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## Section 08: Spindle Drive Systems

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### Spindle Drives

Fadal has used many spindle drives when manufacturing VMCs. The drives in the beginning were inverters and are currently Vector Drives. The difference between inverters and vector drives is the monitoring of the output and the adjustments made due to that information. Inverters (Lovejoy, Toshiba, Sweo) take the input commands for speed and direction then product an output to the motor. The inverter assumes that the motor is running correctly. The vector drive (Baldor, AMS) monitors the motor speed and direction as well as the output current. It takes this information and makes corrections to the output to keep the motor operation proper. Rigid tapping requires the vector drive. The Mitsubishi drive that was used is in the middle. It monitored the motor and made corrections but was not completely a vector drive and would not rigid tap.

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### Inverter/Vector Drives

EMC model VMCs use the Yaskawa drives. The TRM does not use Inverter/Vector drives, all other Fadal VMCs use one of two drive designs from Baldor or AMC. The basic operation of each drive is the same.



*Figure 8-1* Yaskawa, AMC, Baldor Small, Baldor Large (From Left to Right)

**Inverter/Vector Drive  
Inputs & Outputs****Drive Ground**

The drive is required to have a ground connection. A green and yellow 16 AWG (10 AWG for 50 taper) wire grounds the drive to the machine chassis.

**Input Three Phase Power**

The three phase 230 VAC (460 VAC for 50 taper) input connects to terminals L1, L2 and L3 (R, S and T). This voltage should be between 220 and 240 volts (460 and 480 for 50 taper). When the voltage is too high, braking problems or damage to the drive may occur. When the voltage is too low, faults may occur while accelerating or cutting under load. The voltage leg to leg, in all three combinations, must be checked when installing new machines or changing the power source for the machine. If the voltage to the machine must be adjusted, it is better to be close to the lower end of the voltage range.

**Output Three Phase Power**

The drive outputs a three phase signal for the spindle motor. This signal varies in frequency and voltage depending on the motor's speed. The output voltage is checked leg to leg. The output voltage should be about 80 VAC (60 VAC for 50 taper) at 300 RPM 20 Hz and all three legs should be about equal (No more than a 2 volt variation). The output voltage should be about 200 VAC at 900 RPM 60 Hz and should remain the same through 2500 RPM in the low range.

If a problem is detected (Output fault), check the spindle motor leads with an Ohm meter by disconnecting the output leads at T1, T2 and T3. Check the leads going to the motor side leg to leg. Resistance readings between the three combinations of legs should each read between .05 to .8 ohms, and should read close to the same for each combination. The leg to ground resistance should be open when measured with an ohm meter and 80 meg ohms minimum when using a meg ohm meter for all three legs.

**Drive Control 6 Pin Molex Connector**

The drive control 6 pin molex connector has the inputs from the spindle controller card and the fault line from the inverter. Pin 1 is the common line for the spindle direction, pin 2 is the spindle reverse signal, pin 3 is the spindle forward signal, pin 4 is the common for speed control, pin 5 is the fault line and pin 6 is spindle speed command signal.

For standard spindle operation the voltage output (20 volts DC) for the drive spindle direction (pin 2 reverse and pin 3 forward) is determined by the pulling of the appropriate signal to ground by activating K3 or K4 on the 1100-2 board. When this voltage is pulled to about ground level the drive knows which direction to run in and is enabled.

The drive also requires a speed command signal (0 - 10 volts DC through pin 6). This signal, along with the direction signal, allows the spindle to be

operated. On a standard machine a 1.3 volt DC signal will result in a speed of about 300 RPM in low range.

On machines with rigid tapping both the K3 and K4 relays are active, enabling drive, and a speed command of either positive or negative voltage (-10 to +10 VDC) is used to determine spindle speed and direction.

The fault line receives a voltage from the drive (10 VDC). An E-stop fault in another device will drop this voltage to zero by deactivating K2 on 1100-1 board.

#### **Inverter Wye Delta 6 Pin Molex Connector**

Machines that use the Wye Delta motor configuration send input to the drive through pin 1 and pin 4 when in the delta mode.

The High gain option sends signals through pin 3.

#### **Load Meter Output**

The drive produces an output voltage for load meter indication. This voltage output is proportional to the total current that the drive is using, and is displayed by the load meter as a percentage of the total current that the drive can develop or use.

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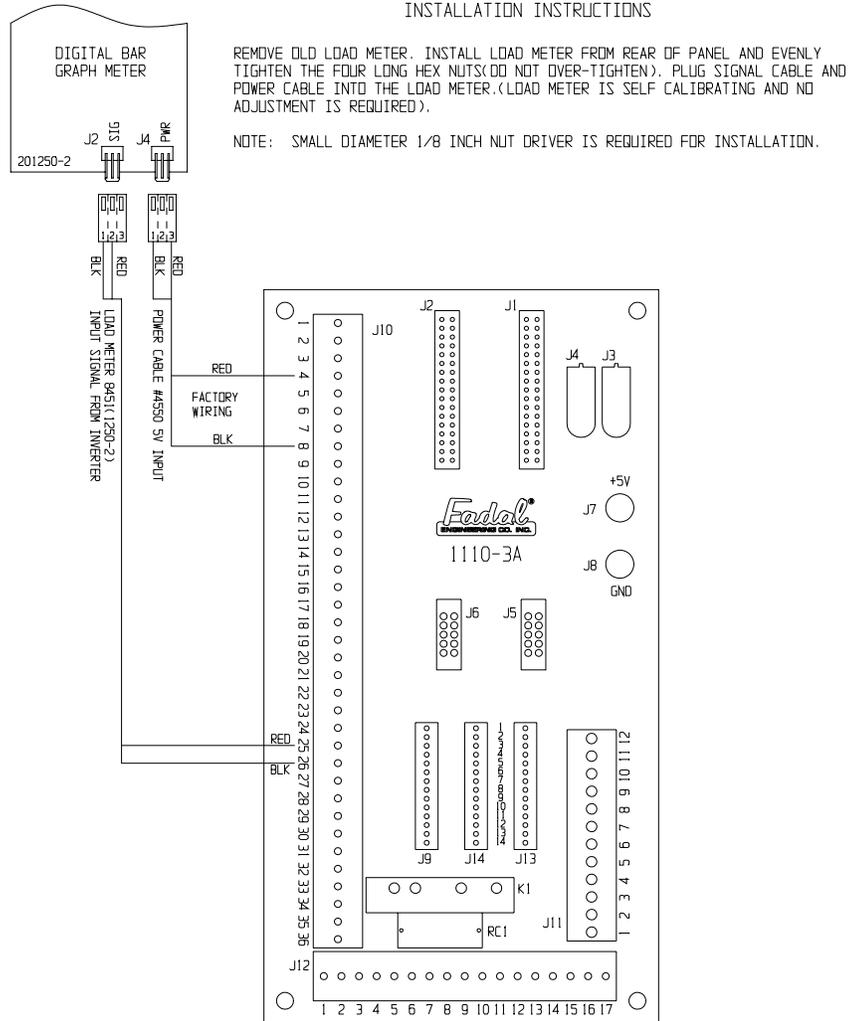


Figure 8-2 1250-2 Spindle Load Meter Wiring Diagram

**Vector Drive Encoder 9 pin Molex Connector**

The encoder output signals A, /A, B & /B are input through this connector. There is a +5V ground line through this connector also.

**Vector Drive with Rigid Tapping**

Output the encoder signals to the spindle controller PCBA through the Rigid Tapping Cable.

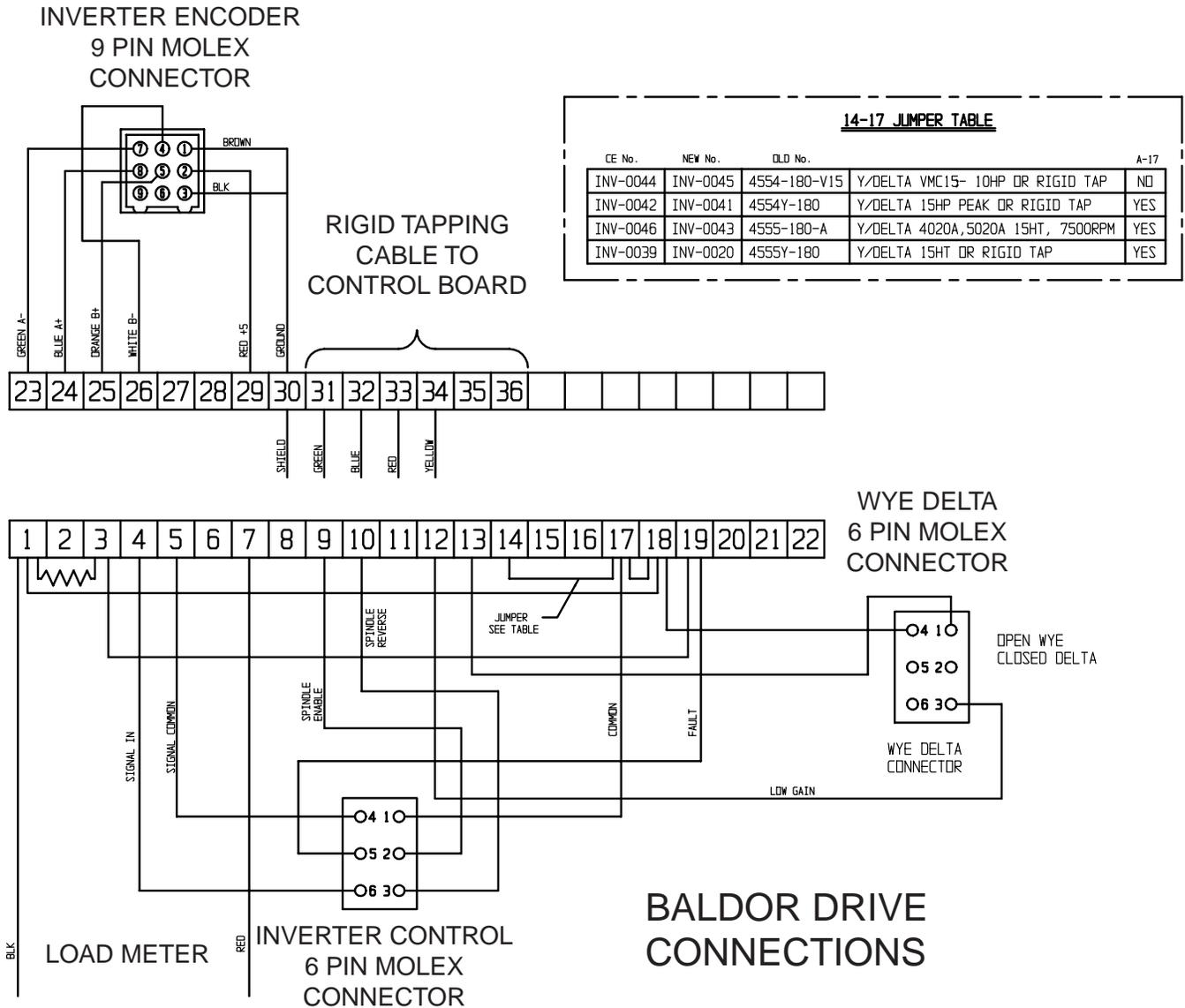


Figure 8-3 Baldor Drive Connections

## Adjustments

### Adjusting the Baldor Vector Drives

Whenever a Baldor Drive's DC Power Supply or a spindle controller card is replaced, it will need to be ZERO BALANCED to the machine. On Rigid Tapping machines in particular, the control sets the RPM and direction by supplying a precise -10 to +10 VDC control voltage through pins 4 and 6 at the control molex plug hanging on the right side of the inverter. To reverse the direction, a negative 0 to 10 VDC control voltage is sent. In rigid-tapping this allows the spindle motor to be rapidly reversed and ramped up and down. If the control voltage at idle is not exactly 0 VDC, then it is possible for the inverter to interpret it as a command to move in one direction or another at a slow speed.

### Auto Tuning/ Zero Balance

Verify that the inverter is installed properly, the spindle is off, and the keypad is installed. Use the keypad to complete the following procedure:

- 1) Install the display unit in inverter (if not already installed).
- 2) The display should read OFF MOTOR SPEED REMOTE 0 RPM.
- 3) Press PROG.
- 4) Press the DOWN ARROW twice. The display will read LEVEL 2 BLOCKS.
- 5) Press ENTER.
- 6) Press the DOWN ARROW three times. The display will read AUTO TUNING.
- 7) Press ENTER.
- 8) Press the UP ARROW once. The display will read CMD OFFSET TRM.
- 9) Press LOCAL.
- 10) Press ENTER two times. The display will read TEST PASSED.
- 11) Press RESET three times. The display will read PRESS ENTER FOR PRESET SPEED.
- 12) Press the DOWN ARROW once. The display will read ENTER FOR PROGRAMMING EXIT.
- 13) Press ENTER.



Figure 8-4 Keypad

14) Press LOCAL. The display will read OFF MOTOR SPEED REMOTE 0 RPM.

### **Baldor Spindle Drive Parameter Usage for Fadal VMC**

The inverter replacements are **INV-052** and **INV-054**. These two units are replacements for inverters (Toshiba, Sweo and Mitsubishi). They cannot be used in machines with Rigid Tapping. They do not have encoder feedback and **do not require Zero Balancing or Auto Tuning**. If the drive is Zero Balanced in error, recovery procedure is to set the ANA CMD Offset parameter to -1.

**NOTE:** When in the inverter replacement unit, it is necessary to change to Input / Operating Mode parameter to Keypad in order to make changes and return it to Fan Pump 2 Wire for operation.

**Baldor Vector Drives** require Zero Balancing whether rigid tapping is installed or not. The other tests and procedures are normally not necessary to perform. With INV-0070 the Motor Mag Amps parameter should be checked to insure that the current software is installed. To determine whether or not the parameters are changeable in the unit, change a parameter and power off machine, power on and check the parameter to determine if the new value was retained.

### **Terms and Procedures:**

The **Zero Balancing or Auto Tuning** function matches the drive's zero or speed reference point to the input speed command on pins 4 and 6 of the 6 pin Molex connector coming from the spindle controller board. The purpose is to match the zero point so that the speed command voltage input will obtain the same RPM of the motor for the same voltage for both positive and negative. If this is not set correctly problems such as hard reversals in Rigid Tapping, damaged threads, out-of-balance Spindle Motor, or Spindle turning slowly at idle in Rigid Tap standby may occur. Whenever the Input power to the machine, Baldor Drive, DC power supply, or a Spindle Controller card is replaced, it will need to be "Zero-Balanced" to the machine.

<i>TYPE:</i>	<i>DISPLAY:</i>
---	"OFF MOTOR SPEED REMOTE 0 RPM"
LOCAL	"STOP MOTOR SPEED LOCAL 0 RPM"
PROG	"PRESS ENTER FOR PRESET SPEEDS"
↓ ↓	"PRESS ENTER FOR LEVEL 2 BLOCKS"
ENTER	"PRESS ENTER FOR OUTPUT LIMITS"
↓ ↓ ↓	"PRESS ENTER FOR AUTOM TUNING"
ENTER	"CALC PRESETS P: NO"
↑	"CMD OFFSET TRM P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
RESET	"CMD OFFSET TRM P: PRESS ENTER"
RESET	"PRESS ENTER FOR AUTO TUNING"
RESET	"PRESS ENTER FOR PRESET SPEEDS"
↑ ↑ ↑ ↑	"PRESS ENTER FOR INPUT"
ENTER	"OPERATING MODE P: FADAL SPECIAL"
↑ ↑ ↑	"ANA CMD OFFSET P: XX.X%" (Note: XX.X is the Offset value)
RESET	"PRESS ENTER FOR INPUT"
RESET	"PRESS ENTER FOR PRESET SPEEDS"
DISPLAY	"STOP MOTOR SPEED LOCAL 0 RPM"
LOCAL	"OFF MOTOR SPEED REMOTE 0 RPM"

If the "ANA CMD OFFSET" value reads any value other than 0.0%, then the "Zero Balance Offset Trim" has been set.

The **Factory Parameters** procedure is to load or re-load the factory parameters.

Replacement Baldor Vector Drive unit will not run properly, but display is lit. The Factory Parameters may not have been loaded from the Eproms or PLC. Load Factory Parameters using INV-0017 Display Unit, and following procedure:

<i>Keystrokes:</i>	<i>Display shows:</i>
	Off            0        0 RPM
	REM           0.0A    0.0 HZ
PROG ↓ ↓	PRESS ENTER FOR LEVEL 2 BLOCKS
ENTER	PRESS ENTER FOR OUTPUT LIMITS
↑ ↑ ↑	PRESS ENTER FOR MISCELLANEOUS
ENTER	RESTART    AUTO/MAN P:           CONTINUOUS
↑ ↑ ↑	FACTORY    SETTINGS P:           NO
ENTER ↑	FACTORY SETTING P:        YES
ENTER	FACTORY SETTINGS ( <i>Loading parameters</i> ) LOADING PRESETS
	FACTORY SETTING P:        NO
RESET RESET	PRESS ENTER FOR PRESET SPEEDS
↓ ↓	PRESS ENTER FOR LEVEL 2 BLOCKS
ENTER	PRESS ENTER FOR OUTPUT LIMITS
↓ ↓ ↓	PRESS ENTER FOR AUTO TUNING
ENTER	CALC PRESET P:        NO
LOCAL	CALC PRESETS P:        NO

↑	CMD OFFSET TRIM P: PRESS ENTER
↑↑	TEST PASSED PRESS ENTER
RESET RESET RESET ↓	PRESS ENTER FOR PROGRAMMING EXIT
ENTER	STOP 0 V 0 RPM LOC 0.0 A 0.0 HZ
LOCAL	OFF 0 V 0 RPM REM 0.0 A 0.0 HZ

The **Motor Tuning** procedure tunes the drive to the motor. This is not necessary to perform because the factory parameters are set up for our motors. This procedure can be used for troubleshooting on units that will or will not retain parameter changes. These tests must be performed with motor unloaded (Belts must not be engaged): CUR LOOP COMP, FLUX CUR SETTING, FEEDBACK TESTS, and SLIP FREQ TEST.

<i><b>TYPE:</b></i>	<i><b>DISPLAY:</b></i>
---	"OFF MOTOR SPEED REMOTE 0 RPM"
LOCAL	"STOP MOTOR SPEED LOCAL 0 RPM"
PROG	"PRESS ENTER FOR PRESET SPEEDS"
↓ ↓	"PRESS ENTER FOR LEVEL 2 BLOCKS"
ENTER	"PRESS ENTER FOR OUTPUT LIMITS"
↓ ↓ ↓	"PRESS ENTER FOR AUTO TUNING"
ENTER	"CALC PRESETS P: NO"
↑	"CMD OFFSET TRM P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"CUR LOOP COMP P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"FLUX CUR SETTING P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"FEED BACK TESTS P: PRESS ENTER"
	<i>NOTE: this test will test the encoder and encoder feedback to the Vector drive.</i>
ENTER	"PRESS ENTER TO START THE TEST"
	<i>(If test fails continue on with the rest of the tests. Then come back and use this test for troubleshooting the encoder circuit.)</i>
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"SLIP FREQ TEST P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"SPD CNTRLR CALC P: PRESS ENTER"
ENTER	"PRESS ENTER TO START THE TEST"
ENTER	"TEST PASSED PRESS ENTER"
ENTER	"PRESS ENTER FOR MENU EXIT"
RESET	"PRESS ENTER FOR AUTO TUNING"
RESET	"PRESS ENTER FOR PRESET SPEEDS"
DISP	"STOP MOTOR SPEED LOCAL 0 RPM"
LOCAL	"OFF MOTOR SPEED REMOTE 0 RPM"

**Motor Mag Amps for INV-0070**

On VHT machines equipped with INV-0070, during an acceleration cycle the spindle motor will slow down and then speed up several times, appearing similar in symptoms to that given by a failing encoder. Acceleration to full speed may take longer than the 2.2 seconds programmed into the drive.

The Motor Mag Amps parameter in the INV-0070 Spindle Drive Unit is set too high by the Auto-Tuning procedure, and needs to be manually set to 22.

In Auto Tuning, the parameter Flux Current is used to calculate the spindle Motor Mag Amps. **Note:** when running this self-tuning parameter the belts must first be disengaged to obtain an accurate measurement.

After following the Auto-Tuning procedure, and with the machine powered on:

<u>Keystrokes</u>	<u>Baldor Display</u>
	STOP MOTOR SPEED LOCAL 0 RPM
Press PROG key	PRESS ENTER FOR PRESET SPEEDS
Press ↓↓	PRESS ENTER FOR LEVEL 2 BLOCKS
Press ENTER Key	PRESS ENTER FOR OUTPUT LIMITS
Press ↑↑↑↑	PRESS ENTER FOR MOTOR DATA
Press ENTER key	MOTOR VOLTAGE P: 230V
Press ↑↑↑↑ key	MOTOR MAG AMPS <i>(This value will vary between drives)</i> P: XX.X A
Press ENTER key (Using the ↑ ↓ and shift keys change the value to 22)	
Press ENTER	
Press RESET	PRESS ENTER FOR MOTOR DATA
Press RESET	PRESS ENTER FOR PRESET SPEED
Press DISP	OFF MOTOR SPEED REMOTE 0 RPM

**NOTE:** Do not re-run the Auto-Tuning procedure without restoring value 22 in the Motor Mag Amps parameter.

## Yaskawa Drive 515 (INV-0072)

### Set up Instruction, Initializing and balancing the drives

- 1) Use this procedure for new drive installation, or replacement
- 2) Power off Machine
- 3) Install Yaskawa Drive with display unit.
- 4) Power on Machine
- 5) Press "MENU" to display \*\*Main Menu Operation\*\*
- 6) Press "UP ARROW" 1 time to display \*\* Main Menu Initialize\*\*
- 7) Press "ENTER" to display \*\*Select Language English\*\*
- 8) Press "UP ARROW" 3 times to display \*\*Init Parameters /No Initialize\*\*
- 9) Press "ENTER" to display \*\*A1-03= 0 /No Initialize\*\*
- 10) Press "UP ARROW" 1 time to display \*\*A1-03= 2220 2- Wire Initial\*\*
- 11) Press "ENTER" to display \*\*Entry Accepted\*\*  
(loading parameters)  
  
Init Parameters  
No Initialize
- 12) Press "MENU" to display \*\* Main Menu \*\*  
Operation
- 13) Press "ENTER" to display Frequency Ref  
U1-01= 1 RPM (RPM may be fluctuating)
- 14) Press "JOG" and hold for 2 sec. Zero bias signal Frequency Ref (Balancing)  
U1-01= 1 RPM

Any time press and hold the "JOG" for few second until balance 0 to 1 count, thus zero bias the command signal.

### Yaskawa V7 (INV-0071) on Fadal EMC Spindle setup Instructions

#### Before beginning, please note:

All references to the V7 Manual are to TM 4315, dated 04/02/2001. The latest V7 manual can be downloaded from [www.drives.com](http://www.drives.com)

This instruction set assumes that the Yaskawa V7 hardware has been flashed with Fadal default software. Please check the Monitor Display U-10 and verify that it has value XXXX. The value in U-10 is the software version that is installed on this V7.

The Monitor displays can be accessed from the keypad by pressing DSPL until the LED moves to MNTR. Then press DATA/Enter and use the L button to move to Monitor U-10. (See page 4-3 in the V7 Manual)

Refer to page 4-2 in the V7 manual for more details on how to use the V7 keypad.

#### Setting Access level for parameters

Using the DSPL key on the V7 keypad, move the LED to PRGM. Select parameter n001 and press DATA/ENTER. Select value 5 and confirm data by pressing DATA/ENTER. This opens all n-constants for programming access. When you complete the task, reset n001 to 0 or 1.

#### Displaying Fault Sequence

Using the DSPL key on the V7 keypad, move the LED to MNTR. Use the L button to move to MonitorU-09 and press DATA/ENTER. Use the L button to scroll through the last four faults. (See page 6-8 in the V7 Manual).

#### Adjusting zero point on Analog velocity input

When performing this adjustment, be sure that the CNC analog velocity output to the V7 is asking for zero speed. This procedure will show how to zero out any noise on the analog line between the CNC and the V7.

**Caution: If this procedure is performed when the CNC analog velocity signal is not zero, the spindle will not operate correctly.**

Using the DSPL key on the V7 keypad, move the LED to PRGM. Select parameter n069-Analog Frequency Reference Bias. This parameter has an adjustment range of -100 to 100. You will probably need a value of between -005 and 005.

In order to verify that the value you select is correct, you will have to use the DSPL button to return the LED to FREF and verify that the value is zero. If it is not, repeat the procedure.

**Regenerative Resistors**

If on command of a rotating spindle to stop (M5), the Spindle Vector Drive causes the motor to brake and coast, brake again and then coast alternately until it finally stops.

If Spindle Vector Drive units are faulting on deceleration, resetting, and then faulting again, and resetting, this could be due to inoperative Regen Resistors, or Vector Drive parameters not matched to the resistors.

Regenerative energy is the power generated when the power supplied to the motor is less than the motor requires to maintain the running RPM. The motor will begin to act like a generator as it slows to the new power level. When the motor is decelerated and begins to regenerate energy to the motor control, the control must dispose of this energy or burn up. Regenerative braking capability is the control's ability to either absorb the energy or pass the energy somewhere else.

Fadal uses the regenerative braking principles for stopping the spindle and for stopping the axis motors on AC brushless machines. Regenerative resistors are used to dispose of the excess energy created in the regenerative braking process. The regen resistors used for the spindle braking process are:

- ELE-0148 Regen Resistor 25 ohm
- ELE-0149 Regen Resistor 13 ohm 1100 Watt
- ELE-0150 Regen Resistor 24 ohm 1200 Watt
- ELE-0929 Regen Resistor 19.5 ohm 3205 Watt

The 25 ohm regen resistor was used with the Toshiba 5 HP inverters, the 24 ohm resistors were used with the Mitsubishi Brake unit, the 13 ohm have been used for years by most of the other drives, such as Baldor and AMC, including the Glentek brake unit, and the 19.5 ohm has been available for the last year or so. The smaller Mitsubishi drives had internal regen resistors. These regen resistors convert the excessive energy into heat and are connected to the spindle drive to absorb more energy either as a single resistor, or two in parallel, or even three in parallel. **Do not make a combination of resistors with a total resistance of less than 6 ohms; this would cause excessive current in the circuit.**

To perform a basic test on the regen resistors, disconnect one or both wires for the regen resistors from the Spindle Vector Drive unit. With an ohmmeter, measure the resistance between the two wires of the Regen Resistor. The results should be the value of the regen resistor if one resistor, or the value of the resistor divided by the number of resistors connected in parallel. When two or more resistors are connected in parallel the wattage ratings of the individual resistors are added together, and define the amount of power that can be dissipated without burning up.

The braking circuit is the circuit, internal to the drive or on an external brake unit, that outputs the excessive power to the regen resistors. This circuit monitors the DC buss voltage of the drive and when it exceeds approximately 385 volts DC (765 volts DC for 50 taper), the circuit will activate and dissipate the excess voltage. If the buss voltage reaches approximately 400 volts DC (800 volts DC for 50 taper), the drive will produce a “DC buss high” or “Buss Overvoltage” fault and base block the drivers causing the spindle to coast. Fadal’s current drives will automatically reset and try to regen again. If the drive faults after regen, then it resets, and the spindle will coast and brake alternately until it stops.

If this symptom occurs on a Baldor Vector Drive and the Resistors test OK, then check the parameters for correct setting. To check the Baldor parameters with the keypad unit, depress the <Local> key for local mode, <Prog> key for program mode, then the <Down Arrow> key until “Level 2 Block” is displayed. Press the <Enter> key, <Down Arrow> key until “Brake Adjust” is displayed. Press the <Enter> key, and then the <Down Arrow> key until “Resistor Ohms” is displayed. Set this value to be the net resistance value of the Regen Resistors as installed in the machine. Press the <Down Arrow> key until “Resistor Watts” is displayed. Set this value to that of the total Regen Resistors’ wattage rating. Reset the drive to “Remote” and check performance.

If the stopping load is heavy, as it is on the 15K RPM machines, then an additional Regen Resistor can be added in parallel to absorb more power and may correct the problem. Don’t forget to reset the parameters.

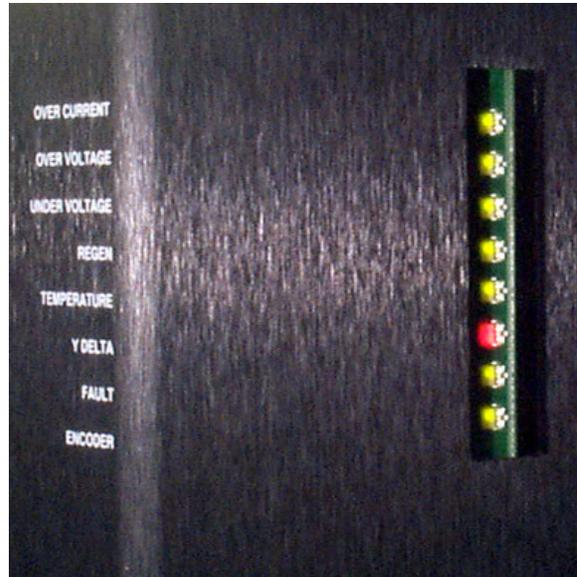
If the deceleration causes the spindle to coast without an attempt to regen, then check the regen resistors, the regen circuit fuse, and then the regen circuit. In the current Baldor 15HP drives the regen circuit PCB can be replaced (INV-0068). In many cases the regen circuit can be disconnected and a Glentek brake unit (INV-0030) can be substituted for the regen circuit. (Please consult with Fadal before performing).

To connect the Regen Resistors to the drives, use the following guide:

Toshiba	PA & PB
Mitsubishi or Glentek Brake	PR & P
AMC, Baldor Sweo, Sweo	R1 & R2
Baldor 10HP	B+/R1 & R2 with external fuse in series
Baldor 15HT and VHT	B+/R1 & R2 (some drives may have external fuse)

### Adjusting the AMC Vector Drive

The AMC VE150AD Vector drive works with all spindle controller cards. The AMC Drive HP rating must match the motor HP rating. If they are mismatched, the motor may not run to full speed.



*Figure 8-5* Match AMC Drive HP Rating with Motor HP Rating

#### LEDs

- Over Current - Red for over current; otherwise green
- Over Voltage - Red for bus over voltage; otherwise green
- Under Voltage - Red for bus under voltage; otherwise green
- Regen - Red when active; otherwise green
- Temp - Red for drive overtemp; otherwise green
- Wye/Delta - Red for Wye, green for Delta
- Fault - Red for fault; otherwise green
- Encoder pulses - flashes when encoder pulses received

#### Velocity Monitor Output

Velocity Output P6-1 gnd P6-5 (0.1167V/100 RPM)

Switch Positions

Table 1: Switch Positions

#	Switch	Position
1	Test/Offset	Off (Offset)
2	Magnetizing Current Only	Off
3	NC	Off
4	Torque/Velocity Mode	Off (Velocity Mode)
5	Reserved	Off
6	Velocity/Torque Mode	On (Velocity Mode)
7	+/- Direction Inhibit/Enable Select	Off (Enable)
8	5000/7500 Motor RPM	On/Off (5000/7500 RPM)
9	150/50 m/sec vel Loop Time Constant	On
10	10hp/15hp Motor	On/Off (10/15hp)

**Note:** Switches are located under cover; cover must be removed for access.

Switches should be preset; only switch 8 and 10 are changed. See Figure 7-6.

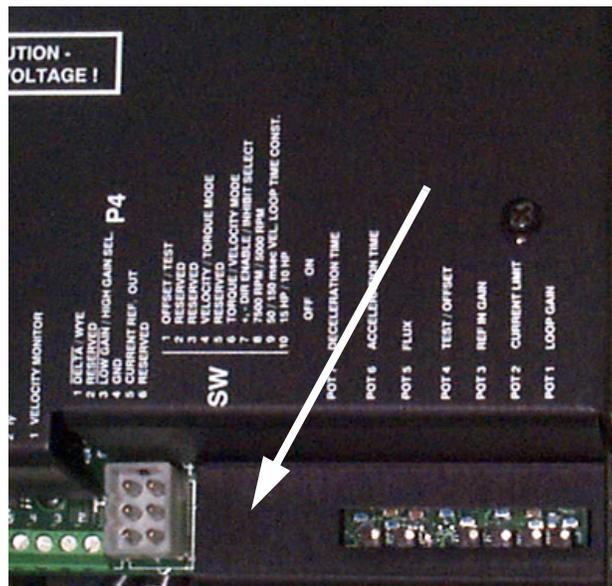


Figure 8-6 Switches are Preset

**Pots: (16 turn pots)**

- Deceleration Time\* (CW to increase time)
- Acceleration Time\* (CW to increase time)
- Flux (This pot has been removed)
- Test/Offset
- Ref. In Gain (signal gain)

- Current Limit
- Loop Gain

\* Accel & decel pots have no effect in rigid tap mode.

### Adjustments

Switches and pots will be preset to initial settings by AMC.

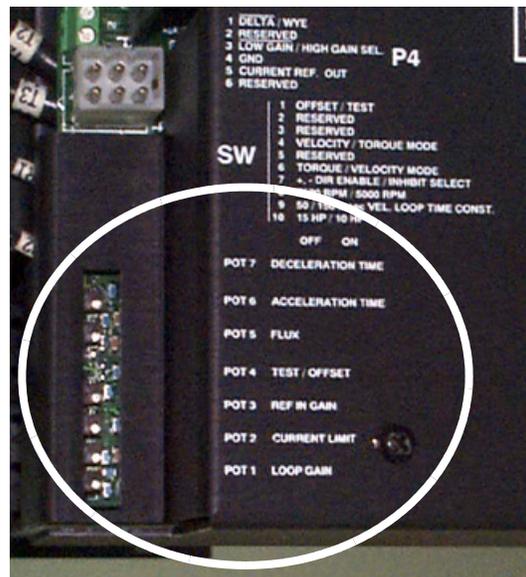
### Switch Settings

8 On-5000 RPM Off-7500 RPM

10 On-10hp motor Off-15hp motor

### Pot Adjustments

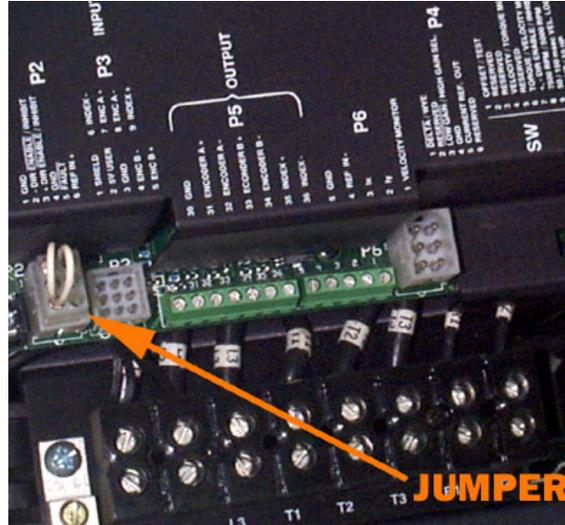
Adjust Accel, Decel, Loop gain, Offset, and Reference gain in the following order:



*Figure 8-7* Pot Adjustments

- 1) ACCEL/DECEL: These pots have no effect in rigid tap mode. Machine must be off. Measure from P6-5 to test point below pot. 20k ohms for 2.2 sec Acc/Dec (11.8k for 3.5 sec). Turn CW to increase time.

- 2) LOOP GAIN: Remove P2 connector and install jumper plug (FOR & REV to COM). Turn the Loop Gain CW until it hums, then turn two turns CCW. Remove jumper plug and install P2 connectors.



*Figure 8-8* Remove Jumper Plug

- 3) TEST/OFFSET:

**Rigid Tap Machines:**

In MDI enter “G84.2”.

Adjust Offset for 0 VDC at P2 pins 4 and 6 (Ref In+ and Gnd).

**Non Rigid Tap Machines:**

Remove P2 connector and install jumper plug (FOR and REV to COM).

Adjust Offset until spindle stops.

Remove jumper plug and install P2 connector.

- 4) REF. GAIN:

In MDI, enter “S1000 M49 M3”.

Adjust Ref. Gain for -1.22 VDC at Velocity Monitors (P6-1, gnd P6-5).

**Note:** If pots were not preset, or if problems are encountered, preset pots as follows:

- 5) LOOP GAIN: Turn fully CCW (minimum loop gain).
- 6) CURRENT LIMIT: Turn fully CW (maximum current).
- 7) REF. GAIN: Turn fully CW (maximum gain).

- 8) TEST/OFFSET: Turn fully CCW, then \* turns CW (middle).
- 9) FLUX: Not Adjustable.
- 10) ACCEL/DECEL: 20k ohms for 2.2 sec Acc/Dec (11.8k for 3.5 sec) (Measure from P6-5 to Test points below pots. Machine must be off when setting pot with ohmmeter).

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**Rigid Tapping  
(Optional Feature)****Fadal Rigid Tapping  
Procedure**

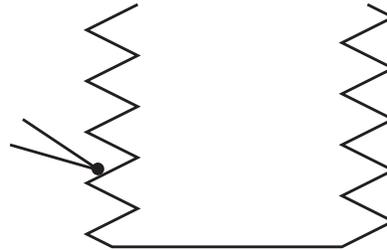
This method of rigid tapping program is for Format 1.

- 1) Place the rigid tapping test screw (SVT-0077) in the spindle.

If using the test programs in the machine, use program # 6000. If not, enter the following program:

```
G84.2  
G84.1 R0+0 Z-1. Q0.0714 F1000.  
X0.0001  
X-0.0001  
M99 P4
```

- 2) Once the program is loaded, jog the Z axis down. Insert the indicator tip into the second thread from the bottom of the rigid tapping test screw. The tip must be touching the lower thread side at the half way point.



*Figure 8-9* Insert Indicator Tip Into Second Thread

- 3) Type SETZ and press the ENTER key.
- 4) Move the indicator back away from the test screw and start the test program. Observe that the program appears to be running correctly.
- 5) Press the SINGLE STEP key. Verify that the rigid tapping test screw is back to the original position. Move the indicator back into position.
- 6) Run the test. The indicator reading should not exceed .001" on either side of the indicator zero. If the indicator exceeds .001, adjust the ramp and gain in SETP. the ramp effects the center point (it should be at the zero) and the gain affects the total fluctuation (it should be within +/- .001).

The following are starting points for each machine type:

Software Version AC-0017 and Later

-

**Table 2: Metric Screws**

	7,500 RPM	10,000 RPM	15,000 RPM				
	A Models	L Models	EMC	6535 40T	6535 50T	ALL	1:2 ratio
RPM Factor	0	0	0	0	0	0	0
Orientation Factor	10	15	20	10	10	10	10
Gain	60±15	45±15	45±15	70±15	50±15	90±15	90±15
Ramp	100 or less						
Z Tap Gain	Medium	Normal	Normal	Medium	Medium	Medium	Medium
XYZ Ramp	160	160	160	250	250	160	160

**Table 3: Inch Screws**

	7,500 RPM	10,000 RPM	15,000 RPM
	L Models	ALL	ALL
RPM Factor	0	0	0
Orientation Factor	15	10	10
Gain	56±15	80±15	65±15
Ramp	100 or less	100 or less	100 or less
Z Tap Gain	High	High	High
XYZ Ramp	100	100	100

**Before AC-0017  
Software Version**

-

**Table 4: Metric Screws**

	7,500 RPM	10,000 RPM	15,000 RPM				
	A Models	L Models	EMC	6535 40T	6535 50T	ALL	1:2 ratio
RPM Factor	0	0	0	0	0	0	0
Orientation Factor	15	15	15	10	15	10	10
Gain	38±15	38±15	38±15	70±15	50±15	58±15	45±15
Ramp	100 or less						
Z Tap Gain	Normal	Normal	Normal	Medium	Medium	Normal	Normal
XYZ Ramp	160	160	160	250	250	160	160

**Table 5: Inch Screws**

	7,500 RPM	10,000 RPM	15,000 RPM
	L Models	ALL	ALL
RPM Factor	0	0	0
Orientation Factor	15	10	10
Gain	58±15	82±15	65±15
Ramp	100 or less	100 or less	100 or less
Z Tap Gain	High	High	High
XYZ Ramp	100	100	100

**Procedure for Setting GAIN Parameter:**

For Rigid Tapping with VMCs that have METRIC Ballscrews, the GAIN in SETP must be set to 80.

**Procedure for Setting Z TAP GAIN Parameter:**

For Rigid Tapping with VMCs that have METRIC Ballscrews, the Z TAP GAIN in SETP must be set to MEDIUM.

**Procedure for Setting XYZ RAMP Parameter:**

XYZ RAMP in SETP for all other AC Drive machines EXCEPT 6535 and 8535 are set at 160.

The XYZ RAMP setting for the VMC6535 and 8535 is 250, instead of 160. The VMC6535 and 8535 also require SYS101.3 or later software.

**Procedure for Adjusting Amplifiers:**

The procedure for adjusting Loop Gain on AC Amplifiers is not changed when using the 25 IPM and the flashing LED on the controller card.

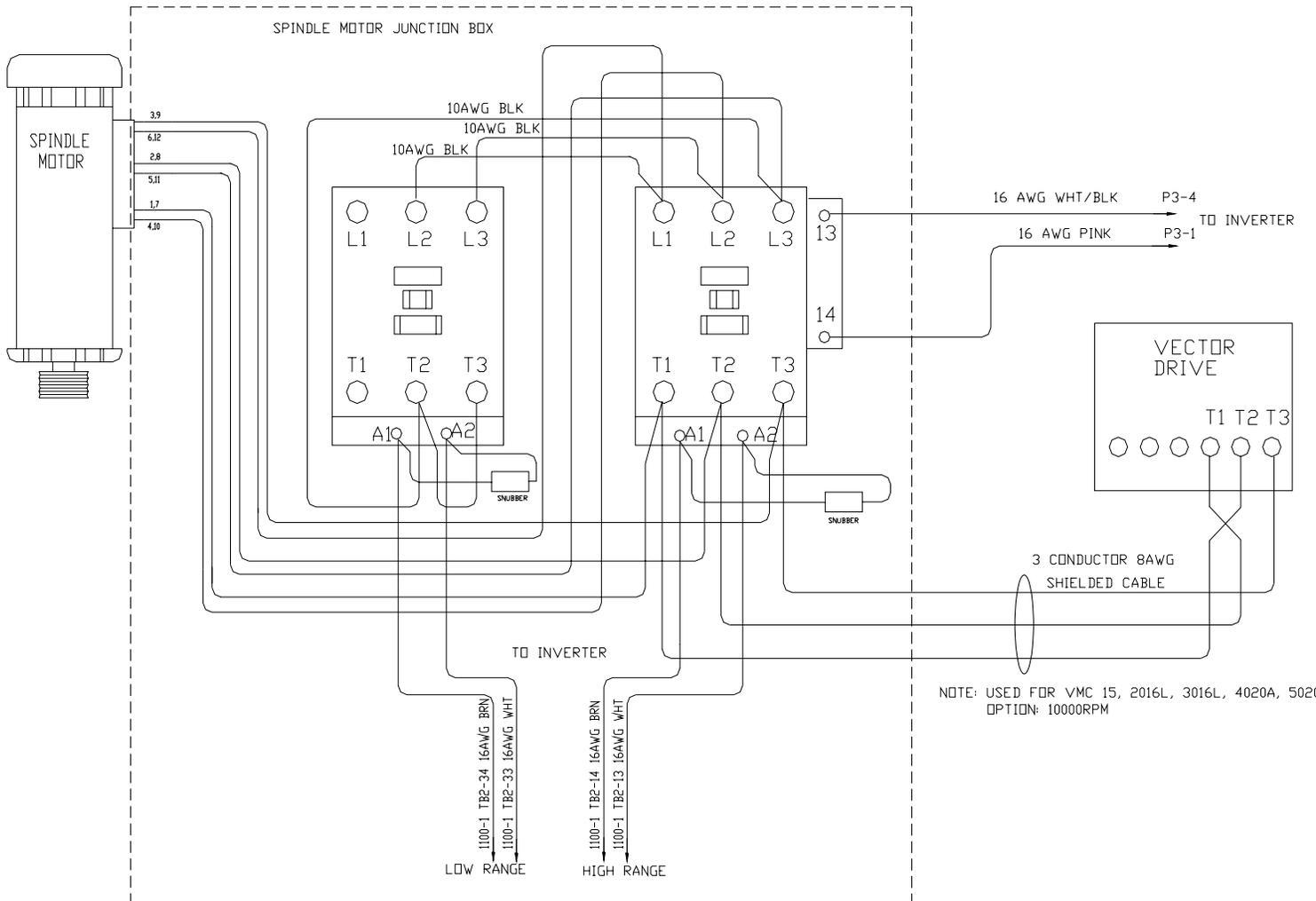
In general, when updating from an earlier software version to AC0017, the amplifiers will not need adjusting, but, the displayed following errors in Program 5811 will be similar to those shown in the table above.

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**Motors**

<b>7.5 HP Motor</b>	The 7.5 HP motor is standard on EMC model VMC's.
<b>10 HP Motor</b>	The 10 HP motor is standard on all VMC models except the EMC, 4020A, 5020A, 6030 and 8030. It is continuously rated at 10 HP with a peak rating of 15 HP.
<b>15 HP Motor</b>	The 15 HP motor is the standard motor on the following VMCs: 4020A, 5020A, 6030 and 8030. It is an optional motor on all other VMC models. It is continuously rated at 15 HP with a peak rating of 22.5 HP.
<b>20 HP Motor</b>	The 20 HP Very Hi-Torque Motor is an optional motor available on the following model VMCs: 3020, 4020, 6030 and 8030. It is continuously rated at 20 HP with a peak rating of 30 HP.
<b>35 HP Motor (50 HP Drive)</b>	The 35 HP motor is a standard motor on the VMC 6535 50 taper. It is continuously rated at 35 HP with a peak rating of 50 HP.

**WYE / DELTA Motors** Standard motors are run in the wye mode only. Wye / Delta motors offer a flatter torque curve over the entire speed range of the motor/spindle system.



**Figure 8-10** WYE Delta Relay Wiring Diagram

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**Belt Drive Systems****Posi-Drive Belt System**

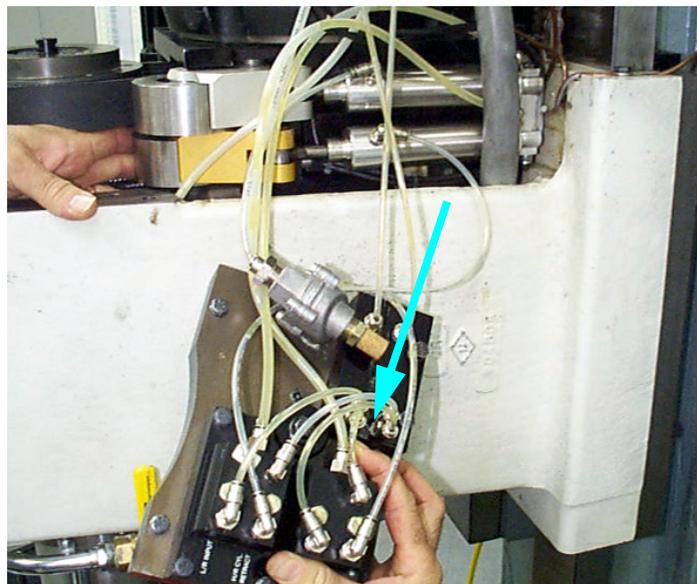
The Posi-Drive Belt System features two belts that run on a 1-2 and 2-1 reduction pulley arrangement.

**Spindle Belts Replacement on Auto Hi/low System**

The spindle drive belts are Gates 315K10. Gates manufactures the belts to Fadal specification. When replacing the spindle belts, use only the belts supplied by Fadal Machining Centers. The belts supplied by Fadal are sized.

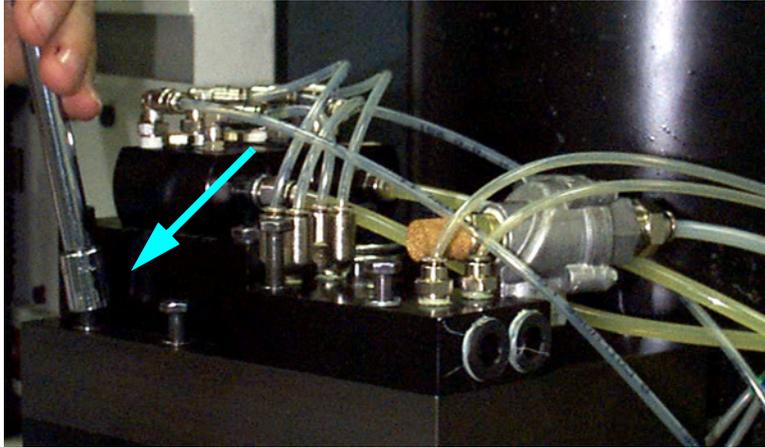
The following steps are for replacing the belts on the auto HI/LOW spindle:

- 1) Verify that the VMC is aligned with the cold start indicators.
- 2) Power off the VMC and lock out the main disconnect.
- 3) Disconnect the air supply from the VMC.
- 4) Remove four each of the 1/4" cap bolts on the Head Cover and remove the Head Cover. Cut all the wire ties holding the air lines and wires in place.
- 5) The Auto Hi/Low pistons need to be released. Determine which piston is applying force on the belts, the upper piston is the low speed belt piston the lower piston is the high speed belt piston. To release the actuator, push the check valve into the actuator. With the check valve released, pull the idler away from the belts.



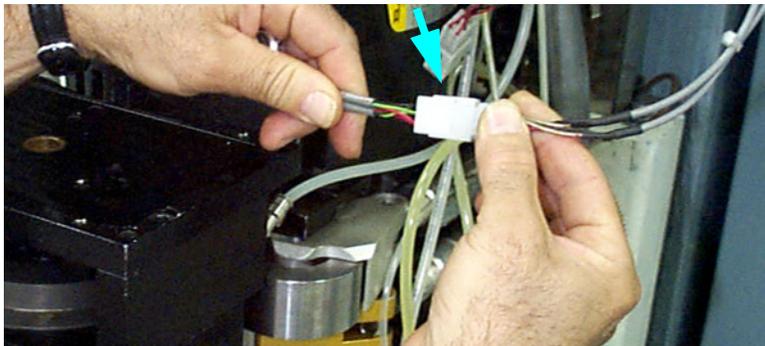
*Figure 8-11* Release Check Valve and Pull Idler Away from the Belts

- 6) Remove six each of the 1/4" hex bolts holding the Drawbar Cylinder assembly.



*Figure 8-12* Remove Hex Bolts Holding Drawbar Cylinder Assembly

- 7) Remove the Drawbar Cylinder assembly.
- 8) Disconnect the Orientation Bridge/Drawbar hall effect sensor 6 pin molex connector. Disconnect air line to the Orientation piston.

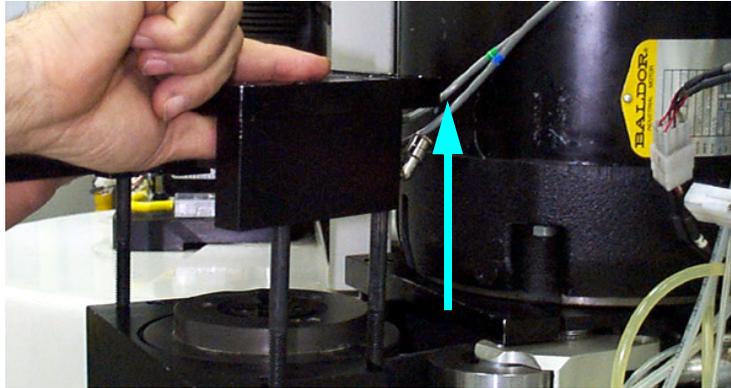


*Figure 8-13* Disconnect Orientation Bridge/Drawbar



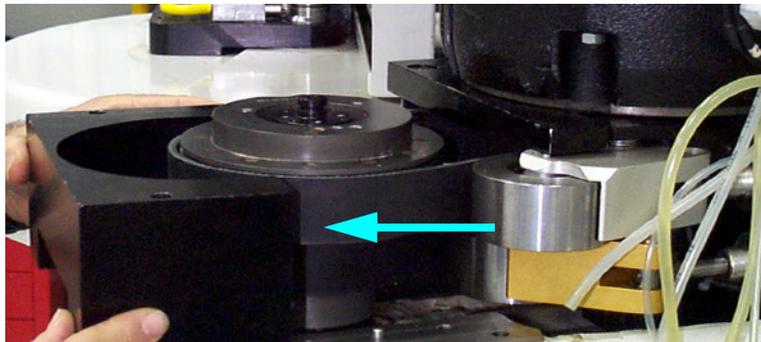
*Figure 8-14* Disconnect Air Line to Orientation Piston

- 9) Remove three each of the 3/8" socket head cap screws holding the Orientation Bridge assembly.



*Figure 8-15* Remove Socket Head Cap Screws

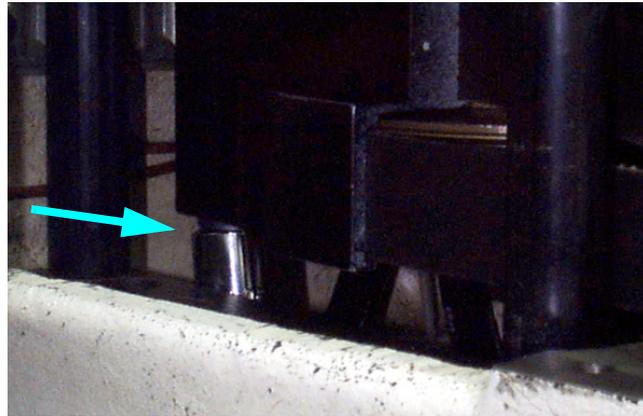
- 10) Remove the Orientation Bridge assembly and front belt guide.



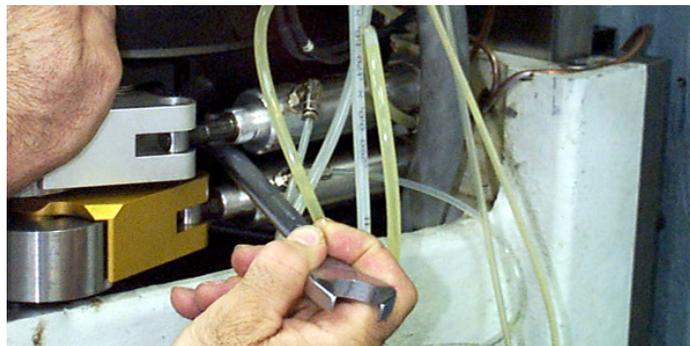
*Figure 8-16* Remove Orientation Bridge Assembly & Front Belt Guide

- 11) Remove the Core Cover located on the bottom of the head.

- 12) Remove both of the 1/2" bolts to the rear belt guide, as well as the left 1/2" Spindle motor bolt.

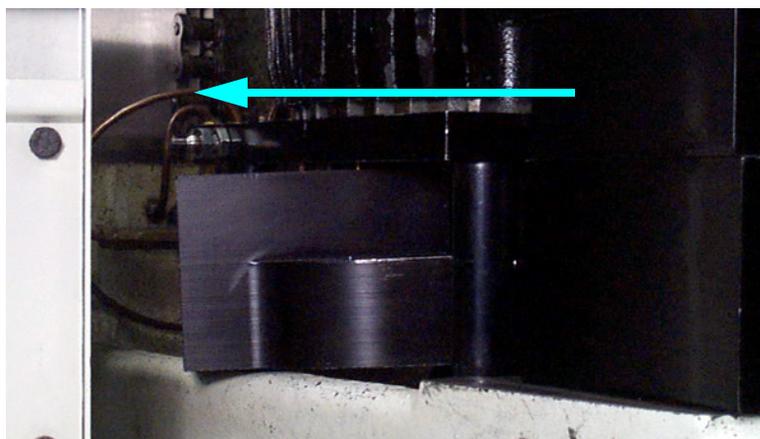


*Figure 8-17* Remove Bolts to Rear Belt Guide



*Figure 8-18* Remove Spindle Motor Bolt

- 13) Swing the spindle motor forward and remove the rear beltguide from the left side.



*Figure 8-19* Remove Rear Belt Guide

14) Remove the 2 spindle drive belts.

15) Replace the 2 spindle drive belts. Reassemble using the previous steps in reverse order.

### **Motor Plate Tensioner Cable**

Machines equipped with a motor plate tensioner cable system, as shown in the figure below, will need adjusting when belts are replaced.

Adjustment procedure:

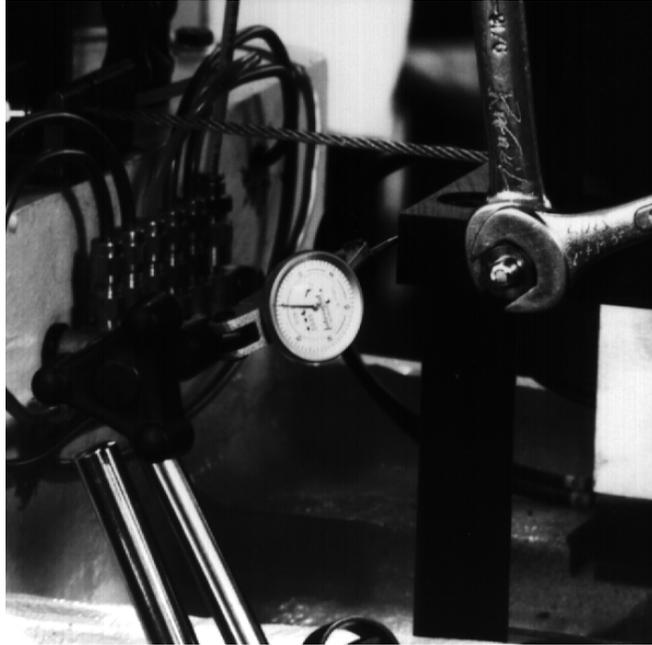
- 1) Disconnect the air supply from the machine. Remove the tension from the belts. Place an indicator as shown. Use either a dial indicator or a travel indicator.



*Figure 8-20* Place Indicator

- 2) Once the indicator is in place, you will need two 9/16" open end wrenches to tighten and lock the cable tensioner screw.

- 3) Zero the indicator and slowly turn the 3/8" hex head bolt.



*Figure 8-21* Zero Indicator

- 4) Adjust the screw until the plate moves .002 to .005 on the indicator.
- 5) After adjusting, lock down the 3/8" jam nut with the other wrench while holding the adjuster screw. Watch the indicator to verify that there is no movement.

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### Hydraulic Hi/low System

The hydraulic hi/low system requires very little maintenance. It is an air over oil system with check valves. Periodically check that you can see fluid in the 1/4 inch lines that go to the rear of the cylinder. If the lines have an excessive amount of bubbles then it is an indication that the oil level is low.

#### Filling

- 1) Remove the head cover.
- 2) Disconnect the air supply from the machine.
- 3) With the air source disconnected one actuator will still be engaged. To release the actuator, push the check valve into the actuator.
- 4) With the check valve released, pull the idler away from the belts.
- 5) Remove the 1/4" line that goes to the rear of the cylinder and fill with Mobil DTE heavy medium oil.

- 6) The reservoir is full when oil enters the 5/32 line on the actuator.

**WARNING**

DO NOT allow an excessive amount of oil to flow into the separator.

- 7) Reattach the 1/4" line to the fitting on the cylinder.
- 8) Repeat the above steps for the other range.
- 9) Reconnect the air supply to the machine.

**WARNING**

Verify that the oil lines are secure.

- 10) In MDI, cycle between the high and low ranges about 10 times. This will fill the cylinders.

**MDI Example**

Type:  
MD, ENTER  
S.1, ENTER  
S.2, ENTER

Repeat the S.1 and S.2 to continue switching ranges.

**7,500 RPM Poly  
Chain Belt**

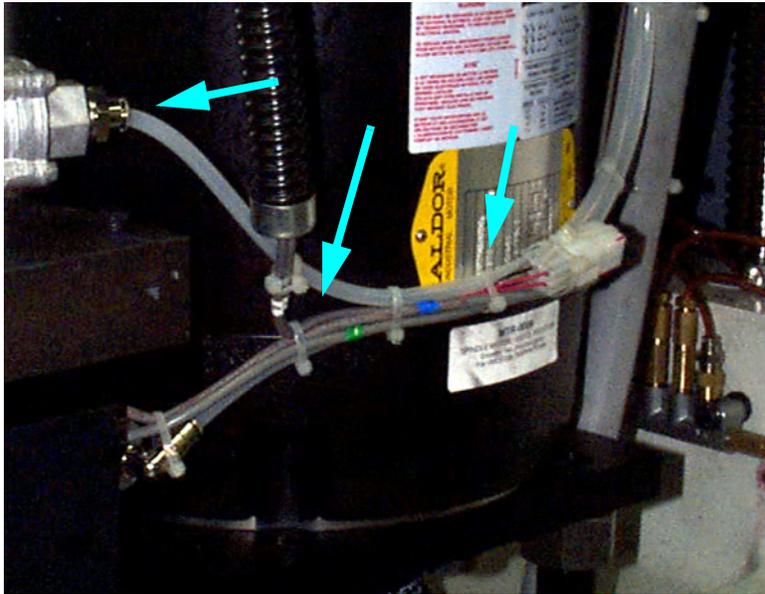
This system features a single belt that runs on a 1-1 pulley arrangement.

**Spindle Belt Replacement**

The spindle drive belt is a Gates Poly-chain. Gates manufactures the belt to Fadal specification. When replacing the spindle belt, use only the belts supplied by Fadal Machining Centers.

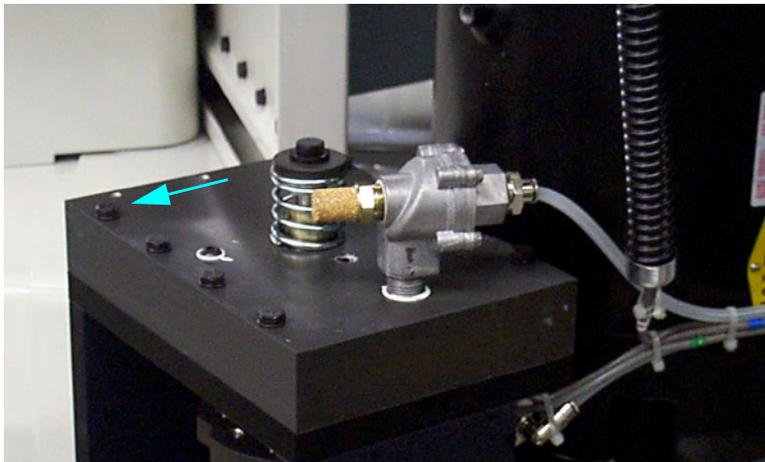
- 1) Verify that the VMC is aligned with the cold start indicators.
- 2) Power off the VMC and lock out the main disconnect.
- 3) Disconnect the air supply from the VMC.
- 4) Remove four each of the 1/4" cap bolts on the Head Cover and remove the Head cover.

- 5) Cut all the wire ties holding the air lines and wires in place. Disconnect the 1/4" assembly.



*Figure 8-22* Cut Wire Ties Holding Air Lines and Wires

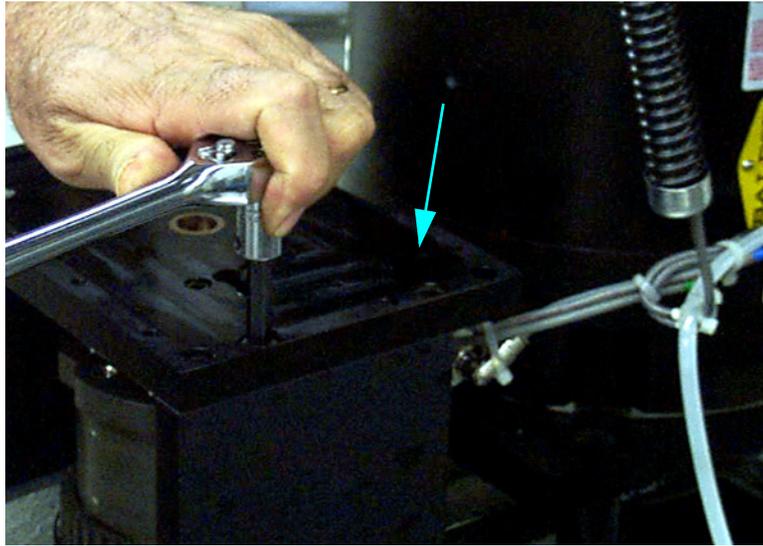
- 6) Remove each of the six 1/4" hex bolts to the Drawbar assembly.



*Figure 8-23* Remove Hex Bolts to Drawbar Assembly

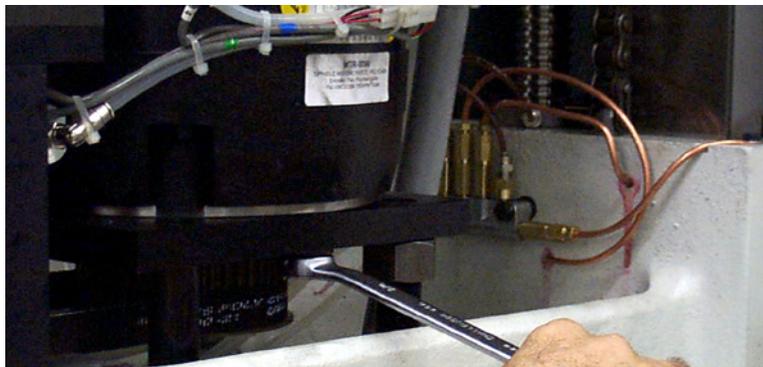
- 7) Remove the Drawbar assembly.

- 8) Remove each of the four 3/8" cap bolts to the Orientation Bridge assembly.



*Figure 8-24* Remove Cap Bolts to Orientation Bridge Assembly

- 9) Remove the Orientation Bridge.  
10) Loosen each of the two 1/2" hex bolts to the Spindle motor.



*Figure 8-25* Loosen Hex Bolts to Spindle Motor

- 11) Swing the Spindle motor forward.  
12) Remove the Spindle drive belt.  
13) Install the new Spindle drive belt.  
14) Mount a Mag base with an indicator on the head and touch off the top-front edge of the spindle pulley.  
15) Set a zero reading while there is NO belt tension, then push back on the Spindle motor until about .0005" of deflection is seen on the indicator.

16) Tighten two each of the 1/2” hex bolts to the Spindle motor.

17) Verify that the reading has not changed.

**Note:** If the belt tension is too tight, then vibration will appear at the tool tip, and a poor finish may result.

18) Reassemble using the previous steps in reverse order.

**Table 6: Application List for Spindle Drives and Regen Resistors**

Part No.	Spindle Type	CE	Size	Regens	Ohms	Used
<b>Baldor (production):</b>						
INV 0020	15HP 10000RPM HT	No	C	2	13 OR 19.5	19.5
INV 0041	10HP 10000RPM	No	B	1	13 OR 19.5	19.5
INV 0042	10HP 10000RPM	No	C	2	13 OR 19.5	19.5
INV 0043	15HP 7500RPM HT	No	C	2	13 OR 19.5	19.5
INV 0045	10HP 7500RPM	No	B	1	13 OR 19.5	19.5
INV 0058	20HP 10000RPM VHT	No	C	2	13 OR 19.5	19.5
INV 0070	25HP 10000RPM VHT	Yes	C	3	19.5	19.5
INV 0073	35HP 7500RPM	YES		3	19.5	19.5
<b>AMC (production):</b>						
INV 0056	All types except VHT	Yes		2*	13 OR 19.5	19.5
<b>Baldor (service):</b>						
INV 0039	15HP 10000RPM HT	Yes <sup>1</sup>	C	2	13 OR 19.5	19.5
INV 0044	10HP 7500RPM	Yes <sup>1</sup>	C	1	13 OR 19.5	19.5
INV 0046	15HP 7500RPM HT	Yes <sup>1</sup>	C	2	13 OR 19.5	19.5
INV 0052	10HP 10000RPM NCL	No		1	13	
INV 0054	20HP 10000RPM NCL	No		2	13	
<b>Yaskawa (production):</b>						
<b>INV 0071</b>	10HP 7500 RPM	YES		2	13	
<b>Others:</b>						
INV 4551	TOSHIBA	No		1	13	
INV 4556	SWEO	No		1	13	
INV 4558	MIT.	No		INTERNAL	NONE	
INV 4552	TOSHIBA	No		2	13	
INV 4557	SWEO	No		2	13	
INV 4558-320	MIT. (BRAKE+)	No		2	13	
INV 4551-15	TOSHIBA	No		1	13	
INV 4558-15	MIT.	No		INTERNAL	NONE	
INV 4554	SWEO	No		1	13	

Table 6: Application List for Spindle Drives and Regen Resistors

Part No.	Spindle Type	CE	Size	Regens	Ohms	Used
INV 4558-320	MIT. (BRAKE+)	No		2	13	
INV 4551-15	TOSHIBA	No		1	13	
INV 4558-15	MIT.	No		INTERNAL	NONE	
INV 4554	SWEO	No		1	13	
INV 4554-175	BALDOR-SWEO	No		1	13	
INV 4554Y-175	BALDOR-SWEO	No		1	13	
INV 4554Y-180	BALDOR-SWEO	No		1	13	
INV 4558Y	MIT. CL	No		INTERNAL	NONE	
INV 4555	SWEO	No		2	13	
INV 4555-175	BALDOR-SWEO	No		2	13	
INV 4555Y-175	BALDOR-SWEO	No		2	13	
INV 4555Y-180	BALDOR-SWEO	No		2	13	
INV 4558-315	MIT. (BRAKE+)	No		2	13	
INV 4554-175-V15	BALDOR-SWEO	No		1	13	
INV 4554-180-V15	BALDOR-SWEO	No		1	13	
INV 4558-205	MIT.	No		INTERNAL	NONE	
INV 4558-15CL	MIT.	No		INTERNAL	NONE	
INV 4558-305-6.5K	MIT.	No		INTERNAL	NONE	
INV 4558-305-V15	MIT. (BRAKE+)	No		2	13	
INV 4558-180-A	BALDOR-SWEO	No		2	13	
INV 4554-SP	BALDOR-SWEO (single phase)	No		1	13	
AMP-0064	Glentek, spindle drive, TRM	No		1	19	

\* FD2 uses 1 for 10HP, 2 for 15HP

<sup>1</sup> Cannot be used for current CE production

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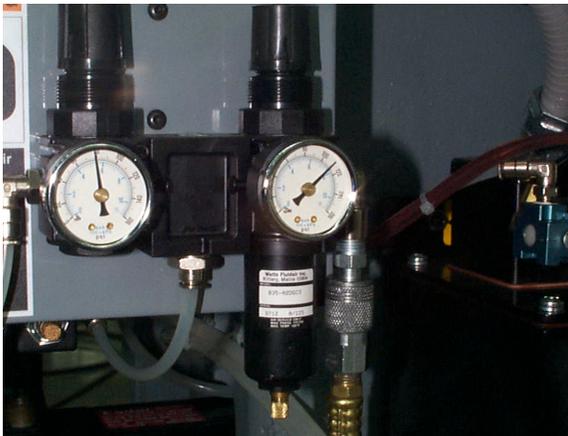
## Tools Sticking in the Spindle During a Change Cycle

There are many different solutions to problems leading to sticking tools, and although most machines experiencing a sticking tool problem will exhibit only one or two of these symptoms, it is better to check out all of them in each case. Inspection and elimination of the items on this list ensures a complete resolution to the problem.

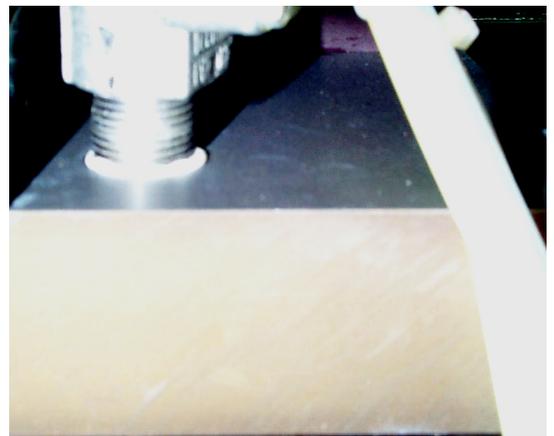
Please refer to testing procedure in item 18.

### 1. Air Supply Pressure

Minimum air pressure from the building to the machine must be greater than 80 PSI, or 5.5 Bar. The supply volume must be adequate enough to not drop more than 5 PSI during a tool change cycle. Check for restrictions in the building plumbing, air filtration system, regulator bowl, lack of a closed loop in air supply plumbing around the shop, or excessive water in the air supply. A good test for inadequate volume is the observation of large pressure drops during a tool change cycle, or when other machinery in the shop uses air. Those machines with dual regulators should have the main regulator on the right side set no greater than 120 PSI (8 bar), and the secondary regulator at 70-80 PSI (5-5.5 bar). The main regulator feeds the Drawbar Cylinder, and its output force is computed at 100 PSI, for example, 38 square inches x 100 pounds per square inch or 3800 pounds pushing force. An increase of pressure to the Drawbar Cylinder proportionately increases Drawbar force at a factor of 38:1.



Dual Air Regulator set at 80 PSI and 120 PSI



Exhaust Valve pipe nipple

**2. Drawbar Cylinder  
Hall Effects Switch**

Tool "Popping" can be reduced on machines equipped with Drawbar Cylinder Hall Effects switches, by checking the adjustment on the switch. If the switch is up too high, then the Z-axis may start up prematurely in the Tool Extraction cycle, wrenching the tool out of the spindle. Note that there is a new parameter in SETP labelled "Do you have Air Valve feedback?" This does not mean that electric signals are returning to the control from the air valve. It means that there could be Hall Effects switches on the Idlers and Drawbar Cylinder, and if so, the answer would be "YES". To answer "NO" might mean that the control will ignore any such feedback and Z-axis may lift off the tool prematurely.

**3. Insufficient Air  
Volume: MAC In-Line  
Valve**

In some cases, the rear MAC In-Line valve that delivers air to the Drawbar Cylinder may have reduced output by volume. There have been cases of 40% reduction in airflow when this valve experiences a failure. This condition will not allow the Drawbar Cylinder to fill fast enough to provide enough impact to operate properly. A simple test is to swap the valve with another in the manifold and retest.

**4. Air Leaks; Exhaust  
Valve**

Inside the Exhaust Valve on top of the Drawbar Cylinder is a diaphragm valve/seat. A tiny pinhole leak in the diaphragm will cause the valve to leak out the exhaust and not fill up the Drawbar Cylinder. Inspect the diaphragm visually for a rupture, and replace if necessary. Part numbers are VLV-0032 and VLV-0033 for repair kits, the large valve style or the small valve style, respectively.

**5. Air Leaks; Exhaust  
Valve Nipple**

The pipe nipple that attaches the Exhaust Valve to the Drawbar Cylinder Housing may be cracked from overtightening, and then leak. Inspect and replace, if necessary.

**6. Air Leaks;  
Drawbar Cylinder  
Bushing**

Test for an air leak with soapy water sprayed around the air lines. The bronze bushing that guides the Drawbar Cylinder Shaft may be worn, or damaged, or too rough internally to prevent premature wear to the O-ring around the shaft. Disassemble the Drawbar Cylinder and inspect/replace the O-ring and bushing. A new bushing design will be available soon to not only house a second O-ring, but provide a smoother surface to reduce O-ring wear. It will be retrofittable to all earlier Drawbar Cylinders. It has been included in the Sticking Tool Retrofit kit listed on the last page.

**7. Air Leaks;  
Drawbar Cylinder  
Plate**

Another source of air leaks can be from the large O-ring around the Drawbar Cylinder Plate, and to discover this will require disassembly and inspection. The Drawbar Cylinder Plate itself can be cracked or distorted. When reassembling, please note the correct location of the magnet for the Hall Effects switch, and avoid cutting the large O-ring accidentally.

**8. Air Leaks;  
Hydraulic Actuator  
Assembly Bolts**

Two of the 1/4-20 bolts used to mount the Hydraulic Actuator assembly penetrate the Drawbar Cylinder housing, and may not have been sealed with teflon tape adequately. Test with soapy water for air leaks, sealing the bolt threads with teflon tape.

**9. Air Leaks;  
Coolant-Thru  
Drawbar Cylinder**

On Coolant-Thru Drawbar Cylinders equipped with a brass "shuttle valve" there is a port fitted to the top of the housing that was designed to feed air first to the shuttle valve, and then down the Drawbar Shaft to clear off the tool holder. The existence of this port is a leak to the Drawbar Cylinder, bleeding off air from the chamber. Earlier versions had a large port, and later versions have an orifice restricting airflow.

A mechanical air valve can be installed to draw air for the shuttle valve back at the main regulator, instead of from the Drawbar Cylinder. Contact the Fadal Parts Department for details.

**10. Orientation  
Bridge "Lifting"**

When the Drawbar Cylinder pushes downward with 3000 to 4000 pounds force, and meets resistance in extracting the tool, an upward force is created that wants to "lift" the Orientation bridge up from the head casting. The 3 bolts that hold the Bridge down to the Belt Guide resist this upward movement. During a tool change, inspect the movement upward of the Orientation Bridge. A closer inspection might reveal stripped bolt threads, distortion of the Bridge plate, damaged pockets in the Bridge plate containing the 3 bolt heads. A new design Orientation Bridge and Belt Guide will have 4 bolts holding it down, and is included in the Sticking Tools Retrofit kit listed below.

**11. Black Oxide Tool  
Holders**

We recommend "Side Ground" tool holders. Those manufactured with "Crush Ground" or those with Black Oxide coated finish are more vulnerable to tool sticking problems.

**12. Dirty Tool  
Holders**

Foreign matter on the tool holder taper, and sometimes coolant gel from evaporated coolant on the taper, will contribute some to the problem. As a test, clean the tapers thoroughly, and spray an anti-rust lubricant such as LPS-3 or Ironclad (not WD40) on the taper and retest.

**13. Spring Pilot;  
Oversized Diameter**

The outer diameter of the Spring Pilot, either non-locking or locking, may be too large and fit too tightly into the spindle bore. Check for score marks on the pilot, which would indicate galling of the surface. Recently the Knock-Out Cap was redesigned to provide a capturing ridge to contain the upper points of the crown of the spring pilot. With the increased tool retention forces, we have seen some distortion of the pilot. Check the inner bore of the Spindle Rotor where the Spring Pilot is located and carefully stone any developed burrs.

- 14. Spring Pilot; Ball Pockets Incorrect** With the Spring Pilot removed from the spindle, carefully inspect the 4 ball pockets and insert (4) BRG-0004 1/4 steel balls into them. Remount the Spider on top of them. The balls should easily retract full travel when pressed, and return under gravity force. Any binding indicates a misformed pocket. The pockets themselves should show no sign of distortion that might restrict ball travel when heavily loaded.
- 15. Drawbar Scored** Inspect the shaft of the Drawbar itself, particularly where the Belleville springs may contact it. Should the Belleville springs twist around the Drawbar, they may shift off of their rims, and dig into the Drawbar, and resist up and down movement. The introduction of hardened flat washers every 10th Belleville spring helps prevent the stack shift. A newly designed Drawbar and Spring Pilot will be available soon that has a larger diameter shaft which should restrict the stack shift from occurring. See the Sticking Tools Retrofit kit below.
- 16. Damaged Drawbar** At the bottom of the Drawbar is a pocket for the Pull Stud of the tool holder, and around its perimeter are 8 holes for the 3/16 inch balls to grasp the Pull Stud. Earlier Drawbars had a deeper pocket, and CAT tools were pushed out of the spindle by the lowest rim of this pocket contacting the pull stud. Eventually the rim of the Drawbar was distorted and the balls might not retract as smoothly as expected. Later Drawbars have a shorter pocket so that the Drawbar shaft pushes on the top of the pull stud, rather than on its base. A damaged Drawbar rim might prevent the pull stud from extraction smoothly.
- 17. Damaged Floater** The Floater is located by two 3/16 balls in a circular track in the spindle throat. These hold the Floater steady when the Drawbar is pressed through it, and the step at the bottom of the Floater allows the 8 3/16 balls to retract out of the way to release the tool. Should the Floater be damaged in a way that allows it to move with the Drawbar, the Pull Stud cannot be extracted from the Drawbar. Replace the damaged Floater, if necessary.
- 18. Testing Procedure** Use the following page to measure Drawbar performance, both before inspection, and after completion of the procedures outlined in this bulletin, for comparison.

**MEASURING  
DRAWBAR  
PERFORMANCE**

In order to measure the amount of push force that the Drawbar Cylinder has upon the tool, place a tool holder into the spindle (without a tool in it) and Jog the machine **slowly** downward in Z-axis onto the SVT-0066 Pressure Gauge-3000PSI. Once the gauge begins to register after contact, press the Tool In/Out button to release the tool. Measure how much **net force** is pressed upon the tool by the Drawbar.

Use the following chart to figure the amount of force that is lost.

Drawbar Cylinder force	_____	(38 x #PSI)
Less Drawbar return spring	- 100	
Less Belleville Springs-	800	
Net Force	= _____	
Less Pressure Gauge reading	- _____	
Lost Pressure Force	= _____	

Drawbar Cylinder force is the air pressure in PSI multiplied by 38. Figuring the Drawbar return spring to be about 100 pounds, and the resistance from the Belleville Springs to be 800 pounds, we deduct 900 from the Drawbar Cylinder force. This gives us the expected Net Force.

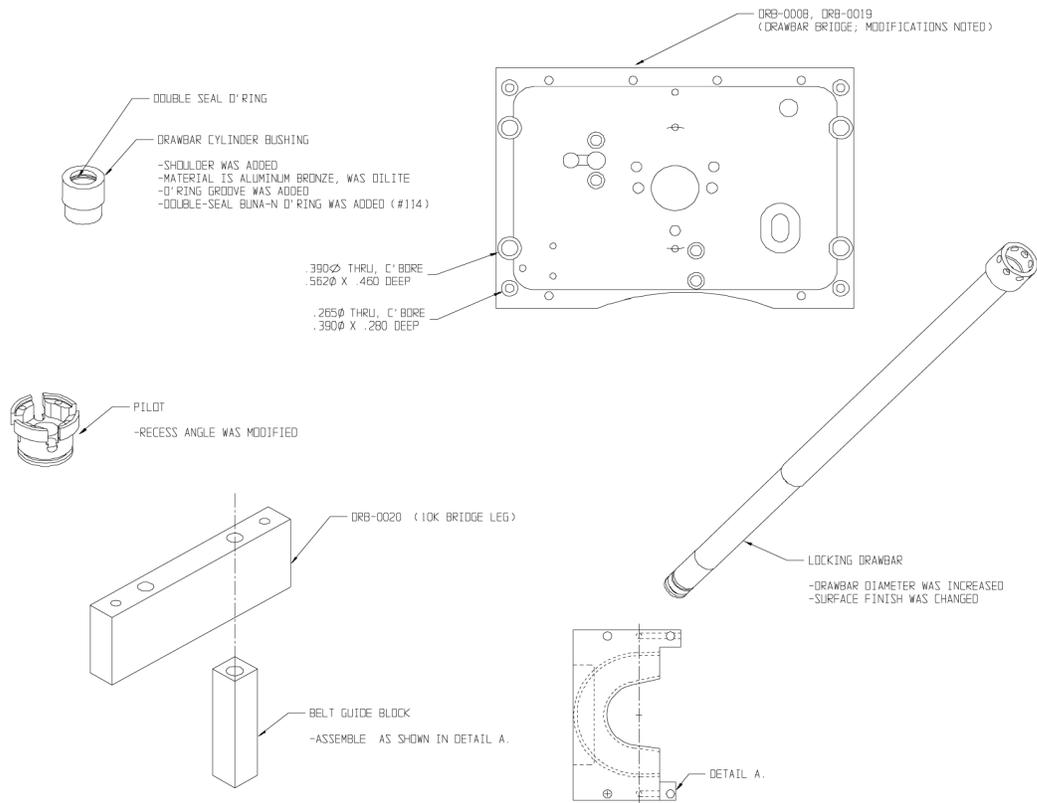
However, it is necessary to measure with the Pressure Gauge what the Net Force **actually** is. The difference is lost forces, such as binding, friction losses, etc. A higher number Lost Pressure Force will result in Sticking Tools.

The technician should check items 1 through 17 in this section and the corrections should restore any missing forces and allow more of the Drawbar Cylinder pressure to reach the tool holder.

**DRB-0024 Sticking  
Tools Kit, 10K LDB**

**DRB-0025 Sticking  
Tools Kit, 10K LDB-  
CT=**

DRAWBAR KIT (FOR SERVICE)



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**Tap-Tap Cycle**

The purpose of the Tap-Tap Cycle is to release tools that are stuck in the spindle. When the Drawbar Cylinder is activated, the Drawbar Hall Effect switch is activated to indicate that the tool was successfully released. If the switch is not activated a repeating Tap-Tap cycle is initiated, where it applies the Drawbar Cylinder pressure, releases, and then applies the Orientation cam-roller to the spindle pulley, and over again. This process aimed at knocking the tool loose will repeat until a timeout and fault mode is reached.

To adjust the Tap-Tap cycle drawbar Hall Effect switch (ELE-0145), temporarily reverse the air lines to the Drawbar Cylinder and the Orientation Bridge, so that when a M19 is called in MDI, the Drawbar Cylinder will be activated constantly. May need to use a 5/32" to 1/4" adapter fitting. The Hall Effect switch reads the drawbar cylinder magnet (left side of orientation bridge).

Using "DI" and "DS" from the command line, display switches. Locate DRAWBAR and watch the "01". While adjusting the switch position lower (away from the drawbar cylinder), when it changes to "00", rotate the switch upward until it changes back to "01", and then further upward 1/2 turn, and tighten locknut. Don't forget to restore air lines properly.

This process enables the control to know the difference between a tool that is stuck in the spindle, and one that was removed. If it was stuck the Tap-Tap cycle is initiated.

In some situations, most likely in VMC15 or 15000 RPM machines, where there is not a Hi/Low idler assembly installed, you may experience trouble extracting tools. A quick and simple test of the Tap-Tap cycle can be achieved by disconnecting the 1/4" air line to the drawbar cylinder (at either end). Without any tools in the spindle or in the turret pocket, make a tool change. The slide will advance to the spindle, the drawbar cylinder solenoid will activate, blowing air out into the room, and begin the Tap-Tap cycle. Over and over the machine should blow air out the disconnected line, and then stop and activate the orientation cylinder and tap on the pulley, and then repeat until it faults. If the drawbar cylinder Hall Effect switch is not properly adjusted, it may continue making a tool change without using the drawbar.

Also, if the machine does not have Hi/Low idlers, then jumpers must be installed at 1060/J9/10-11 and 1060/J11/4-5. These jumpers fool the control into thinking that there is an idler assembly installed so that it will know to monitor the drawbar cylinder switch and not ignore it. If no jumpers are present, then add them using about 4 inches of # 16 wire and Molex pins.

A further solution for those customers who have the Tap-Tap cycle and yet still have a problem is the Drawbar Cylinder Adapter assembly. This device uses

the air output to the drawbar cylinder from the air valve assembly to trigger a valve that supplies up to 120 PSI air to the Drawbar Cylinder to extract the stuck tool. It is simple to install and setup and should be used in conjunction with the Tap-Tap cycle.

Sanding the upper one-third of the taper of the spindle with a fine grade (600 grit) of sand paper also helps (100RPM for 10 seconds).

Troubleshooting the Tap-Tap cycle:

- 1) Check the Drawbar Hall Effect switch and its adjustment.
- 2) The wires connect to J9 pins 1,2 & 3 for the Drawbar Hall Effect switch.
- 3) The 1040 Mill Interface board reads the switch and activates the relays for the air valves.
- 4) The 1030 Computer Interface board communicates the instructions between the 1040 and the CPU 1400 board and the 1610 Program Module.

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### **Spindle Drawbar and Belleville Spring Replacement**

#### **Drawbar Removal**

- 1) Remove the Drawbar Cylinder Assembly.
- 2) Remove the Orientation Bridge Assembly.
- 3) Place a long 3/8 inch drive extension or similar item in the spindle and jog the head down until the extension is under slight tension between the drawbar and the table. **Caution:** Do not place high tension on the extension; it only needs to support the drawbar. Place a piece of wood between the extension and the table, if needed.
- 4) Remove the Knock out cap (on locking drawbars only).
- 5) Place pilot tool on spring pilot.
- 6) Use wheel puller to depress the spring pilot.
- 7) Remove spring retainers.
- 8) Remove wheel puller.
- 9) Jog head up and remove the extension and the drawbar. Be careful not to drop the ball bearing.

10) Now remove the belleville springs or the floater.

11) To reinstall, reverse the above steps.

**Replace Belleville  
Springs**

- 1) Remove drawbar (See Section A).
- 2) Using a spring hook or a magnet remove the belleville springs (Be sure to remove any broken pieces).
- 3) Install replacement springs starting with first one cupped downward and reverse every other one. The quantity will vary depending on the spindle pocket size (See the spring quantity chart).
- 4) Reinstall drawbar.

**Remove Floater  
(This will rarely be  
necessary.)**

- 1) Remove the drawbar (See Section A).
- 2) The floater has two ball bearings that hold it in place. Using a floater removal tool or a magnet pull the ball bearing toward the center and the floater should come out. If badly damaged the floater can be difficult to remove.

**Spindle Belleville Springs Quantity Chart**

There have been many spindle and spring retainer combinations over the years. To determine the number of Belleville Springs in a spindle, three factors have to be considered: The depth of the spring pocket in the spindle, the depth of the spring retainer and the width of the Belleville springs. The following chart is a guide line for the number of springs and may vary slightly from spindle to spindle.

This chart covers the most common depths of spindles. In most cases the deeper spring retainers will use one less spring then number in the chart.

Spindle Type	Spindle Depth	Number of springs	Remarks
10K Non-Locking	2.00	19	
10K Non-Locking	3.00	30	
10K Non-Locking	4.25	43	
7.5K & 15K Non-Locking	4.326	44	
7.5K & 15K Non-Locking	4.627	47	
10K Locking	2.00	18	
10K Locking	3.00	29	
10K Locking	4.25	42	
10K Locking	4.326	40	
10K Locking	4.627	44	

**Spindle Pre-Load**

**Measuring the Spindle Pre-Load**

- 1) Place a Pressure Gage (SVT-0066) on the table and align it with the Spindle nose.
- 2) Set an indicator on the Head and touch the indicator tip on the nose of the Spindle.
- 3) Jog the head (Z axis) down until the pressure gage reads 1000 pounds.
- 4) Zero the Indicator.
- 5) Jog the head (Z axis) up until it is no longer in contact with the pressure gage.
- 6) Depress the "Tool In Out" Button on the keyboard.
- 7) Release Button.
- 8) Read the value on the indicator.

If adjustment is necessary on a adjustable spindle then turn the spindle preload adjustment nut clockwise to tighten and counter clockwise to loosen.

Listed below are the "Fadal factory recommended specifications" for the various spindles.

<b>RPM Rating</b>	<b>Preload setting: (Deflection at 1,000 psi.</b>	<b>Lube Method</b>
15,000 / 10,000.	0014-.0017 (Can Not be adjusted)	Air/Oil
7,500	0013-.0015 (Adjustable preload)	Grease Pac
10,000	0013-.0015 (Adjustable preload)	Grease Pac
15,000	0017-.0019 (Adjustable preload)	Grease Pac

**Spindle Duty Cycle**

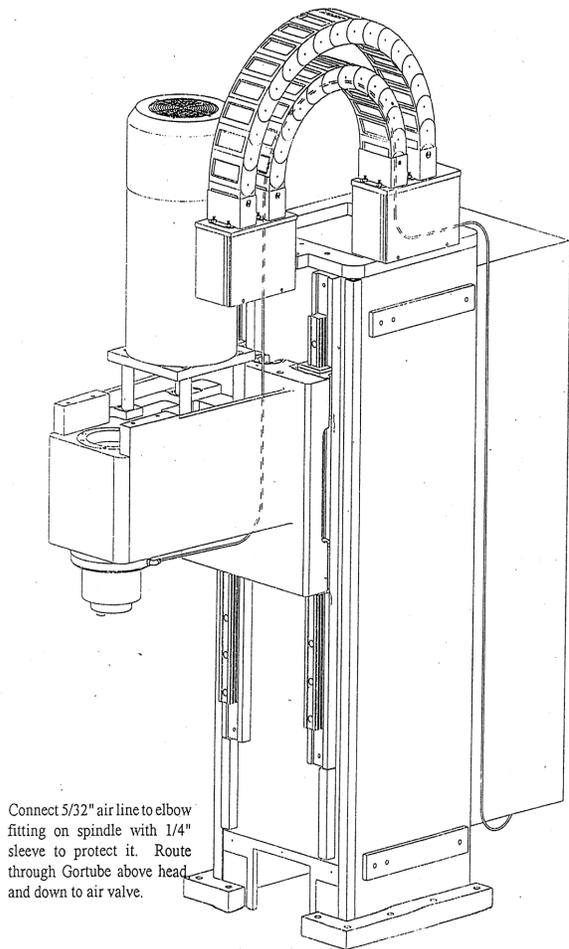
It is the recommendation of the Engineering Department in conjunction with the bearing manufacturers that the following procedures be followed to increase spindle life under extreme operating conditions.

Spindles operating under 8,000 RPMs need no cool down period regardless of on time or load to the tool.

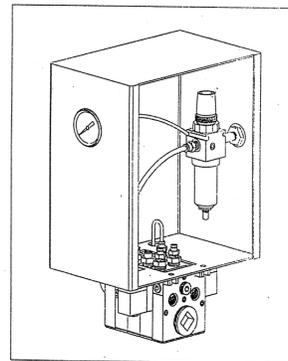
Fadal recommends that Spindles operating at over 8,000 RPMs for extended periods of time should be shut down for a period of at least 20 minutes after

every 5 hours of continuous operation. This will allow cooling of the races and re-lubrication of the grease lubricated bearings. The actual load to the spindle is not a factor at these higher RPMs. The time period should be monitored as closely as possible to increase spindle life.

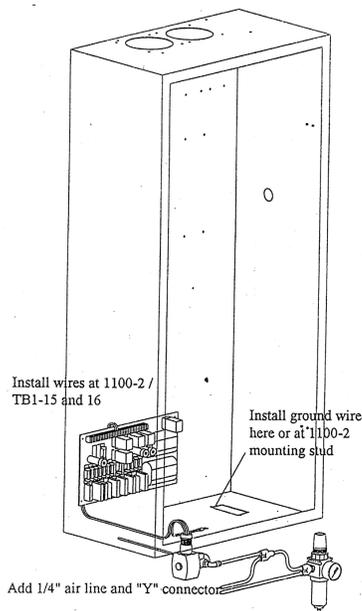
## Air Positive Flow System



Connect 5/32" air line to elbow fitting on spindle with 1/4" sleeve to protect it. Route through Gortube above head and down to air valve.



Remove plug, and install 1/4" x 1/8" MIPT bushing and 5/32QD x 1/8 MIPT fitting into MAC valve at "Orientation OFF" position.



Install wires at 1100-2 / TB1-15 and 16

Install ground wire here or at 1100-2 mounting stud

Add 1/4" air line and "Y" connector

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## Spindles

### 7.5K & 10K Grease Packed Spindles

#### Components

The 7.5K and 10K grease packed spindles are self contained units.

#### Functional Description

These spindles are belt driven and require no maintenance. There is air supplied to the spindle on the top and bottom for positive pressure.

These spindles are self-contained, therefore they should be replaced when bad. The 7.5K spindle has a non-locking drawbar and the 10K has a locking drawbar.

### 15K Air/Oil Spindle

#### Components

The 15K air/oil system consists of a spindle, a spindle lubricating oil supply pump, a vacuum pump, a positive displacement injector (PDI) block, a coalescent filter, four pressure switches (2-15psi, 1-80psi, 1-265psi) mounted on a pressure switch manifold, an electronic control board with wire harness, and various standard plumbing parts. This spindle is also belt driven.

#### Functional Description

The electronic control board controls the ON time of solenoids for oil and air while monitoring:

- Supply oil pressure
- Oil reservoir level
- Supply air pressure
- Air/oil pressure to the upper and lower bearings of the spindle

The pump pressurizes oil to the PDI block. Oil pressure is monitored by an oil pressure switch. Air is supplied to the PDI block through a coalescing filter from a solenoid valve. Air pressure to the machine is monitored by an air pressure switch. The PDI block mixes air and oil. The two lines carry the air/oil mixture to the upper and lower bearings. The pressure of each line is monitored by a pressure switch. A vacuum pump is used to remove any oil that blows by the upper or lower bearings, to reduce oil leakage.

## Spindle/Lube Pump/ Control

### Spindle

Bearings	Ceramic Steel Hybrid
Lubrication	Air and oil pressure feed back control
Operating temp.	Ambient +20°F during steady state operation
Motor Power	15 HP
Max. Speed	15,000 RPM
Max. Cut	3/8"
Max. Depth of cut	3/8"
Max. Tool diameter	3/4"

### Spindle Lube Pump

Lube Pump	Air and oil feed back pressure control
Oil	Mobil DTE 797 Steam Turbine Oil or equivalent
Oil Cycle	Nominal 0.025 cc/injection cycle
Oil Filtration	5 micron absolute
Air Flow	160 SCFH @ 80 psi
Air Filtration	10 micron
Venturi Vacuum Pump	9" Hg

### Control Circuit

Supply voltage	120 VAC
Overload protection	2 amp (fused)

### Spindle Removal

- 1) Verify that the VMC is aligned with the cold start indicators.
- 2) Power off the VMC and lockout/tagout the main disconnect.
- 3) Disconnect the air supply from the VMC.
- 4) Remove the head cover by removing the four 1/4 -20 socket head cap screws.
- 5) Disconnect the electrical connection to the orientation bridge assembly at the six pin connector plug.
- 6) Disconnect the two 1/4" air lines from the orientation bridge assembly.
- 7) Remove the draw bar cylinder plate by removing the six 1/4" hex head bolts and set them aside.
- 8) Remove the orientation bridge assembly and the front belt guide by removing the three 3/8" socket head cap screws.
- 9) To swing the spindle motor forward, loosen the 1/2" hex bolt on the left side of the spindle motor and loosen the two 1/2" hex bolts on the right side of the spindle motor.



10) Remove the spindle drive belt.

**WARNING**

Use heavy duty work gloves when handling the heated spindle and pulley.

11) Using a propane torch, direct the flame at the spindle pulley for approximately 6-10 minutes while slowly rotating the spindle. Maintain an even amount of heat throughout the pulley. The spindle pulley will drop down on the spindle when it is expanded enough to remove it from the spindle.

12) Label and disconnect the upper and lower spindle cooling lines from the spindle. Disconnect the 5/32" air seal line from the lower spindle flange. This will be reused later as the air supply to the vacuum pump.

13) Loosen the upper spindle retainer clamping screw.

14) Remove the six 1/2" hex bolts and lock washers from the upper spindle retainer and lift the retainer from the spindle. Ensure that the cooling line O-ring and the spindle O-ring are removed.

15) Remove the coolant supply manifold by removing the 1/4" socket head cap screw. Move it out of the work area and support it so that the lines are not crimped.

**WARNING**

Support the spindle with a wooden block while performing the next step.

16) Remove the six 3/8" socket head cap screws holding the spindle in the head, remove the old spindle and O-ring. Discard the used O-ring. Save the socket head cap screws.

**Component  
Installation****Regulator/ Separation Block Mounting**

The regulator should be installed at the same location that it was at when the machine was originally installed.

**Installing Spindle Lubrication Pump**

Mount the spindle lubrication pump plate assembly to the side of the column above the way lube pump. On older model VMCs four 1/4-20 holes may need to be drilled and tapped; use the spindle lubrication pump plate assembly as a template.

**Vacuum Pump Installation**

Using the vacuum pump base as a template, drill through and tap two 1/4-20 holes into the left counter weight arm on top of the column. Mount the vacuum pump to the plate.

**Pressure Manifold Mounting**

Mount the pressure switch manifold block on the inside bottom of the cabinet, by removing the four knockouts and drilling the necessary mounting holes.

**Control Board Mounting**

Mount the control board on the inside upper right side of the cabinet, by drilling the necessary holes to attach.

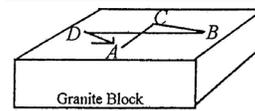
**Solenoid Modification**

- 1) Remove the solenoid fitting on the solenoid closest to the rear of the cabinet.
- 2) Install the T-fitting and 1/4" to 5/32" reducer on solenoid.

- Spindle Tram**
- 1) Level Machine.
  - 2) Adjust TABLE GIBS, SADDLE GIBS, and HEAD GIBS.

Watch for Turcite gibs: .0003"  
 Non-Turcite gibs: .0005"

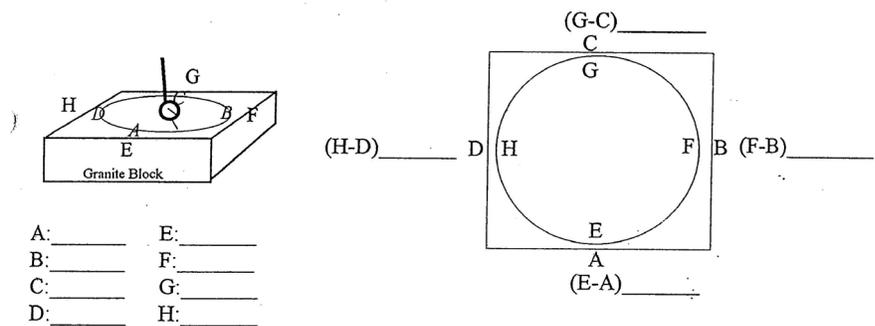
- 3) Adjust TABLE STRAPS.
- 4) Adjust SADDLE STRAPS and HEAD STRAPS.
- 5) Above items must be checked properly or Spindle Tram test may be invalid.



- 6) Establish X,Y plane by mounting an indicator in spindle. Touch off granite block at points A,B,C, and D by moving in MDI as follows:

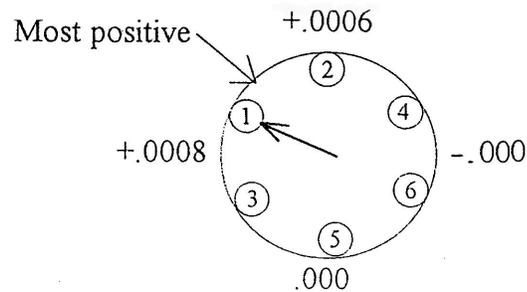
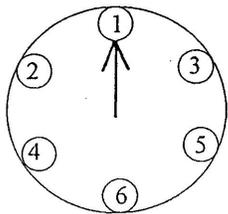
Zero indicator at A	Y-10. F75. G1	(Move to C and record)
	Y5.X5.	(Move to B and record)
	X-10.	(Move to D and record)
	Y5.X5.	(Verify zero at A)

- 7) Sweep indicator over the same four points by rotating spindle by hand. Check each point at E,F,G,H.



### Adjusting Spindle Tram

If spindle is to be installed, follow this procedure. Clean all surfaces and replace O-rings. Mount spindle in head using 6 SoCap bolts. Check tram as described above. Determine which position shows the most POSITIVE error. Imagine a pointer using diagram below, and align arrow on diagram to point towards most POSITIVE direction. Loosen 6 bolts slightly, and tighten according to the diagram bolt pattern with a torque wrench. First, tighten to 25 Ft.Lb. and then to 55 Ft.Lb. Retest tram, and install upper O-Ring and clamp ring. Tighten these 6 bolts also using the following bolt pattern.



### 15K Air/Oil Spindle Installation

- 1) Verify that the lower spindle O-ring is in good condition (not cut, torn or pinched).
- 2) Position the 15K spindle in the head with O-ring seal.
- 3) Install six socket head cap screws and evenly tighten them until they are snug. Torque the socket head cap screws in increments of 25 ft/lbs then 40 ft/lbs.
- 4) Place a magnetic dial indicator base on the spindle. Check the run out on a true plate. The run out should be less than .0005"(.0127mm).
- 5) Shim the spindle if necessary to achieve a proper run out specification.
- 6) Verify that the upper spindle retainer O-rings are in good condition (not cut, torn or pinched).
- 7) Align the upper spindle retaining ring with the cooling passage. Lightly cover the hex head bolts with gasket sealing compound and evenly tighten them until snug. Torque the hex head bolts to 30 ft/lbs.
- 8) Snugly tighten the retainer ring clamping screw.

- 9) Using a propane torch, direct the flame at the spindle pulley for approximately 5 minutes. Maintain an even amount of heat throughout the spindle pulley.

**WARNING**

Use heavy duty work gloves when handling the heated spindle and spindle pulley.

- 10) While the spindle pulley is heating, place the spindle pulley locating spacer (part # SVT-0096) on the ground surfaces of the head.
- 11) Find the orientation mark on the top of the spindle housing and position the spindle so that the orientation mark is toward the front of the VMC. Secure the spindle so that it will not rotate when installing the spindle pulley.
- 12) Place the spindle pulley on the spindle so that it rests on the locating spacer, at the same time align the orientation marks of the spindle and the spindle pulley.
- 13) Allow the spindle pulley to cool to the touch before continuing with the assembly.
- 14) Install the spindle drive belt.
- 15) Place a dial indicator against the top front edge of the pulley and set it at zero.
- 16) Swing the spindle motor towards the rear of the machine until the dial indicator reads .0003" (.0076mm).

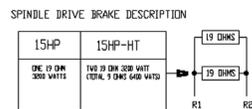
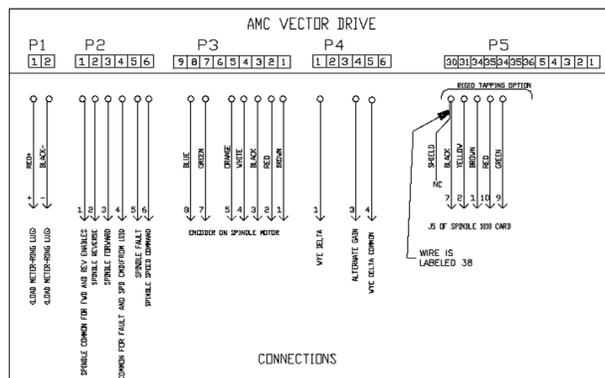
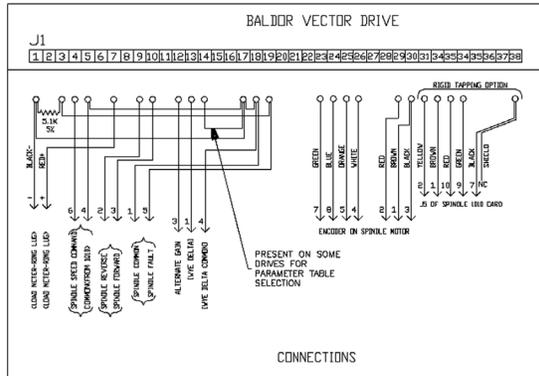
**WARNING**

Do not adjust the belt tension more than the recommended deflection.

- 17) Tighten the 1/2" hex bolt on the left side of the spindle motor and the two 1/2" hex bolts on the right side of the spindle motor.
- 18) Install the orientation bridge assembly and front belt guide with the three 3/8" socket head cap screws, and tighten them snugly.
- 19) Install the draw bar cylinder plate with the six hex head bolts, and tighten the bolts.
- 20) Connect the six pin connector plug into the orientation bridge assembly.
- 21) Connect the two 1/4" air lines to the orientation bridge.
- 22) Connect the coolant lines removed from the old spindle to the upper and lower connections on the new spindle.

**Wiring Harness Installation**

- Using the figure below and the following clarifying instructions, install the wire harness assembly inside the control cabinet.



- The spindle lubrication pump cable runs through any available existing wire way knockout located on the bottom of the control cabinet.
- Attach the spindle pump's black wires to black wire J2-3 from the 1980-0 control board. Connect the spindle pump's white wire to the white wire J2-4 from the 1980-0 control board. The green spindle pump wire should be grounded to the nearest convenient system grounding terminal.
- Remove the wire marked "1" from the spindle overload relay. Splice the wire marked spindle overload relay from the 1980-0 control board onto the spindle overload relay wire. Reattach the spindle overload relay wire to the spindle overload load relay.

- 5) Inspect the machine for the version of mill interface board (1040) installed. The 15K spindle system requires a 1040-2B or newer mill interface board. Update the machine to the newer card if necessary.

**Plumbing Spindle**

- 1) Pull four 5/32" air lines from the back of the machine up through the cable ways to a point just above the head next to the motor mounts. Leave a portion of the lines coiled for extra.

**Note:** Check the machine for the High/Low option 5/32" lines. If these lines are present they can be used instead of pulling the new lines through the cable ways. Label these lines as 21, 22, 25 and 26 if used.

- 2) Pull the 5/32" air seal line previously removed from the old spindle up through the cable way. Connect it to the fitting (32) on the vacuum pump.
- 3) Insert three 5/32" lines in 3 foot lengths into the fittings located on the lower spindle flange. The three lines are the inlet line stamped "AIR/OIL IN" (23), the exhaust line stamped "AIR OUT" (29), and the vacuum line stamped "VACUUM" (27).
- 4) Cover the two lines (23, 27) with 1/4" nylon tubing from the fittings to the point where they enter the head.
- 5) Feed the line from the fitting on the lower flange stamped with "AIR/OIL IN" (23) up through the head to where the four lines are located next to the motor mount.
- 6) Insert three 5/32" lines in 3 foot lengths into the three fittings located on the upper bearing retainer just below the pulley. The three lines are the inlet line stamped "AIR/OIL IN" (24), the exhaust line stamped "AIR OUT" (30), and the vacuum line stamped "VAC/AIR" (28).
- 7) Feed the inlet line, stamped "AIR/OIL IN" (24) on the upper bearing retainer, into the head and up along side the other lines from the lower flange.
- 8) The four lines coming to the head from the back of the machine are two PDI lines (21, 22) and two Pressure switch lines (25, 26). Be sure to keep these lines labeled.
- 9) Connect one air/oil PDI line (21) and one pressure switch line (25) to the double end of the Y-fitting.
- 10) Connect the inlet line, stamped "AIR/OIL IN" (23) on the lower flange, to the single end of the Y-fitting.

- 11) Connect the other air/oil PDI line (22) and the other pressure switch line (26) to the double end of the second Y-fitting.
- 12) Connect the inlet line, stamped "AIR/OIL IN" (24) on the upper bearing retainer, to the single end of the Y-fitting.
- 13) Feed the two outlet lines, one from the lower flange Stamped "AIR OUT" (29) and one from the upper bearing retainer stamped "AIR OUT" (30), into the inside of the head and fasten them to any hose with a nylon wire tie. These two lines are the exhaust lines.
- 14) Verify that a 5-in-line valve system or air-seal valve is installed on the machine. If they currently do not exist on the machine, order and install part number VLV-0006.
- 15) Feed the lower vacuum line (27) up through the head to the vacuum pump and connect it to the Y-fitting (27) on the vacuum pump.
- 16) Feed the upper vacuum line (28) along the top of the head to the vacuum pump and connect it to the fitting (28) on the vacuum pump.
- 17) Verify that all plumbing lines are installed correctly. Secure loose lines as necessary with nylon wire ties.

**Install Component  
Plumbing**

- 1) Complete the installation of all lines for the air supplies, oil supply lines and pressure feed back lines.
- 2) Before filling the spindle lubrication pump with the recommended oil (Mobil DTE 797 Steam Turbine Oil), remove the reservoir and inspect the float on the level switch. The cutaway ridge on the float should be on top. Remove the float and reverse it if the ridge is on the bottom of the float.

**Start Up After Installation**

- 1) Fill the reservoir on the spindle lube tank with Mobil DTE 797 ISOVG32 oil or equivalent. Any other viscosity oil will cause damage to the spindle.
- 2) Check the wiring on the circuit control board.
- 3) Plug in the air supply line to the machine and set the regulators to 80 psi for the left regulator and 120 psi for the right regulator.
- 4) Remove the oil pressure line from the oil pressure switch fitting on the pressure switch manifold. Hold the line over a collecting container. Prime the spindle lubricating pump by depressing the solenoid button with a small screwdriver until all air bubbles are removed from the oil pressure line.

**Note:** Observe the color of the oil coming out of the oil pressure line. If the color is DARK BROWN, there is way lube oil in the pump. Prime the line until the way lube oil is flushed out. The spindle oil color is LIGHT YELLOW, prime the oil pressure line until the oil coming out is this color.

- 5) Replace the oil pressure line at the oil pressure switch fitting.
- 6) Press the reset button on the control board and observe the LED lights (if any lights are illuminated then take the action necessary to correct the condition).
- 7) Prime the PDI block with the spindle inlet lines at the Y-fitting on the head disconnected. Prime until oil is seen flowing through both of the 5/32" lines coming out of the PDI block. Prime by pressing the spindle lubrication pump solenoid button with a small screwdriver. Press it for 10 seconds and release it for 10 seconds and repeat until oil flow is satisfactory. Priming can only be done while the air is flowing to the spindle. If air is not flowing then press and release the reset button. This will provide 2 minutes of air flow.
- 8) After priming the PDI block, run the spindle at 10,000 RPM and monitor the temperature for 20 minutes. If the temperature is high, check the PDI block operation.
- 9) Run the spindle at 15,000 RPM and monitor the temperature. The spindle temperature should be below 100°F after one-half hour. This is the steady-state temperature of the spindle.
- 10) If the temperature exceeds this specification, verify the oil line connections and the oiling cycle.

### Normal Operation

The air/oil spindle lubrication system operates automatically using the 1980-0 control board. The pressure switches will cause an emergency stop condition if the system is not operating properly.

On start-up the 1980-0 Control Board LEDs operate as follows:

- 1) Power on without air and oil to the machine.

**HB** - blinking.

**OIL, AP, LEV, AIR** - illuminate.

**OE, UAP, LAP** - remain out for 13 seconds from power ON, then illuminate.

**OIL** - illuminates, turns OFF in 15 seconds from power ON.

- 2) Power on with air and oil to the machine (Green CNC button depressed).

**HB** - blinking.

**OIL, AIR** - illuminate.

**AP, LEV, OE, UAP, LAP** - remain OFF.

**OIL** - illuminates, turns OFF in 15 seconds from power ON.

**AIR** - illuminates, turns OFF in 2 minutes from power ON.

3) While the spindle is running.

**HB** - blinking.

**OIL** - illuminates only during oiling cycle for 15 seconds every 20 minutes.

**AIR** - illuminated continuously, turns OFF 2 minutes after the spindle stops.

**AP, LEV, OE, UAP, LAP** - remain OFF.

## Troubleshooting

### LED Indications

**HB LED** - Normally flashes indicating that the 1980-0 control board is functioning properly.

**AP LED** - This LED will illuminate when air pressure does not reach or drops below 80 psi. Air pressure less than 80 psi will cause an emergency stop of machine.

Adjust the regulator air output pressure to clear this condition. If the regulator fails to maintain pressure repair or replace the regulator.

If the air pressure is correct, check the setting of the air pressure switch. The slotted adjusting screw, on top of the switch, should be two turns from flush with the switch housing. Check for loose wires. The switch may be faulty if adjusting it has no effect.

**LEV LED** - This LED will illuminate when the oil level in the spindle lube pump tank is low. A low oil level signal will cause a feed hold on the machine until corrected.

Check the sight glass for an adequate level in the supply tank. If tank level is okay, then check for binding, an inverted float, the level float sticking or loose electrical wiring.

**OE LED** - This LED will illuminate when the oil pressure does not reach or drops below 265 psi. Low oil pressure will cause an emergency stop of the machine.

Correct the oil pressure output, by adjusting the air pressure to the pump/PDI block. Loose wires, broken hoses, a bad pressure switch or failure of the

solenoid can also cause this indication. If the oil pressure is still low, verify that the air and oil filters are clean replace elements if required.

**UAP LED/LAP LED** - These LEDs will illuminate if the oil pressure to the upper or the lower spindle bearings drops below 15 psi. Low bearing pressure will cause an emergency stop of the machine.

Loose wires, broken hoses, a faulty pressure switch or the pressure switch adjusted too low can also cause this indication. The adjusting screw, on top of the pressure switch, should be flush with the top of the housing.

### Reset Condition

If any of the above errors occur remedy the problem. Press the reset button located near the top of the 1980-0 control board to clear the error signal. The reset button can be pressed while the spindle is running. The 1980-0 control board will also reset if the power to the CNC is turned off then on.

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## Coolant Thru the Spindle

### Electrical

The coolant thru pump receives its three phase power from the transformer routed through three fuses to a overload starter relay that is controlled by mist coolant output from 1100-1 TB2-23 & 24. K22 (protected by F18) is turned on with a M8 or M7 (SETP setting).

### Mechanical

When the pump is activated, it draws coolant into the filter and then to the pump. The coolant is pumped up to the Drawbar Cylinder. The coolant flows down through the Drawbar Cylinder rod to the seals. The system is designed to ride together under the pressure of the three weak springs, and then hydraulically press together when coolant is present. It will need lubricant present at least 1 or 2 times a day to prevent premature abrading. This is accomplished by activating the coolant thru.

### Coolant-Thru Spindle Seal Kit Instructions

- 1) With a tool already installed in the spindle, remove Drawbar Cylinder and Hydraulic Actuator assembly, if equipped.
- 2) Using 1/4-20 x 2 bolts, thread into CNT-0041 Seal Retainer Ring to hold it into the Orientation Bridge upon disassembly.
- 3) Remove the Orientation Bridge and lay aside, being careful not to fold nylon air lines.

- 4) Remove existing Ceramic Seal retainer and Locking Drawbar Knock-out cap.
- 5) Using Gear Puller and SVT-0073 Drawbar Removal Tool, remove LDB Spring Pilot and replace inner and outer O-rings with HDW-0155 and HDW-0158 respectively.
- 6) Re-install Spring Pilot.
- 7) Now, replace HDW-0177 O-ring on Drawbar and mount new style knock out cap using original bolts.



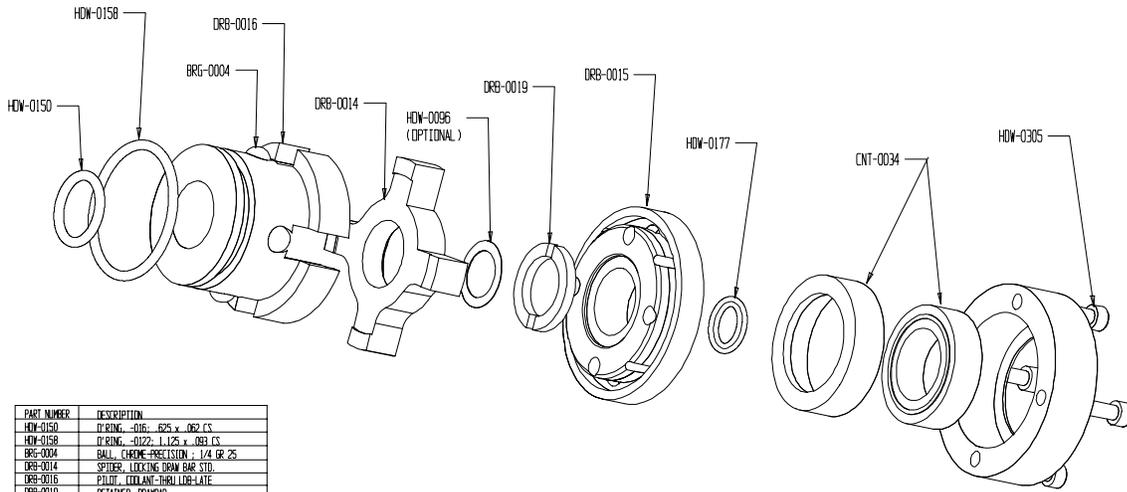
**WARNING:** Do not handle the graphite seal with bare hands, wear latex gloves while installing. Finger oils contain acids which will shorten the service life of the seal.

- 8) Assemble Ceramic seal face into its boot, and press into pocket on new retainer with smooth or unmarked side into pocket first. Install HDW-0177 O-ring onto DRB-0015 Knock-Out cap.
- 9) Mount new Retainer and Ceramic Seal assembly onto Knockout Cap, rotating slightly over the HDW-0177 O-ring. Do not level Ceramic Seal face as in previous versions; it is self-leveling.
- 10) Replace O-rings in the Orientation Bridge, and replace the CNT-0033 Graphite seal.
- 11) Note that the CNT-0041 Retainer has two similar sized O-rings but has the HDW-0156 on the outer piston portion, and the HDW-0150 inside at the top, and HDW-0155 inside at the bottom.
- 12) Place a small amount of Plain water, NOT oil or COOLANT, on the white Ceramic Seal face before mounting the Orientation bridge. Align the Orientation Bridge with the SVT-0071 Coolant-Thru Alignment tool, and reassemble it and the Drawbar Cylinder. Don't forget to remove the two bolts holding the seal retainer.
- 13) After reassembly, run the spindle at S150 RPM for 30 seconds to level out the Ceramic Seal, and lap the Graphite to the Ceramic Seal face.

#### Determining the Leak Location

- 1) Examine area under the Orientation Bridge and around the pulley. If the wires for the orientation and drawbar down hall effect switches has coolant on them then the O-rings (HDW-0150) at the top of the Piston Housing, coolant -thru (CNT-0042) are most likely the problem.
- 2) Remove the Drawbar Cylinder and the Orientation Bridge (don't forget your coolant-thru retainer screws).

- 3) With an indicator, check the level of the Ceramic Seal, this seal needs to be level and is manufactured to a 2 Light-Bars flatness. Run out less than .0003" (.0076mm)
- 4) Verify that the Piston assembly moves freely up and down under the spring pressure on the orientation bridge.
- 5) Inspect the Graphite and Ceramic seals for pitting or chipping.
- 6) Check the O-rings in the Piston assembly.
- 7) Install a 10 micron filter.

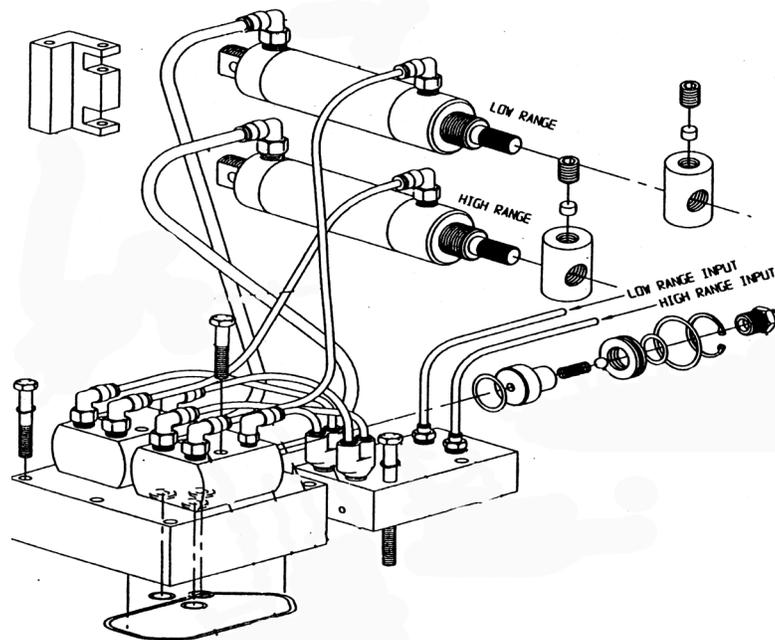


PART NUMBER	DESCRIPTION
HDW-0150	O-RING, -018, -018 x .062 CS
HDW-0158	O-RING, -0122, 1.125 x .063 CS
BRG-0004	BALL, CHROME-PRECISION, 1/4 GR 25
DRB-0014	SPIDER, LOCKING DRAW BAR STD.
DRB-0016	PILLOT, COOLANT-THRU LOG-LATE
DRB-0019	RETAINER, SPANNER
HDW-0086	SPACER, ADJUST, LOG SPIN, .007 THK.
DRB-0015	NOCK, OIL CAP, LOG
HDW-0177	O-RING, -111, .437 x .063 CS
CNT-0034	SEAL, CERAMIC FACE, COOL-THRU
HDW-0305	SCREW, 6-32 x 1/2, STEEL
CNT-0015	SEAL KIT, COOLANT-THRU UPGRADE

COOLANT-THRU-SPINDLE SEAL SYSTEM

E:\30 MODELING\COOLANT THRU SPINDLE SEAL SYSTEM 07/16/97

### Hydraulic Actuator Set-up



40 Taper BT & CAT  
Pull Studs

