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Product Identification: PCNC 1100 Milling Machine (Pre-Series II)

Background:

Pre-Series II PCNC 1100 use an analog VFD (variable frequency drive) as the primary spindle drive (PN 30163). By their nature, analog VFDs require occasional recalibration by adjusting the settings of the potentiometers on the VFD. These settings can affect the accuracy of the spindle speed, stability of speed, torque levels, and even fundamental operability.

Drives are factory preset, but adjustment may become necessary as contactors become oxidized over time and affect performance. Adjustment will also be necessary if installing a replacement drive.

Indicators that the analog VFD may need calibration include:

- Spindle is slow to accelerate or decelerate
- Spindle does not reach speed
- Spindle will not start
- Unexpected spindle fault
- Spindle slows considerably or stalls under normal loading
- Spindle speed surges

This document does not apply to Series II PCNC 1100 machines, which use a digital VFD to drive the spindle. A digital VFD upgrade kit is available (PN 31090) for Pre-Series II machines and provides improved performance. See http://www.tormach.com/document_library/TD31090_DesignAnalysis.pdf for design details. A digital VFD does not require tuning or calibration procedures such as those described in this service bulletin.

Warning:

The VFD contains potentially lethal voltages any time there are LED's lighted. These voltages are exposed on terminals and on various sections of the circuit boards. Qualified technicians often adjust such devices while they are under power, but this should only be done with properly insulated tools and with extreme caution. Under no circumstances should you ever adjust a potentiometer with their finger while the drive is under power. Seek the assistance of a qualified electrical technician if needed.

Wiping the Potentiometers:

The electrical contacts on potentiometers can become corroded over time, and this can affect the performance of the analog VFD. Many issues related to corrosion can be corrected by simply *wiping the pots*; that is, turning each potentiometer through its full range of motion several times before returning it to its initial position. This will generally remove any corrosion and restore performance.

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Complete Adjustment:

Complete adjustment of the analog VFD may be necessary if wiping the pots did not restore function or if a replacement VFD is installed.

There are two parts to the adjustment process.

1. Setup the VFD and calibrate to the manual speed command.

2. Calibrate the computer generated speed command to match the manual speed command.

Part 1 is done for each machine at the factory but may also be required if the VFD is replaced. The process requires a tachometer for speed calibration. Part 2 is completed by the machine owner. This is a normal machine setup procedure and detailed in the maintenance section of the machine operators manual. The process requires a voltmeter and does not involve measurement of spindle speed.

Notes:

WARNING: Errors in the wiring or jumper settings can destroy the motor drivers.

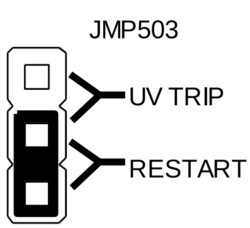
WARNING: Errors in application of this procedure are NOT covered by product warranty.

Part 1, the manual speed calibration, requires a tachometer and a voltmeter. Tormach offers a suitable digital tachometer (PN 30527). Part 2 only requires a voltmeter.

Part 1: VFD Configuration and Adjustment to Manual Speed Command

Before Adjustment:

Ensure the jumpers are installed correctly as shown in the following diagrams. Approximate potentiometer positions are indicated as well. <u>Understand that the actual position of the potentiometers will vary among machines and should be set as indicated in *Fine Tuning* section below.</u>



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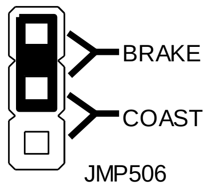
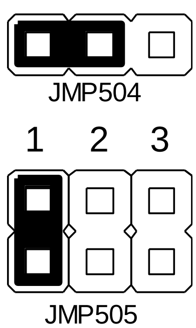

BRAKE
COAST
JMP506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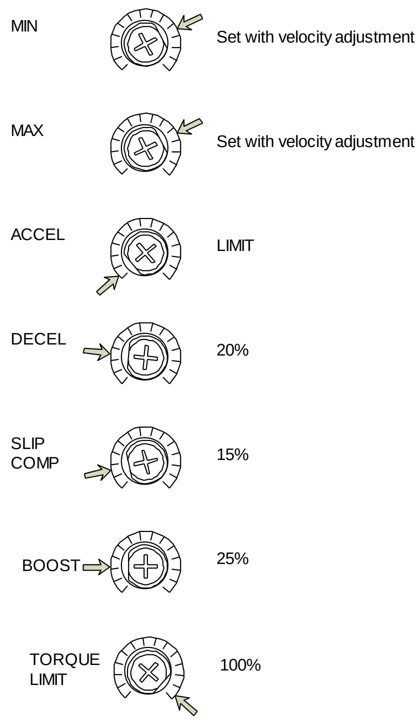

NOTE:

These are approximate positions only. Check the ***Fine Tune*** reference below for details.

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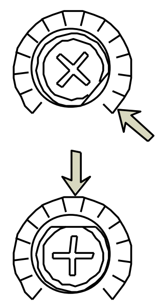
BRAKE CURRENT



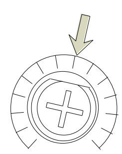
100%

BRAKE TIME

50%

NOTE:

These are approximate positions only. Check the ***Fine Tune*** reference below for details.



4mA ZERO SET

Set with velocity adjustment

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Fine Tune Velocity Adjustment Procedure

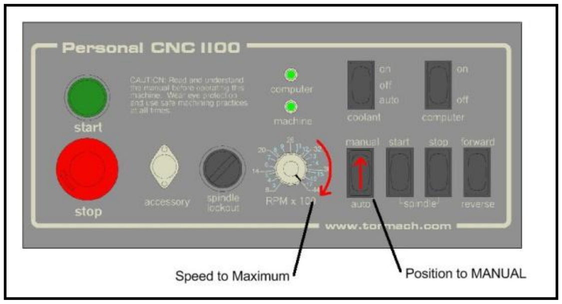

Figure 1

Figure 2

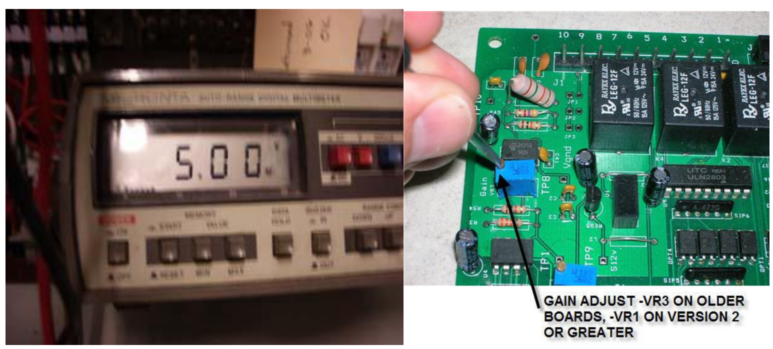

Figure 3 Adjusting GAIN on PCNC Control Board

Procedures of Velocity Adjustment

1. Turn on machine power
2. Turn on operator console key switch "SPINDLE LOCKOUT" to make sure the spindle can run, and then turn speed control to full speed. **(Figure 1)**
3. Set operator console spindle to MANUAL **(Figure 1).**
4. Press the black "START" of spindle control to start the spindle.
5. Set voltmeter to DC volts
6. Black (negative volt) voltmeter to wire S1. **(Figure 2)**
7. Red (positive volt) voltmeter to wire S2. **(Figure 2)**
8. Voltmeter should read 5.0 V. This is the spindle speed command. If not, use VR3 to make small adjustment for exact reading of 5.0 V on the PCNC control board by using a small screw driver **(Figure 3)** [1,2,3]
9. Put machine V-belt in low speed position (lower).
10. Press "START" of spindle control
11. Using a tachometer, adjust MAX until speed is at 1750 RPM while the speed control is at full speed.

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1 On some machines, VR3 is labeled as VR1 on the control board.
2 Machine serial numbers 1 through 58 originally were set to 10 V. Adjust VR3 as necessary to reach 5 V.
3 Voltage can also be measured on the control board. Wire S1 is analogous to wire J1-2 and wire S2 is analogous to wire J1-1.

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12. Turn manual speed control on operator console to minimum. Use 4mA ZERO SET until speed is 300 RPM. If 300 RPM cannot be achieved, then adjust MIN. Both 4mA ZERO SET and MIN can be used.
13. The MAX and MIN settings will each change the other. Repeat procedures 11 and 12 until 1750 RPM is high speed and 300 RPM is low speed. There is some interaction between 0-4mA ZERO SET, MIN, and MAX such that a change of MIN has some effect on MAX. By iterating between procedures 11 and 12 you will narrow in on the correct balance.

Fine Tuning

NOTE: Fine Tuning is not normally needed on anything other than the MIN, MAX, and ZERO SET adjustments as described in the prior section. The procedures below can be useful if nominal settings result in problematic operation of the drive.

ACCEL: Acceleration of the drive should be set to maximum by turning it CCW. CCW is greater acceleration, CW is slower acceleration.

Troubleshooting

- Very slow acceleration is observed: On occasion there may be a dead spot at the limit of travel. In this case it will "fall off" and the resulting acceleration to speed will take more than 10 seconds. If this occurs then simply turn the potentiometer a small amount CW until the maximum acceleration is achieved.

DECEL: The best deceleration rate can be found by running the spindle with the belt in the high speed position under manual spindle control. CCW is greater rate of deceleration, CW is a slower deceleration rate. After the spindle has come up to speed, rapidly turn the speed to the minimum. If the deceleration is too rapid the FAULT LED will come on. This is due to an overvoltage fault, created by the energy of the spinning spindle being transferred to the drive capacitors. The fault will be reset by stopping the spindle and restarting. If this occurs then adjust CW. Too far CW will result in excessive time for deceleration. The best position is to decelerate as quickly as possible, but no so quick as to create a fault condition.

Troubleshooting

- Variable or slow stop action under automatic control: Too rapid of a deceleration rate can also result in very slow stop action when stopping with the spindle under computer control. This is the result of the spindle faulting while stopping.
- Faults occur after spindle is warm: As the machine warms up the spindle turns more freely. If you have set the DECEL just on the edge of faulting then it is likely to fault when friction is reduced because the machine has warmed up. Just back it up a bit (CW).
- Faults can occur with very heavy tooling. Deceleration rate will mayneed to be turned back a bit (CW) if heavy tools are used at high speed as this increases the kinetic energy which the drive must absorb during deceleration.

SLIP COMP: The speed of an induction motor will be reduced when a load is applied. This is referred to as slip. The spindle drive has a feature where it can sense the load and will increase the speed in order to compensate for the speed reduction. This is referred to as Slip Compensation and is adjusted at the SLIP COMP trimmer. CCW is less compensation. With too little compensation the spindle will slow down noticeably when under load. The effect is more pronounced at low speeds. Turning CW it more compensation. Too much compensation can lead to speed surge, speed oscillation, and drive faults. The 15% suggested normally works. Further CCW is safe but the spindle will not offer the best possible slow speed performance. Note that adjustment of SLIP COMP may alter the velocity adjustments. If this occurs, the FINE TUNING OF VELOCIY procedure above should be revisited. Optimum setting requires the addition of a controlled load on the spindle.

Spindle Loading: Our preferred method to test spindle loading is to use a TTS machinable blank (PN 30475) and a rugged leather glove. With the spindle in the high speed belt position and the spindle running at the lowest possible speed, the operator will apply friction by hand using at leather glove and squeezing on the spinning cylinder. It's actually quite easy to put a significant load on the spindle in this way. Any smooth round object with a 3/4" shank or R8 taper can also be used in place of PN 30475. It should have at least 1.25" diameter, preferably 1.5" in diameter. Never use anything that is not smooth, or anything that has a cutting tool. Chucks or other spinning objects can easily catch clothing.

By loading a slowly turning spindle as described above, the speed reduction associated with an increased load is quite easy to detect. When SLIP COMP is turned CW, you can detect a significant response from the spindle. When you try to slow it down, it comes back and counteracts. It's rather like pushing against someone and feeling them push back. When the adjustment is made too far CW, the drive will overreact and any load will create a speed surge.

The correct adjustment is when there is some slip compensation, but not enough to increase the actual speed. There should always be a speed reduction when loaded. If not, then a load will likely result in a speed oscillation. Slightly too much compensation (too far CW) will result in a speed oscillation. Far too much can result in speed surges and drive faults.

BOOST: Boost adjusts the current to the motor at low speed. It should be set as shown. There is no need for fine tuning on the boost parameter.

TORQUE LIMIT: This is adjusted for the current capacity of the motor. The correct setting is fully CW. As this is turned CCW the available torque of the spindle will be reduced. Torque limit is active when the yellow LED is on.

Troubleshooting

- Torque limit LED always comes on: On occasion there may be a dead spot at the limit of travel. In this case it will "fall off" at the end and the resulting torque limit is a minimum instead of a maximum. If this occurs then simply turn the potentiometer a small amount CCW until LED does not come on.

BRAKE CURRENT: The drive is brought to a stop using a DC injection brake. The motor can accept the maximum brake current the drive is able to deliver, so this should be set fully CW.

BRAKE TIME: The current is held on for a fixed amount of time, adjusted by the BRAKE TIME setting. CCW is less brake time, CW is more brake time. The middle setting is normally correct, about 7 or 8 seconds. This is the amount of time necessary to bring the spindle to a stop from 4500 RPM. Note that, in terms of the spindle drive, stopping is not the same as deceleration. Stopping occurs when the enable signal is dropped and involves the DC injection brake. Deceleration occurs when the spindle enable signal is held on, but the speed command is reduced. The DECEL adjustment dominates over deceleration, the BRAKE adjustments dominate over stopping.

Observation of brake action: Using a TTS machinable blank (PN 30475), or any other device mounted in the spindle that would be safe to grab by hand (no cutting tools please!), set the spindle to the lowest possible speed and then command a spindle stop. After the spindle stops turning, grab the spindle by hand and try to turn it. You will feel a distinct resistance to rotation. This is the DC injection brake acting. After a few seconds the resistance goes away. This time is the BRAKE TIME. This technique can be used to document the time of the braking action and determine the correct brake time setting. There is no need to extend the brake action time beyond the time required to stop from the highest

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possible spindle speed. Conversely, if the brake action stops before the spindle comes to a complete stop, the spindle stop time will be extended.

Part 2: Adjustment of Computer Speed Command to Match Manual Speed Command

Refer to Operators Manual, section 9.5.8, http://www.tormach.com/document_library/PCNC1100-3-UM-C4.1.pdf

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