

# TB166 (Rev3) - Encoder Alignment on AC Brushless Motors

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## Purpose

AC drives rely on knowing the motor position in order to stay synchronized while driving the motor. Before the motor is mounted on a machine, the motor's encoder commutation tracks are aligned with the motor phases. The drive applies sinusoidal voltages to the three-phase input to rotate the motor shaft to a starting position. Typically, there will be four poles in a full rotation of the shaft. In Centroid software, the index pulse can be aligned with any one of these.

The drive also looks at the commutation lines from the encoder to give it a coarse position of the shaft for smooth movement on power up. These commutation signals are interpreted by the drive as zones 1 through 6. As the motor turns clockwise looking at the output shaft the encoder counts should increase. Centroid AC motors use a differential, 8 pole, 5V, quadrature encoder with an index pulse. The encoder resolution depends on the motor and the drive (see below).

**This procedure can also be repeated if you suspect the encoder alignment is incorrect. An incorrect alignment will show the following symptoms:**

1. Axis is jumping.
2. Motor is running roughly.
3. Motor runs better in one direction than the other.
4. Motor has an uneven amount of current draw in one direction than the other.
5. Large current draw with a light load.

## Prerequisites

- If connecting a motor to a drive for the first time, please complete the following steps:
  - Check for  $>100\text{ M}\Omega$  between the motor chassis and power terminals.
  - With the motor connected to drive, confirm continuity between the drive chassis and motor chassis.
  - On the drive terminal, check for  $>100\text{ M}\Omega$  between your power and shield terminals.
  - Check VM wiring for correct polarity
  - Additional information on motor testing can be found in your installation manual and [Technical Bulletin 155](#).

## Tools and Equipment for Encoder Alignment

- A set of metric and SAE hex keys.
- A small Philips head screw driver set.
- Loctite Blue 242 (Optional)
- If removing the motor from the machine, a set of clamps such as Irwin Quick Grips.
- If there is any contamination or debris inside the end cap, basic cleaning supplies such as a paper towel and all-purpose cleaner.
- If changing the encoder, the correct replacement encoder and pigtail (see chart on next page).

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### Stock Centroid AC Encoders

Encoder Model	Encoder Description	Typical Application	Encoder Pigtail <sup>2</sup>
Quantum Devices QR12-2048-8-A-B-E-A-A	2,048 line, 8 pole, 5V, 8mm shaft	750W, 1KW, and 2KW motors in systems not using an AC/DC drive.	For 1KW and larger motors: <a href="#">Drawing Number: S13244</a>
Quantum Devices QR12-10000-8-A-B-E-A-A	10,000 line, 8 poles, 5V, 8mm shaft	Motors used with the AC/DC drive.	For 750W motors: <a href="#">Drawing Number: S13267</a>
Dynapar F144096/8395A	4,096 line, 8 pole, 5V, 8mm shaft	3kW and 4KW motors in systems not using an AC/DC drive.	<a href="#">Drawing Number: S14427</a>
<b>(OBSOLETE)</b> <sup>1</sup> : Koyo TRDA-VC2048v8-7154	2,048 line, 8 pole, 5V, 8mm shaft	750W, 1KW, and 2KW motors in older systems.	No drawings available online. Contact Centroid for details.
<b>(OBSOLETE)</b> <sup>1</sup> : Dynapar F142048/8395A			
<b>(OBSOLETE)</b> <sup>1</sup> : Renco R35i-2048/8			

1. **Obsolete Encoders:** Obsolete encoders are replaced by Quantum Devices Model QR12-2048-8-A-B-E-A-A. If you are replacing an obsolete encoder with a Quantum encoder, you may need to drill and tap new encoder mounting holes.

2. **Encoder Pigtails:** Drawings are for standard pigtails using standard **Centroid** motors. These drawing might not apply to some rotary tables, retrofits/upgrades, or custom systems.

Older motors may have a temperature sensor on the motor connected to pins S & T of the MS connector. **Disconnect the temperature sensor by unplugging it (if possible) or cutting the wires.** Use of the motor temperature sensor was never supported, and newer encoder cables and pigtails use pin T as the shield ground. At the bottom of Figure 5., you can see an example of a cut temperature sensor.

If you are replacing the encoder pigtail, inspect the condition of the rubber gasket around the MS connector. Worn gaskets need to be replaced. A replacement gasket is Centroid Part Number 4647.

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## Alignment Setup

The motor must be disconnected from the machine or have the machine drive belt removed for the alignment process. This procedure is best performed on a sturdy bench where you have good lighting and easy access to the encoder. If the motor is removed from the machine, the motor frame must be firmly secured to the bench using clamps or some other attachment method. The motor may try to jump around during the procedure (especially if something goes wrong during the alignment). Before starting the alignment procedure, the drive software must be configured correctly.

## Alignment Procedure

**DANGER:** Do not jog the axis until instructed!

1. Remove the motor end cap.

- NOTICE:** Any dust, dirt, coolant, or other contamination inside the motor end cap can get inside the sensitive internal components of the optical encoder and cause a premature failure. Make sure the inside of the motor end cap and encoder mounting plate are clean before continuing with encoder alignment.

If there is a large amount of contamination inside the end cap, there is a high probability that the existing encoder will work unreliably and need to be replaced. If there is liquid inside the end cap, there may also be liquid inside the motor. A motor with liquid inside is a serious safety hazard, and will have to be replaced.

- If installing a new encoder, remove the old encoder. Attach the new encoder. Loosely tighten the encoder ears and encoder set screws so the encoder spins when the shaft moves. **TIP:** A small nylon washer between the encoder mounting screws and the encoder ears will make alignment easier. This step is optional.
- Connect power cable and encoder cable from the drive to the motor.
- Power up your drive and control system running Centroid CNC software
- In your CNC software, access the PID menu by pressing **F1-Setup**, **F3-Config**, **F4-PID** as shown below in Figure 1. Homing the motor is not necessary.

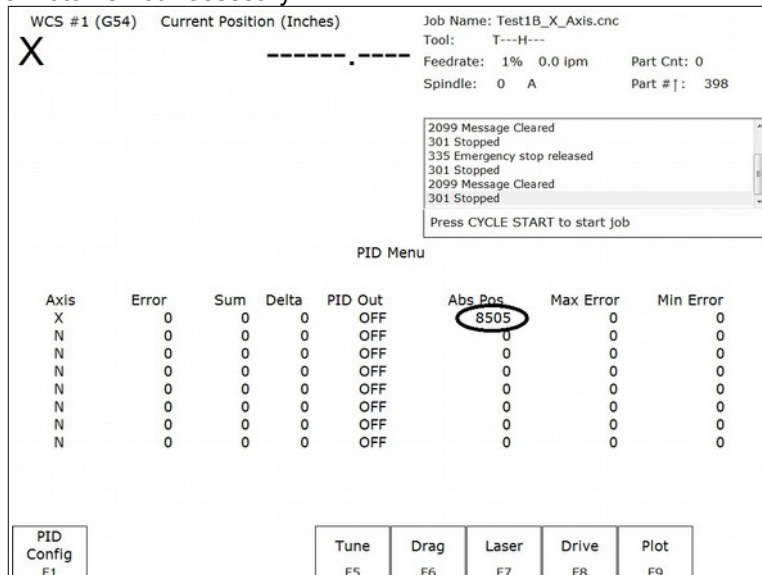


Figure 2. Drive Configuration Menu

- Looking at the motor mounting flange, manually rotate the motor shaft clockwise. The "absolute position" on the PID screen should increase as circled in the picture above. If the position does not increase check the drive communication, encoder cable, and encoder pigtail.

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- NOTICE:** The AC/DC drive needs the encoder correctly connected/wired **before** starting up the CNC11 software or drive. If the encoder is not detected upon start up, you will need to restart both the AC/DC drive and the CNC11 software before trying to test the encoder again. AC/DC users can troubleshoot drive errors through the HSC bit screen definitions as described in the AC/DC manual.

- Go to the drive configuration menu by pressing **F8-Drive** as shown below in Figure 2.

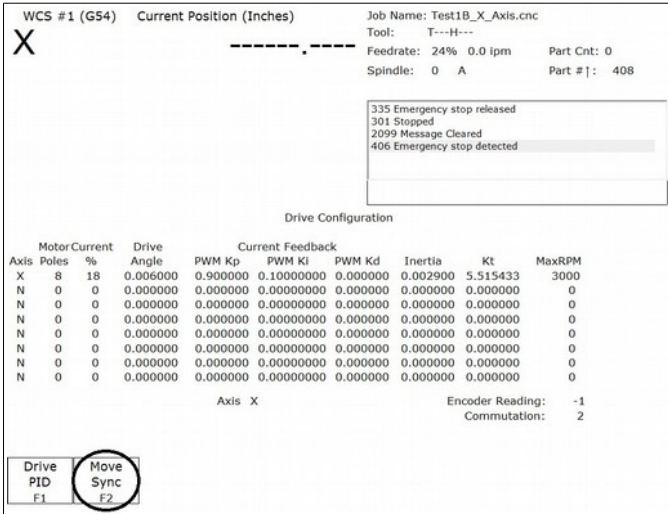


Figure 2. Drive Configuration Menu

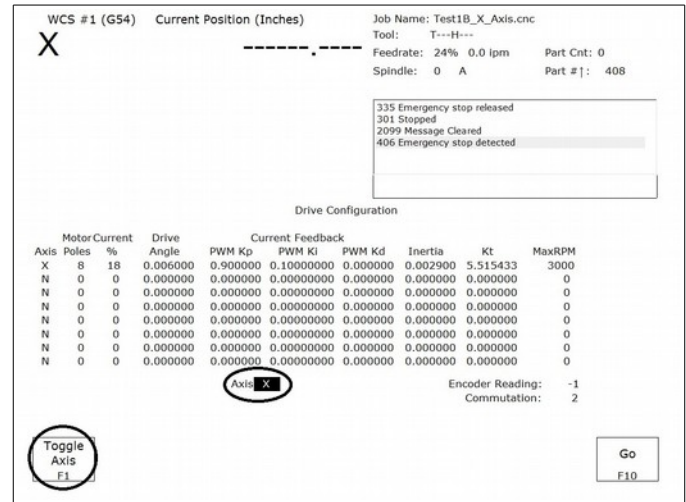


Figure 3. Move Sync

- Press **F2-Move Sync** as circled in Figure 2. The axis selected is shown underneath PWM Kp as circled in Figure 3. If you are not on the correct axis, press **F1-Toggle Axis** until the correct axis label is on the screen. Finally press **F10-GO**. The shaft should rotate. The first move sync rotation may cause the motor to jerk or move roughly. Move sync a few more times by pressing **F2-Move Sync** then **F10-GO** repeatedly. All move syncs after the first sync should cause the shaft to rotate smoothly. **If the motor oscillates wildly, moves erratically, or makes loud unusual noises, kill the motor power immediately!**

- DANGER:** An incorrectly wired or configured motor may move violently or unpredictably when attempting move sync. Keep your body (and others) away from the motor when move syncing for the first time, and be prepared to hit the emergency stop.
- DANGER:** Large motors may have a tendency to oscillate violently during a move sync due to nature of the current feedback loop. It is recommended for 3KW and larger motors that you adjust the motor current to half of the recommended value in the current feedback menu while move syncing. After the encoder alignment process is complete, set the current back to the recommended setting.
- NOTICE:** If the motor slightly oscillates after move syncing or continues to move a little rough while move syncing, grab the motor on the shaft carefully with your hand. Move sync the motor while gently squeezing the motor shaft. If the oscillations and/or jerky movements go away after applying a small amount of load to the shaft, this is normal. This problem will not occur during normal motor operation.
- NOTICE:** If no motor movement occurs, an error was encountered. AC/DC users can troubleshoot drive errors through the HSC bit screen definitions as described in the AC/DC manual.

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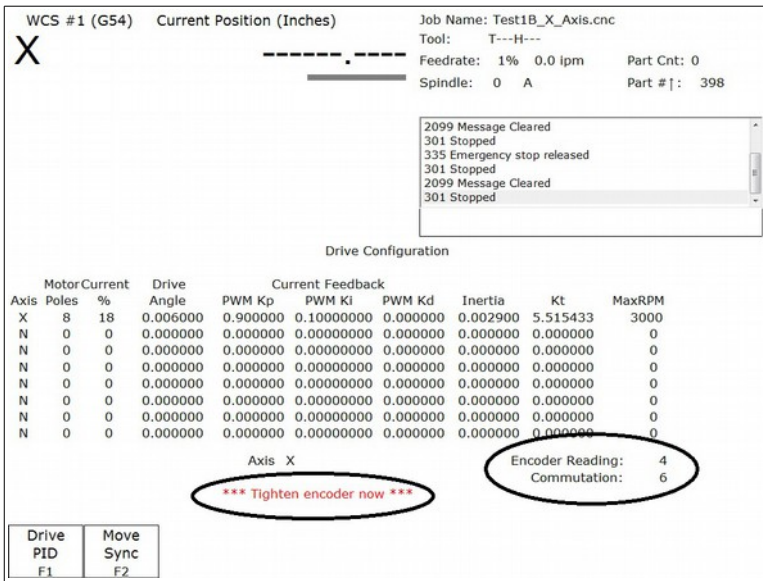


Figure 4. Encoder Alignment



Figure 5. Encoder Collar Set Screws

- Keep running the move sync operation until the point where the encoder reading is closest to 0 or its maximum encoder count. The "Encoder Reading" is circled in Figure 4.
- Loosen the encoder collar set screws as shown in Figure 5.
- Move the encoder until the encoder reading is as close to zero as reasonably possible.
- Tighten the encoder collar set screws. The encoder collar usually has two set screws on most encoders; make sure both are tight if applicable.
- Loosen up the encoder ears and use them to fine tune the adjustment. When the encoder is within specifications, a red message will appear on the control saying "\*\*\* Tighten Encoder Now \*\*\*" as circled in Figure 4. Tighten the encoder ears. The encoder mounting plate is usually made out of aluminum, so **DO NOT OVERTIGHTEN!** If the screws do not fit tightly in the encoder mounting plate, Loctite blue (242) or similar may be used.
- Press **F2-Move Sync** and **F10 - Go** to rotate the motor shaft several full revolutions. Verify that the software still displays "\*\*\* Tighten Encoder Now \*\*\*" when closest to the zero position. Some encoder re-adjustment may be needed. Observe the commutation count goes 1 through 6 consecutively. The commutation count is displayed below encoder reading as circled in Figure 4. At rest position the commutation zone should be either a 1 or a 6 only. A 0 or a 7 as the commutation value indicates a bad encoder or wiring problem.
- Install the end cap onto the motor. Be careful placing the encoder cable in the end cap. If the cable is causing any strain or tension on the encoder, it will push the encoder out of alignment.
- Reboot the drive and control system.

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17. After a reboot, fast jog the motor in each direction to verify correct operation.
18. In the drive configuration menu, do a final move-sync check to verify that the motor is still aligned correctly. Look for the red message saying “\*\*\* **Tighten Encoder Now** \*\*\*” when the motor is closest to zero.
19. The motor is ready for normal operation after the system has been rebooted again.

### **Important Notice!**

**This procedure must be done every time a new encoder is installed on a Centroid AC Brushless motor.**

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### **Document History**

Rev3 Created on 2014-03-10 by #369

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