Quantum Devices

QPhase™ Encoders

QC201 Commutation Indicator

Innovative technology simplifies alignment of encoder commutation channels to servo motor, with an easy-to-use handheld tool to measure alignment and reduce assembly time.

Motion control applications utilize encoders to translate position, or rotation of a shaft or axle, to analog or digital output signals. Some of these applications also require a method to commutate a brushless direct current (BLDC) motor.

Commutation is the process of switching current in the motor phases in order to generate motion of the rotor. This switching was traditionally done with a trio of hall effect sensors and in modern systems is accomplished with a commutating encoder. A commutating encoder produces digital commutation channels in addition to the traditional position outputs for motion control applications. Motor manufacturers typically prefer to use a commutating encoder if the application requires both positional signals and commutation signals. Installing one external device to perform both tasks reduces both time and cost for the motor assembly.

The traditional process of commutation timing for BLDC motors is time-consuming and is often the bottleneck in manufacturing. An OEM's skilled operator (or end-user technician) with expensive machinery is tasked with determining the precise angle of the permanent magnets on a motor's rotor, and subsequently must align that angle with the signals produced by an external commutation device.

Most motor manufacturers currently use a variation of the following procedure to time their motors to an external commutation device:

1) One phase of the motor is energized locking the motor into position.

2) The encoder shaft is rotated to a reference position, which is usually the start of one of the commutation signals (e.g., leading edge of U). Often this corresponds with the encoder's index pulse.

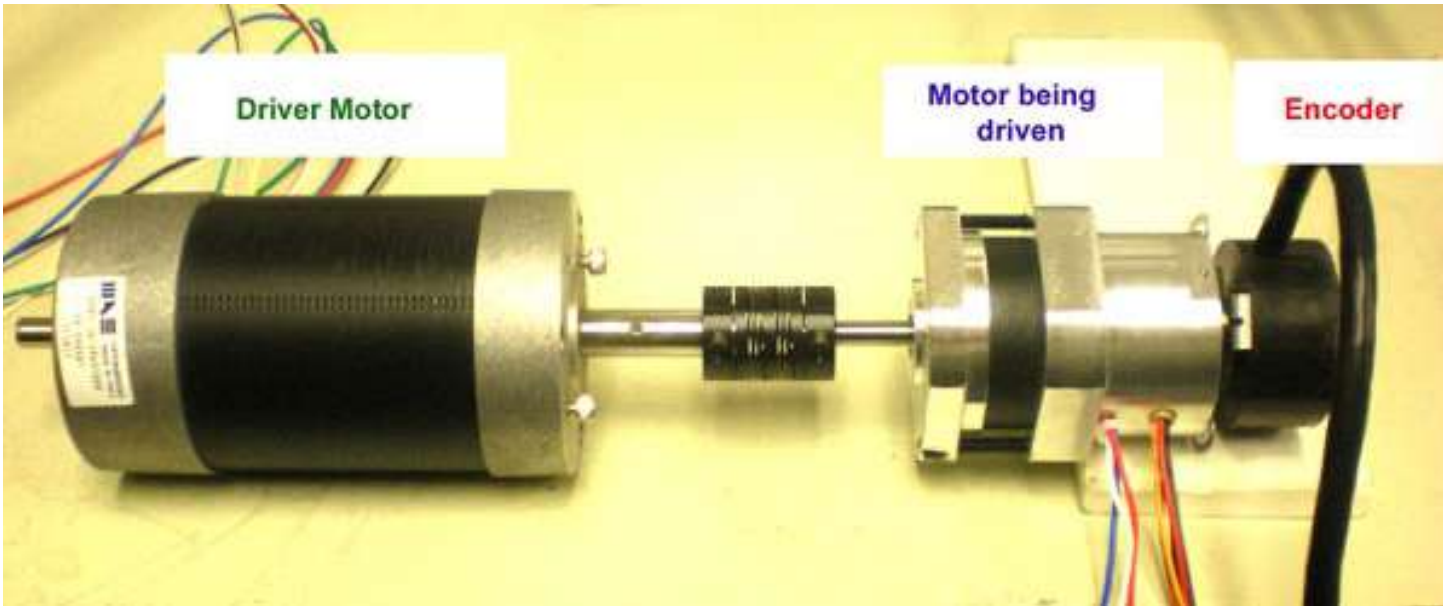
3) The encoder is assembled to the motor and the shaft is locked in place (via encoder set screws).

4) The motor winding is de-energized.

5) The commutating encoder is powered.

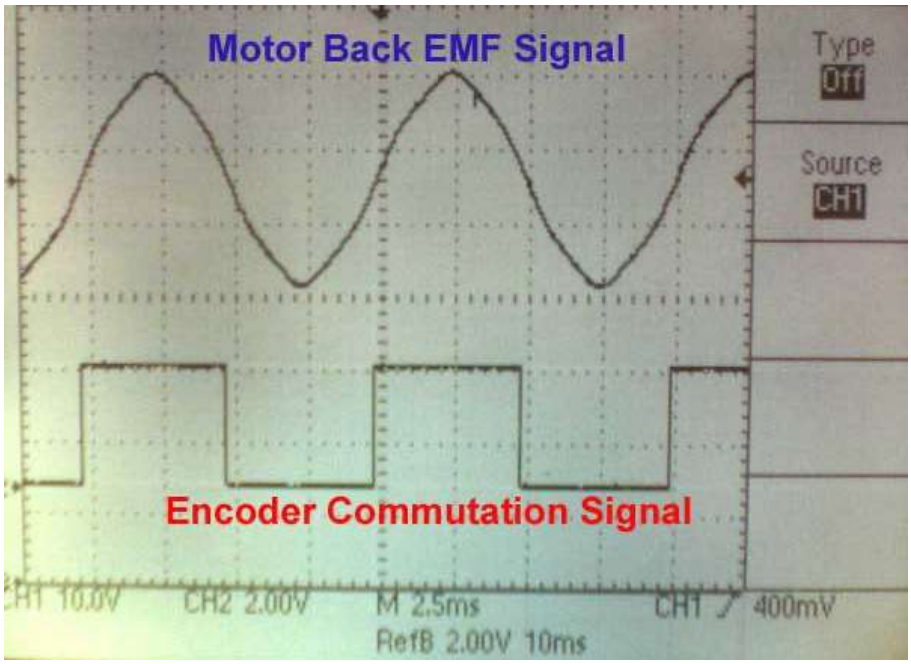
6) The motor/encoder is back driven by another motor (driver motor).

7) The motor and encoder are connected to an oscilloscope to display two waveforms – the back EMF from the motor phase and the encoder commutation (hall) channel.



Simplified example of a back driven motor set up

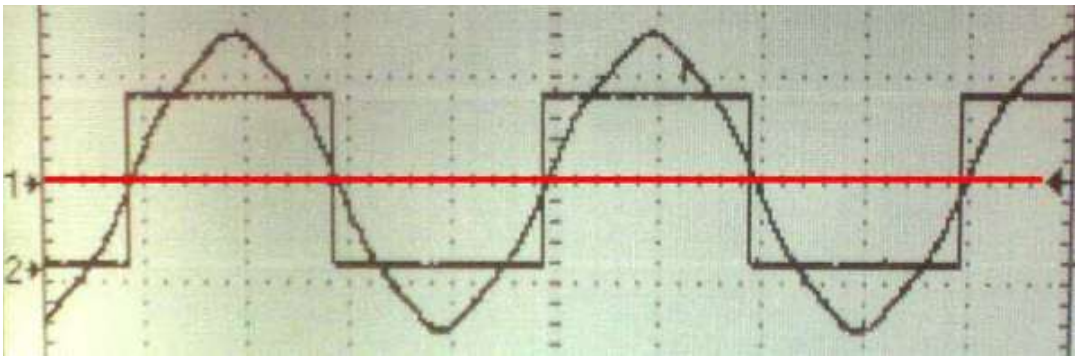
The motor back EMF and encoder commutation (hall) signals are shown below. They have been separated for clarity. When timing a motor, you will want them to overlap.



8) While the motor is rotating, the encoder commutation alignment is fine-tuned by rotating the commutating encoder body to align the encoder commutation signal to the Motor waveform.

Video of BLDC motor back EMF to optical encoder hall phasing

Ideal timing is typically realized by aligning the zero-volt level of the back EMF analog periodic waveform (sine wave) with the edges of the digital commutation signals. That level is shown below by the red line.



9) Once alignment is achieved, the encoder is fully fastened, securing the phase relationship between the motor and encoder.

QC201 Innovation

Traditional alignment and timing tasks have been greatly simplified and specialized equipment has been eliminated by using the QC201 Commutation Indicator in conjunction with a Quantum Devices encoder.

Commutation alignment with QC201:

1) One phase of the motor is energized locking the motor into position.

2) The encoder shaft is rotated to a visual reference position, which corresponds to the encoder's leading edge of the U commutation channel and the index pulse.

3) The encoder is assembled to the motor and the shaft is locked in place (via encoder set screws).

4) Plug encoder into the QC201 commutation indicator.

5) Rotate body of encoder to desired commutation alignment as indicated in electrical degrees on the QC201 display. Then fully secure encoder to motor to maintain timing position.

6) Disconnect QC201 and de-energize motor winding. The assembly is timed.

Video of QC201 timing process

The QC201 commutation indicator not only reduces the steps to time a motor to an encoder but also eliminates the need for a back-drive station, oscilloscope and a trained operator to set up and decipher the traces of an oscilloscope in order to calculate the offset.

Quantum Devices' encoders have been designed to be timed with the QC201 commutation indicator. This is due to the synergy between the lithography of the custom photodiode arrays and the precision pattern of the code disc. The relative distance from the index pulse to the rising edge of the U channel is reliably known. With this known fixed location, the QC201 is able to use the incremental channels to determine the encoder's commutation position in relation to the motor's winding. This position is conveyed in electrical degrees of commutation on an easy-to-read LCD screen.

The Quantum Devices QC201 Commutation Indicator is a quick and accurate method to time any of Quantum Devices encoders' commutation channels to a BLDC motor. The QC201 Commutation Indicator is an easy-to-use tool for motor assembly which simplifies and shortens the motor assembly process, thereby saving money during manufacturing.

QC201 Spec Sheet Link