The Quantum Devices EZ-Comm system is the fastest and most economical way to align an optical encoder’s commutation channels to a motor. EZ-Comm was designed to reduce assembly cost for high volume manufacturing. By eliminating multiple steps from the typical timing of an encoder and motor, EZ-Comm saves manufacturing time and reduces assembly cost. EZ-Comm is integrated into the high performance, low profile modular design of the QML35. QML35 EZ-Comm is ideal for high volume OEM applications and priced competitively for all sizes of motion control projects. As simple as a push of a button, EZ-Comm is the newest and simplest way to commutate your BLDC motors.

**Configuration Options:**

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Commutation</th>
<th>Voltage</th>
<th>Cover</th>
<th>Bore Size</th>
<th>Mounting</th>
<th>Index</th>
<th>Hardware</th>
</tr>
</thead>
<tbody>
<tr>
<td>L - 1000</td>
<td>4 - D - A - L - A - A - A</td>
<td>D = 5V ± 5% with EZ-Comm</td>
<td>C = Hole in Cover</td>
<td>A = 1.280&quot;</td>
<td>A = 90° A &amp; B High</td>
<td>A = 0.375&quot;</td>
<td>Please refer to hardware options on page 7</td>
</tr>
</tbody>
</table>

**Note:**
1. 4 poles has four states per revolution (2 pole pair), or two 360° electrical cycles per revolution
2. Mounting option A allows for resolver size 15
3. Consult factory for configurations not shown

**Available Line Count and Pole Combinations**

<table>
<thead>
<tr>
<th>Poles</th>
<th>Line Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>500, 512, 1000, 1024, 2000, 2048, 2500</td>
</tr>
<tr>
<td>6</td>
<td>500, 512, 1000, 1024, 2000, 2048, 2500, 4000, 4096</td>
</tr>
<tr>
<td>8</td>
<td>500, 512, 1000, 1024, 2000, 2048, 2500, 4000, 4096, 5000</td>
</tr>
<tr>
<td>10</td>
<td>500, 512, 1000, 1024, 2000, 2048, 2500, 4000, 4096, 5000</td>
</tr>
<tr>
<td>14</td>
<td>2048</td>
</tr>
</tbody>
</table>
**ELECTRICAL SPECIFICATIONS**

- **Input Voltage**: 5 VDC ± 5%
- **Input Current Requirements**: 65 mA typical, 100 mA max plus interface loads
- **Input Ripple**: 2% peak to peak @ 5 VDC
- **Output Circuits**: Single-ended TTL, sink or source 4 mA max (compatible with Renco PP option)
- **Incremental Output Format**: Quadrature with A leading B for CCW rotation viewed from the encoder top
- **Max Operating Frequency**:
  - < 5000 PPR = 500 kHz or 15,000 RPM
  - 5000 PPR = 675 kHz
  - 1000LC-10P, 1024LC-10P, 2000LC-10P, 2048-10P and 2048LC-14P = 7000 RPM
- **Commutation Format**: Three phase 4, 6, 8, 10 or 14 poles (other pole counts upon request)
- **Commutation Accuracy (UVW)**: See EZ-Comm specifications
- **Interpolation Factors**: 1000/1024 PPR = 2x, 2000/2048 PPR = 4x, 2500 PPR = 5x, 4000/4096 PPR = 8x, 5000 PPR = 10x

**MECHANICAL SPECIFICATIONS**

- **Bore Minimum Diameter**: Bore Size +0.0002”
- **Recommended Shaft Tolerance**: +0.0000/-0.0005”
- **Minimum Shaft Engagement**: 0.400” [10.2 mm]
- **Allowable Shaft Runout**: 0.002” [0.05 mm] TIR (± 0.001” shaft radial play from initial shaft position of assembled encoder)
- **Allowable Axial Shaft Movement**: ± 0.010” [± 0.25 mm]
- **Mounting**: 
  - A = 1.280” bolt circle/size 15 resolver
  - B = 1.812” bolt circle
- **Dynamic Commutation Adjustment Range**: 30° mechanical
- **Moment of Inertia**: 8.0 x 10^6 oz-in-s²

**ENVIRONMENTAL SPECIFICATIONS**

- **Storage Temperature**: -40 to 125°C
- **Operating Temperature**: -30 to 115°C
- **IP Rating**: IP40
- **Humidity**: 90% non-condensing
- **Vibration**: 20 g’s @ 25 to 2,000 Hz
- **Shock**: 100 g’s @ 6ms duration

**OUTPUT WAVESFORMS**

CCW Shaft Rotation as Viewed Looking at the Encoder Top

- Q1 + Q2 = 0.5T ± 0.125T
- Q2 + Q3 = 0.5T ± 0.125T
- Qn = 0.25T ± 0.125T (n = 1, 2, 3, 4)

**ELECTRICAL PIN FUNCTIONS**

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
</tr>
<tr>
<td>2</td>
<td>Z</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
</tr>
<tr>
<td>4</td>
<td>Vcc</td>
</tr>
<tr>
<td>5</td>
<td>B</td>
</tr>
<tr>
<td>6</td>
<td>U</td>
</tr>
<tr>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>8</td>
<td>W</td>
</tr>
</tbody>
</table>

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### EZ-COMM SPECIFICATIONS

**Encoder Commutation Accuracy after Alignment Process**

U V W edge position error (max), after Power On until the first Index: 4P = 4°e, 6P = 6°e, 8P = 8°e, 10P = 10°e, 14P = 14°e.

<table>
<thead>
<tr>
<th>Line Count</th>
<th>4 Pole</th>
<th>6 Pole</th>
<th>8 Pole</th>
<th>10 Pole</th>
<th>14 Pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>1.0°e</td>
<td>2.4°e</td>
<td>3.4°e</td>
<td>3.8°e</td>
<td></td>
</tr>
<tr>
<td>512</td>
<td>1.0°e</td>
<td>2.8°e</td>
<td>3.4°e</td>
<td>5.2°e</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>1.0°e</td>
<td>2.4°e</td>
<td>3.4°e</td>
<td>2.8°e</td>
<td></td>
</tr>
<tr>
<td>1024</td>
<td>1.0°e</td>
<td>2.8°e</td>
<td>3.4°e</td>
<td>3.2°e</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>1.0°e</td>
<td>2.4°e</td>
<td>3.4°e</td>
<td>2.8°e</td>
<td></td>
</tr>
<tr>
<td>2048</td>
<td>1.0°e</td>
<td>2.8°e</td>
<td>3.4°e</td>
<td>3.2°e</td>
<td>4.5°e</td>
</tr>
<tr>
<td>2500</td>
<td>1.0°e</td>
<td>2.1°e</td>
<td>3.2°e</td>
<td>3.4°e</td>
<td></td>
</tr>
<tr>
<td>4000</td>
<td>2.0°e</td>
<td>2.6°e</td>
<td>2.8°e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4096</td>
<td>2.0°e</td>
<td>2.6°e</td>
<td>2.7°e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5000</td>
<td>2.5°e</td>
<td>2.9°e</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Accuracy specification does not include motor winding pole pair position and magnetizing inaccuracies.*

**Power on Latency**

Power on to valid UVW states: 22 ms
BEFORE ALIGNMENT PROCESS
The waveforms below are the QML35 EZ-Comm encoder Index (Z), U, V, and W phases in relation to the motor back electromotive force (BEMF) phases, prior to any alignment process. The red segments indicate the desired states to be aligned.

- Encoder Index
- Encoder U
- Encoder V
- Encoder W
- Alignment Error
- Winding 3 - 1
- Winding 1 - 2
- Winding 2 - 3

Electrical cycle Electrical cycle
One mechanical rotation

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AFTER ALIGNMENT PROCESS
The waveforms below are the QML35 EZ-Comm encoder Index (Z), U, V, and W phases in relation to the motor back electro motive force (BEMF) phases, after the Semi-Automatic Commutator Alignment. The green arrow indicates motor shaft position where the alignment process occurred. The U, V, and W phases are aligned to the BEMF phases of the motor. The index marks are not repositioned.

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**MECHANICAL DIMENSIONS**

Model QML35 EZ-Comm – 1.280” Bolt Circle (Mounting Option A)

Model QML35 EZ-Comm – 1.812’’ Bolt Circle (Mounting Option B)

**MOUNTING REQUIREMENTS**

Mounting Option A (1.280” Bolt Circle)

Mounting Option B (1.812” Bolt Circle)

Servo Size 15 Mounting (Mounting Option A)

Note:
- Shown with Cover option A (hole in cover).
- Cover option B (closed) – Maximum shaft length up to 0.512” [13.0 mm]. Overall height increases from 0.43” [10.9 mm] to 0.57” [14.5 mm]. This additional height has a cylinder diameter 0.56” [14.2 mm], centered on the cover top.
- Cover option C (closed) – Maximum shaft length up to 0.450” [11.4 mm]. Overall height increases from 0.43” [10.9 mm] to 0.51” [13.0 mm]. This additional height has a cylinder diameter 0.56” [14.2 mm], centered on the cover top.

Patent Protection:
- US Patent 9,857,205
- US Patent 6,563,108

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**HARDWARE OPTIONS – ORDERING INFORMATION**

### MOUNTING OPTION A (1.280” BOLT CIRCLE)

<table>
<thead>
<tr>
<th>Set Screws</th>
<th>Mounting Screws</th>
<th>Mounting Screws with Thread Lock</th>
<th>Option A</th>
<th>Option B</th>
<th>Option C</th>
<th>Option D</th>
<th>Option E</th>
<th>Option F</th>
<th>Option G</th>
<th>Option H</th>
<th>Option I</th>
<th>Option J</th>
</tr>
</thead>
<tbody>
<tr>
<td>#3-48 x 1/16”</td>
<td>#3-48 x 1/16”</td>
<td>#3-48 x 1/16”</td>
<td>0.050” Hex (Torque = 18 - 22 oz·in)</td>
<td>0.050” Hex (Torque = 18 - 22 oz·in)</td>
<td>0.050” Hex (Torque = 18 - 22 oz·in)</td>
<td>0.050” Hex (Torque = 18 - 22 oz·in)</td>
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<td>0.050” Hex (Torque = 18 - 22 oz·in)</td>
</tr>
<tr>
<td>Part Number: 1826ZG002</td>
<td>Part Number: 1829ZG014</td>
<td>Part Number: 1829ZG014</td>
<td>Part Number: 1829ZG014</td>
<td>Part Number: 1829ZG014</td>
<td>Part Number: 1829ZG014</td>
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<td>Part Number: 1829ZG014</td>
<td>Part Number: 1829ZG014</td>
<td>Part Number: 1829ZG014</td>
</tr>
</tbody>
</table>

Note:
1. Bore Size option N (0.375”) requires Hardware option A, B, D, E, K, L, M or N. This hardware can optionally be used with all other hub sizes.
2. Hardware options F, G, H, J, P, Q, R and S have longer #3-48 set screws (3/32”) and are not compatible with Bore Size option N (0.375”).
3. Hardware options D, E, H, J, M, N, R and S contain a thread lock which is applied to the mounting screws only. This preapplied thread locking product contains a microencapsulated epoxy resin that is suspended in a hardener. The force of thread engagement crushes the microscopic capsules of epoxy resin, mixing the reactant components, and initiating a chemical reaction which locks the parts together. This product series provides consistent and predictable torque values and requires no heat or primers for curing.

Product - ND Industries 593S.

### MOUNTING OPTION B (1.812” BOLT CIRCLE)

<table>
<thead>
<tr>
<th>Set Screws (Qty. 2 each)</th>
<th>Mounting Screws (Qty. 2 each)</th>
<th>Cover Screws (Qty. 2 each)</th>
<th>Option A</th>
<th>Option B</th>
<th>Option C</th>
<th>Option D</th>
<th>Option E</th>
<th>Option F</th>
<th>Option G</th>
<th>Option H</th>
<th>Option I</th>
<th>Option J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Number: 1834ZG050</td>
<td>Part Number: 1834ZG050</td>
<td>Part Number: 1826ZG002</td>
<td>#3-48 x 3/32”</td>
<td>#3-48 x 3/32”</td>
<td>#3-48 x 3/32”</td>
<td>#3-48 x 3/32”</td>
<td>#3-48 x 3/32”</td>
<td>#3-48 x 3/32”</td>
<td>#3-48 x 3/32”</td>
<td>#3-48 x 3/32”</td>
<td>#3-48 x 3/32”</td>
<td>#3-48 x 3/32”</td>
</tr>
</tbody>
</table>

**HARDWARE SELECTION BREAKOUT**

<table>
<thead>
<tr>
<th>Option A</th>
<th>Option B</th>
<th>Option C</th>
<th>Option D</th>
<th>Option E</th>
<th>Option F</th>
<th>Option G</th>
<th>Option H</th>
<th>Option I</th>
<th>Option J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Ox</td>
<td>Black Ox</td>
<td>Black Ox</td>
<td>Black Ox</td>
<td>Black Ox</td>
<td>Black Ox</td>
<td>Black Ox</td>
<td>Black Ox</td>
<td>Black Ox</td>
<td>Black Ox</td>
</tr>
<tr>
<td>#3-48 x 1/16”</td>
<td>#3-48 x 1/16”</td>
<td>#3-48 x 1/16”</td>
<td>#3-48 x 1/16”</td>
<td>#3-48 x 1/16”</td>
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<td>#3-48 x 1/16”</td>
</tr>
<tr>
<td>0.050” Hex (Torque = 18 - 22 oz·in)</td>
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</tr>
<tr>
<td>Part Number: 1826ZG002</td>
<td>Part Number: 1829ZG014</td>
<td>Part Number: 1829ZG014</td>
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<td>Part Number: 1829ZG014</td>
<td>Part Number: 1829ZG014</td>
</tr>
</tbody>
</table>

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CABLE ACCESSORIES

(2161AG039, 2162AG019)
Consult Factory for Custom Lengths

One Meter Cable Both Ends Terminated:
2161AG039 = 8 conductor 28 AWG for UVW Commutation
Connector = BERG (FCI) P/N 90312-008 LF

Half Meter Cable One End Terminated:
2162AG019 = 8 conductor 28 AWG for UVW Commutation
Connector = BERG (FCI) P/N 90312-008 LF

Note:
1. Cable has internal foil shield with 28 AWG drain wire trimmed to jacket edge
2. Unused wires to be locally isolated from adjacent signal wires, Vcc and GND to prevent damage to encoder signals

Pin Number | Encoder Pin Function | 2161AG039 Wire Color | 2162AG019 Wire Color
---|---|---|---
1 | GND | Black | Black
2 | Z | Orange | Orange
3 | A | Yellow | Yellow
4 | Vcc | Red | Red
5 | B | Blue | Blue
6 | U | Green | Green
7 | V | Brown | Brown
8 | W | White | White

Note:
1. Cable has internal foil shield with 28 AWG drain wire trimmed to jacket edge
2. Unused wires to be locally isolated from adjacent signal wires, Vcc and GND to prevent damage to encoder signals

Note: BERG (FCI) P/N 90312-008 LF connector using 77138-001LF pins is compatible with 26-30 AWG wire.

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**INSTALLATION INSTRUCTIONS FOR 1.280" BOLT CIRCLE**

QM35 Connector shown in illustrations

**STEP 1**
Rotate printed circuit board (PCB) to expose the mounting holes. This is the Lock position. Mounting/motor surface must be clean and flat.

**STEP 2**
A. Install mounting screws through encoder into mounting/motor surface. Insert 1-2 turns.
DO NOT tighten screws.

Note: Alignment of Z mark on hub to white mark on PCB is NOT required.

**STEP 3**
A. Press down on the hub with a force between 150 g (0.33 lb) and 700 g (1.5 lb). This will center the encoder assembly to the motor shaft.
B. Using slight forefinger and thumb force, verify no radial (side-to-side) movement of the encoder occurs.

Illustrated is accessory Q-Scale p/n 2160AG276. Proper downward force is indicated when pin is between the force lines.

**STEP 4**
A. Tighten hub set screws to motor shaft.
   - #3-48 x 1/16" screw = 18-22 oz·in
   - #3-48 x 3/32" screw = 28-32 oz·in
B. The downward force on the hub can be removed.
C. Tighten mounting screws to 45-51 oz·in

TIP: Place Q-Scale point within the Z mark of hub.

**STEP 5**
Place cover on encoder. Observe the cover dowel pins positioned into mating PCB holes.

**STEP 6**
A. Twist cover/PCB to expose screw holes for cover screws.
B. Install cover screws and tighten to 37-43 oz-in.
C. Install cable to complete installation.

Note: Refer to Hardware Selection Breakout chart for driver sizes.

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**EZ-COMM ALIGNMENT PROCEDURE**

A. Energize appropriate motor windings to align shaft to U rise position.

B. Press button to Start Alignment process.
   - LED 1 will flash.
   - LED 4 will illuminate, indicating power applied to encoder.

C. Remove power from motor windings applied in step A.

D. Rotate motor shaft (~one rotation) to align commutation.
   - LED 1 will light steady when align is complete.
   - LED 2 will flash.

E. Rotate motor shaft (~one rotation) to verify installation.
   - LED 2 will light steady when installation verification is complete.
   - LED 4 will extinguish removing power from encoder.

For multiple alignments, the power switch on the box side can remain in the ON position.

Rotational speed limited to 350RPM.

**EZ-COMM SET UP:**

Connect Programmer Cable between encoder and EZ-Comm Programmer.

**QML35 EZ-COMM PROGRAMMING INSTRUCTIONS**

**QML35 EZ-COMM PROGRAMMING KIT, P/N: 2174AG003**

Includes:
- EZ-Comm Programmer
- 19" Programmer Cable p/n: 2174AG004
- 9VDC, 6W Power Supply

**EZ-COMM PROGRAMMER INDICATORS**

LED1 Flashing: Rotate Shaft to Align Commutation.
LED1 Steady: Commutation Alignment Complete.
LED2 Flashing: Rotate Shaft to Verify Installation.
LED2 Steady: Encoder Installation is Good.
LED3 Flashing: Error (repeat installation).
LED4 Steady: Encoder has Power.

**PROGRAMMER PINOUT**

Pin 1 = Encoder power  
Pin 2 = Ground  
Pin 3 = Chan U  
Pin 4 = Chan V  
Pin 5 = Chan W

**REMOTE/AUTOMATED CONNECTION**

Pin 7 = Input Open Collector – ground and release to Start Alignment process, alignment procedure step B.
Pin 8 = Output TTL logic High during alignment procedure steps B, C and D.
Pin 15 = Output TTL logic High during alignment procedure step E.
Pin 14 = Output TTL logic High upon complete of step E to signal the installation was verified (passing).
Pin 13 = Output TTL High if an installation error occurs.

Repeat next assembly: First ground and release of Pin 7 to clear Pass or Fail from the previous alignment.

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