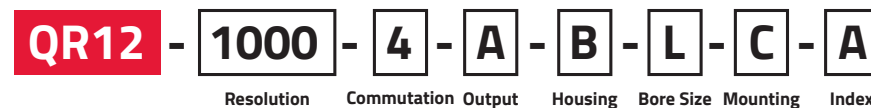# Quantum Devices

## QPhase™ Encoders

# QR12



## DESIGN FEATURES

- Low profile assembled height of 0.99"
- Bearing design simplifies encoder attachment
- Incremental resolutions up to 20,000 PPR
- Sin/Cos outputs available up to 1250 PPR
- 4, 6 or 8 pole commutation[1]
- 1.280", 1.575" or 1.812" bolt circle mounting
- Through bore sizes up to 0.375" (10 mm) diameter
- High noise immunity
- Cost competitive with modular encoders
- 500 kHz frequency response
- RoHS construction

Quantum Devices, Inc. Model QR12 provides an improved feedback solution in applications traditionally using modular encoders. With an overall height of less than one inch and the stability of a bearing encoder design, the model QR12 can provide significant performance upgrades in applications limited by modular encoder solutions. Outputs consist of two incremental quadrature channels with an index pulse and three-phase commutation. A flexible spring steel mount allows for much greater tail shaft run out and TIR than can be tolerated by modular encoder designs, while also providing 30 degrees of rotation for commutation timing.

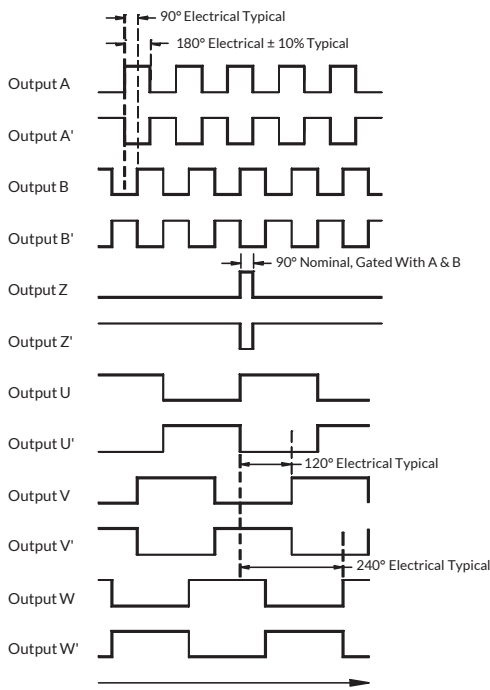| QR12 | - | 1000 | - | 4 | - | A | - | B | - | L | - | C | - | A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Resolution | | Commutation | | Output | | Housing | | Bore Size | | Mounting | | Index |

### Configuration Options:

| Resolution[1] | Commutation[1] | Output[1] | Housing | Bore Size | Mounting | Index |
|---|---|---|---|---|---|---|
| 24[2], 256, 360, 500, 512, 1000, 1024, 1250, 2000, 2048, 2500, 4000, 4096, 5000, 8000, 8192, 10000, 16000, 16384, 20000 | 0 = No Comm<br>4 = 4 Pole<br>6 = 6 Pole<br>8 = 8 Pole | A = Line Driver<br>B = Line Driver ABZ / Open Collector UVW<br>C = Sin/Cos[3] / Line Driver UVW<br>D = Sin/Cos[3] / Open Collector UVW | B = Through Hole Cover<br>C = Closed Cover | A = 3 mm<br>B = 4 mm<br>C = 5 mm<br>D = 6 mm<br>E = 8 mm<br>F = 10 mm<br>G = 7 mm<br>J = 0.125"<br>K = 0.1875"<br>L = 0.250"<br>M = 0.3125"<br>N = 0.375" | A = 1.812"<br>B = 1.575"<br>C = 1.280" | A = 90° gated to A & B<br>C = Ungated Square Wave (Sin/Cos Option Only)<br>D = Ungated Sinusoidal (Sin/Cos Option Only) |

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Note:
1.) Consult factory for configuration options not shown (e.g. resolution, commutation, output, etc.)
2.) 24 PPR only available with No Comm (Commutation option 0)
3.) Sin/Cos Outputs are limited to Resolutions between 500 and 1250 PPR

**ISO 9001**
CERT. NO. FM 52711

## OUTPUT WAVEFORMS

Output A — 90° Electrical Typical
180° Electrical ± 10% Typical

Output A'

Output B

Output B'

Output Z — 90° Nominal, Gated With A & B

Output Z'

Output U

Output U' — 120° Electrical Typical

Output V

Output V' — 240° Electrical Typical

Output W

Output W'

Clockwise Shaft Rotation as Viewed Looking at the Encoder Face *(see figure below)*

**Note:** *Relationship of Z signals to U, V, W signals is not to scale. A & B signals have no relationship to U, V, W signals.*

CW Rotation for Output Waveforms
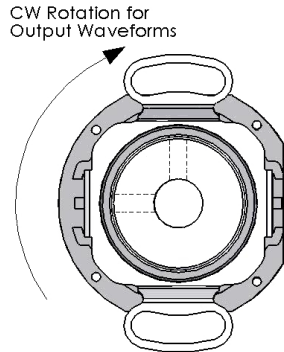
## INCREMENTAL ELECTRICAL SPECIFICATIONS

| | |
|---|---|
| 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 | A = 26C31 line driver (RS-422 or single-ended TTL)<br>B = ABZ 26C31 line driver, UVW open collector (no U' V' W') |
| Incremental Output Format | Quadrature with A leading B for CW rotation<br>Index pulse true over A and B high |
| Max Operating Frequency | 500 kHz |
| Symmetry | 180° electrical ± 10% typical |
| Minimum Edge Separation | <4000 PPR = 54° electrical<br>≥4000 PPR = 45° electrical |
| Commutation Format | Three phase 4, 6 or 8 poles (other pole counts upon request) |
| Commutation Accuracy | ± 1° mechanical |
| Z Channel to U Channel | ± 1° mechanical |

## ENVIRONMENTAL SPECIFICATIONS

| | |
|---|---|
| Storage Temperature | -40 to 125°C |
| Operating Temperature | -20 to 115°C |
| IP Rating | IP40 |
| Humidity | 90% non-condensing |
| Vibration | 20 g's @ 50 to 500 CPS |
| Shock | 50 g's @ 11 mS duration |

## MECHANICAL SPECIFICATIONS

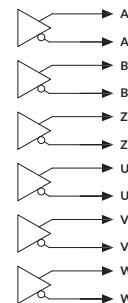| | |
|---|---|
| Bore Diameter (Tolerance) | 0.125", 0.1875", 0.250", 0.3125", 0.375", 3 mm, 4 mm, 5 mm, 6 mm, 7 mm, 8 mm, 10 mm (+0.0006/-0.0000") |
| Recommended Shaft Engagement | 0.500" minimum |
| Allowable Shaft Runout | 0.007" TIR |
| Axial Shaft Movement | ± 0.030" |
| Maximum Shaft Speed | 8000 RPM |
| Interface Connector | Connector: JAE P/N FI-W15P-HFE |
| Mounting | 1.280", 1.575", 1.812" bolt circle |
| Moment of Inertia | $9.1 \times 10^{-5}$ oz·in·s² |
| Acceleration | $1 \times 10^{5}$ radians/s² |
| Accuracy | Instrument error 1.5 arc minutes max |

### 15 PIN CONNECTOR
JAE P/N: FI-W15P-HFE

| Pin Number | Function |
|---|---|
| 1 | A |
| 2 | A' |
| 3 | B |
| 4 | B' |
| 5 | Z |
| 6 | Z' |
| 7 | U |
| 8 | U' * |
| 9 | V |
| 10 | V' * |
| 11 | W |
| 12 | W' * |
| 13 | Vcc |
| 14 | GND |
| 15 | NC |

* U', V' and W' are "no connect" for Output option B (open collector UVW)
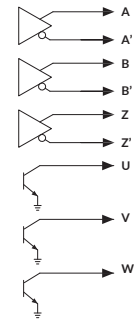
## ELECTRICAL OUTPUT CIRCUITS

**Output Option A:**
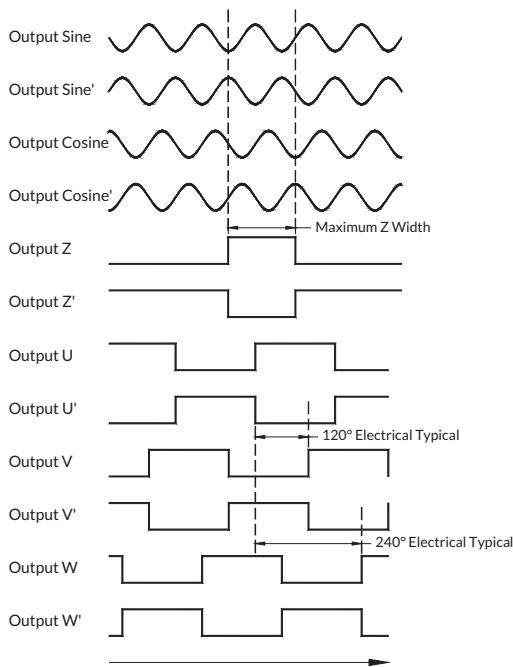ABZ = 26C31 line driver (RS-422)
UVW = 26C31 line driver (RS-422)

A, A', B, B', Z, Z', U, U', V, V', W, W'

**Output Option B:**
ABZ = 26C31 line driver (RS-422)
UVW = open collector

A, A', B, B', Z, Z', U, V, W

- 26C31 line driver is TTL compatible (can be wired single-ended)
- 26C31 sink/source 20 mA max (meets RS-422 at 5 VDC supply)
- Open collector sink 30 mA max, pull up voltage 30 VDC max
- U, V and W are "no connect" for Commutation option 0

## SIN/COS OUTPUT WAVEFORMS

Output Sine
Output Sine'
Output Cosine
Output Cosine'
Output Z — Maximum Z Width
Output Z'
Output U
Output U' — 120° Electrical Typical
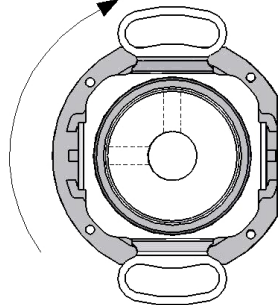Output V
Output V' — 240° Electrical Typical
Output W
Output W'

Clockwise Shaft Rotation as Viewed Looking at the Encoder Face *(see figure below)*

**Note:** *Relationship of Z signals to U, V, W signals is not to scale. Sine & cosine signals have no relationship to U, V, W signals.*

CW Rotation for Output Waveforms

## SIN/COS 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 | C = sine/cosine 1 Vpp (measured differentially), index**, UVW 26C31 line driver (RS-422 or single-ended TTL) <br> D = sine/cosine 1 Vpp (measured differentially), index**, UVW open collector (no U' V' W') |
| Incremental Output Format | Quadrature sine/cosine with sine leading cosine for CW rotation. Ungated index pulse. |
| Max Operating Frequency | 500 kHz |
| Sine/Cosine Amplitude | 1 Vpp ± 5% (measured differentially) |
| Index Amplitude ** | C = 1 Vpp ± 5% (measured differentially) square wave <br> D = 1 Vpp ± 5% (measured differentially) sinusoidal |
| Commutation Format | Three phase 4, 6 or 8 poles (other pole counts upon request) |
| Commutation Accuracy | ± 1° mechanical |
| Z Channel to U Channel | ± 1° mechanical |

## 15 PIN CONNECTOR
### JAE P/N: FI-W15P-HFE

| Pin Number | Function |
|---|---|
| 1 | sine |
| 2 | sine' |
| 3 | cosine |
| 4 | cosine' |
| 5 | Z |
| 6 | Z' |
| 7 | U |
| 8 | U' * |
| 9 | V |
| 10 | V' * |
| 11 | W |
| 12 | W' * |
| 13 | Vcc |
| 14 | GND |
| 15 | NC |

* U', V' and W' are "no connect" for Output option D (open collector UVW)
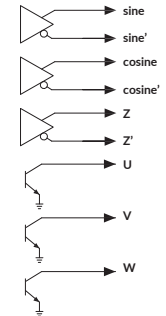
## ELECTRICAL OUTPUT CIRCUITS

**Output Option C:**
sin/cos = 1 Vpp sine/cosine line driver
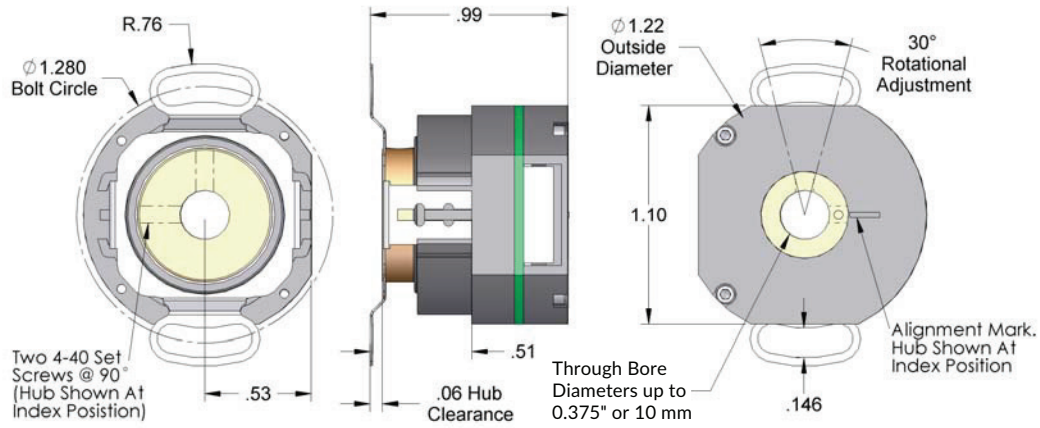UVW = 26C31 line driver (RS-422)

sine
sine'
cosine
cosine'
Z
Z'
U
U'
V
V'
W
W'
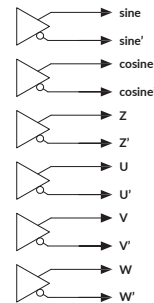
**Output Option D:**
sin/cos = 1 Vpp sine/cosine line driver
UVW = open collector

sine
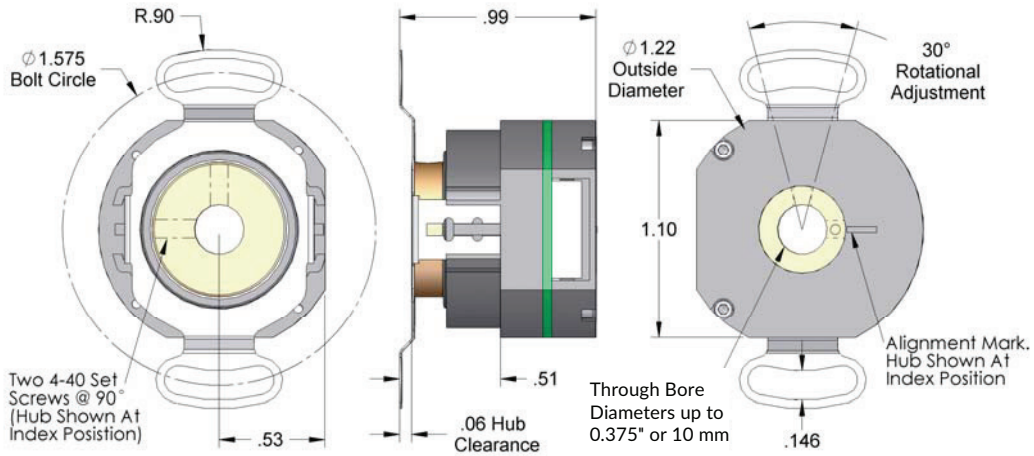sine'
cosine
cosine'
Z
Z'
U
V
W

- 26C31 line driver is TTL compatible (can be wired single-ended)
- 26C31 sink/source 20 mA max (meets RS-422 at 5 VDC supply)
- Open collector sink 30 mA max, pull up voltage 30 VDC max
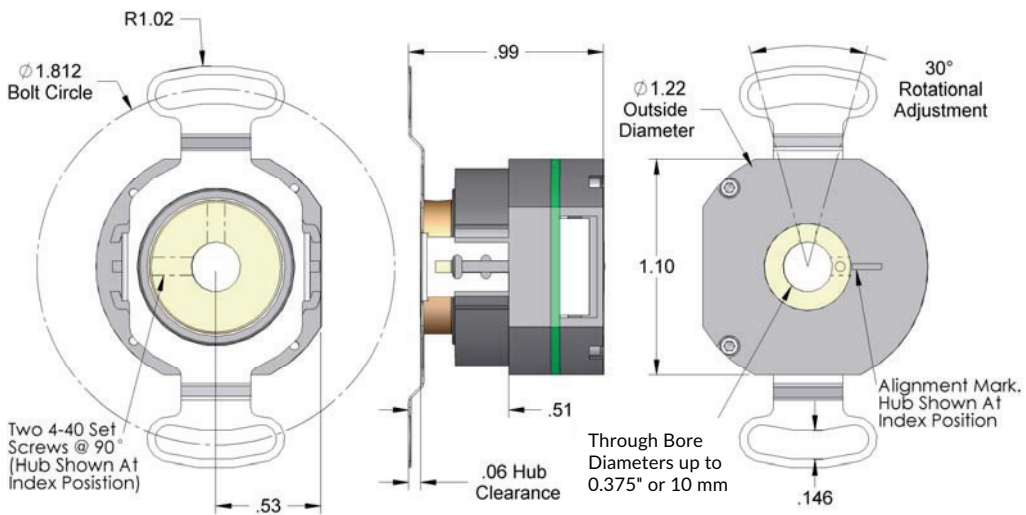- U, V and W are "no connect" for Commutation option 0

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## 1.280" BOLT CIRCLE WITH BOTTOM MOUNT HUB

R.76

Ø1.280 Bolt Circle

Two 4-40 Set Screws @ 90° (Hub Shown At Index Posision)

.53

.99

.51

.06 Hub Clearance

Ø1.22 Outside Diameter

1.10

30° Rotational Adjustment

.146

Through Bore Diameters up to 0.375" or 10 mm

Alignment Mark. Hub Shown At Index Position

## 1.575" BOLT CIRCLE WITH BOTTOM MOUNT HUB

R.90

Ø1.575 Bolt Circle

Two 4-40 Set Screws @ 90° (Hub Shown At Index Posision)

.53

.99

.51

.06 Hub Clearance

Ø1.22 Outside Diameter

1.10

30° Rotational Adjustment

.146

Through Bore Diameters up to 0.375" or 10 mm

Alignment Mark. Hub Shown At Index Position

## 1.812" BOLT CIRCLE WITH BOTTOM MOUNT HUB

R1.02

Ø1.812 Bolt Circle

Two 4-40 Set Screws @ 90° (Hub Shown At Index Posision)

.53

.99

.51

.06 Hub Clearance

Ø1.22 Outside Diameter

1.10

30° Rotational Adjustment

.146

Through Bore Diameters up to 0.375" or 10 mm

Alignment Mark. Hub Shown At Index Position

# SIZE 15 RESOLVER MOUNTS

Utilize the optional resolver mount adapters to mate the QR12 - 1.280" flex mount option to Size 15 Pancake Resolver motor configurations. Eliminate the expensive mounting servo clamps by attaching either the two or three point adapters directly to the servo clamp holes. Assemble the QR12 to the adapter plate using (2) #4-40 screws. For jam nut attachment to threaded motor shafts, refer to JR12 Jam Nut Mount Optical Encoder Literature.
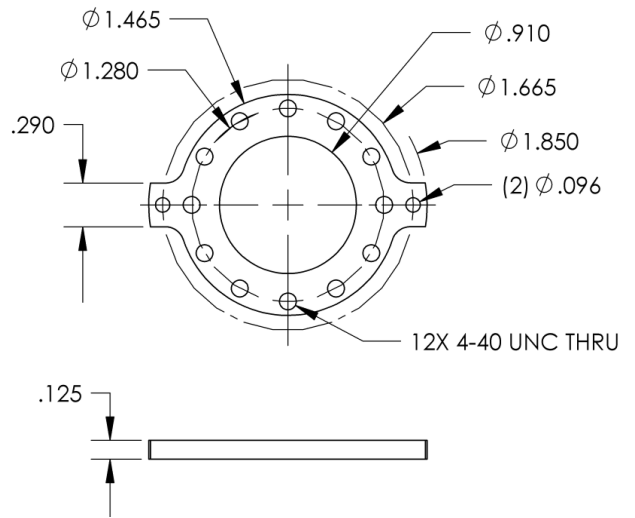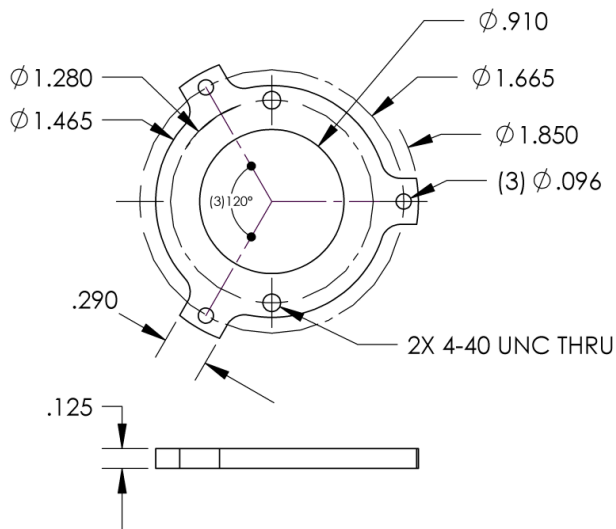
## DIMENSIONS

**Optional Aluminum Resolver Adapters**

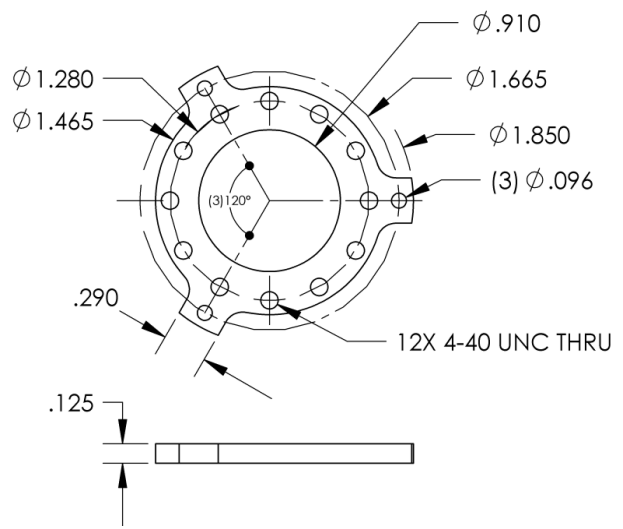### 2074D024 – Two Point 30 Degree Commutation Adjustment Range
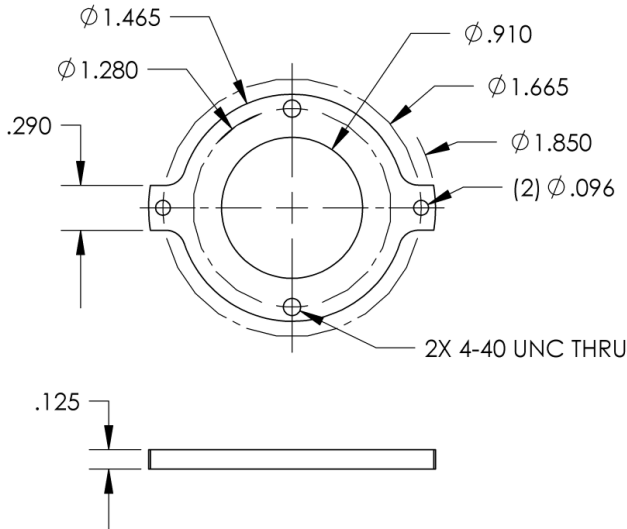


### 2074D025 – Two Point 360 Degree Commutation Adjustment Range



### 2074D026 – Three Point 30 Degree Commutation Adjustment Range



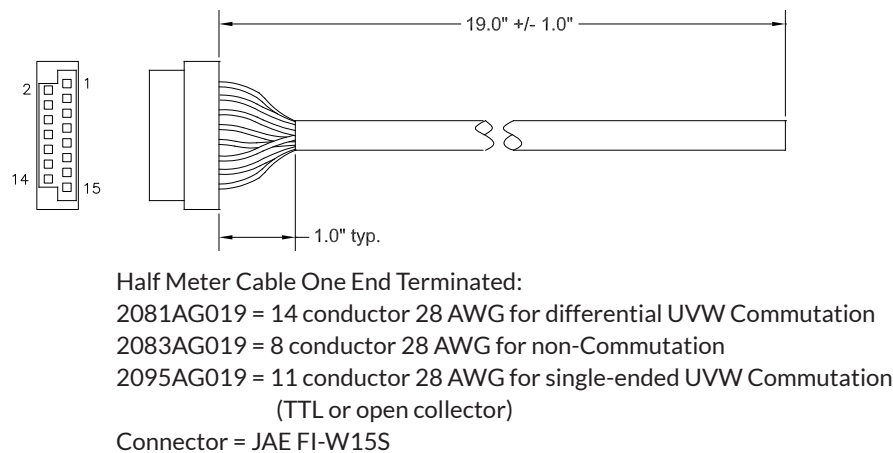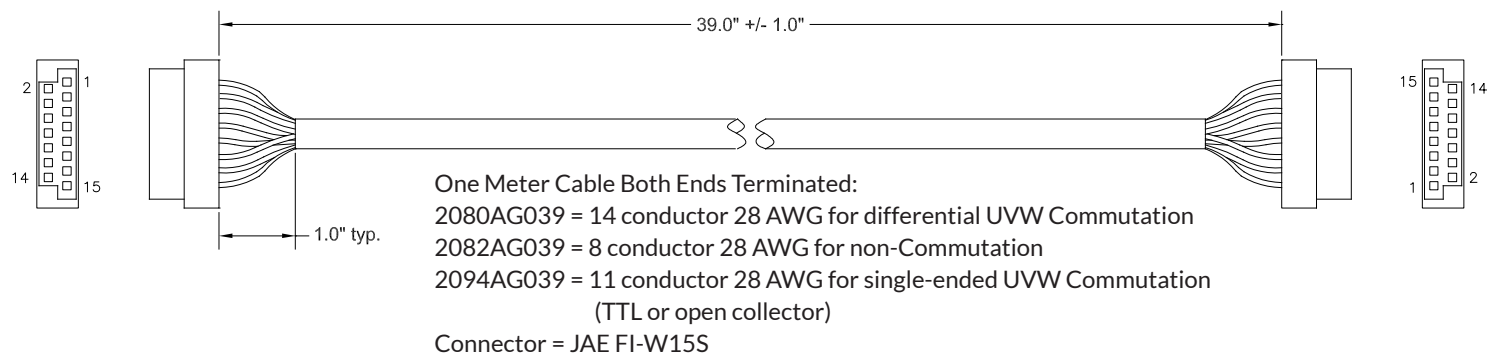### 2074D027 – Three Point 360 Degree Commutation Adjustment Range



*Quantum Devices, Inc. reserves the right to make changes in design, specifications and other information at any time without prior notice.*

**(2080AG039, 2082AG039, 2094AG039, 2081AG019, 2083AG019, 2095AG019)**
Consult Factory for Custom Lengths



One Meter Cable Both Ends Terminated:
2080AG039 = 14 conductor 28 AWG for differential UVW Commutation
2082AG039 = 8 conductor 28 AWG for non-Commutation
2094AG039 = 11 conductor 28 AWG for single-ended UVW Commutation
            (TTL or open collector)
Connector = JAE FI-W15S



Half Meter Cable One End Terminated:
2081AG019 = 14 conductor 28 AWG for differential UVW Commutation
2083AG019 = 8 conductor 28 AWG for non-Commutation
2095AG019 = 11 conductor 28 AWG for single-ended UVW Commutation
            (TTL or open collector)
Connector = JAE FI-W15S

| Pin Number | Encoder Pin Function | 2080AG039 2081AG019 Wire Color | 2082AG039 2083AG019 Wire Color | 2094AG039 2095AG019 Wire Color |
|---|---|---|---|---|
| 1 | A / sine | Brown | Brown | Brown |
| 2 | A' / sine' | White | White | White |
| 3 | B / cosine | Blue | Blue | Blue |
| 4 | B' / cosine' | Green | Green | Green |
| 5 | Z | Orange | Orange | Orange |
| 6 | Z' | Yellow | Yellow | Yellow |
| 7 | U | Violet | - | Violet |
| 8 | U' | Gray | - | - |
| 9 | V | White/Brown | - | White/Brown |
| 10 | V' | White/Red | - | - |
| 11 | W | White/Orange | - | White/Orange |
| 12 | W' | White/Yellow | - | - |
| 13 | Vcc | Red | Red | Red |
| 14 | GND | Black | Black | Black |
| 15 | No Connect | - | - | - |

*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
3. 2094AG039 and 2095AG019 can be used with Output option A or C to provide TTL UVW signals

## ENCODER INSTALLATION INSTRUCTIONS

1. Using two fingers slide the encoder onto shaft.

2. For additional security, Loctite can be applied to the encoder hub set screws. Remove the encoder's set screws and using tip of toothpick apply appropriate amount of Loctite thread locking adhesive. A non-permanent adhesive is recommended.

3. Insert and tighten encoder set screws using a 0.050" hex wrench. Torque range of 50 to 80 oz·in.

4. Fixture the stainless steel flex mount to the mounting surface with #6-32 button head screws.

## For brushless motors requiring commutation timing:

• Encoder drawings indicate position of encoder hub to encoder body at Z (index). Rotating the hub to this position allows for known U channel transition state (prior to step one above).

• Powering appropriate motor windings allow for locking motor shaft location to match the appropriate U transition (prior to step one above).

• While mechanically back driving the motor, monitor motor winding EMF position to the powered encoder position. Rotate the encoder stainless steel flex mount to achieve accurate timing of encoder commutation feedback channels to the appropriate motor winding EMF. Tighten the screws retaining the encoder stainless steel flex mounts.

Additional installation and handling instruction available at: www.quantumdev.com

REV. 200618

**ISO 9001**
**CERT. NO. FM 52711**

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