

## AS38-H39E Series

### 39-Bit Energy-Harvesting Multi-Turn Absolute Encoder



## Introduction

The Broadcom® AS38-H39E series encoder is a high-resolution optical absolute encoder that offers 23-bit single-turn and 16-bit multi-turn counts, hence a combined 39-bit high resolution. The AS38-H39E series encoder is a house encoder consisting of a patterned disk, a light source, and photosensitive elements to translate the mechanical motion into electrical signal.

The AS38-H39E series encoder has a built-in communication protocol that is supported by a full-duplex or half-duplex line transmissions drive, offering good noise immunity for more robust transmission of data up to 10 Mb/s in harsh industrial applications. Because the product is intended for industrial applications, ESD protection circuitry has been designed in to achieve Class 3 ESD immunity per IEC -61000-4-2 standard. The AS38-H39E series is also compliant with IP50 per IEC 60529 standard.

The key advantage of the AS38-H39E series is its multi-turn tracking that employs energy-harvesting technology by harvesting the magnetic energy as the encoder shaft rotates. It is the gearless multi-turn counting that eliminates the gear wear-out or acoustic noise issue that is encountered in conventional geared multi-turn encoders. When compared to battery backed-up multi-turn counting, this technology does not require periodic maintenance of the battery backup components and the down time associated with it.

## Operating Theory

The encoder contains two main functional blocks: the single-turn optical engine block and the energy-harvesting multi-turn counter block. The single-turn engine comprises a Broadcom-developed high-performance optical detector ASIC, which is accompanied by high-precision amplifier circuitry, coupled with a special multi-track code disk that rotates between the LED emitter and detector IC.

The multi-turn counting is enabled utilizing energy-harvesting technology. When the shaft is rotating, the magnet mounted on the shaft moves in tandem. The energy-harvesting coil module cuts the moving magnet field, and generates energy as a result.

The beauty of the energy-harvesting effect is that the same amount of energy is generated independent of the rotation speed. The generated energy is sufficient to power-up the revolution tracking circuitry. Therefore, no miscounts occur even in the absence of an external power supply.

## Features

- 39-bit resolution: 16-bit energy-harvesting multi-turn and 23-bit optical single-turn
- Built-in communication protocol (optional): BiSS C mode, SSI mode, and RS-485 half-duplex
- Overall encoder outer diameter Ø38 mm and maximum height of 40 mm
- Supporting 1/4 inch, 6-mm and 8-mm diameter of the blind hollow shaft

## Benefits

- No battery or capacitor required for position detection during power failure
- Immediate position detection on power up

## Applications

- Robotics
- Factory automation
- Linear positioning system
- CNC machine tool
- Medical and lab equipment

**NOTE:** Broadcom encoders are not recommended for use in safety-critical applications, such as ABS braking systems, power steering, life support systems, and critical care medical equipment. Contact a sales representative if more clarification is needed.

## Product Specifications

### Electrical Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
Current Consumption	Without load, $T_{amb} = 25^\circ C$	—	115	—	mA
Supply Voltage	—	4.5	5	5.5	V
Electrically Permissible Speed	—	—	—	6000	$min^{-1}$

### Mechanical Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
System Accuracy	With electrical correction, $T_{amb} = 25^\circ C$	—	±80	—	Arc-sec
Mechanical Permissible Speed	—	—	—	6000	$min^{-1}$
Shaft Radial Play	—	—	—	±0.05	mm
Shaft Axial Play	—	—	—	±0.1	mm
Starting Torque	$T_{amb} = 25^\circ C$	—	—	$9.8 \times 10^{-3}$	N.m

### Environmental Specifications

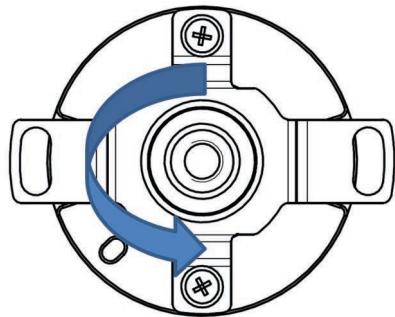
Parameter	Conditions	Min.	Typ.	Max.	Unit
Storage Temperature	—	-20	—	105	°C
Operating Temperature	—	-20	—	105	°C
Relative Air Humidity (Non-Condensing)	$T_{amb} = 40^\circ C$	—	90	—	RH%
Protection	—	—	IP50	—	
Vibration	Per IEC 60068-2-6	—	—	10G; 10~2000 Hz	
Shock	Per IEC 60068-2-27	—	—	6 ms; Half Sine; 200G	

## Encoder Specifications

Parameter	Remarks
Resolution	Single-turn 23-bit (8388607 counts) and multi-turn 16-bit (65535 counts)
Counting Direction	Increase with Counter Clockwise (CCW) shaft rotation, view from coupling end ( <a href="#">Figure 1</a> )
Initialization Time	500 ms

**NOTE:** After encoder initialization duration of 500 ms upon power-up, perform an alarm clear command before starting to interface with the encoder.

**Figure 1: Shaft Rotation**



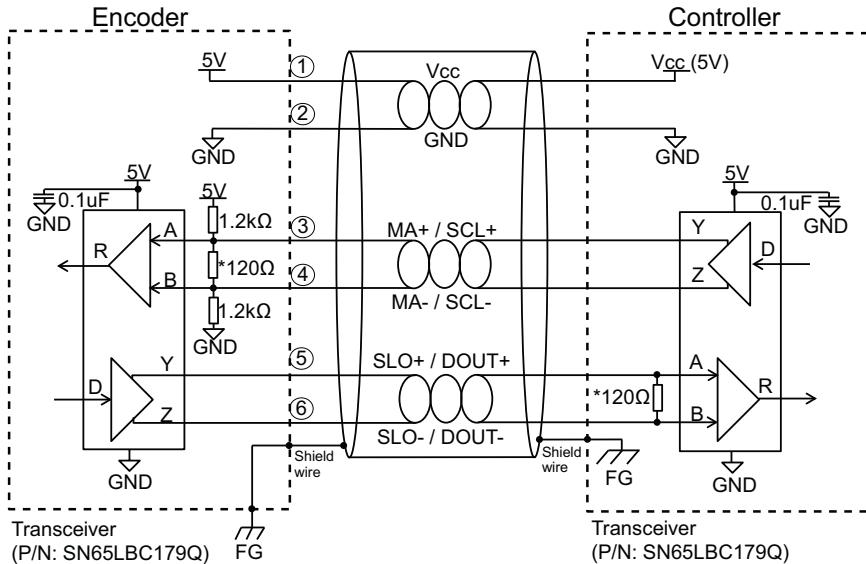
**NOTE:** Exposure to absolute maximum rating conditions for extended periods might affect reliability.

## Interface Diagram

The following are examples of the circuit diagram of full-duplex and half-duplex transceiver.

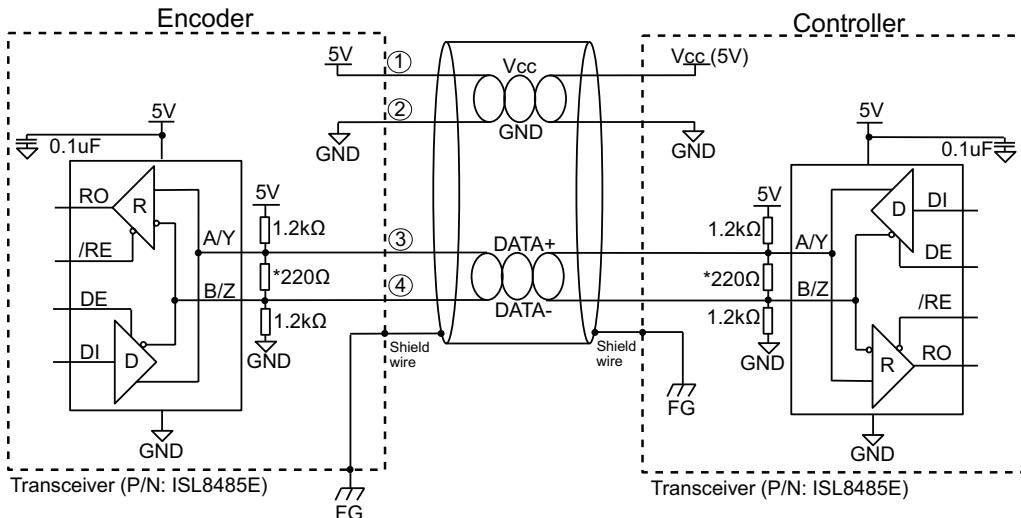
### Full-Duplex Transceiver (BiSS C Mode/SSI Mode Protocol)

Figure 2: Circuit Diagram of Full-Duplex Transceiver



### Half-Duplex Transceiver (RS-485 Half-Duplex Protocol)

Figure 3: Circuit Diagram of Half-Duplex Transceiver



\* Termination resistor, 120Ω and 220Ω are recommended but may depend on the characteristic impedance of cable used.

**NOTE:** Connect encoder chassis and cable shield to frame ground (FG) in application for enhanced noise immunity in harsh operating conditions.

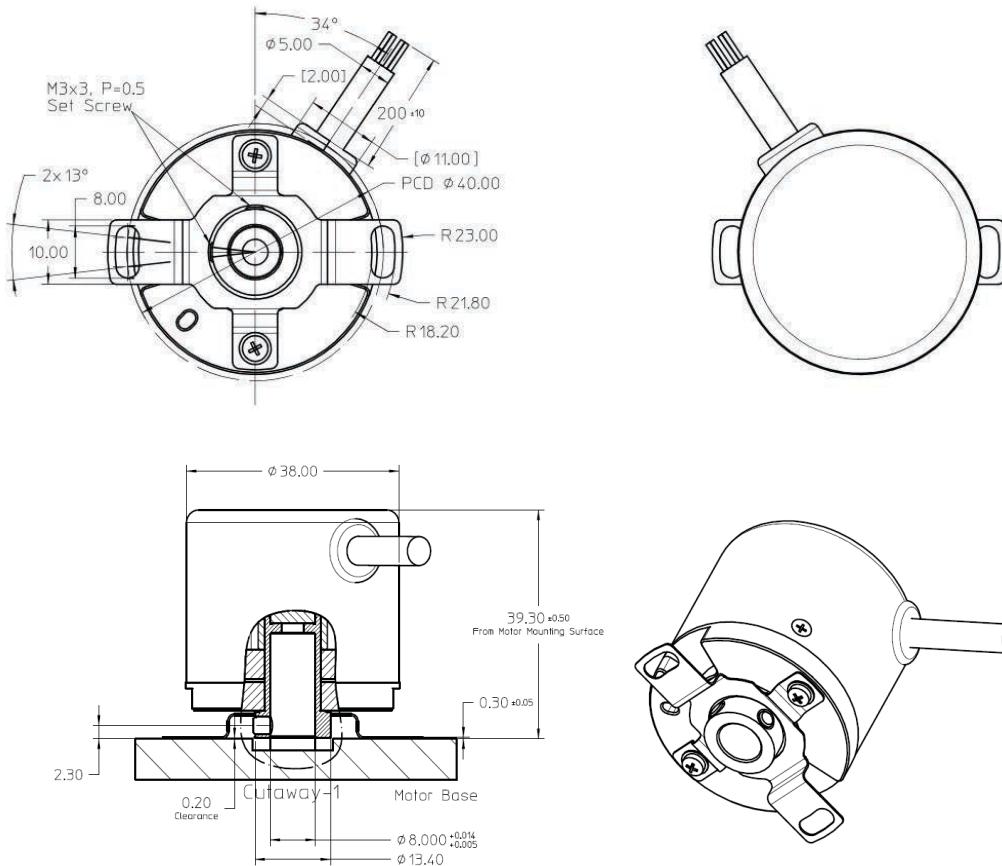
## Cable Connection Information

No.	Cable Color	AS38-H39E-Bxxx (BiSS-C) (Output: 7-Core Cable)	AS38-H39E-Sxxx (SSI) (Output: 7-Core Cable)	AS38-H39E-Kxxx (RS-485 Half-Duplex) (Output: 5-Core Cable)
1	RED	V <sub>CC</sub> , Positive Supply	V <sub>CC</sub> , Positive Supply	V <sub>CC</sub> , Positive Supply
2	BLACK	GND, Ground	GND, Ground	GND, Ground
3	BROWN	MA+	SCL+	DATA+
4	WHITE	MA-	SCL-	DATA-
5	ORANGE	SLO+	DOUT+	N/A
6	BLUE	SLO-	DOUT-	N/A
7	Cable Shield Strand	Cable shield, connect to chassis	Cable shield, connect to chassis	Cable shield, connect to chassis

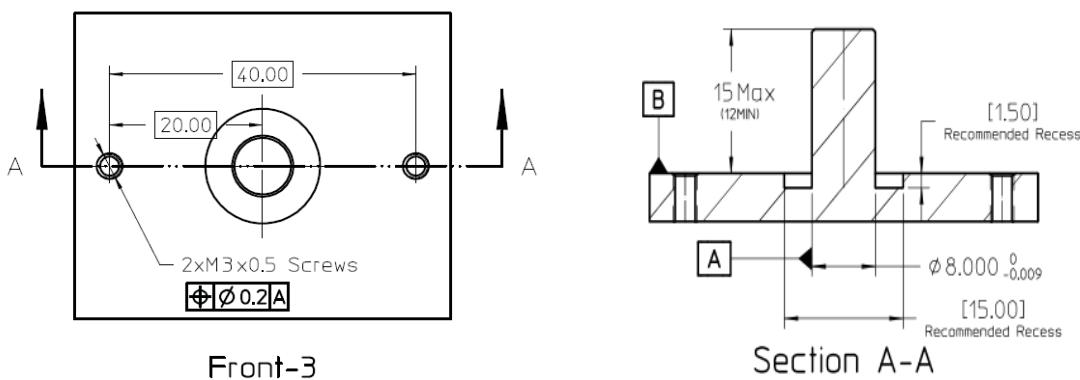
**NOTE:** Cable provided is 200 mm ± 10 mm (included pigtail length) with AWG28.

# Mechanical Drawing

## Package Dimensions



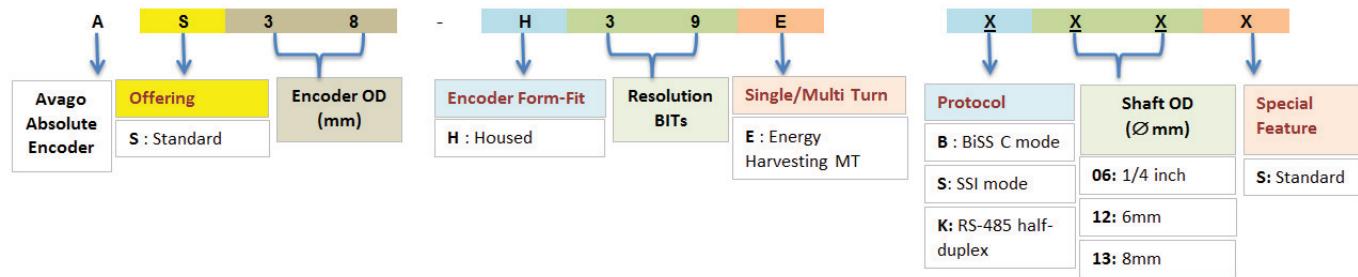
## Recommended Shaft and Mounting Requirement



### NOTE:

1. Dimensions are in millimeters.
2. 3rd angle projection.
3. Unless otherwise specified, all tolerances are within  $\pm 0.5$  mm.
4. It is recommended to have a recess on the motor mounting surface to prevent encoder shaft interference with motor base.

## Ordering Information



**NOTE:** Contact Broadcom for sample orders and lead time.

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