

Commissioning Sine-Cosine with Serial Comms Encoders Connected to Unidrive SP or ES

The Encoder:

The direction of rotation of the encoder must be verified. Facing the shaft end – or for an encoder with a through hole bore, facing the normal mounting end, if the shaft is rotated then Parameter, Pr3.29 should count up. If not, then the wiring to the encoder connector terminals 1, 2, 3, 4 (cosine, cosine ref, sine, sine ref) at the drive is usually not correct if the Pr3.29 counts down. If the count is erratic or it doesn't count, this could be caused by improper wiring as well or a problem in the encoder where it does not produce proper sinusoidal outputs or the ref voltages. Alternatively there could be a problem in the drive's receiver electronics. See below the section on proper encoder signals.

The number of sine waves per revolution, set at Pr.3.34, must be correctly (4096, 2048, 1024, etc.). If this is not correct, then if the shaft is rotated one revolution clockwise (facing shaft end), Pr3.29 will not count to 65535 and roll-over to 0 every one rev of rotation – it will take twice or half as much rotation for example. Pr3.34 will need to be changed until the 65536 counts per revolution occurs. Often the number of wave/rev is marked on the encoder or motor. **Note that setting Pr3.41 to an ON state will cause the drive to automatically query the encoder via its serial comms and the proper waves/rev will appear in Pr3.34 – this also helps to verify that the serial comms is working properly.**

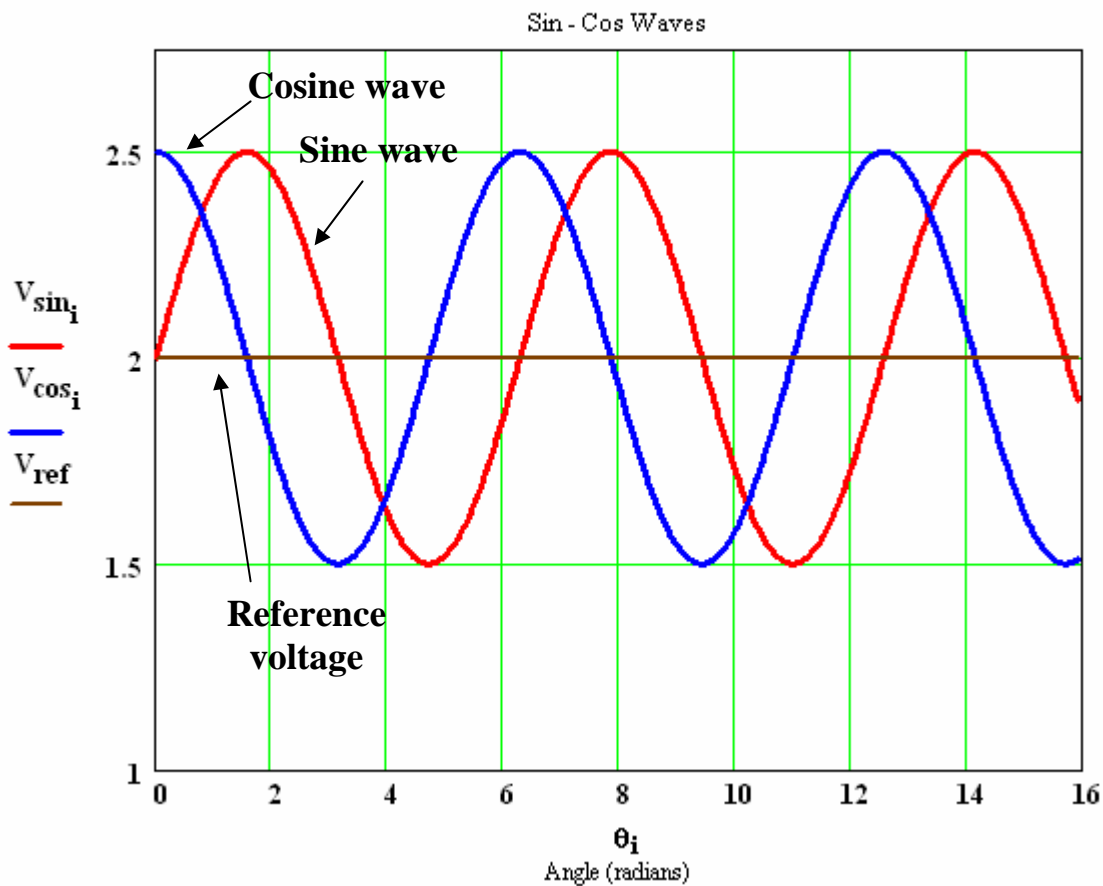
The count per revolution in Pr3.29 must be exactly 65536 – rolling over from 65535 to 0 for clockwise rotation, or 0 to 65535 for CCW rotation, after exactly each revolution. Marking the encoder shaft and housing may be needed to verify this. Assuming that Pr3.34 (waves/rev) is set properly, if some other count is observed, so that the roll-over point (to or from 0 and 65535) recesses or processes in angle, this usually indicates a large amount of electrical noise exists on the signals, or otherwise there may be problem in the encoder or the electronics in the drive receiving the signals. See below in the section on proper encoder signals.

The Driven Encoder Single Turn Bits, Pr3.35 must be set to 15. The default value for this parameter is 0. The motor and drive may function properly after an autotune with this parameter set to 0, however it will usually not function properly after an interruption of AC power to the drive. **Note that setting Pr3.41 to an ON state will cause the drive to automatically query the encoder via its serial comms and the proper number will appear in Pr3.35 – this also helps to verify that the serial comms is working properly.**

The sine and cosine and reference voltage waveforms are shown in the diagram below. This is what would be expected to be seen on an oscilloscope for clockwise rotation facing the encoder shaft. (*Note that this is CCW for the encoder itself, or as thought of as “looking out” from the encoder towards its own shaft. This follows the standard mathematic convention where increasing angle is in a CCW direction. The same convention is followed for motor given a “U, V, W” sequence of phase voltages.*) In the diagram, the cosine wave leads the sine wave for CW rotation facing the encoder shaft – for CCW, the two signal reverse there relative position.

For clockwise rotation facing the encoder shaft:

$$V_{\text{ref}} := 2 \quad V_{\text{sin}_i} := .5 \cdot \sin(\theta_i) + V_{\text{ref}} \quad V_{\text{cos}_i} := .5 \cdot \cos(\theta_i) + V_{\text{ref}}$$



The communication data can be observed on an oscilloscope as a differential signal between terminals 5 and 6 at the drive’s encoder connector. During drive operation, occasional bursts (about every second) of data, only 10 to 20msec long will be seen on terminals 5 and 6 (relative to the 0V common of the encoder connector). The voltage, when data is being transmitted, is about 2Vp-p riding on top of a 2 to 3.5 volt DC level.

Proper sine and cosine wave and serial data reception at the drive can be verified if Pr3.40 is set to 3. With this parameter set to 3, the drive interrogates the encoder via serial comms as to its angular position once per second. It compares this to the count of sine and cosine waves it has been receiving from the analog channels. If a discrepancy of 10 degrees occurs for 10 repeated interrogations, a trip will be initiated.

Motor Parameters and Connections:

For servo (synchronous) motors the proper motor parameters must be entered: operating mode, Pr0.48 = **SE-UD**, motor current, Pr0.46, number of motor poles, Pr0.42, and motor max speed Pr0.02.

If the number of motor poles is not known: The number of poles can be determined by shorting two of the winding leads and manually rotating the motor rotor by hand. As the rotor is rotated distinct angular positions of higher and lower resistance torque will be felt. There will be as many of these torque pulsations per revolution of the rotor as there are poles of rotor magnets (combined N and S poles on the rotor). (Note that the number of poles is twice the number of pole pairs so that if a motor has 6 poles, for example, it will rotate at 1/3 the electrical applied frequency – i.e.: 60Hz input results in 20 rev/sec or 1200RPM.)

For induction (vector) motors: The operating mode, Pr0.48 = **CL UECE**, motor current, Pr0.46, number of motor poles, Pr0.42, and motor max speed Pr0.02 must be entered. For induction motors, it is important that Pr0.45, the motor rated full load speed be entered properly. Often “vector” duty motors will give a rated speed of 1800RPM for a 60Hz, 4 pole motor, for example. For such a motor this is its “synchronous”, no load speed. For typical induction motors, full load speed will be on the order of 97% to 99% of the synchronous speed, so that for a 4 pole, 60Hz motor, Pr0.45 might need to be set to 1760RPM, for example. Once the drive can be run under load, Pr0.33, the rated speed autotune, can be set to 1 – this will automatically adjust the rated speed to an optimum value.

The motor 3-phase connection must have the proper phase rotation sequence. If the drives output sequence is U, V, then W (which is normal for “forward” rotation) then the motor should rotate clockwise, given a positive speed reference – that is if you are facing the shaft end – or more specifically it must make the encoder rotate CW facing its shaft end.

Motor direction of rotation: If it is desirable to make the motor rotate in the opposite direction given a positive polarity reference, it is not possible to reverse two motor phases and reverse the encoder signals as can be done with a common “A A\ B B\” encoder. It will be necessary to either provide the drive with the opposite polarity signal or invert the reference by setting Pr1.12 to a 1, for example.

For Additional Information consult [CTAN256](#)

Questions ?? Ask the Author:

Author: Jim Thompson
(716)-774-0093

Latest Rev.: 2008.01.28
e-mail: jim.thompson@emerson.com