5 axes tool length compensation) on machines with a Gimbaled Spindle. The B-axis normally moves the A-axis, but if this is not true, this bit can be set to change which is the inner axis. Normally, this bit should be set to 0.</td>
<td></td>
</tr>
<tr>
<td>23 TC DR SWITCH</td>
<td>Horizontal tool carousel door configuration. This bit specifies the Horizontal Mill tool carousel door configuration. If it is set to 0, this indicates the old configuration where the door is driven open by a timed operation. If it is set to 1, this indicates the new configuration where the door is spring-loaded closed and is driven open by the timed operation against the door open switch. In open position, the door switch signal is 0 (low). The switch status is checked before and after commanding the door to open in order to be fail-safe. For all horizontal mills that have the switch installed, this bit must be set to 1. For all other mills, this bit must be set to 0.</td>
<td></td>
</tr>
</tbody>
</table>
24  **HS2 SDMTCRSL**  
This parameter bit is for the HS-2 sidemount tool changer. It must be set to 1 on all HS-2 mills, and 0 on all other mills.

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

26  **S MNT BIT 1**  
Bits 26, 27, and 28 work together to specify the type of sidemount tool changer that is installed on a vertical mill. The following table shows the bit combinations that must be used:

<table>
<thead>
<tr>
<th>Bit 26</th>
<th>Bit 27</th>
<th>Bit 28</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>No side-mount tool changer installed</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>Serpentine 1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>Serpentine 2</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>Serpentine 3</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Disk 1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>Disk 2</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Disk 3</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Disk 4</td>
</tr>
</tbody>
</table>

27  **S MNT BIT 2**  
Bits 26, 27, and 28 work together to specify the type of sidemount tool changer that is installed on a vertical mill.

28  **S MNT BIT 3**  
Bits 26, 27, and 28 work together to specify the type of sidemount tool changer that is installed on a vertical mill.

29  **SAFETY INVERT**  
This bit supports the CE door interlock that locks when power is turned off. For machines that have the regular door lock that locks when power is applied, this bit must be set to 0. For machines that have the inverted door lock, this bit must be set to 1.

30  **SWAP A & C**  
This parameter causes the A and C axes to be swapped internally. This parameter bit should be set to 1 for the bridge mill. All other mills should set this bit to 0.

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

**Parameter 279  X SCALE GAIN MULT**  
This parameter is used on machines with linear scales. Linear scales are used to continuously correct any errors in the encoder position. The parameter determines the gain of the correction factor, that is, how fast it corrects. This parameter should be set to 40.

**Parameter 280  Y SCALE GAIN MULT**  
See parameter 279 for description

**Parameter 281  Z SCALE GAIN MULT**  
See parameter 279 for description

**Parameter 282  A SCALE GAIN MULT**  
See parameter 279 for description

**Parameter 283  B SCALE GAIN MULT**  
See parameter 279 for description

**Parameter 284  RESERVED**

**Parameter 285  X LINEAR SCREW OFFS**  
This parameter is used on machines with linear scales. This parameters account for the unused portion of the lead screw between zero and the actual motor. This parameter should be a positive value (400000) unless the NEG COMP DIR bit for the axis is set, in which case this parameter should be a negative value (-400000.)
Parameter 286  Y LINEAR SCREW OFFS
See parameter 285 for description.

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

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

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

Parameter 292  AUTO DOOR PAUSE
This parameter supports the Auto-Door feature. It specifies the length of a pause (in 50ths of a second) that occurs during the door close sequence. As the door closes and the switch is activated, the motor is turned off for this amount of time and the door coasts. This allows the door to close smoothly. This parameter should be set to 1 (0.02 seconds) nominally. It works in conjunction with parameter 293.

Parameter 293  AUTO DOOR BUMP
This parameter supports the Auto-Door feature. It specifies the length of time (in 50ths of a second) that the motor should be reactivated after the pause specified by parameter 292. This causes the motor to close the door fully and smoothly. This parameter should be set to 2 (0.04 seconds) nominally.

Parameter 294  MIN BUSS VOLTAGE
This parameter specifies the minimum Haas Vector Drive buss voltage. It should be set to 200 (the units are volts). Alarm 160 will be generated if the voltage falls below this value.

Parameter 295  SHTL SETTLE TIME
Used on mills with an air driven shuttle. This parameter allows settling time for the shuttle after it has moved toward the spindle and before a tool change is performed. It should be set to approximately half a second (500) on all mills with the Air Driven Shuttle. This may vary. All other mills can be set to 0 as they are unaffected by it.

Parameter 296  MAX OVER VOLT TIME
Specifies the amount of time (in 50ths of a second) that an overvoltage condition (alarm 119 OVER VOLTAGE) will be tolerated before the automatic shut down process is started.

Parameter 297  MAX OVERHEAT TIME
Specifies the amount of time (in 50ths of a second) that an overheat condition (alarm 122 REGEN OVERHEAT) will be tolerated before the automatic shut down process is started.

Parameter 298  MAX FEED (DEG/MIN)
Used on 5-axes mills. This parameter specifies the maximum rotary feed rate in degrees per minute. Any attempt at cutting faster than this will result in "LIM" being displayed next to the FEED message on the Program Command Check screen.

On mills with a Gimbaled Spindle, this parameter must be set to 300. For all other mills, this bit should be set to 99999.

Parameter 299  AUTOFEED-STEP-UP
This parameter works with the AUTOFEED feature. It specifies the feed rate step-up percentage per second and should initially be set to 10.

Parameter 300  AUTOFEED STEP-DOWN
This parameter works with the AUTOFEED feature. It specifies the feed rate step-down percentage per second and should initially be set to 20.

Parameter 301  AUTOFEED-MIN-LIMIT
This parameter works with the AUTOFEED feature. It specifies the minimum allowable feed rate override percentage that the AUTOFEED feature can use and should initially be set to 1.
Parameter 302 FEED ACCELERATION
This parameter supports the motion control feature. This is the acceleration that applies to feed motion in encoder steps per second squared. For Vertical mill, 1/2 of the value of parameter 7 is a good starting point. For horizontal Mills, 1000000 is a good value to start with. This parameter can be further updated as necessary.

Parameter 303 FEED TIME CONSTANT
This parameter supports the motion control feature. It is the base 2 exponent of the feed time constant in milliseconds. It should be set to 3.

Parameter 304 SPIGOT REV POS DLY
This parameter is used to specify the length of a delay (units are ms) when moving the coolant spigot in reverse. This parameter should be set to zero on all machines.

Parameter 305 SERVO PO BRK DLY
The SRV PO (Servo Power On) discrete output is used to engage and disengage an axis brake. This parameter is used to specify a time in milliseconds that the control should wait after activating the SRV PO output and turning off power to the servo motors via the MOCON. This parameter also specifies the time to wait after deactivating the SRV PO output and reactivating the servo motors via the MOCON.

Parameter 306 POCKET UP / DN DELAY
This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) for the tool pocket to be raised or lowered. If the pocket does not move to its commanded position within the time allowed by this parameter and by parameter 62, alarm 626 TOOL POCKET SLIDE ERROR is generated. For mills without a side mount tool changer, this parameter should be set to 0.

Parameter 307 POCK UN / LOCK DELAY
This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) to lock or unlock a tool pocket. For mills without a side mount tool changer, this parameter should be set to 0.

Parameter 308 ARM ROTATE TIME
This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) for the arm to rotate to the next position. The positions are, Clamp, Unclamp, and Origin. If the arm does not move to the commanded position within the allowed time, alarm 622 TOOL ARM FAULT is generated. For mills without a side mount tool changer, this parameter should be set to 0.

Parameter 309 MOTOR COAST TIME
This parameter supports the side mount tool changers. It specifies the time allowed for the tool changer to start only. If the arm has not moved after the allowed time, alarm 627 ATC ARM POSITION TIMEOUT is generated. Units are milliseconds.

Parameter 310 CAM LOCK DELAY
This parameter supports the side mount tool changers. It specifies the time allowed (in milliseconds) to lock the cam by pushing the shot pin in, or to unlock the cam by pulling the shot pin out. If the shot pin has not moved to its commanded position within the allowed time, alarm 625 INVALID TC START CONDITION is generated.
Parameter 311  ARM BUMP TIME
This parameter supports the side mount tool changers. During tool change recovery, the arm may
be moved a small amount by pressing the ATC FWD or ATC REV key. Each press of the key will
cause the arm motors to run for the amount of time (in milliseconds) specified by this parameter.
For mills without a side mount tool changer, this parameter should be set to 0.

On horizontal mills with a side mount tool changer, the arm may be rotated a small amount by
pressing the END or PAGE DOWN keys. The shuttle may be moved by pressing the Left Arrow or
Right Arrow keys. Each press of the key will cause the motor to run for the amount of time (in
milliseconds) specified by this parameter. This parameter is most commonly set to 30.

Parameter 312  CAROUSEL BUMP TIME
This parameter supports the side mount tool changers. During tool change recovery, the carousel
may be moved a small amount by pressing the Left Arrow or Right Arrow key. Each press of the key
will cause the carousel motors to run for the amount of time (in milliseconds) specified by this
parameter. For mills without a side mount tool changer, this parameter should be set to 0.

Parameter 313  POCKET INCREMENT
This is a parameter for the bridge mill. Under normal circumstances it should be set to 1. If it is set
to 2, for example, the control will only recognize every other pocket. That is, it will treat the tools and
pockets as follows:

Tool 1 is in pocket 1
Tool 2 is in pocket 3
Tool 3 is in pocket 5
Tool 4 is in pocket 7
etc...

If this parameter is set to 3 the control will only recognize every third pocket and so on. It is the
operator's responsibility to ensure that the total number of pockets in the tool changer is evenly
divisible by this parameter value. If not, the control will pick the wrong pocket after the carousel has
exceeded a full revolution.

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Basic Value</th>
<th>Model</th>
<th>Basic Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS-1</td>
<td>8</td>
<td>VF-0</td>
<td>32</td>
</tr>
<tr>
<td>HS-1R</td>
<td>8</td>
<td>VF-0E</td>
<td>32</td>
</tr>
<tr>
<td>HS-1RP</td>
<td>8</td>
<td>VF-EC</td>
<td>32</td>
</tr>
<tr>
<td>HS-15AXT</td>
<td>8</td>
<td>VF-1</td>
<td>32</td>
</tr>
<tr>
<td>HS-2RP</td>
<td>8</td>
<td>VF-2</td>
<td>32</td>
</tr>
<tr>
<td>HS-3</td>
<td>8</td>
<td>VF-3</td>
<td>24</td>
</tr>
<tr>
<td>HS-3R</td>
<td>8</td>
<td>VF-3D</td>
<td>24</td>
</tr>
<tr>
<td>MM-1</td>
<td>32</td>
<td>VF-4</td>
<td>24</td>
</tr>
<tr>
<td>VR-11</td>
<td>16</td>
<td>VF-4D</td>
<td>24</td>
</tr>
<tr>
<td>VB-1</td>
<td>8</td>
<td>VF-5</td>
<td>24</td>
</tr>
<tr>
<td>VB-3</td>
<td>8</td>
<td>VF-6</td>
<td>16</td>
</tr>
<tr>
<td>VS-3</td>
<td>8</td>
<td>VF-7</td>
<td>16</td>
</tr>
<tr>
<td>G-1</td>
<td>8</td>
<td>VF-8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VF-9</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VF-10</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VF-11</td>
<td>8</td>
</tr>
</tbody>
</table>

Parameter 315  COMMON SWITCH 4
0 ALIS M GRPHC When this bit is set to 0, all user defined M codes (such as M50 normally
used to do a pallet change on a horizontal mill) will be ignored when a
program is run in graphics mode. If it is necessary to have graphics
recognize such M codes, this bit should be set to 1.
1 GANTRY
2 NO X MV NXTL
   This parameter only affects horizontal mills, and is intended for use primarily on the HS-3. If this bit is set to zero, it will have no effect. If it is set to one, the X-axis will not move following a NEXT TOOL button press. The reason for this is because after pressing NEXT TOOL on an HS-1 or HS-2, the spindle, which is mounted on the X-axis, is moved closer to the operator so the next tool can be manually installed. On an HS-3, the X-axis is on the table and there is no advantage to moving it. Setting this bit to one will save time.

3 XL TOOLS
   This parameter enables the user to specify that large tools are considered to be extra large, and allow the Tool Pocket table to get set up as shown below. This parameter bit should be set to 1 on all mills with the 50 Taper Side Mount Tool Changer. Note that when this parameter bit is set to 1, the following tool pocket configuration is not allowed (see alarm 422).
   An example of a tool pocket table with extra large tools:
   
   1 -
   2 L
   3 -
   4 -
   5 L
   6 -

4 HIGH SPEED
   This parameter bit enables the High Speed Machining feature.
   This parameter requires an unlock code in order to set the bit to 1. This option requires the Floating Point Co-Processor and Floating Point software. If this option is turned on when non-floating point software is installed the High Speed option will have no effect.

5 FAEMAT SPIN
   This bit controls the tool clamp and unclamp sequence for different spindles. This bit should be set to 1 when the mill has a Faemat spindle installed. Otherwise the bit should be set to 0. This improvement is intended primarily for the VB-1 bridge mill.

6 MANUAL TC
   This parameter must be set to 1 when a TM-1 has no tool changer and zero when it has a tool changer. When it is set to 1, an M06 will stop the program and display a message requesting the operator to change tools manually.

7 RST STOP PAL
   This parameter enables the RESET button to stop a pallet change. It is intended for use with the future hard-coded pallet changer macro program. It should be set to zero.

8 MINI MILL
   When parameter 315 bit 8 MINI MILL is set to 1, the Over Voltage discrete input will be displayed as P.S. Fault.
   When it is set to 1:
   (a) The DC BUSS voltage that is normally displayed on the diagnostics screen for a Vector Drive machine will not be displayed.
   (b) The conditions that would normally generate alarm 119 OVER VOLTAGE and alarm 160 LOW VOLTAGE will instead generate alarm 292 320V POWER SUPPLY FAULT and this alarm will be added to the alarm history only after a 1 second delay to prevent false 292 alarms being added to the alarm history at the moment power is turned off. This parameter bit must be set to 1 on all Mini Mills.

9 DOOR OPEN SW
   The bit allows the software to work with an optional door-open switch. This bit should be set to 1 on all machines fitted with the second door switch. If this bit is set to 1, the control will look for a second door switch when the door is opened automatically to the fully open position. If the switch is not found, alarm 238 DOOR FAULT will be generated. If this bit is set to zero, the control behaves as before.
10 PAL HARDCODE  
This bit supports the hard-coded APC pallet changer function. It must be set to 1 when an APC is present that is wired for two APC door switches. On all other machines, it must be set to 0.

11 ADVANCED JOG  
This parameter bit enables the Index Jog and Jog Travel Limits features.

12 MANUAL JOG  
This parameter bit enables the manual jog feature for the Tool Room Mill’s handwheels.

13 SAFETY SWITCH  
When set to zero, the control behaves as normal. When it is set to 1, the Toolroom Mill’s safety switch must be pressed by the operator for controlled motion to start or continue.

14 FOURTH AXIS  
This parameter bit prevents unauthorized use of the 4th (A) axis. It can only be set to 1 with a magic code. When it is set to zero, it prevents the user from altering setting 30 and prevents the user from zeroing the parameter 43 DISABLED bit. When this parameter bit is changed to zero, setting 30 will be returned to OFF and the parameter 43 DISABLED bit will be set to 1.

15 FIFTH AXIS  
This parameter bit prevents unauthorized use of the 5th (B) axis. It can only be set to 1 with a magic code. When it is set to zero, it prevents the user from altering setting 78 and prevents the user from zeroing the parameter 151 DISABLED bit. When this parameter bit is changed to zero, setting 78 will be returned to OFF and the parameter 151 DISABLED bit will be set to 1. Note that when parameter 209 HORIZONTAL is set to 1, setting 78 is unavailable and not displayed because the B axis is used for the tool changer.

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

17 VIBRN SENSOR  
This parameter enables the vibration sensor. When it is set to 1, the output from the sensor will be converted to Gs and displayed on the Current Commands Tool Load screen. When this parameter is set to zero, NO SENSOR will be displayed instead.

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

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

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

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

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

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>327 X SCALES PER INCH</td>
<td>This parameter is used on machines equipped with linear scales. This parameter should be set to 25,400 on mills fitted with linear scales. On all other mills, they should be set to zero.</td>
</tr>
<tr>
<td>328 Y SCALES PER INCH</td>
<td>This parameter is used on machines equipped with linear scales. This parameter should be set to 25,400 on mills fitted with linear scales. On all other mills, they should be set to zero.</td>
</tr>
<tr>
<td>329 Z SCALES PER INCH</td>
<td>This parameter is used on machines equipped with linear scales. This parameter should be set to 25,400 on mills fitted with linear scales. On all other mills, they should be set to zero.</td>
</tr>
<tr>
<td>330 A SCALES PER INCH</td>
<td>This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.</td>
</tr>
<tr>
<td>331 B SCALES PER INCH</td>
<td>This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.</td>
</tr>
<tr>
<td>333 X SCALES PER REV</td>
<td>This parameter is used on machines equipped with linear scales. This parameter should be set to 50,000 on mills fitted with linear scales. On all other mills, they should be set to zero.</td>
</tr>
<tr>
<td>334 Y SCALES PER REV</td>
<td>This parameter is used on machines equipped with linear scales. This parameter should be set to 50,000 on mills fitted with linear scales. On all other mills, they should be set to zero.</td>
</tr>
<tr>
<td>335 Z SCALES PER REV</td>
<td>This parameter is used on machines equipped with linear scales. This parameter should be set to 50,000 on mills fitted with linear scales. On all other mills, they should be set to zero.</td>
</tr>
<tr>
<td>336 A SCALES PER REV</td>
<td>This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.</td>
</tr>
<tr>
<td>337 B SCALES PER REV</td>
<td>This parameter is used on machines equipped with linear scales. This parameter should be set to 0 on mills with or without linear scales.</td>
</tr>
<tr>
<td>339 X SPINDLE THERM COEF.</td>
<td>This parameter supports the Spindle Head Thermal Compensation feature, and should be set to 0.</td>
</tr>
<tr>
<td>340 Y SPINDLE THERM COEF.</td>
<td>See parameter 339 for description.</td>
</tr>
<tr>
<td>341 Z SPINDLE THERM COEF.</td>
<td>See parameter 339 for description.</td>
</tr>
<tr>
<td>342 A SPINDLE THERM COEF.</td>
<td>See parameter 339 for description.</td>
</tr>
<tr>
<td>343 B SPINDLE THERM COEF.</td>
<td>See parameter 339 for description.</td>
</tr>
<tr>
<td>345 X SPINDLE THERM TIME.CONST.</td>
<td>This parameter supports the Spindle Head Thermal Compensation feature, and should be set to 0.</td>
</tr>
<tr>
<td>346 Y SPINDLE THERM TIME.CONST.</td>
<td>See parameter 345 for description.</td>
</tr>
</tbody>
</table>
Parameter 347  Z SPINDLE THERM TIME. CONST.
See parameter 345 for description.

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

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

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

Parameter 352  RELAY BANK SELECT
This parameter allows the user to change which bank of relays is to be used (Parameter 209 bit 23 MCD RLY BRD assumes that relay bank one is to be used). It may be set to a number from 0 to 3 (inclusive). M codes M21 through M28 will be switched to the selected bank. This parameter requires a revision “S” I/O board. If a previous board is installed (without the additional banks of relays), this parameter should be set to zero.

<table>
<thead>
<tr>
<th>Bank #</th>
<th>Relay Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>I/O PCB</td>
<td>Internal machine functions</td>
</tr>
<tr>
<td>1</td>
<td>I/O PCB</td>
<td>User relay outputs (some may be used for internal functions)</td>
</tr>
<tr>
<td>2</td>
<td>1st M-code PCB</td>
<td>8M option. 8 additional user outputs.</td>
</tr>
<tr>
<td>3</td>
<td>2nd M-code PCB</td>
<td>2nd M-code relay board. Typically used for built in options such as, side mount tool changer, etc.</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>HI LO</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 0 3</td>
</tr>
<tr>
<td>0 1 5</td>
</tr>
<tr>
<td>1 0 7</td>
</tr>
<tr>
<td>1 1 9</td>
</tr>
</tbody>
</table>

If, however, SCALE FACT/X is set to zero, the value of ENC. SCALE FACTOR will be used for the scale ratio instead. Note that any value outside the range of 1 to 100 will be ignored and the scale ratio will remain unaffected. Note also that currently, these parameters are intended for use only on rotary axes (A and B).

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

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

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

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

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

Parameter 594 U ENC. SCALE FACTOR
See parameter 588 for description
Parameter 595 V ENC. SCALE FACTOR
See parameter 588 for description

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

Parameter 600 PEAK SPIN. PWR - KW
This is a new parameter that has been added to support the spindle kilowatt (KW) load display which appears on the current commands page, next to the spindle load percentage. This parameter should be set to the peak power output in KW for the spindle motor.

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

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

**LEAD SCREW COMPENSATION**

Separate lead screw compensation is provided for each of the X, Y, and Z axes. The operator-entered compensation values are spaced at 0.5 inch intervals within the machine coordinate system. The compensation values are entered in inches with a resolution of 0.0001 inch. The operator entered values are used to interpolate into a table of 256 entries. The spacing between two entries in the table of 256 is defined by Parameter 58. The entered values are limited to +/-127 encoder steps; so the limit in inches is dependent on Parameters 5, 19, and 33.

Note that the first entry corresponds to machine position zero and subsequent entries are for increasingly negative positions in the machine coordinate system. The user should not ever need to adjust the lead screw compensation tables.

**ELECTRONIC THERMAL COMPENSATION**

When ballscrews rotate they generate heat. Heat causes the ballscrews to expand. In constant duty cycles, the resultant ball screw growth can lead to cutting errors on the next morning start up. The Haas ETC algorithm can accurately model this heating and cooling effect and electronically expand and contract the screw to give near glass scale accuracy and consistency.

This compensation is based on a model of the lead screw which calculates heating based on the distance traveled and the torque applied to the motor. This compensation does not correct for thermal growth due to changes in ambient temperature or due to part expansion.

Electronic thermal compensation works by estimating the heating of the screw based on the total amount of travel over its length and including the amount of torque applied to the screw. This heat is then turned into a thermal coefficient of expansion and the position of the axis is multiplied by the coefficient to get a correction amount.

If the machine is turned off when there is some compensation applied (due to motion and heating of screw), when the machine is turned back on, the compensation will be adjusted by the clock indicated elapsed time.

**SPINDLE HEAD THERMAL COMPENSATION**

This feature integrates spindle speed over time and builds a model of thermal growth. As the model shows the spindle head warming up, the control adjusts the Z axes to compensate for thermal growth.
7. MAINTENANCE

7.1 General Requirements

**General Requirements**

- Operating Temperature Range: 41°F to 104°F (5 to 40°C)
- Storage Temperature Range: -4°F to 158°F (-20 to 70°C)
- Ambient Humidity: less than 90% relative humidity, non-condensing
- Altitude: 0-7000 ft.

**Electricity Requirements**

All machines require:

AC input power is three phase Delta or Wye power, except that the power source must be grounded (e.g. leg or center leg for delta, neutral for Wye)

- Frequency range of 47-66 Hz
- Line voltage that does not fluctuate more than ± 5%
- Harmonic distortion not to exceed 10% of the total RMS voltage

### 20-15 HP System

<table>
<thead>
<tr>
<th>Voltage Requirements</th>
<th>High-Voltage Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD VF and 10K</td>
<td></td>
</tr>
<tr>
<td>Power Supply¹</td>
<td>50 AMP</td>
</tr>
<tr>
<td>150 AMP</td>
<td>25 AMP</td>
</tr>
<tr>
<td>Haas Circuit Breaker</td>
<td>40 AMP</td>
</tr>
<tr>
<td>80 AMP</td>
<td>20 AMP</td>
</tr>
</tbody>
</table>

If service run from elec. panel is less than 100’ use:
- 8 GA. WIRE
- 12 GA. WIRE

If service run from elec. panel is more than 100’ use:
- 6 GA. WIRE
- 10 GA. WIRE

### 40-30 HP System

<table>
<thead>
<tr>
<th>Voltage Requirements</th>
<th>High-Voltage Requirements²</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 TAPER, 10K (50T), and HT10K (40T)</td>
<td></td>
</tr>
<tr>
<td>Power Supply¹</td>
<td>100 AMP</td>
</tr>
<tr>
<td>110 AMP</td>
<td>50 AMP</td>
</tr>
<tr>
<td>Haas Circuit Breaker</td>
<td>80 AMP</td>
</tr>
<tr>
<td>40 AMP</td>
<td></td>
</tr>
</tbody>
</table>

If service run from elec. panel is less than 100’ use:
- 4 GA. WIRE
- 8 GA. WIRE

If service run from elec. panel is more than 100’ use:
- 2 GA. WIRE
- 6 GA. WIRE

**WARNING!**

A separate earth ground wire of the same conductor size as the input power is required to be connected to the chassis of the machine. This ground wire is required for operator safety and for proper operation. This ground must be supplied from the main plant ground at the service entrance, and should be routed in the same conduit as the input power to the machine. A local cold water pipe or ground rod adjacent to the machine cannot be used for this purpose.

Input power to the machine must be grounded. For wye power, the neutral must be grounded. For delta power, a central leg ground or one leg ground should be used. The machine will not function properly on ungrounded power. (This is not a factor with the External 480V Option.)
The rated horsepower of the machine may not be achieved if the imbalance of the incoming voltage is beyond an acceptable limit. The machine may function properly, yet may not deliver the advertised power. This is noticed more often when using phase converters. A phase converter should only be used if all other methods cannot be used.

The maximum leg-to-leg or leg-to-ground voltage should not exceed 260 volts, or 504 volts for high-voltage machines with the Internal High Voltage Option.

1 The current requirements shown in the table reflect the circuit breaker size internal to the machine. This breaker has an extremely slow trip time. It may be necessary to size the external service breaker up by 20-25%, as indicated by “power supply”, for proper operation.

2 The high-voltage requirements shown reflect the Internal 400V configuration which is standard on European machines. Domestic and all other users must use the External 480V option.

### Air Requirements

The VMC requires a minimum of 100 psi at 4 scfm at the input to the pressure regulator on the back of the machine. This should be supplied by at least a two-horsepower compressor, with a minimum 20-gallon tank, that turns on when the pressure drops to 100 psi.

**NOTE:** Add 2 scfm to the above minimum air requirements if the operator will be using the air nozzle during pneumatic operations.

<table>
<thead>
<tr>
<th>Machine Type</th>
<th>Main Air Regulator</th>
<th>Input Air line Hose Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>VF-1 through VF-11</td>
<td>85 psi</td>
<td>3/8” I.D.</td>
</tr>
<tr>
<td>(40 taper)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VF-5 through VF-11</td>
<td>85 psi</td>
<td>1/2” I.D.</td>
</tr>
<tr>
<td>(50 taper)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The recommended method of attaching the air hose is to the barb fitting at the back of the machine with a hose clamp. If a quick coupler is desired, use a 3/8” for 40 taper machines, or a 1/2” for 50 taper machines and machines with the side mount tool changer option.

**NOTE:** Excessive oil and water in the air supply will cause the machine to malfunction. The air filter/regulator has an automatic bowl dump that should be empty before starting the machine. This must be checked for proper operation monthly. Also, excessive contaminants in the air line may clog the dump valve and cause oil and/or water to pass into the machine.

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

**WARNING!**

When the machine is operating and the pressure gauge (on the machine regulator) drops by more than 10 psi during tool changes, insufficient air is being supplied to the machine.
The following is a list of required regular maintenance for the HAAS VF Series Vertical Machining Centers. Listed are the frequency of service, capacities, and type of fluids required. These required specifications must be followed in order to keep your machine in good working order and protect your warranty.

**7.2 Maintenance Schedule**

**INTERVAL**

**MAINTENANCE PERFORMED**

**DAILY**
- ✓ Check coolant level each eight-hour shift (especially during heavy TSC usage).
- ✓ Check way lube lubrication tank level.
- ✓ Clean chips from way covers and bottom pan.
- ✓ Clean chips from tool changer.
- ✓ Wipe spindle taper with a clean cloth rag and apply light oil.

**WEEKLY**
- ✓ Check Through the Spindle Coolant (TSC) filters. Clean or replace element if needed.
- ✓ Check for proper operation of auto drain on filter regulator.
- ✓ On machines with the TSC option, clean the chip basket on the coolant tank. Remove the tank cover and remove any sediment inside the tank. Be careful to disconnect the coolant pump from the controller and POWER OFF the control before working on the coolant tank. Do this MONTHLY for machines without the TSC option.
- ✓ Check air gauge/regulator for 85 psi. For 15K-spindle machines, check spindle air pressure regulator for 20 psi.
- ✓ For machines with the TSC option, place a dab of grease on the V-flange of tools. Do this MONTHLY for machines without the TSC option.
- ✓ Clean exterior surfaces with mild cleaner. **DO NOT** use solvents.
- ✓ Check the hydraulic counterbalance pressure according to the machine’s specifications.

**MONTHLY**
- ✓ Check oil level in gear box. **For 40 taper spindles:** Remove inspection cover beneath spindle head. Add oil slowly from top until oil begins dripping from overflow tube at bottom of sump tank. See section 1.4. **For 50 taper spindles:** Check oil level in sightglass. Add from side of gearbox if necessary. See section 1.5.
- ✓ Inspect way covers for proper operation and lubricate with light oil, if necessary.
- ✓ Place a dab of grease on the outside edge of the guide rails of the tool changer and run through all tools.

**SIX MONTHS**
- ✓ Replace coolant and thoroughly clean the coolant tank.
- ✓ Check all hoses and lubrication lines for cracking.

**ANNUALLY**
- ✓ Replace the gearbox oil. Drain the oil from the bottom of the gearbox. Remove inspection cover beneath spindle head. Add oil slowly from top until oil begins dripping from overflow tube at bottom of sump tank. **For 50 taper spindles,** add oil from the side of the transmission.
- ✓ Check oil filter and clean out residue at bottom of filter.
- ✓ **Replace air filter on control box every 2 years.**
- ✓ Check SMTC oil level in sight glass, (see Side Mount Tool Changer Oil Level in this section).
7.3 TSC MAINTENANCE

- Check the dirt indicator on the 100-micron mesh filter with the TSC system running and no tool in the spindle. Change the element when the indicator reaches the red zone.
- On newer machines, clean the pump intake filter when indicator is in the red zone. Reset indicator with button. All intake filters can be cleaned with a wire brush.
- After changing or cleaning filter elements, run TSC system with no tool in spindle for at least one minute to prime system.

**TSC coolant pump assembly.**

**Cleaning the intake filter.**

**IMPORTANT!**

**GATE FILTER**

CLEAN THE GATE FILTER REGULARLY

To clean the filter:
- Turn off the coolant pump.
- Remove the filter.
- Clean and reinstall filter.
* Mineral cutting oils will damage rubber components throughout the machine.

**WARNING!**

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

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

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

Machining of ceramics and the like voids all warranty claims for wear and is done entirely at the customer’s risk. Increased maintenance schedules are absolutely required with abrasive swarf. The coolant must be changed more often, and the tank thoroughly cleaned of sediment on the bottom. A larger coolant tank is recommended.

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

---

### 7.4 Lubrication Chart

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

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

**WARNING!**

DO NOT ADD LUBE ABOVE THE “HIGH” LINE MARKED ON THE RESERVOIR.

DO NOT ALLOW THE LUBE LEVEL TO GO BELOW THE “LOW” LINE MARKED ON THE RESERVOIR AS MACHINE DAMAGE COULD RESULT.

To lubricate the system, pull up on the primer pull-tab located next to the fill port. The primer will automatically send 3 cc of lube through the system.
There is no visible indicator for the level of transmission oil in the VF 1-6/40T models.

To add transmission oil, remove the access panel located directly behind the spindle head. This will expose the Transmission Oil Overflow Pipe. Place a container on the table, beneath this outlet. Manually jog the Z axis to its full -Z travel. Power down the machine. Locate the Transmission Oil Fill Cup, accessed from the top of the motor housing (see figure below). There is a cut-out provided in the top of the motor housing sheetmetal for filling. Slowly pour in Mobil DTE 25 oil until oil starts to come out of the overflow pipe. This overflow indicates your transmission oil reservoir is full. Close the Transmission Oil Fill Cup. Wipe off the overflow pipe and replace the access cover. Consider any overflow oil to be used and dispose of properly.
CAUTION! Power down the machine before performing any maintenance tasks.

The VF 6 through 11 50T machines provide a means to check the transmission oil level. The transmission oil level eye is located behind an access panel secured to the right side of the spindle housing (as viewed from the front; see figure below). To visually check the oil level, remove the 6 BHCS securing the access panel to the spindle housing sheetmetal. Remove the access panel. The transmission oil level eye will be visible. The oil level should reach the middle of the eye.

![Diagram of VF 6 through 11 50T Oil Level](image)

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

**7.8 Chip Auger**

**MAINTENANCE**

During normal operation, most chips are discharged from the machine at the discharge tube. However, very small chips may flow through the drain and collect in the coolant tank strainer. To prevent drain blockage, clean this trap regularly. Should the drain become clogged and cause coolant to collect in the machine’s pan, stop the machine, loosen the chips blocking the drain, and allow the coolant to drain. Empty the coolant tank strainer, then resume operation.
7.9 Side Mount Tool Changer Oil Level Check

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

7.10 Periodic Maintenance

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

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

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

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

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

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

### 7.12 Interior Worklight

**Bulb Replacement**

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

*Interior worklight assembly.*
### MICRO PROCESSOR PCB - P/N 93-1010B

<table>
<thead>
<tr>
<th>PROC.</th>
<th>CABLE #</th>
<th>SIGNAL NAME</th>
<th>TO</th>
<th>LOCATION</th>
<th>PLUG #</th>
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<tbody>
<tr>
<td>J1 ADDRESS</td>
<td>ADDRESS BUSS</td>
<td>VIDEO</td>
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<td>MOTIF PCB</td>
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<td>J2 DATA</td>
<td>DATA BUSS</td>
<td>MOTIF PCB</td>
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<td>POWER SUPPLY PCB</td>
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<tr>
<td>J3</td>
<td>860</td>
<td>LOW VOLTAGE</td>
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<td>KEY. INTERFACE</td>
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<td>J6</td>
<td>N/A</td>
<td>REPLACEMENT BAT. CONNECTION</td>
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<td>SERIAL PORT #1</td>
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<tr>
<td>PORT 1</td>
<td>850</td>
<td>SERIAL PORT #1</td>
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<td>SERIAL PORT #2</td>
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<td>PORT 2</td>
<td>850A</td>
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BRUSHLESS SERVO AMPLIFIER - P/N 93-5550C

SERVO DRIVE SIGNAL (FROM MOCON)

LOW VOLTAGE (INPUT)

HAAS BRUSHLESS SERVO AMPLIFIER

A
B
C
- HV
+HV

Fuse Open

TO SERVO MOTOR

325VDC (FROM HAAS VECTOR DRIVE)
### CABLE LOCATIONS

#### BRUSHLESS SERVO AMPLIFIER - P/N 93-5550C

**CABLE CONNECTIONS**

<table>
<thead>
<tr>
<th>MOCON PLUG #</th>
<th>CABLE #</th>
<th>SIGNAL NAME</th>
<th>TO</th>
<th>LOCATION</th>
<th>PLUG #</th>
</tr>
</thead>
</table>

**X AXIS AMP**

- P 570 LOW VOLTAGE
- TB A, B, C MOTOR DRIVE
- P 610 X DRIVE SIGNAL
- TB -HV +HV 320VDC

<table>
<thead>
<tr>
<th>MOCON PLUG #</th>
<th>CABLE #</th>
<th>SIGNAL NAME</th>
<th>TO</th>
<th>LOCATION</th>
<th>PLUG #</th>
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**Y AXIS AMP**

- P 580 LOW VOLTAGE
- TB A, B, C MOTOR DRIVE
- P 620 Y DRIVE SIGNAL
- TB -HV +HV 320VDC

<table>
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<tr>
<th>MOCON PLUG #</th>
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<th>TO</th>
<th>LOCATION</th>
<th>PLUG #</th>
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</table>

**Z AXIS AMP**

- P 590 LOW VOLTAGE
- TB A, B, C MOTOR DRIVE
- P 630 Z DRIVE SIGNAL
- TB -HV +HV 320VDC

<table>
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<tr>
<th>MOCON PLUG #</th>
<th>CABLE #</th>
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<th>LOCATION</th>
<th>PLUG #</th>
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**A AXIS AMP**

- P 600 LOW VOLTAGE
- TB A, B, C MOTOR DRIVE
- P 640 A DRIVE SIGNAL
- TB -HV +HV 320VDC

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POWER PCB  93-0227A
**POWER PCB - P/N 93-0227A**

**CABLE CONNECTIONS**

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<td>Probe PS</td>
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<td>P4</td>
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<td>Switch Door Fan</td>
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<td>From Low Voltage Power Supply</td>
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<td>P9</td>
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<td>Monitor</td>
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<td>IO PCB</td>
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<td>Contactor K1/I/O PCB</td>
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<td>Front Panel</td>
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<td>740</td>
<td>Prim/Sec</td>
<td>To T5</td>
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<td>Overvolt Protection</td>
<td>From Contactor K1</td>
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<tr>
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<td>SKBIF</td>
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<tr>
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<td>IO PCB</td>
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<td>P28</td>
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<td>Processor PCB</td>
<td>J3</td>
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</tr>
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<td>TB2</td>
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<td>Barfeeder / T/C PCBA</td>
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<td>From Transformer</td>
<td></td>
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</tr>
</tbody>
</table>
I/O PCB T - P/N 93-0228A  CABLE CONNECTIONS

I/O PLUG #  CABLE #  \(\Rightarrow\) TO \(\Rightarrow\)  LOCATION  PLUG #

P1   140B  \(\Rightarrow\)  Chip Conveyor VB1/Gantry
P2   820B  \(\Rightarrow\)  TC in/SMT PKT down
P3   820  \(\Rightarrow\)  TC out/SMT PKT up/Tool #1/TC mark
P4   900  \(\Rightarrow\)  Low TSC press
P5   770  \(\Rightarrow\)  E-Stop Front Panel
P6   770A \(\Rightarrow\)  E-Stop Sw B
P7   770B \(\Rightarrow\)  E-Stop Sw C
P8   1050 \(\Rightarrow\)  Door Open A
P9   1050A \(\Rightarrow\)  Door Open B
P10  100 \(\Rightarrow\)  M-Fin
P11  970 \(\Rightarrow\)  VD Over Volt  VD J1
P12  950 \(\Rightarrow\)  Low Air/Low Oil/VB low chill pressure
P13  960 \(\Rightarrow\)  Low Lube
P14  830 \(\Rightarrow\)  Regen Overheat
## I/O PCB T - P/N 93-0228A CABLE CONNECTIONS

<table>
<thead>
<tr>
<th>I/O PLUG #</th>
<th>CABLE #</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>P15</td>
<td>890</td>
<td>SPDB Open/Closed</td>
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<td>780</td>
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<td>410</td>
<td>APC Door Open , VB Clamshell</td>
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<td>790</td>
<td>APC Pin Clear</td>
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<td>480</td>
<td>Spare APC door closed/Open / APC pal clamped</td>
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<td>P41</td>
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<td>SP Fan/Oil Pump</td>
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<td>P42</td>
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<td>P43</td>
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<td>PSUP P23</td>
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<td>P44</td>
<td>930</td>
<td>Coolant Output</td>
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<td>940A</td>
<td>250V TSC/Cool Input Power</td>
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<td>120</td>
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<td>Axis Brake</td>
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<td>Trans P6</td>
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<td>P51</td>
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<td>710</td>
<td>Trans P4</td>
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<td>P54</td>
<td>880B</td>
<td>Spare A/B</td>
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<tr>
<td>P55</td>
<td>880A</td>
<td>Wye-Delta Switch</td>
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<td>90</td>
<td>High/Low Gear</td>
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<tr>
<td>P57</td>
<td>810A</td>
<td>Tool unclamp precharge</td>
</tr>
<tr>
<td>P58</td>
<td>810</td>
<td>115V IOPCB Input Pwr(AC)</td>
</tr>
<tr>
<td>P59</td>
<td>810A</td>
<td>TC Jumper or SMTC Resistor</td>
</tr>
<tr>
<td>P60</td>
<td>860A</td>
<td>T.C. in/smctc ATC fwd / APC chn drv en/rev</td>
</tr>
<tr>
<td>P61</td>
<td>540</td>
<td>T.C. CW/ SMTC CRSCLow</td>
</tr>
<tr>
<td>P62</td>
<td>540A</td>
<td>+5/+12V Logic Pwr (IOPCB)</td>
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<td>P63</td>
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<td>Outputs Cable 24-55</td>
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<td>P64</td>
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<td>510</td>
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<td>TB2</td>
<td>M25</td>
<td>Auto Door Clutch</td>
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<td>Pocket Up/Down,VR Shuttle Out, VB Clamshell</td>
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<td>Outputs Cable 16-23</td>
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<td>User Spare</td>
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SERIAL KEYBOARD INTERFACE PCB WITH HANDLE JOG
P/N 93-1072B

J1

J2

J5

J3
JOG HANDLE

P1

P6

P5

P3

P4

P2

DISCRETE INPUTS

32-4031E

Y1

U9

J12

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

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<thead>
<tr>
<th>PLUG#</th>
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<td>700A</td>
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<td>J1</td>
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<td>J5</td>
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<td>J7</td>
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<td>860C</td>
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* See "Keyboard Diagnostic" section of this manual for Troubleshooting information.
### VIDEO & KEYBOARD PCB W/ FLOPPY DRIVE
P/N 93-1001A

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* Not used with Serial Keyboard Interface
# MOCON PCB - P/N 93-1067F
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### MOTIF PCB - P/N 93-1066
#### CABLE CONNECTIONS

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<td>TO</td>
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RS-232 PORT #1 PCB - P/N 32-4090
CABLE CONNECTIONS

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### 50T TRANSMISSION P.S. / HYDRAULIC C.B. PCB

P/N 93-4095D

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## M Code Relay Board

P/N 93-1057B Cable Connections

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Addressing Jumpers

![Diagram of M Code Relay Board](image)
Y-DELTA SWITCH ASSEMBLY
P/N 32-5850A

TO K5 AUX
TO K5 COIL
TO SPINDLE MOTOR

650A

TO K4 COIL
TO IO PCB, P12
TO IO PCB, P58

650B
TO HAAS VECTOR DRIVE

K4

K5

P/N 32-5850A

CABLE LOCATIONS

June 2002
### SERVO DISTRIBUTION J
### CABLE CONNECTIONS
### P/N 34-4025J

<table>
<thead>
<tr>
<th>PLUG #</th>
<th>CABLE #</th>
<th>➔ TO ➔</th>
<th>LOCATION</th>
<th>PLUG #</th>
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<td>P1</td>
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<td>P2</td>
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<td>P5</td>
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## 9. Cable List

<table>
<thead>
<tr>
<th>Wire/Terminal</th>
<th>Function Name</th>
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<tr>
<td>INCOMING POWER 195-260 VAC (353-488 VAC OPTIONAL)</td>
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<td>L1</td>
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<td>INCOMING 195-260VAC, PHASE 2, TO CB1-2</td>
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<td>INCOMING 195-260VAC, PHASE 3, TO CB1-3</td>
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<td>71</td>
<td>PROTECTED 195-260 VAC FROM MAIN CB1-4 TO K1-1</td>
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<td>72</td>
<td>PROTECTED 195-260 VAC FROM MAIN CB1-5 TO K1-2</td>
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<td>73</td>
<td>PROTECTED 195-260 VAC FROM MAIN CB1-6 TO K1-3</td>
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<td>74</td>
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<td>75</td>
<td>195-260 VAC FROM K1-5 TO XFORMER T1</td>
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<td>76</td>
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<tr>
<td>77</td>
<td>230VAC PHASE 1, FROM XFORMER T1 TO VECTOR / CHIP CONV</td>
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<tr>
<td>78</td>
<td>230VAC PHASE 2, FROM XFORMER T1 TO VECTOR / CHIP CONV</td>
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<td>79</td>
<td>230VAC PHASE 3, FROM XFORMER T1 TO VECTOR / CHIP CONV</td>
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<tr>
<td>90</td>
<td>115 VAC FROM TB2 (CB2 OUTPUT) TO IOPCB P33 - (3 + SHIELD)</td>
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<tr>
<td>91</td>
<td>STEPPED-DOWN 115 VAC (FROM XFRMER T1) #18</td>
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<tr>
<td>92</td>
<td>STEPPED-DOWN 115 VAC (FROM XFRMER T1) #18</td>
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<td>93</td>
<td>STEPPED-DOWN 115 VAC (FROM XFRMER T1) #18</td>
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<td>94</td>
<td>SHIELD DRAIN</td>
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<td>—</td>
<td>115 VAC FROM XFORMER T1 TO TB1 (CB2 INPUT)</td>
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<tr>
<td>94</td>
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<td>115 VAC TO CRT - (2 + SHIELD)</td>
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<td>91A</td>
<td>LEG 1 #16</td>
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<td>92A</td>
<td>LEG 2 #16</td>
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<td>93A</td>
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<td>90B</td>
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<td>91B</td>
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<td>92B</td>
<td>LEG 2 #16</td>
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<td>93B</td>
<td>SHIELD DRAIN</td>
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90C 115 VAC TO CB4 - (2 + SHIELD)
91C LEG 1 #16
92C LEG 2 #16
93C SHIELD DRAIN

100 M-FIN (IOASM TO SIDE OF BOX) - (2 + SHIELD)
101 SIGNAL #20
102 COMMON #20
101 SIGNAL #20
102 COMMON #20
103 SHIELD DRAIN

140 230VAC 3PH POWER TO CHIP CONVEYOR MOTOR (5 + SHIELD)
141 PHASE A 230VAC
142 PHASE B 230VAC
143 PHASE C 230VAC
144 STARTING WINDING 230VAC
145 STARTING WINDING 230VAC
146 SHIELD DRAIN

160 3PH 230VAC TO CHIP CONVEYOR CONTROLLER (3 + SHIELD)
161 PHASE A 230VAC
162 PHASE B 230VAC
163 PHASE C 230VAC
164 SHIELD DRAIN

170 AUTO OFF FUNCTION - (2 + SHIELD)
171 UNSWITCHED LEG 1 #20
172 SWITCHED LEG 2 #20
173 SHIELD DRAIN

180 COOLANT SPIGOT DETENT SWITCH (2 + SHIELD)
181 SIGNAL
182 COMMON
183 SHIELD DRAIN

190 UNCLAMP FROM SPINDLE HEAD TO IOASM
191 INPUT 25
192 DIGITAL RETURN

200 COOLANT SPIGOT MOTOR (12VDC)
201 MOTOR +
202 MOTOR -

210 DATA CABLE TO 3" FLOPPY DISK DRIVE (40 PINS)

220 SERVO BRAKE 115VAC - (2 + SHIELD)
221 115VAC COMMON
222 115VAC SWITCHED
223 SHIELD DRAIN
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<tr>
<th>CABLE LIST</th>
<th>Service Manual</th>
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<td>260 K210 CBLING FOR EC</td>
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<td>270 K111 CBLING FOR EC</td>
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<td>280 RED/GREEN STATUS LIGHT WIRING (3+ SHIELD)</td>
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<td>281 RED LAMP 115VAC</td>
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<td>282 GREEN LAMP 115VAC</td>
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<td>283 COMMON 115VAC</td>
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<td>290 115VAC TO SPINDLE MOTOR FAN/OIL PUMP/OILER (2 + SHIELD)</td>
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<td>291 LEG 1 115VAC PROTECTED #18</td>
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<td>292 LEG 2 115VAC PROTECTED #18</td>
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<td>293 SHIELD DRAIN</td>
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<td>295 SERVO BRAKE RELEASE 115VAC - (2 + SHIELD)</td>
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<tr>
<td>296 LEG 1 COMMON</td>
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<td>298 SHIELD DRAIN</td>
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<td>299 RESERVED</td>
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<td>300 115VAC TO 4'TH AXIS BRAKE (LATHE PART DOOR) - (2 + SHIELD)</td>
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<tr>
<td>301 LEG 1 COMMON</td>
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<td>302 LEG 2 SWITCHED</td>
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<td>303 SHIELD DRAIN</td>
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<td>305 ALL BRUSHLESS AXIS SERVO MOTOR DRIVE POWER CABLE</td>
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<td>306 A PHASE</td>
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<td>307 B PHASE</td>
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<td>308 C PHASE</td>
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<td>30A A AXIS MOTOR POWER</td>
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<td>30B B AXIS MOTOR POWER</td>
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<td>30X X AXIS MOTOR POWER</td>
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<td>30Y Y AXIS MOTOR POWER</td>
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<td>30Z Z AXIS MOTOR POWER</td>
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<td>500</td>
<td>OVERTEMP SENSOR FROM SPINDLE MOTOR - (2 + SHIELD)</td>
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<td>OVERTEMP WIRE 1 #20 (N.C.)</td>
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<td>502</td>
<td>OVERTEMP WIRE 2 #20</td>
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<td>INPUTS CARD CABLE (MOTIF-P10) 34 WIRE RIBBON #24</td>
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<td>610</td>
<td>X AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD (MOTOR CONTROLLER BOARD SIDE CONNECTION)</td>
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<td>610-2</td>
<td>ANALOG GROUND</td>
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<td>610-3</td>
<td>+B CHANNEL</td>
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<td>610-4</td>
<td>ANALOG GROUND</td>
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<td>610-5</td>
<td>ENABLE</td>
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<td>610-6</td>
<td>LOGIC GROUND</td>
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<tr>
<td>610-7</td>
<td>FAULT</td>
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<td>610-8</td>
<td>LOGIC GROUND</td>
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<td>NOT USED</td>
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<td>610-10</td>
<td>SHIELD/ANALOG GROUND</td>
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<td>620</td>
<td>Y AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD (SAME AS 610-1 THRU 610-10)</td>
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<td>630</td>
<td>Z AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD (SAME AS 610-1 THRU 610-10)</td>
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<td>640A</td>
<td>A AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD (SAME AS 610-1 THRU 610-10)</td>
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<td>640B</td>
<td>B AXIS HAAS AMPLIFIER CABLE TO MOTOR CONTROLLER BOARD (SAME AS 610-1 THRU 610-10)</td>
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<td>640C</td>
<td>C AXIS HAAS VECTOR CURRENT COMMAND CABLE TO MOTOR CONTROLLER BD. (SAME AS 610-1 THRU 610-10)</td>
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<td>650</td>
<td>THREE PHASE POWER TO SPINDLE MOTOR - (3 + SHIELD)</td>
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<tr>
<td>651</td>
<td>LEG 1 OF 230VAC</td>
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<tr>
<td>652</td>
<td>LEG 2</td>
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<td>653</td>
<td>LEG 3</td>
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<td>654</td>
<td>SHIELD DRAIN</td>
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650A  THREE PHASE POWER TO SPINDLE MOTOR - (3 + SHIELD)
651A  LEG 1 OF 230VAC
652A  LEG 2
653A  LEG 3
654A  SHIELD DRAIN

650B  THREE PHASE POWER TO SPINDLE MOTOR - (3 + SHIELD)
651B  LEG 1 OF 230VAC
652B  LEG 2
653B  LEG 3
654B  SHIELD DRAIN

660  X-ENCODER CABLE (ALL #24)
660-1  LOGIC RETURN (D GROUND)
660-2  ENCODER A CHANNEL
660-3  ENCODER B CHANNEL
660-4  +5 VDC
660-5  ENCODER Z CHANNEL (OR C)
660-6  HOME/LIMIT SW
660-7  OVERHEAT SWITCH
660-8  ENCODER A*
660-9  ENCODER B*
660-10  ENCODER Z* (OR C*)
660-11  X HALL A (NOT USED)
660-12  X HALL B (NOT USED)
660-13  X HALL C (NOT USED)
660-14  X HALL D (NOT USED)
660-15  SHIELD DRAIN
660-16  NOT USED

670  Y-AXIS ENCODER CABLE
(SAME AS 660-1 THRU 660-16)

680  Z-AXIS ENCODER CABLE
(SAME AS 660-1 THRU 660-16)

690  A-AXIS ENCODER CABLE
(SAME AS 660-1 THRU 660-16)

690B  B-AXIS ENCODER CABLE
(SAME AS 660-1 THRU 660-16)

690C  C-AXIS ENCODER CABLE
(SAME AS 660-1 THRU 660-16)

700  KEYBOARD CABLE - 34 WIRE RIBBON WITH IDC
(from VIDEO P4 TO KBIF P1)
<table>
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<tr>
<th>Cable Number</th>
<th>Description</th>
<th>Notes</th>
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<tr>
<td>710</td>
<td>FORWARD/REVERSE/RESET TO SPINDLE - (4 + SHIELD)</td>
<td>(BRUSH SYSTEMS)</td>
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<tr>
<td>711</td>
<td>FORWARD COMMAND (CN1-19 TO IO P9-3)</td>
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<td>712</td>
<td>REVERSE COMMAND (CN1-19 TO IO P9-3)</td>
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<td>713</td>
<td>RESET COMMAND (CN1-21 TO IO P9-2)</td>
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<td>714</td>
<td>COMMON (CN1-14 TO IO P9-1)</td>
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<td>715</td>
<td>SHIELD DRAIN</td>
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<td>720</td>
<td>ANALOG SPEED COMMAND TO SPINDLE - (2 + SHIELD)</td>
<td>(BRUSH SYSTEMS)</td>
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<td>721</td>
<td>0 TO +10 VOLTS SPEED COMMAND (SPINDLE DRIVE CN1-1)</td>
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<td>722</td>
<td>SPEED COMMAND REFERENCE (A GROUND) (CN1-17)</td>
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<td>SHIELD DRAIN</td>
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<td>730</td>
<td>POWER METER FROM SPINDLE DRIVE TO KBIF - (2 + SHIELD)</td>
<td>(BRUSH SYSTEMS)</td>
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<td>731</td>
<td>METER + (SPINDLE DRIVE CN1-5 TO KBIF)</td>
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<td>732</td>
<td>METER - (CN1-6 TO KBIF)</td>
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<td>SHIELD DRAIN</td>
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<td>734</td>
<td>POWER METER FROM KBIF TO METER - (2 + SHIELD)</td>
<td>(BRUSH SYSTEMS)</td>
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<td>METER + AFTER TRIM POT (KBIF TO METER)</td>
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<td>METER - AFTER TRIM POT (KBIF TO METER)</td>
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<td>750</td>
<td>JOG-CRANK DATA CABLE (REM JOG SIDE CONNECTION)</td>
<td>(ALL #28)</td>
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<td>751-1</td>
<td>LOGIC RETURN (D GROUND)</td>
<td>0VDC</td>
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<td>751-2</td>
<td>ENCODER A CHANNEL</td>
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<td>ENCODER B CHANNEL</td>
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750-2 CYCLE START
750-4 D GROUND
750-6 FEED HOLD

760 MONITOR VIDEO DATA CABLE - (9 + SHIELD) (ALL #24) (FROM VIDEO P3 TO CRT)

770 EMERGENCY STOP INPUT CABLE - SHIELD +2
771 SIGNAL (INPUT 8) #20
772 RETURN (D GROUND) (65) #20
772 RETURN (D GROUND) (65) #20

770A SECOND E-STOP INPUT FOR HORIZONTAL

770B THIRD E-STOP INPUT FOR APC (REMOTE CONTROL PANEL)

780 STATUS CABLE FROM SPINDLE DRIVE - (4 + SHIELD) (BRUSH SYSTEMS)
781 +12 VDC (SPINDLE DRIVE CN1-25) #24
782 FAULT (INPUT 18 TO CN1-24) #24
783 AT SPEED (INPUT 20 TO CN1-23) #24
784 STOPPED (INPUT 19 TO CN1-22) #24
785 SHIELD DRAIN

790 SPARE INPUTS FROM IOPCB P24
791 SPARE 1
792 SPARE 2
793 COMMON

810 TOOL CHANGER MOTORS - (2 + SHIELD) #20
811 TURRET MOTOR + (IO P30-2 TO P6-J) #14
812 TURRET MOTOR - (IO P30-1 TO P6-I) #14
812 SHIELD DRAIN

810A TOOL CHANGER MOTORS - (2 + SHIELD) #20
813 SHUTTLE MOTOR - (IO P30-4 TO P6-A) #14
814 SHUTTLE MOTOR + (IO P30-3 TO P6-B) #14
812 SHIELD DRAIN

820 TOOL CHANGER STATUS - (7 + SHIELD) 7
821 LOGIC RETURN (D GROUND) (P6-F/H/L/M) #24
822 GENEVA MARK (INPUT 5 TO P6-G) #24 (LATHE PART DOOR)
823 TOOL #1 (INPUT 3 TO P6-E) #24
824 SHUTTLE IN (INPUT 1 TO P6-C) #24 (LATHE TURRET CLAMPED)
825 SHUTTLE OUT (INPUT 2 TO P6-D) #24 (LATHE TURRET UNCLAMPED)
826 SHUTTLE IN (INPUT 1 TO P6-C) #24 (LATHE TURRET CLAMPED)
827 SHIELD DRAIN
830 OVERHEAT THERMOSTAT - (2 + SHIELD)
831 OVERHEAT SIGNAL (INPUT 14) #20
832 OVERHEAT RETURN (D GROUND) (65) #20
833 SHIELD DRAIN

840 CIRCUIT BREAKER FOR 160 VDC - SHIELD +2
841 LEG 1 (TO 81) #14
842 LEG 2 #14
843 SHIELD DRAIN

850 SERIAL PORT #1 TO SERIAL KEYBOARD INTERFACE CABLE (16 WIRE RIBBON #24)
850A SERIAL PORT #2 INTERFACE CABLE (16 WIRE RIBBON #24)

860 +12V/+5V/Gnd POWER CABLES - 6 WIRE (all #18)
861 +12 VOLTS
862 -12 VOLTS FROM LOW V SUPPLY TO 68020 PCB
863 +5 VOLTS
864 -5 VOLTS
865 LOGIC POWER RETURN (D GROUND)
866 POWER GOOD SIGNAL FROM SUPPLY

860A 12 VOLT POWER TO IOPCB - SHIELD +2
861 +12 VOLTS
862 LOGIC POWER RETURN (D GROUND)

860B +5 POWER TO 3” FLOPPY DRIVE
860C +5,+12,-12 POWER TO 68030

870 115VAC TO OILER - (2 + SHIELD)
871 115VAC LEG 1 #18
872 115VAC LEG 2 #18
873 SHIELD DRAIN

880A HIGH/LOW GEAR UNCLAMP/LOCK SOLENOID POWER - SHIELD +6
881 115 VAC SOLENOID COMMON (IO P12-5) #18
882 HIGH GEAR SOLENOID (IO P12-4) #18
883 LOW GEAR SOLENOID (IO P12-3) #18
884 TOOL UNCLAMP SOLENOID (IO P12-2) #18
885 SPINDLE LOCK SOLENOID (IO P12-1) #18
886 PRE-CHARGE SOLENOID #18 (IO P12-7)
887 SHIELD DRAIN

880B TRANSMISSION HIGH/LOW GEAR SOLENOIDS FOR LATHE
881 115 VAC SOLENOID COMMON (IO P12-5) #18
882 HIGH GEAR SOLENOID (IO P12-4) #18
883 LOW GEAR SOLENOID (IO P12-3) #18
884 SHIELD DRAIN
890  SPINDLE STATUS SWITCHES (6 + SHIELD)
891  SIGNAL RETURN (D GROUND) (65) #24
892  HIGH GEAR (INPUT 6) #24
893  LOW GEAR (INPUT 7) #24
894  TOOL UNCLAMPED (INPUT 15) #24
895  TOOL CLAMPED (INPUT 16) #24
896  SPINDLE LOCKED (INPUT 17) #24
897  SHIELD DRAIN

900  LOW COOLANT STATUS - (2 + SHIELD)
901  LOW COOLANT SIGNAL (INPUT 4 TO P7-C) #20
902  LOW COOLANT RETURN (D GROUND) (65 TO P7-D) #20
903  SHIELD DRAIN

910  115 VAC CIRCUIT BREAKER TO SOLENOIDS - (2 + SHIELD)
911  LEG 1 #18
912  LEG 2 #18
913  SHIELD DRAIN

910A  115VAC FROM CB4 ON MAIN POWER DIST.
910B  115VAC TO SERVO FAN
910C  115VAC TO DELTA/WYE COIL
910D  115VAC TO WORK LIGHT

920  REGENERATIVE LOAD RESISTOR FOR SERVO - (2 + SHIELD) (BRUSH SYSTEMS)
921  LEG 1 #18
922  LEG 2 #18
923  SHIELD DRAIN

930  FUSED 230 VAC FOR COOLANT PUMP - (2 + SHIELD)
931  LEG 1 #14
932  LEG 2 #14
933  SHIELD DRAIN

940  230 VAC TO COOLANT PUMP - (2 + SHIELD)
941  LEG 1 (P7-A) #14
942  LEG 2 (P7-F) #14
943  SHIELD DRAIN

950  LOW AIR PRESSURE SENSOR - (3 + SHIELD)
951  LOW AIR SIGNAL (INPUT 12) #20
952  LOW AIR/OIL RETURN (D GROUND) (65) #20
953  LOW OIL PRESSURE SWITCH FOR VERTICAL TRANSMISSION #20
954  SHIELD DRAIN

950A  LOW HYDRAULIC PRESSURE SWITCH FOR LATHE - (2 + SHIELD)
952  LOW HYDRAULIC RETURN (D GROUND) (65) #20
953  LOW HYD PRESSURE SWITCH FOR VERTICAL TRANSMISSION #20
954  SHIELD DRAIN
960  LOW LUB/DOOR OPEN SENSORS - (4 + SHIELD)
961  LOW LUB SIGNAL (INPUT 13) #24
962  LOW LUB RETURN (D GROUND) (65) #24
963  DOOR OPEN SIGNAL (INPUT 9) #24 (OBSOLETE OPTION)
964  DOOR OPEN RETURN (D GROUND) (65) #24 (OBSOLETE OPTION)
965  SHIELD DRAIN

970  LOW VOLTAGE SENSOR - (2 + SHIELD)
971  LOW VOL SIGNAL (INPUT 11 FROM PMON P9-3) #24
972  LOW VOL RETURN (D GROUND) (PMON P9-4) #24
973  SHIELD DRAIN

980  VOLTAGE MONITOR - (2 + SHIELD)
981  VOLTAGE MONITOR 0 TO +5 (PMON P9-1 / MOTIF P17-1) #24
982  VOLTAGE MON RET (A GND) (PMON P9-2 / MOTIF P17-2) #24
983  VOLTAGE MON RET (A GND) (PMON P9-2 / MOTIF P17-2) #24

990  HOME SENSORS - (4 + SHIELD)
991  X HOME SWITCH (MOTIF P24-2 TO P5-B) #24
992  Y HOME SWITCH (MOTIF P24-3 TO P5-D) #24 (LATHE TAIL STOCK)
993  Z HOME SWITCH (MOTIF P24-4 TO P5-L) #24
994  HOME SWITCH RETURN (MOTIF P24-1 TO P5-C) #24
995  SHIELD DRAIN

1000 SPINDLE ENCODER CABLE - (5 + SHIELD) (LATHE TAIL STOCK)(BRUSH SYSTEMS)
1001 LOGIC RETURN (D GROUND) (TO MOTIF P20-1) #24
1002 ENCODER A CHANNEL (TO MOTIF P20-2) #24
1003 ENCODER B CHANNEL (TO MOTIF P20-3) #24
1004 +5 VDC (TO MOTIF P20-4) #24
1005 ENCODER Z CHANNEL (TO MOTIF P20-5) #24
1006 SHIELD DRAIN

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

1030 SPINDLE LOAD RESISTOR - (2 + SHIELD)
1031 REGEN LOAD RESISTOR FOR SPINDLE DRIVE (B1) #18
1032 REGEN LOAD RESISTOR FOR SPINDLE DRIVE (B2) #18
1033 SHIELD DRAIN

1040 Y160 (MIKRON DOOR LOCK OR HORIZONTAL PART READY LAMP)
1041 SWITCHED RELAY CONTACT
1042 SWITCHED RELAY CONTACT

1050 DOOR SWITCH WIRING THRU SUPPORT ARM - (2 + SHIELD)
1051 DOOR OPEN SIGNAL (INPUT 9) #24
1052 DOOR OPEN RETURN (D GROUND) (65) #24
1053 SHIELD DRAIN
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1060</td>
<td>GROUND FAULT DETECTION SENSE INPUT</td>
</tr>
<tr>
<td>1061</td>
<td>+ INPUT FROM SENSE RESISTOR</td>
</tr>
<tr>
<td>1062</td>
<td>- INPUT FROM SENSE RESISTOR</td>
</tr>
<tr>
<td>1070</td>
<td>SKIP INPUT FROM SENSOR - (2 + SHIELD)</td>
</tr>
<tr>
<td>1071</td>
<td>LOGIC COMMON</td>
</tr>
<tr>
<td>1072</td>
<td>SKIP SIGNAL</td>
</tr>
<tr>
<td>1073</td>
<td>SHIELD DRAIN</td>
</tr>
</tbody>
</table>
ELECTRICAL WIRING DIAGRAMS
INPUT VOLTAGE 195-260 VAC

MAIN POWER DISTRIBUTION

115 VAC

MAIN TRANSFORMER

195-260 VAC INPUT

115 VAC

OPERATOR PENDANT

230 VAC

VIDEO, KEYBOARD, AND JOG

BRUSHLESS SERVO AMPLIFIERS

320 VDC

SPINDLE DRIVE

SPINDLE MOTORS

REGEN ASSY

SPINDLE MOTOR

230 VAC

MICRO PROCESSOR (CNC)

CMDS

FAULTS

PWR

SPINDLE COMMANDS

SPINDLE ENCODER

POSITION AND FAULT DATA

DISCRETE INPUTS AND OUTPUTS

230 VAC

COOLANT PUMP AND CHIP CONVEYOR

HEAT SENSOR

SENSORS

CMDS

HOME-LIMIT SWITCHES/GEAR BOX/ TOOLCHANGER/OVERHEAT SENSORS/ LOW LUBE/LOW COOLANT/SOLENOIDS

NOTE FOR HIGH VOLTAGE IN, SEE PAGE C.

SYSTEM BLOCK DIAGRAM - LOW VOLTAGE

HAAS AUTOMATION VF SERIES PAGE B
ELECTRICAL DIAGRAMS

INPUT VOLTAGE
353-480 VAC

MAIN POWER DISTRIBUTION

MAIN TRANSFORMER

OPERATOR PENDANT

VIDEO, KEYBOARD, AND JOG

115 VAC

230 VAC

BRUSHLESS SERVO AMPLIFIERS

SPINDLE DRIVE

320 VDC

SPINDLE ELECTRICAL

EXCESS PWR

SP PWR

SERVO MOTORS

REGEN ASSY

SPINDLE MOTOR

POSITION AND FAULT DATA

FAULTS

CMDS

SPINDLE COMMANDS

PWR

HEAT SENSOR

Sensors

CMDS

COOLANT PUMP AND CHIP CONVEYOR

DISCRETE INPUTS AND OUTPUTS

MICROPROCESSOR (CNC)

LOW VOLTAGE

230 VAC

115 VAC

NOTE FOR LOW VOLTAGE IN, SEE PAGE B.

SYSTEM BLOCK DIAGRAM - HIGH VOLTAGE

HAAS AUTOMATION VF SERIES PAGE C
SERVO SYSTEM
HAAS AUTOMATION VF SERIES PAGE 1
ELECTRICAL DIAGRAMS

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VF SERIES
Service Manual

MAIN TRANSFORMER - HIGH VOLTAGE
HAAS AUTOMATION VF SERIES PAGE 3

357/480 VAC IN

POWER SUPPLY PCB
- FUSES ON POWER SUPPLY ARE 1/2A, FAST BLOW ONLY,
- THEY WILL OPEN IF VOLTAGE EXCEEDS 570 VAC ON INCOMING
- 3 PHASE POWER, DROPPING OUT K1.

FU1
FU2
FU3

AUX

24VCT

POWER ON
ON 742

POWER OFF
OFF 744

OPERATOR PENDANT

741

743

717

67

K7

PART OF I/O PCB

PH1

230 VAC

357-376V

377-400V

401-425V

425-451V

452-480V

115V PH1

PH2

230 VAC

357-376V

377-400V

401-425V

425-451V

452-480V

115V PH2

PH3

230 VAC

357-376V

377-400V

401-425V

425-451V

452-480V

115V PH3

I/O PCB

PART OF POWER SUPPLY PCB.

CB1

CB2

CB3

M

TSC MOTOR 220/240 VAC

COOLANT MOTOR 220/240 VAC
115 VAC 3 PHASE FROM T1

HEAT EXCHANGER

REAR OF CONTROL CABINET

WORK LAMP

*K13 LOW GEAR

*K14

*K15 SPINDLE LOCK

*K16

*K24 PRECHARGE

*K21

*K5 4TH AXIS BRAKE

*K23 5TH BRAKE (OPTION)

*K30 RED BEACON

*K29 GREEN BEACON

FUSE

BL AMP. FAN

SPINDLE COOLING (VF-0)

*K8

SPINDLE LUBE

SPINDLE FAN

OIL PUMP FOR GEAR BOX

WAY LUBE PUMP

115 VAC CIRCUITS

HAAS AUTOMATION VF SERIES PAGE 5
ELECTRICAL DIAGRAMS

INPUT NUMBER

01. SHUTTLE IN
02. SHUTTLE OUT
03. TOOL #1 MARKER
04. LOW TSC COOLANT (OPTIONAL)
05. GENEVA MARK
06. IN HIGH GEAR
07. IN LOW GEAR
08. EMERGENCY STOP
09. DOOR OPEN
10. M CODE FINISH
11. 971.- LOW VOLTAGE
12. 972.- LOW AIR PRESSURE (SENSOR)
13. LOW WAY LUBE OIL
14. OVERHEAT SERVO REGEN
15. DRAW BAR OPEN
16. DRAW BAR CLOSED

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

DISCRETE INPUTS 1 THROUGH 16
HAAS AUTOMATION  VF SERIES  PAGE 6
ELECTRICAL DIAGRAMS

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

DISCRETE INPUTS 17 THROUGH 32
HAAS AUTOMATION  VF SERIES  PAGE 7
NOTE: ANY RELAY K1 .......K35 CAN BE REPLACED WITH A SOLID STATE EQUIVALENT

RELAY COIL DRIVERS, K1 THROUGH K8

HAAS AUTOMATION VF SERIES PAGE 8
NOTE: ANY RELAY K1 THROUGH K35 CAN BE REPLACED WITH A SOLID STATE EQUIVALENT

RELAY COIL DRIVERS, K9 THROUGH K16

HAAS AUTOMATIONVF SERIESPAGE 9
NOTE: ANY RELAY K1 .........K35 CAN BE REPLACED WITH A SOLID STATE EQUIVALENT

RELAY COIL DRIVERS, K17 THROUGH K24
HAAS AUTOMATION VF SERIES PAGE 10
NOTE: ANY RELAY K1 ........ K35 CAN BE REPLACED WITH A SOLID STATE EQUIVALENT

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

**Service Manual**

**SPINDLE DRIVE UNIT**

HAAS AUTOMATION  VF SERIES  PAGE 12

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**LOW VOLTAGE POWER SUPPLY**

- 115 VAC (IN)
- +5V, +12V, 0V, -5V, -12V, GND

**POWER SUPPLY PCB**

- 860 TO PROCESSOR BOARD ASSEMBLY MODULE

**SPINDLE DRIVE UNIT**

- NOTE:
  - PINOUTS ARE LISTED FOR MFG. AS SHOWN: MITSUBISHI (MAGNETEK)

**SPINDLE MOTOR**

- W, U, E

**THermal OVERLOAD**

- TO MOCON BOARD P16
- TO OPERATOR PANEL *SOLID STATE
- TO INPUTS BOARD 18/19/20
- TO SPINDLE LOCK

---

**SPINDLE DRIVE UNIT**

HAAS AUTOMATION  VF SERIES  PAGE 12
ELECTRICAL DIAGRAMS

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96-8100 rev E

CABINET CONNECTOR

TO MOCON THROUGH CABLE:
690 A AXIS ENCODER
690B B AXIS ENCODER.

( THIS GROUP IS ALL 24 AWG WIRES. )

TWISTED PAIR TO INDUCTORS & AMPLIFIERS

OVER/HEAT

TO MOCON

HOME

TO RELAY K5/K23
(20 AWG)

4TH AXIS SOLENOID IS ON ROTARY TABLES ONLY (NO COLLET OR MULTI-COLLET INDEXERS)

A/B AXIS

HAAS AUTOMATION VF SERIES PAGE 15
ELECTRICAL DIAGRAMS

P5 HOME SENSORS/DOOR/LUBE

TO RELAY K9
TO RELAY K10
TO INPUT #01
TO INPUT #02
TO INPUT #03
TO INPUT #05
TO RELAY K11
TO RELAY K12
TO LOGIC GND

TO IO PCB P14 #900

COOLANT MOTOR
230 VAC SINGLE PHASE

TSC MOTOR
230 VAC THREE PHASE

WAY LUBE PUMP MOTOR
SPINDLE COOLING SOLENOID (VF-0 ONLY)

LOW LUBE PRESSURE SWITCH

SHUTTLE MOTOR
SHUTTLE IN
SHUTTLE OUT
TOOL #1 MARKER
GENEVA MARK
TURRET MOTOR

NOTE: CONNECTORS ARE LOCATED ON SIDE OF CONTROL CABINET.

CABINET CONNECTORS
HAAS AUTOMATION VF SERIES PAGE 16
CHIP CONVEYOR AND SPIGOT MOTORS
HAAS AUTOMATION VF SERIES PAGE 18
1. 50-3300 Linear guide
2. 30-0171 Oil line assembly
3. 32-2030 Telemecanique switch assembly
4. 62-0014 Yaskawa sigma 09 motor*

*Except XRT

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

*Except XRT

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

*Except XRT

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

*Except XRT
1. 30-0687 Oil line assembly
2. 32-2041 Telemachinique switch assembly
3. 50-9011 Linear guide
4. 62-0014 Yaskawa Sigma 09 motor*

*Except XRT

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

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

*Except XRT

**VF-6 Base**
1. 32-2050 Telemecanique limit switch assembly
2. 62-0014 Yaskawa sigma 09 motor*
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide

*Except XRT

VF-6 Column
1. 62-0014 Yaskawa sigma 09 motor*
2. 50-9806 Linear guide
3. 30-0463 Oil line assembly
4. 32-2051 Telemechanique limit switch assembly

*Except XRT

VF-6 Saddle
1. 62-0014 Yaskawa sigma 09 motor*
2. 50-9010 Linear guide
3. 30-0461 Oil line assembly
4. 32-5056 Telemecanique limit switch assembly

*Except XRT

VF-8 Base
1. 32-2050 Telemecanique limit switch assembly
2. 62-0014 Yaskawa sigma 09 motor*
3. 30-0464 Oil line assembly
4. 50-9010 Linear guide

*Except XRT

**VF-8 Column**
1. 62-0014 Yaskawa sigma 09 motor*
2. 50-9806 Linear guide
3. 30-0463 Oil line assembly
4. 32-2051 Telemechanique limit switch assembly

*Except XRT

VF-8 Saddle
1. 59-6655 Rubber plug guide rail
2. 22-7458 Cam, linear guide
3. 20-9218 Y-axis bumper, motor end
4. 20-0150 Nut housing
5. 58-3031 Banjo elbow 5/16 female x M6 male
6. 58-1560 Adaptor 1/8m (NSK and THK Linear guides) 59-0001 (Star linear guides)
7. 30-0461 Oil line assembly
8. 20-0156 Bumper for 40 and 50 mm ballscrews
9. 32-5056 Limit switch assembly
10. 25-7268 Bracket mounting Y-axis
11. 50-9010 Linear guide
12. 24-9960 40mm ballscrew*
13. 25-9203 Cover plate motor mount
14. 62-0014 servo motor (40 taper) 62-0016 servo motor (50 taper)*
15. N/A
16. N/A

*Except XRT

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

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

*Except XRT

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

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

32 Tool Changer Assembly VF-6..10
1. 30-0016 Geneva driver assembly
2. N/A
3. 54-0010 Cam follower T/C
4. 20-9289 Shuttle stop block
5. 78-1996 Split flex tuning 1/2 I.D.
6. 20-9291 Shuttle vertical plate
7. 25-9342 Shuttle cover
8. 30-0017A carousel assembly
9. 20-9290 Shuttle base plate
10. 20-9293 Shuttle gusset
11. 32-2030 Limit switch Y-axis
12. 22-7263 Block switch mounting
13. 51-0002 V-roller W-4
14. 59-9340 Spring, tool door
15. 22-9344 Tool door trip bracket
16. 25-9343 Tool door
17. 22-2065 Locating pin
18. 70-0050 PLT4S-M cable ties
19. 32-7014 Molded T/C Cable Assembly (VF 5/50)
   32-7012B molded T/C cable assembly (VF 6-11)
20. 22-9287 Tool changer mounting arm
21. 32-0011 Motor shuttle assembly
22. 22-7163 Rider trap door
23. 25-9345 Holding arm cover plate
24. 22-7263 Switch mounting block
25. 20-9292 Shuttle hub block
26. 25-9341 Tool changer cover
27. 46-1720 Nut 1/2-13 hex plt
28. 25-7162 Connector bracket
29. 75-15721 MLX 2 pin M 7.11 LSW/earmolex
30. 51-0003 Adj eccentric model BX-4
31. 48-0020 Dowel pin 1/4 x 1
32. 20-9295 V-track
33. 20-9289 Shuttle stop block
34. 32-2010 Limit switch shuttle in/out 24"
35. 20-9288 Shuttle plate
36. 30-0019B Slip clutch assembly
37. 20-9393 Shuttle gusset
38. 20-9336 20 pocket geneva star
39. 22-7255A Tool #1 standoff
40. 48-0020 Dowel pin 1/4 x 1
41. 51-0010 Bearing, deep groove
42. 48-0019 Dowel pin 1/4 x 5/8
43. 25-7036 Cap, tool changer
44. 51-0012 Bearing locknut BH-06
45. 20-7035G Vertical axle
46. 20-9283 Bearing housing T/C hub
47. 32-7616 TL Carriage Cable 50T (VF 5-11)
20 Pocket Tool Changer
1. 20-7029B Holding arm
2. 57-7379 Tool holding arm gasket
3. 79-1000 Wire channel 1in. x 2in.
4. 79-1001 Cover wire channel 1"
5. 54-0030 Guide wheel
6. 22-7263 Block switch mounting
7. 54-0020 Bushing guide wheel
8. 48-0019 Dowel pin 1/4 x 5/8
9. 24-9257 Spring, extractor
10. 22-7067F Key extractor spring
11. 48-0002 Roll pin 7/32 x 7/8
12. 22-9574A CT extractor spring load
13. 22-9256 Bushing extractor
14. 20-7476 Hub slip clutch
15. 48-0005 Dowel pin 3/16 x 3/8
16. 22-7034 Spacer, cam follower
17. 20-7475 Arm slip clutch
18. 54-0040 Standard bushing guide wheel
19. 22-9256 Bushing extractor
20. 45-2020 Washer 1 1/4 nylon
21. 51-6000 Bearing locknut NT-05
22. 55-0010 Spring washer B2500-080
23. 22-2065 Locating pin
24. 25-7168 Bracket, door opener
25. 70-0050 PLT4S-M cable ties
26. 25-9253 Conduit mounting plate
27. 32-1800 Shuttle motor assembly
28. 51-0010 Cam follower T/C
29. 20-7030E Tool carriage
30. 32-1900A Turret motor assembly
31. 32-7011A Molded T/C cable assembly (VF 0-5)
   32-7012B Molded T/C cable Assembly (VF 6-11)
32. 75-15721 MLX 2 pin M 7.11 LSW/Earmolex
33. 25-7162 Connector bracket
34. 46-1705 Nut 3/4-10 nylon lock
35. 32-2010 Limit switch shuttle In/Out 24"
36. 63-1031 Cable clamp 1/4
37. 48-1750 Dowel pin 1/2 x 1 1/2
38. 22-7106 V track
39. 20-7033 F hold plate
40. 51-0010 Bearing deep groove
41. 22-7163 Rider trap door
42. 20-9336 20 pocket geneva star
43. 48-0020 Dowel pin 1/4 x 1
44. 25-7238C Tool trap door
45. 25-7249 Sliding panel
46. 25-7250B Sliding panel cover
47. 24-2010A Compression Spring
48. 22-7255A Tool #1 standoff
49. 20-7038A bearing housing
50. 20-7035G Vertical axle
51. 54-0040 Standard bushing guide wheel
52. 25-7036Cap, tool changer
53. 51-0012 Bearing locknut BH-06
54. 26-7239 Spacer ring
55. 32-2000 Limit switch 4 wire 12"
56. 25-7570 Number ring
57. N/A
58. 20-7352B 20 tool carousel
59. 51-0001 Bearing 3/4 cam follower
60. 20-9332 Driver geneva 2 pin
61. N/A
62. 25-7237C 20 pocket T/C cover
63. 20-7236A Motor mounting plate
64. 32-7618 TL Carriage cable 40T (VF 6-11)
65. 57-7378 Tool Carriage gasket (VF6-10)
66. 78-1996 Split flex tubing 1/2 I.D.
MINI-MILL AND TRM TOOL CHANGERS

1  32-1875  Motor Assembly
2  22-7263  Block Switch Mounting
3  32-2010  Limit Switch
4  32-2000  Limit Switch
5  25-4146  Cover T/C Switch
6  20-0682  Tool Holding Plate
7  22-7034  Spacer Cam Follower
8  54-0010  Cam Follower T/C
9  30-7200A  Actuating Arm
10 54-0030  Guide Wheel
11 25-0466  Door Opener Bracket
12 22-2065  Locating Pin
13 54-0020  Bushing Guide Wheel
14 25-7162  Connector Bracket
15 20-1354A  T/C Carriage
16 54-0040  Standard Bushing Gd Wheel
17 30-1679  Turret Motor Assembly
18 20-0680A  Plate Motor Mtg 10 pkt
19 25-0634  T/C Cover
20 32-1999  Limit Switch
21 22-7163  Rider Trap Door
22 25-0633  T/C Shroud
23 25-0636A  Trap Door
24 20-0681  Vertical Axle
25 22-7255A  Tool #1 Standoff
26 20-0678  Geneva Star
27 20-0079  T/C Link
28 51-2022  Bearing Radial
29 51-2041  Bearing Locknut BH-05
30 A 22-9574A  CT Extractor
    B 22-7067F  Extractor Key
    C 22-9256  Extractor Bushing
    D 24-9257  Extractor Spring
31 20-0670  Carousel
32 25-0638  Number Ring
33 25-0635  Bearing Cover
34 20-1118A  (TRM)
35 20-1263  (MM)
36 25-4030  (TRM)
37 25-9912  (MM)
1. 25-9333 Number ring
2. 20-9324 Carousel 32 tool
3. 20-9193 Carousel support plate
4. 24-2010A Compression spring
5. 25-9328 Sliding panel cover
6. 24-9257 Spring extractor
7. 25-7249 Sliding panel
8. 22-9256 Bushing extractor
9. 22-7166A Extractor BT-40 T/C
10. 22-7067F Key extractor spring
11. 48-0004 Roll pin 3/8 x 1

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

32 Tool Carousel Assembly Assembly (CT) VF 3-10
1. 20-9296 50 Taper carousel
2. 22-9256 Bushing extractor
3. 25-9349 Number ring
4. 24-9257 Spring extractor
5. 22-9297 Extraction finger
6. 20-9298 Alignment key
VF 1-11 Gearbox Assembly 15 HP
VF 1-11 Gearbox Assembly 15 HP

1. 25-0108 Fan bracket motor shroud
2. 36-3035 Spindle fan assembly
3. 59-7130 Protective strip
4. 32-2011 Telmech. 30” cable assembly
5. 32-2010 24” limit switch
6. 25-7264 Switch mounting bracket
7. 59-1482 Nylon finish plug, 13/16
8. 25-01074 Motor shroud
9. 20-0064 Adaptor encoder pulley
10. 62-3010 Spindle motor, 10HP
11. 59-0046 Soundcoat shroud RT/LT
12. N/A
13. N/A
14. N/A
15. 25-7433 Sump bracket
16. 22-7445A drain tube dry sump
17. 22-7446 Pick up tube dry sump
18. 58-2745 Magnetic oil plug
19. 57-0001 Oil seal
20. 58-3657 1/4 female 1/8 male adaptor
21. 54-2125 Drive belt HTD 300-3M-09
22. 54-1013 Drive sprocket .250 RTAP
23. 59-2040 Cable clamp 7/16
24. 58-2001 Polyu hose 1/2OD x 3/8ID
25. 32-1455D RTAP encoder cable
26. 60-1810 Shaft encoder 2000 line
27. 54-7127 Drive sprocket .375 RTAP
28. 22-7260 Encoder standoff
29. 57-0002 Oil seal
30. 25-7434 Sump tank
31. 59-2040 Cable clamp 1/4
32. 59-0006 Hose crimp, 35/64
33. 29-0022 Shroud caution decal
34. 59-1482 Nylon finish plug, 13/16
35. N/A
36. 58-7377 Air reg/solenoid tube
37. 76-2420 Crimp ring, 12-10 10 stud
38. 77-8011 Wire nut, ideal #30-076
39. 30-3270A Precharge regulator Assy
40. N/A
41. 59-0027 Hose clamp 1/2 hose
42. 58-2020 3/8OD natural tubing
43. 22-7487 Oil fill cap modified
44. 58-2065 Coupling, 1/4NPT
45. 58-2070 1/4NPT male to 3/8 comp
46. 58-9114B Trans fill tube
47. 25-7336 Solenoid mounting bracket
48. 33-3200 Solenoid bracket cable assembly
49. 33-5088 Ground strap spindle motor shroud
VF 1-11 Gearbox Assembly HT10K
## VF 1-11 Gearbox Assembly HT10K

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<tr>
<th>Part Number</th>
<th>Description</th>
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<tr>
<td>25-0108</td>
<td>Fan bracket motor shroud</td>
</tr>
<tr>
<td>36-3035</td>
<td>Spindle fan assembly</td>
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<tr>
<td>32-2011</td>
<td>Telmech 30&quot; cable assembly</td>
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<td>32-2010</td>
<td>24&quot; limit switch</td>
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<td>25-7264</td>
<td>Switch mounting bracket</td>
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<tr>
<td>59-1482</td>
<td>Nylon finish plug, 13/16</td>
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<td>29-0022</td>
<td>Shroud caution decal</td>
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<td>55-0035</td>
<td>Spring washer, BS-204</td>
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<tr>
<td>56-2087</td>
<td>Snap ring, N5000-206</td>
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<tr>
<td>29-7399</td>
<td>Transmission motor label</td>
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<tr>
<td>58-2745</td>
<td>Magnetic oil plug</td>
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<tr>
<td>22-7446</td>
<td>Pick up tube dry sump</td>
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<tr>
<td>22-7445A</td>
<td>Drain tube dry sump</td>
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<td>Sump bracket</td>
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<td>22-7376</td>
<td>Sprocket flange</td>
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<td>20-7374</td>
<td>1 1/8 sprocket</td>
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<td>20-0125</td>
<td>Drive sprocket encoder</td>
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<td>57-7573A</td>
<td>Trans motor gasket</td>
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<td>10K 10HP motor kit</td>
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<td>59-0046</td>
<td>Sound coat shroud RT/LT</td>
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<td>25-0107</td>
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<td>Drive belt HTD 300-3M-09</td>
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<td>1/4 female 1/8 male adaptor</td>
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<td>Spring washer, BS-205</td>
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<td>Top plate tube-A</td>
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<td>Sump tank</td>
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<td>58-7358A</td>
<td>Top plate tube-B</td>
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<td>22-7260</td>
<td>Encoder standoff</td>
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<tr>
<td>54-7127</td>
<td>Drive sprocket .375 RTAP</td>
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<tr>
<td>60-1810</td>
<td>Shaft encoder 2000 line</td>
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<td>32-1455D</td>
<td>RTAP encoder cable</td>
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<td>58-2001</td>
<td>Polyu hose 1/2OD x 3/8ID</td>
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<td>59-2040</td>
<td>Cabil clamp, 7/16</td>
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<td>59-0027</td>
<td>Hose clamp 1/2 hose</td>
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<tr>
<td>57-0049</td>
<td>Rubber stud bumper</td>
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<td>46-1625</td>
<td>Nut hex blk ox 1/4-20</td>
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<tr>
<td>45-1800</td>
<td>Washer split lock 1/4 med</td>
</tr>
<tr>
<td>30-3260B</td>
<td>Oil gear pump assembly</td>
</tr>
<tr>
<td>30-3270A</td>
<td>Precharge regulator assembly</td>
</tr>
<tr>
<td>77-8011</td>
<td>Wire nut, ideal #30-076</td>
</tr>
<tr>
<td>76-2420</td>
<td>Crimp ring, 12-10 10 stud</td>
</tr>
<tr>
<td>58-7377</td>
<td>Air reg/solenoid tube</td>
</tr>
<tr>
<td>58-3616</td>
<td>3/8 90 deg elbow 1/4 NPT</td>
</tr>
<tr>
<td>59-4006</td>
<td>Hose crimp, 35/64</td>
</tr>
<tr>
<td>63-1031 Cable</td>
<td>clamp 1/4</td>
</tr>
</tbody>
</table>
VF 1-11 Gearbox Assembly HT10K TSC
VF 1-11 Gearbox Assembly HT10K TSC

1. 25-0108 Fan bracket motor shroud
2. 36-3035 Spindle fan assembly
3. 59-7130 Protective strip
4. 32-2011 Telmech 30" cable assembly
5. 32-2010 24" limit switch
6. 25-7246 Switch mounting bracket
7. 59-1482 Nylon finish plug 13/16
8. 29-0022 Shroud caution decal
9. 57-0006 O-ring 2-328 buna
10. 29-7399 Transmission motor label
11. 29-9128 Label, transmission
12. 48-0020 Pin, dowel 1/4 x 1
13. 58-2745 Magnetic oil plug
14. 22-7446 Pick up tube dry sump
15. 22-7445A Drain tube dry sump
16. 25-7433 Sump bracket
17. 22-7376 Sprocket flange
18. 20-7374 1 1/8 Sprocket
19. N/A
20. N/A
21. N/A
22. N/A
23. 20-7435 Oil plate
24. 20-0064 Adaptor encoder pulley
25. 57-7573A Trans motor gasket
26. 36-3078 10K 10HP motor kit
27. 59-0046 Soundcoat shroud RT/LT
28. 25-0107 Motor shroud
29. 54-1013 Drive sprocket .250 RTAP
30. 54-2125 Drive belt HTD 300-3M-09
31. 58-3657 1/4 female 1/8 male adaptor
32. 55-0036 Spring washer, BS-205
33. 56-0070 Snap ring N5000-187
34. 58-7357 Top plate tube-A
35. 57-0001 Oil seal
36. 25-7434 Sump tank
37. 57-0002 Oil seal
38. N/A
39. 22-7260 Encoder standoff
40. 54-7127 Drive sprocket .375 RTAP
41. 60-1810 Shaft encoder 2000 line
42. 32-1455D RTAP encoder cable
43. 58-2001 Polyu hose 1/2OD x 3/8 ID
44. 59-2040 Cable clamp 7/16
45. 59-0027 Hose clamp 1/2 hose
46. 30-3260B Oil gear pump assembly
47. 30-3270A Precharge regulator assembly
48. 30-3276 Purge solenoid valve assembly
49. 77-8001 Wire nut, ideal #30-076
50. 76-2420 Crimp ring, 12-10 10 stud
51. 58-7377 Air reg solenoid tube
52. N/A
53. 58-3616 3/8 90 deg. elbow 1/4NPT
54. 59-4006 Hose crimp, 35/64
55. 59-2040 Cable clamp 7/16
56. 63-1031 Cable clamp 1/4
57. 63-0001 Nylon cable clamp 1/2
58. 58-7635 Low gear tube VF-3
59. N/A
60. 58-7636 High gear tube vf-3
61. 22-7521A Spacer trans
62. 22-7520A Isolater trans
63. 58-2110 Sleeve nuts lube assembly
64. 58-2100 Sleeve lube assembly
65. 30-3146 Air solenoid assy mac tp
66. 33-5008 Ground strap spindle motor shroud
67. 33-3200 Solenoid bracket cable assembly
68. 25-7336 Solenoid mounting bracket
69. 58-9114B Trans fill tube
70. 58-2070 1/4NPT male to 3/8 comp
71. 58-2065 Coupling, 1/4NPT
72. 22-7487 Oil fill cap modified
73. 58-2020 3/8OD natural tubing
SPINDLES
30-0319A 7.5 Spindle Assembly
30-2132 10K Spindle Assembly
30-1360 15K Spindle Assembly
30-1468 15K spindle assembly VF5-11
30-0449 50 Taper Spindle Assembly

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

Spindle Assemblies
1. 58-3613 1/4 Street elbow
2. 58-3050 Elbow 1/4 bylon tubing
3. 58-3670 1/4NPT M 1/8F reducer
4. 58-3727A 1/4NPT x 4 nipple brass
5. 59-2832B Quick exhaust 1/4
6. 58-2165 Fitting close nipple 1/4
7. 32-5620 TRP solenoid valve assembly
8. 58-2265 Air muffler 3/8 flat
9. 58-3685 1/4NPT M 3/8 tube swivel elbow
10. N/A
11. 22-4045 Spring retainer TRP 30 degree
12. N/A
13. 32-2010 Limit sw shuttle in/out 24"
14. 25-4050C Switch mounting bracket
15. 59-2760 Comp spring/large wire
16. 57-0040 O-ring 2-111 Buna
17. 56-0040 Retaining ring N5100-62
18. 57-0018 O-ring 2-446 buna
1. 59-0049 Spring compression
2. 52-0003 Shaft clamp
3. 58-3050 Elbow 1/4 nylon tubing
4. 58-3631 Reducer bushing 1/2M-1.8F
5. 20-0016B Switch plate
6. 20-0021 Spacer upper TRP 50T
7. 32-2013 Limit switch shuttle assembly
8. 20-0019A Piston TRP 50T
9. 57-0092 O-ring 2-448 Viton
10. 57-0027 O-ring 2-121 Buna
11. 57-0095 O-ring 2-327 Viton
12. 58-1695 Elbow 1/4MPT
13. 58-1627 1/8-27 pipe plug
14. 20-0013 Spacer fork spindle
15. 20-0015 Fork lift Spindle
16. 20-0018A Shaft TRP 50T
17. N/A
18. 22-0014 Spacer 0.62ID x 1.25OD.857
19. 48-1662 Dowel pin 1/2 x 1
20. 20-0017A Sub plate TRP 50T
21. 59-0016 Spring compression
22. 49-0003 Shoulder bolt 5/8 x 3 1/2
23. 20-0020A Spacer lower TRP 50T
24. 20-0022A Housing air cylinder
25. 25-0009 Switch mounting bracket

50 Taper complete assembly 30-3202A

50 Taper Tool Release Piston
1. 58-3618 1/4 Street elbow 90 deg.
2. 58-3727A 1/4NPT x 4 nipple brass
3. 58-3050 Elbow 1/4 nylon tubing
4. 58-3670 1/4NPT M 1/8 F reducer
5. 59-2760 Compr spring/large wire
6. 58-2165 Fitting close nipple 1/4
7. 32-5620 TRP solenoid valve assembly
8. 58-2265 Air muffler 3/8 flat
9. 58-3685 1/4NPT M 3/8 tube swivel elbow
10. 22-7045A Spring retainer TRP 30 degree
11. 20-7626A Shaft TRP hex
12. 58-3614 1/4F 1/8M street elbow
13. 58-0028 Hose barb 3/8 PL-1/4 MP
14. 32-2010 Limit switch shuttle in/out 24"
15. 25-7050C Switch mount tool release
17. 58-0032 Hose barb 3/8 PL 3/8 SAE F
18. N/A
19. N/A
20. N/A
21. 20-7627B Coolant tip carbide
22. N/A
23. 30-3298
24. 56-0040 Retaining ring N5100-62
25. 20-7630A TRP rectangle TSC
26. 57-2156 Quad-ring Q4-440 buna
27. 20-7007A Cylinder housing
28. 93-30-3206 Complete assembly

TSCHP Tool Release Piston Assembly
**Mini-mill**
- Base: 24-3006, VF 0-1: 30-0157, VF 2: 30-0157, VF 3: 30-0196, VF 4-5: 30-0196, VF-5XT: 30-0196
- Saddle: 24-3006, VF 0-1: 30-0157, VF 2: 30-0194, VF 3: 30-0195, VF 4-5: 30-0197, VF-5XT: 30-2152
- Column: 24-3006, VF 0-1: 30-0157, VF 2: 30-0157, VF 3: 30-0196, VF 4-5: 30-0196, VF-5XT: 30-0196

**VF-6/8**
- Base: 30-0474, VF 0-1: 30-0474, VF 2: 30-0474, VF 3: 30-0474, VF 4-5: 30-0474, VF-5XT: 30-0474
- Saddle: 30-0470, VF 0-1: 30-0473, VF 2: 30-0516, VF 3: 30-0474, VF 4-5: 30-0474, VF-5XT: 30-0474
- Column: 30-0474, VF 0-1: 30-0474, VF 2: 30-0474, VF 3: 30-0474, VF 4-5: 30-0474, VF-5XT: 30-0474

**VF-7/9**
- Base: 30-0474, VF 0-1: 30-0474, VF 2: 30-0474, VF 3: 30-0474, VF 4-5: 30-0474, VF-5XT: 30-0474
- Saddle: 30-0473, VF 0-1: 30-0516, VF 2: 30-0474, VF 3: 30-0474, VF 4-5: 30-0474, VF-5XT: 30-0474
- Column: 30-0474, VF 0-1: 30-0474, VF 2: 30-0474, VF 3: 30-0474, VF 4-5: 30-0474, VF-5XT: 30-0474

**VF-10/11**
- Base: 30-0474, VF 0-1: 30-0474, VF 2: 30-0474, VF 3: 30-0474, VF 4-5: 30-0474, VF-5XT: 30-0474
- Saddle: 30-0516, VF 0-1: 30-0516, VF 2: 30-0516, VF 3: 30-0516, VF 4-5: 30-0516, VF-5XT: 30-0516
- Column: 30-0474, VF 0-1: 30-0474, VF 2: 30-0474, VF 3: 30-0474, VF 4-5: 30-0474, VF-5XT: 30-0474

**50 Taper**
- VF5: Base: 30-0202, VF 0-1: 30-0202, VF 2: 30-0895, VF 3: 30-0895, VF 4-5: 30-0895, VF-5XT: 30-0895
- VF-5XT: Base: 30-0202, VF 0-1: 30-0202, VF 2: 30-0895, VF 3: 30-0895, VF 4-5: 30-0895, VF-5XT: 30-0895
- VF-6/8: Base: 30-0198, VF 0-1: 30-2152, VF 2: 30-0896, VF 3: 30-0897, VF 4-5: 30-0516, VF-5XT: 30-0895
- VF-7/9: Base: 30-0202, VF 0-1: 30-2152, VF 2: 30-0896, VF 3: 30-0897, VF 4-5: 30-0516, VF-5XT: 30-0895
- VF-10/11: Base: 30-0202, VF 0-1: 30-2152, VF 2: 30-0896, VF 3: 30-0897, VF 4-5: 30-0516, VF-5XT: 30-0895

*Except XRT

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**Ball Screw Assembly**
### Coupling Assembly

<table>
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<tr>
<th>Type</th>
<th>VF 0-5 &amp; Mini-Mill</th>
<th>VF-5XT</th>
<th>VF 6/8</th>
<th>VF 7/9</th>
<th>VF10/11</th>
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<td>Base</td>
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<td>30-1215</td>
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<td>30-1225A</td>
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### 50 Taper

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Bridge Mill Head Assembly

- Assembly Drawings
- June 2002
- VF SERIES
- Service Manual

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- Bridge Mill Head Assembly
VR-Series Head Assembly

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APC Assembly
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4. Way Cover Bracket
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9. X-axis Waycover
10. X-axis Guide Rails
11. X-axis Guide Rails
12. Way Cover Bracket
13. Y-axis Wiper
14. Y-axis Rear Waycover
15. Z-axis Waycover Support
16. Z-axis Chip Guard
17. Z-axis Waycover
18. X-axis Waycover
19. Table Gutter
20. Table Cover

VF Interior Replaceable Parts
VF Exterior Sheet Metal
VF Exterior Sheet Metal

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

1. Front Left Panel
2. Front Right Panel
3. Floor Pan Left
4. Floor Pan Right
5. Pan Right, Outrigger
6. Pan Support
7. Pan Support
8. Pan Left, Outrigger
9. Back Right Panel Extension
10. Inner Back Panel, Right
11. Inner Back Panel, Left
12. Back Left Panel Extension
13. Apron Extension Right
14. Apron Extension Left
15. Support Beam
16. Support Beam
17. Tool Changer Bracket
18. Tool Changer Cover
19. Tool Changer Pan
20. Back Panel Left
1. Enclosure Side 25-0754
2. Door Assembly 25-0386 (Window 28-0011)
3. Guide Block 20-0712
4. Panel Front Enclosure 25-0753
5. Keybracket 25-0958
6. Switch Mounting Bracket 25-7050C
7. Door Keeper 25-0757
8. Lower Door Rail 22-7616
9. Lube Panel Mounting 25-7195K
10. Enclosure Side Mirror 25-0754
11. Main Electric Control Box 25-0025D
12. Junction Box 25-7198B
13. Regen Cover 25-0461 (front) 25-0462 (back)
14. Box Bar 20-3009
15. Back Panel Left 25-0384A
16. Back Panel Right 25-0385A
1. Fan guard 59-0144
2. Fan bracket top 25-0389
3. Head Cover 25-0382
4. Back Head Cover 25-0388
5. Z lower cover 25-0381
6. Z upper cover 25-0380
7. Y-axis way cover, rear 25-0373
8. Support Cover 25-0377
9. Saddle cover (2) 25-0375
10. Tab side cover (2) 25-0378
11. Front Y-axis motor cover 25-0374
12. Y-axis Waycover, Front 25-0372
13. Motor Cover, X-axis 25-0376
14. Table End Cover (2) 25-0379
15. Tool Changer Shroud 25-0633
16. Trap Door 25-0636A
17. Tool Changer Cover 25-0634
1. 32-1875 Motor Assembly
2. 32-2010 Limit Switch
3. 32-2000 Limit Switch
4. 30-7200A Actuating Arm
5. 20-0682 Tool Holding plate
6. 25-0466 Door Opener Bracket
7. 54-0030 Guide Wheel
8. 25-7162 Connector Bracket
9. 20-1354A T/C Carriage
10. 46-1705 Lock nut
11. 45-1725 3/4" Flat Washer
12. 30-1679 Turret Motor Assembly
13. 25-0634 T/C Cover
14. 32-1999 Limit Switch
15. 25-0636A Trap Door
16. 25-0633 T/C Shroud
17. 45-2020 Nylon Washer
18. 20-0681 Vertical Axle
19. 20-0678 Geneva Star
20. 40-16385 SHCS 5/16-18x3/4
21. 45-1600 Washer 5/16 Split Lock
22. 20-0079 T/C Link
23 a) 22-9574A CT Extractor
    b) 22-7067F Extractor Key
    c) 22-9256 Extractor Bushing
    d) 24-9257 Extractor Spring
24. 20-0670 Carousel
25. 25-0638 Number Ring
26. 25-0635 Bearing Cover
27. 45-1600 Washer 5/16 Split Lock
28. 40-1500 SHCS 5/16-18x1
### VS-3 Sheet Metal Assembly Parts List

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<th>Description</th>
<th>Number</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Fan guard</td>
<td>31</td>
<td>Center, left door</td>
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<tr>
<td>2</td>
<td>Head cover, top plate</td>
<td>32</td>
<td>Center, right door</td>
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<tr>
<td>3</td>
<td>Head cover, left rear cover</td>
<td>33</td>
<td>Right splash tray</td>
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<td>4</td>
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<td>34</td>
<td>Left, splash tray</td>
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<td>Head cover, right rear cover</td>
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<td>Table splash guard</td>
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<td>Head cover, right front cover</td>
<td>36</td>
<td>Pendant arm shroud</td>
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<tr>
<td>7</td>
<td>Head cover, rear bottom</td>
<td>37</td>
<td>Pendant arm</td>
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<tr>
<td>8</td>
<td>Bottom head access plate</td>
<td>38</td>
<td>Z Axis, right chip conveyor tray</td>
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<td>9</td>
<td>Head cover, front bottom cover</td>
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<td>Z Axis, left chip conveyor tray</td>
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<td>10</td>
<td>Head cover, front</td>
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<td>Brace</td>
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<td>Tool changer housing</td>
<td>41</td>
<td>Z Axis chip conveyor gasket</td>
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<td>Tool changer shroud</td>
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<td>Head cover access plate</td>
<td>43</td>
<td>Chip conveyor chute</td>
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<td>X Axis chip conveyor tray, left</td>
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<td>X Axis chip conveyor tray, middle</td>
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<td>X Axis chip conveyor tray, right</td>
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<td>X Axis way cover end plate</td>
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<td>&quot;L&quot; bracket</td>
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<td>Z Axis way cover wiper cover</td>
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<td>X Axis extension access cover</td>
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