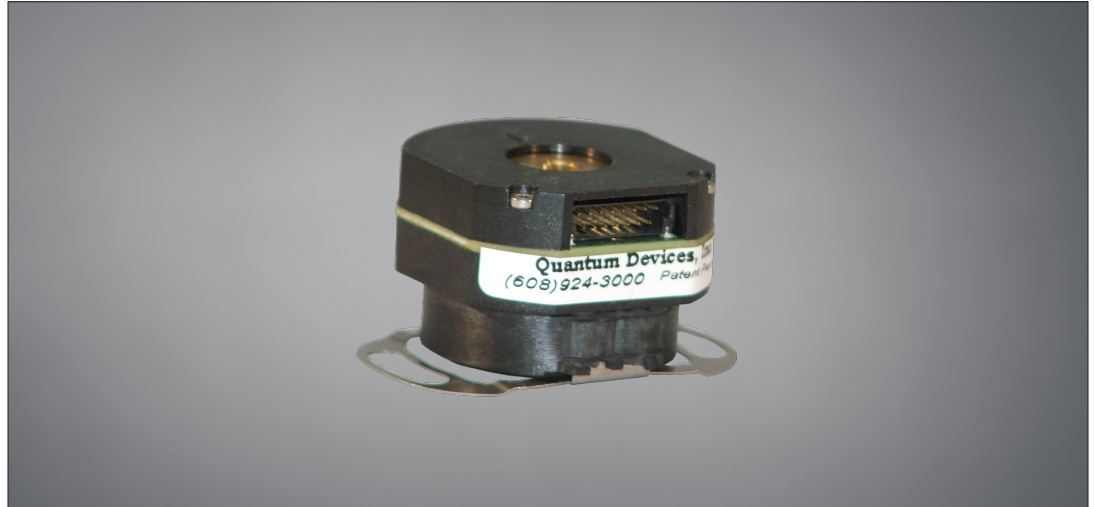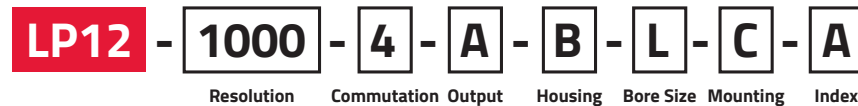# Quantum Devices

QPhase™ Encoders

LP12

DESIGN FEATURES

- **Low profile assembled height of 0.816"**
- **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 0.3125" (8 mm) diameter**
- **High noise immunity**
- **Cost competitive with modular encoders**
- **500 kHz frequency response**
- **RoHS construction**

Quantum Devices, Inc. Model LP12 provides an improved feedback solution in applications typically using modular encoders. With an overall height of less than an inch and the stability of a bearing encoder design, the model LP12 can provide significant performance upgrades in applications limited by traditional modular encoder solutions. Outputs consist of a quadrature with index pulse (incremental or sinusoidal) 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.

LP12 - **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 4 = 4 Pole 6 = 6 Pole 8 = 8 Pole	A = Line Driver B = Line Driver ABZ / Open Collector UVW C = Sin/Cos[3] / Line Driver UVW D = Sin/Cos[3] / Open Collector UVW	B = Through Hole Cover C = Closed Cover	A = 3 mm B = 4 mm C = 5 mm D = 6 mm E = 8 mm J = 0.125" K = 0.1875" L = 0.250" M = 0.3125"	A = 1.812" B = 1.575" C = 1.280"	A = 90° gated to A & B C = Ungated Square Wave (Sin/Cos Option Only) D = Ungated Sinusoidal (Sin/Cos Option Only)

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)
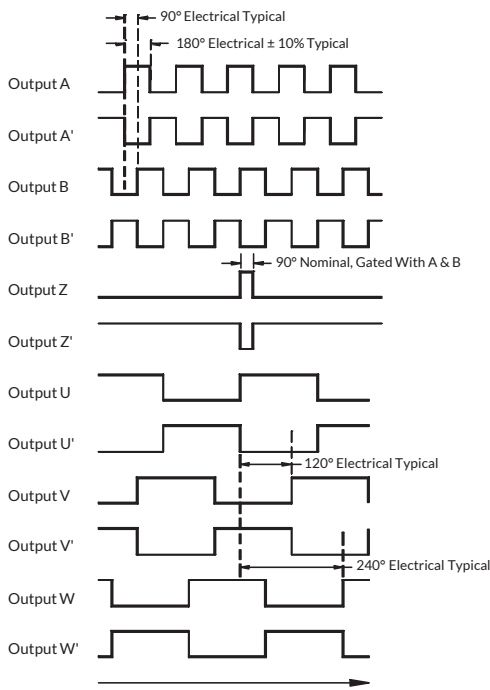3.) Sin/Cos Outputs are limited to Resolutions between 500 and 1250 PPR

- 90° Electrical Typical
- 180° Electrical ± 10% Typical
- Output A
- 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
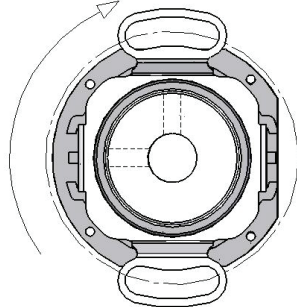- Output V' — 240° Electrical Typical
- Output W
- Output W'

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) B = ABZ 26C31 line driver, UVW open collector (no U' V' W')
Incremental Output Format	Quadrature with A leading B for CW rotation 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 ≥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

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)

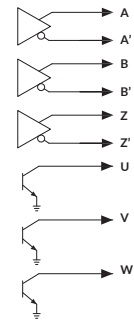## ELECTRICAL OUTPUT CIRCUITS

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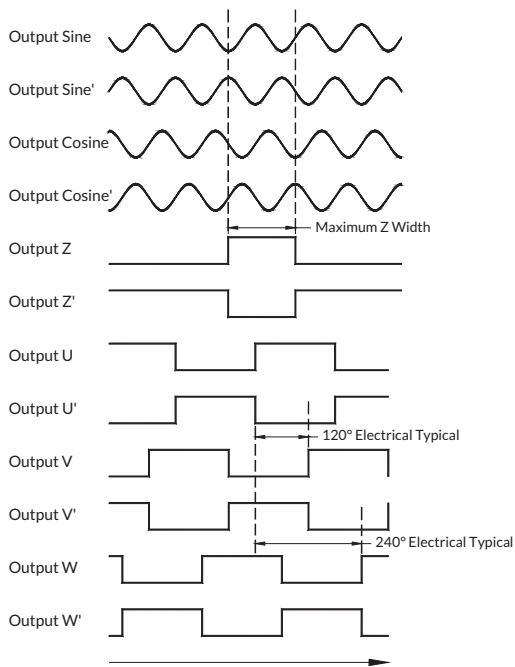UVW = 26C31 line driver (RS-422)
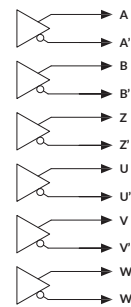
Output Option B:
ABZ = 26C31 line driver (RS-422)
UVW = open collector

- 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
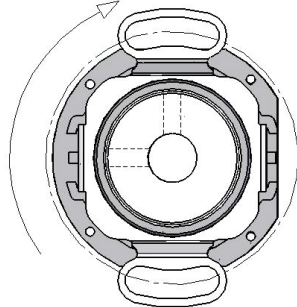- U, V and W are "no connect" for Commutation option 0

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

SIN/COS OUTPUT WAVEFORMS

Output Sine

Output Sine'

Output Cosine

Output Cosine'

Maximum Z Width

Output Z

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) 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 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)
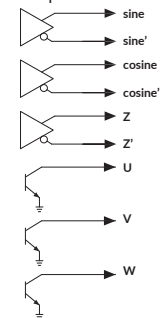
ELECTRICAL OUTPUT CIRCUITS

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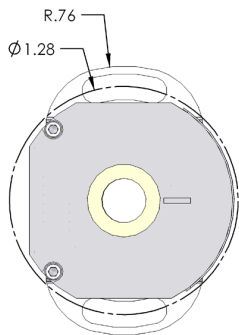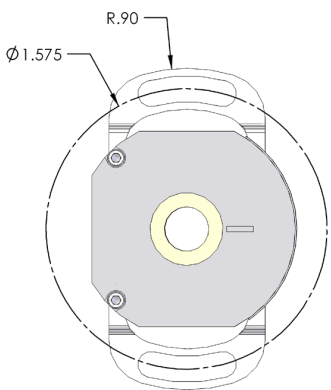UVW = 26C31 line driver (RS-422)

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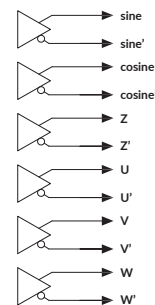
Output Option D:
sin/cos = 1 Vpp sine/cosine line driver
UVW = open collector

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

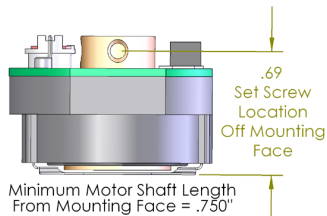- 26C31 line driver is TTL compatible (can be wired single-ended)
- 26C31 sink/source 20 mA max (meets RS-422 at 5 VDC supply)
- Open collector sink 30 mA max, pull up voltage 30 VDC max
- U, V and W are "no connect" for Commutation option 0

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

Quantum Devices

STANDARD BOLT CIRCLES

R1.02
Ø1.81

R.90
Ø1.575

R.76
Ø1.28

Shaft Engagement

.69
Set Screw
Location
Off Mounting
Face

Minimum Motor Shaft Length
From Mounting Face = .750"
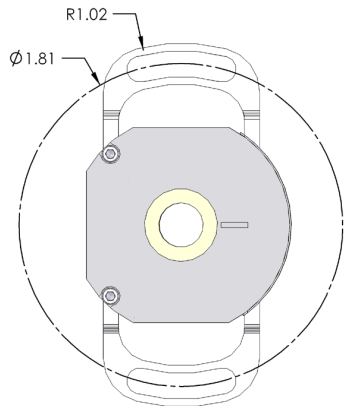
PHYSICAL SPECIFICATIONS

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", 3 mm, 4 mm, 5 mm, 6 mm, 8 mm (+0.0006/-0.0000")
Recommended Shaft Engagement	0.750" 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	9.1×10^{-5} oz·in·s²
Acceleration	1×10^{5} radians/s²
Accuracy	Instrument error 1.5 arc minutes max

MECHANICAL DIMENSIONS

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

1.28
[32.51]

1.51
[38.35]

.53
[13.46]

.82
[20.73]

.34
[8.56]

.025
[0.635]

Hub Clearance

Ø 1.22
[30.99]

30.00°

1.10
[27.84]

Through Bore Diameters
up to 0.3125" or 8 mm

Alignment Mark
Hub Shown At
Index Position

Quantum Devices

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

One Meter Cable Both Ends Terminated:
2080AG039 = 14 conductor 28 AWG for UVW Commutation
2082AG039 = 8 conductor 28 AWG for non-Commutation
Connector = JAE FI-W15S

Half Meter Cable One End Terminated:
2081AG019 = 14 conductor 28 AWG for UVW Commutation
2083AG019 = 8 conductor 28 AWG for non-Commutation
Connector = JAE FI-W15S
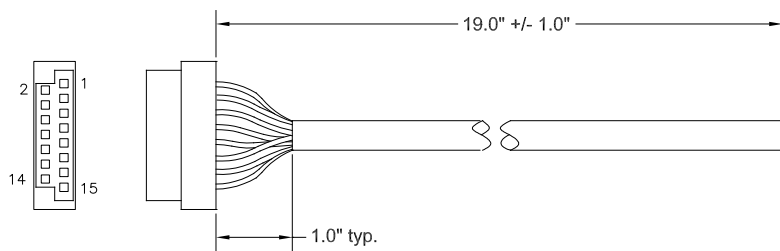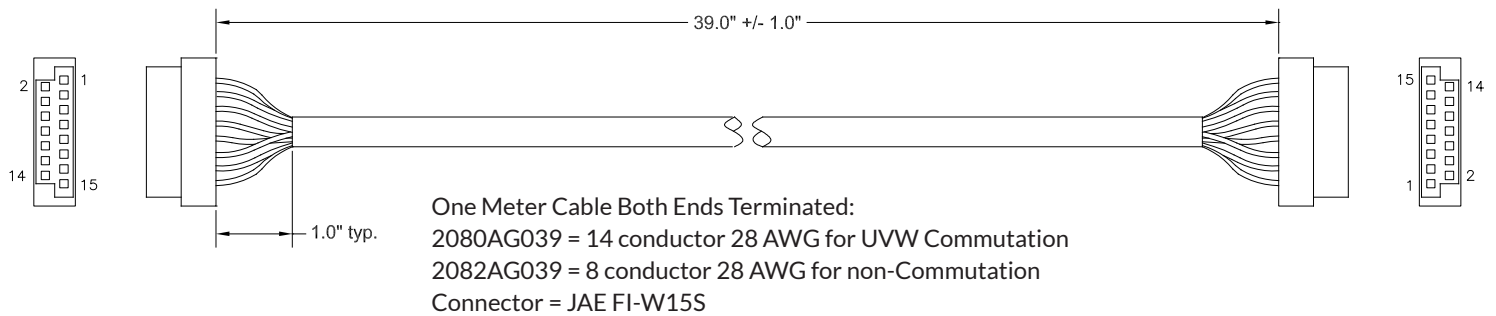
Pin Number	Encoder Pin Function	2080AG039 2081AG019 Wire Color	2082AG039 2083AG019 Wire Color
1	A / sine	Brown	Brown
2	A' / sine'	White	White
3	B / cosine	Blue	Blue
4	B' / cosine'	Green	Green
5	Z	Orange	Orange
6	Z'	Yellow	Yellow
7	U	Violet	-
8	U'	Gray	-
9	V	White/Brown	-
10	V'	White/Red	-
11	W	White/Orange	-
12	W'	White/Yellow	-
13	Vcc	Red	Red
14	GND	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

ENCODER INSTALLATION INSTRUCTIONS

1. Remove two cap screws using an IP5 Torx Plus driver and remove encoder cap, exposing brass hub.

2. Using two fingers slide the encoder onto shaft.

3. 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.

4. Insert and tighten encoder set screws using a 0.050" hex driver. Torque range of 28–32 oz·in.

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

6. Replace encoder cap and re-install two cap screws. Torque range of 12–24 oz·in.

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.

ISO 9001
CERT. NO. FM 52711

REV. 200527

Quantum Devices