

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

### Data Sheet



### Introduction

The AS38-H39E series encoder is a high-resolution optical absolute encoder produced by Broadcom<sup>®</sup>, which 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 application. Because the product is intended for industrial application, 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 acoustics noise issue that is encountered in conventional geared multi-turn encoder. On the other hand, when comparing 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

Structures-wise, 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 amplifiers circuitry, coupled with a special multi-track code disk that rotates between the LED emitter and detector IC.

On the multi-turn side, 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 external power supply.

### Features

- 39-bit resolution: 16-bit energy-harvesting multi-turn and 23-bit optical single-turn
- Built-in communication protocol (option): BiSS C mode, SSI mode and RS-485 half-duplex
- Overall encoder outer diameter  $\varnothing$ 38 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, e.g., 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, Tamb = 25°C	—	115	—	mA
Supply Voltage	—	4.5	5	5.5	V
Electrically Permissible Speed	—	—	—	6,000	min <sup>-1</sup>

### Mechanical Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
System Accuracy	With electrical correction, Tamb = 25°C	—	±80	—	Arc-sec
Mechanical Permissible Speed	—	—	—	6,000	min <sup>-1</sup>
Shaft Radial Play	—	—	—	±0.05	mm
Shaft Axial Play	—	—	—	±0.1	mm
Starting Torque	Tamb = 25°C	—	—	9.8 x 10 <sup>-3</sup>	N.m

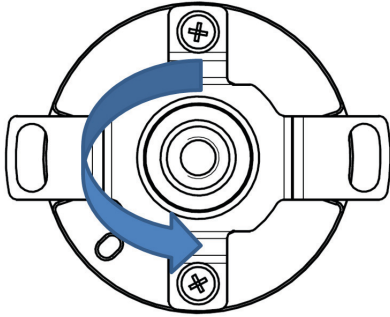
### Environmental Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
Storage Temperature	—	-20	—	105	°C
Operating Temperature	—	-20	—	105	°C
Relative Air Humidity (Non-Condensing)	Tamb = 40°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 (Figure 1).
Initialization Time	500 ms.

**Figure 1 Shaft Rotation**



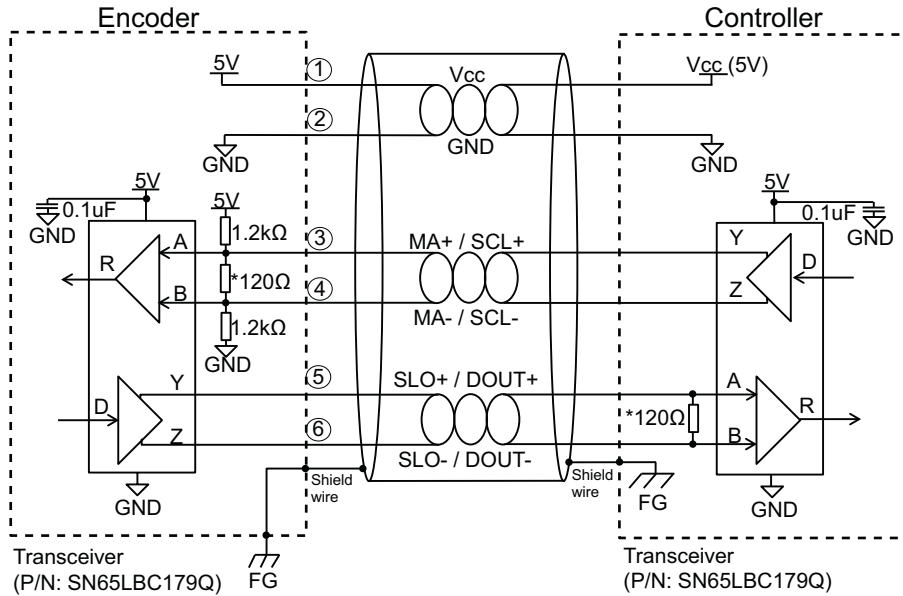
**NOTE** Exposure to absolute maximum rating conditions for extended periods might affect reliability.

## Interface Diagram

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

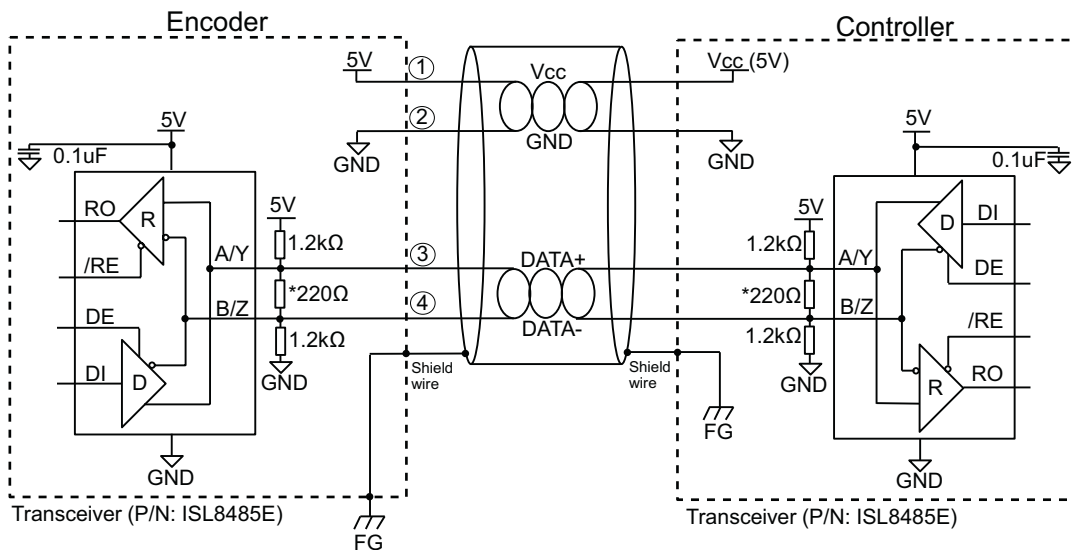
### Full-Duplex Transceiver (BiSS C Mode/SSI Mode Protocol)

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.

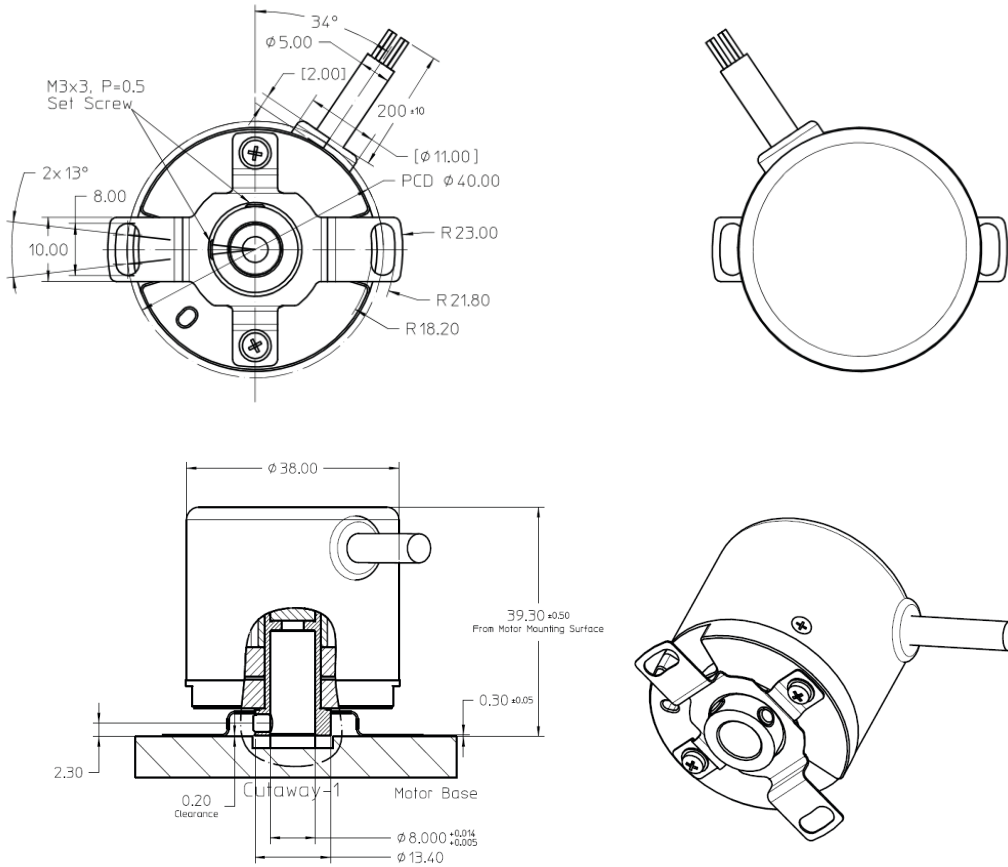
## Cable Connection Information

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	Vcc, Positive Supply	Vcc, Positive Supply	Vcc, 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

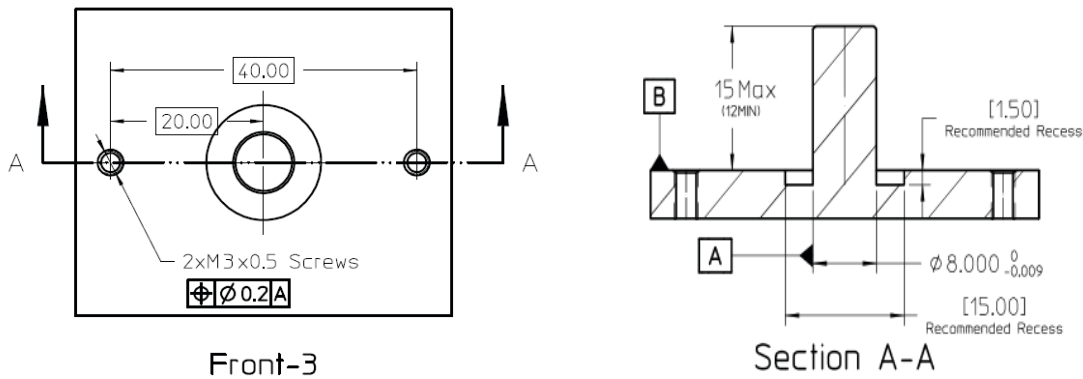
Note: Cable provided is 200 mm  $\pm$  10 mm (included pigtail length) with AWG28.

# Mechanical Drawing

## Package Dimensions

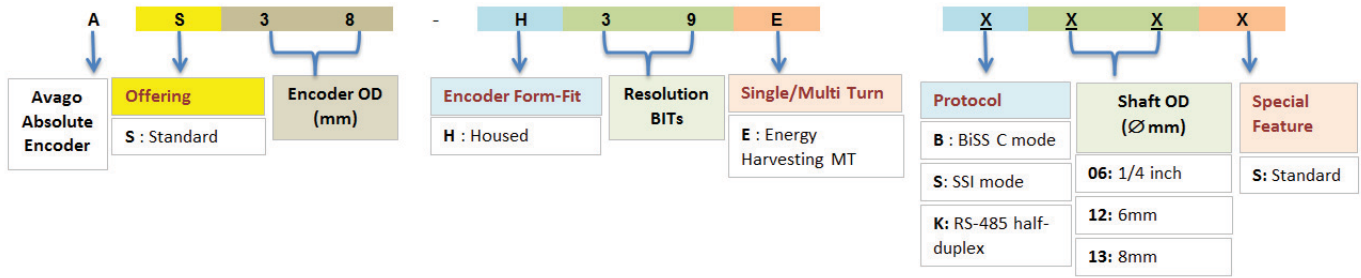


## Recommended Shaft and Mounting Requirement



- Notes:
- Dimensions are in millimeters.
  - 3rd angle projection.
  - Unless otherwise specified, all tolerances are within  $\pm 0.5$  mm.
  - Recommended to have a recess on motor mounting surface to prevent encoder shaft interference with motor base.

## Ordering Information



**NOTE** Refer to factory for sample order and lead time.

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