# AS37-H39B-Bxxx

39 Bits Battery Backup Multi-Turn Absolute House Encoder with BiSS-C Mode Output

# **Data Sheet**





### Description

AS37-H39B series encoder is a high-resolution optical absolute encoder produced by Avago Technologies, which offers 23-bits single-turn and 16-bits multi-turn counts, hence a combined 39 bits high resolution. The AS37- H39B 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 Bxxx option encoders are preloaded with BiSS-C communication protocol with provided CRC and alarm status bits. The BiSS-C protocol is supported by a full-duplex line transmissions drive (RS-485), offering good noise immunity for more robust transmission of data up to 10 Mbps in harsh industrial application.

The key advantage of AS37-H39B series is multi-turn tracking that employs battery backup technologies. It is the gearless multi-turn counting that eliminates the gear worn out or acoustics noise issue that is encountered in conventional geared multi-turn encoders. Because the product is intended for industrial application, ESD protection circuitry has been designed by achieving the following ESD compliance: IEC-61000-4-2 class 3.

## **Operating Theory**

Structure-wise, the encoder contains two main functional blocks: the single-turn optical engine block and the battery backup multi-turn counter block. The single-turn engine comprises the Avago 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.

On multi-turn side, the multi-turn counting is enabled utilizing battery backup counter technology. During battery mode (encoder operates in main power OFF state), the battery backup circuitry periodically powers up the LED emitter, enabling the photo sensor to scan the code disk multi-turn tracks for detection of shaft rotation. In order to prolong the battery life, extra effort has been put into the design of the ASIC to ensure minimum current consumption during battery mode operation. Therefore, no miscounts occur even in the absence of external power supply.

### Features

- 39-bits resolution: 16-bits battery backup multi-turn and 23-bits optical single-turn
- Alarm features with CRC and alarm status bits
- Built in with BiSS-C Mode Communication Protocol
- Ø37 mm and typical mounting height 28 mm
- Supporting 8-mm diameter of the blind hollow and Taper shaft
- 5K bits of user-accessible memory in E<sup>2</sup>PROM

### **Benefits**

- High resolution with higher measurement accuracy
- Position detection during power failure with battery buffer
- Immediate position detection on power up

### Applications

- Robotics
- Factory automation
- Linear positioning system
- CNC machine tool
- Medical and lab equipment
- Wind turbine
- **NOTE** Avago Technologies 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.

### **Mechanical Drawings**

### **Option 1: Ø8-mm Hollow Blind Shaft**

#### **Package Dimensions**







Back-1





¢ 8.000 \*005

 $( \mathbf{+} )$ 

20.0 Max



#### **Recommended Shaft and Mounting Requirement**





- 1. Dimensions are in millimeters.
- 2. Third angle projection.
- 3. Unless otherwise specified, all tolerances are within  $\pm 0.5$  mm.
- 4. Recommended to have a recess on motor mounting surface to prevent encoder shaft interfere with motor base.

### Option 2: Standard Taper Shaft (Ø9 to Ø7.5 mm; 1:10)

#### **Package Dimensions**



Bottom-1

Bottom-2

#### **Recommended Shaft and Mounting Requirement**



- 1. Dimensions are in millimeters.
- 2. Third angle projection.
- 3. Unless otherwise specified, all tolerances are within ±0.5 mm.
- 4. Recommended to have a recess on motor mounting surface to prevent encoder shaft interference with motor base.

### Option 3: Short Taper Shaft (Ø9 to Ø7.65 mm; 1:10)

#### **Package Dimensions**







Back-1



Bottom-1

Bottom-2

#### **Recommended Shaft and Mounting Requirement**



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

### **Device Selection Guide**

Part Number	Resolution	Operating Temperature (°C)	Output Communication	Output Code	DC Supply Voltage (V)
AS37-H39B	39 bits (16 bits ST + 16 bits MT) <sup>a</sup>	–20 °C ~ 105 °C <sup>b</sup>	BiSS-C	Binary	5.0 V ± 10%

a. ST: Single-turn; MT: Multi-turn.

b. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

### **Electrical Specifications**

Parameter	Conditions	Min	Тур	Мах	Unit
Current Consumption	Without load, Tamb = 25 °C	_	120	—	mA
Supply Voltage	_	4.5	5	5.5	V
Electrically Permissible Speed	_	—	—	6,000	min <sup>-1</sup>
Electrically Permissible Acceleration	Normal mode	—	—	8.0 x 10 <sup>4</sup>	rad/s <sup>2</sup>
	Battery mode	-	—	4.0 x 10 <sup>4</sup>	
External Battery Supply Voltage	_	3.6	—	4.5	V
Battery Mode Current Consumption	Tamb = 25 °C	_	95	—	μΑ

### **Mechanical Specifications**

Parameter	Conditions	Min	Тур	Мах	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	Тур	Max	Unit
Storage Temperature	—	-20	—	105	°C
Operating Temperature	_	-20	—	105	°C
Relative Air Humidity (Non-Condensing)	Tamb = 40 °C		90		RH%
Protection	—	—	IP40	—	
Vibration	Per IEC 60068-2-6	—	—	10G; 10 ~ 2000 Hz	—
Shock	Per IEC 60068-2-27	—	—	6 ms; Half Sine; 200G	—

### **Encoder Specifications**

Parameter	Remark
Resolution	ST 23 Bits (8388607 counts) and MT 16 Bits (65535 counts)
Counting Direction	Increase with counter clockwise shaft rotation, view from coupling end
Position Calculation Time	Refer to BiSS C T <sub>busy time</sub>
User-Accessible Memory Size	5K bits
Initialization Time <sup>a</sup>	500 ms
Battery Alarm	3.1 V (typical)
Battery Error	2.9 V (typical)

a. Initialization time is decided the time until possible to receive the request command after the alternation from battery mode to normal mode.

#### **NOTE** Terms definitions:

Normal mode: Encoder operates on encoder main power supply.

Battery mode: Encoder operates in OFF State, while multi-turn data is tracked by battery circuitry.

#### Figure 1 View from Coupling Side



View from coupling side, shaft rotate CCW direction when the count is increasing.

### **Interface Protocol - BiSS-C**

### **Timing Characteristics**

Parameter	Symbol	Condition	Min	Тур	Мах	Unit	Notes
MA Frequency	f <sub>MA</sub>	_	0.08	_	10	MHz	1
Busy	T <sub>busy</sub>	_	2/ f <sub>MA</sub> + 3.35 μs	—	2.5/ f <sub>MA</sub> + 3.75 μs	μs	2
Timeout	t <sub>BiSS-timeout</sub>	_	1.5/ f <sub>MA</sub>	—	1.5/ f <sub>MA</sub> + 90 ns	ns	2
Encoder Initialization Time	—	_	_	500	_	ms	_

#### Figure 2 Timing Characteristics of MA and SLO



- 1. MA low-time =  $0.50/f_{MA}$ ; high-time =  $0.50/f_{MA}$ .
- 2. Refer to Figure 2 for timing description.
- 3. CRC Polynomial = Invert of  $(X^6 + X^1 + X^0)$ .
- 4. nErr bit is active low. (Combine all the Error Status and reflect in nErr bit.)
- 5. nWar bit is active low. (Combine all the Warning Status and reflect in nWar bit.)

#### **Register Communication**

#### Description

Refer to BiSS-C Interface Protocol Description Rev C5 document for detailed information of BiSS-C Register Communication.

http://biss-interface.com/files/Bissinterface\_c5es.pdf

#### Figure 3 Register Write Access



#### Figure 4 Register Read Access



#### Figure 5 Writing Several Registers



#### Figure 6 Reading Several Register



(S=Start, P=Stop, R=Read, W=Write)

### **Register Assignment**

#### Description

Refer to BiSS-C Interface Protocol Description Rev C5 document for detail information of BiSS-C Register Assigment. http://biss-interface.com/files/Bissinterface\_c5es.pdf

There are a total of 10 register banks user areas (register bank 0 to register bank 9) that are accessible by users.

The memory data is kept in nonvolatile memory.

#### Table 1 Table of Register Assignment

Address (Decimal)	Address (Hexadecimal)	Name	Size	Memo
0 63	0x00 0x3F	Register bank	64 bytes	
64	0x40	Bank selection	0 8 bits (1 byte)	a, b
65	0x41	EDS-Bank	0 8 bits (1 byte)	a, c
66 67	0x42 0.43	Profile ID	16 bits (2 bytes)	c, d
68 71	0x44 0x47	Serial number	32 bits (4 bytes)	c, d
72 119	0x48 0x77	Slave register	48 bytes	
120 125	0x78 0x7D	Device ID	48 bits (6 bytes)	c, d
126 127	0x7E 0x7F	Manufacturer ID	16 bits (2 bytes)	c, d

a. If no blank switchover is used, the register should not be implemented.

b. Unused register contents must therefore be filled with 0.

c. Register is protected against accidental writing.

d. The value is saved as a big endian; i.e., with the highest value byte at the lowest value address.

Note: EDS-Bank is not available.

### Memory Map (Non-Volatile Memory)

EEPROM	OM BISS C		Domoska
Address	Bank	Address	Remarks
000h ~ 27Fh	0	00h ~ 3Fh	User Area
	1	00h ~ 3Fh	
	2	00h ~ 3Fh	
	3	00h ~ 3Fh	
	4	00h ~ 3Fh	
	5	00h ~ 3Fh	
	6	00h ~ 3Fh	
	7	00h ~ 3Fh	
	8	00h ~ 3Fh	
	9	00h ~ 3Fh	
280h ~ 2FFh	10	00h ~ 3Fh	Avago Reservation Area (User prohibited write)
	11	00h ~ 3Fh	
300h ~ 37Fh	12	00h ~ 3Fh	
	13	00h ~ 3Fh	
380h ~ 3BFh	14	00h ~ 3Fh	
3C0h ~ 3FFh	_	40h	Bank Selection
		41h	EDS-Bank (User prohibited write) –
			Not Available
		42h ~ 43h	Profile ID (User prohibited write)
		44h ~ 47h	Serial Number (User prohibited write)
		48h ~ 77h	Slave Register (Refer to the Slave Register Description – user area)
		78h ~ 7Dh	Device ID (User prohibited write)
		7Eh ~ 7Fh	Manufacturer ID (User prohibited write)

Note: EDS-Bank is not available.

Avago Reservation Area - User needs to consult Avago Technologies before accessing this area.

### **Slave Register Descriptions**

Address 72(0x48) – Error Status [7:0]

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Battery Alarm	Battery Error	Multi-turn Err Error	N/A	Counter Overflow Error	STErr Error	N/A	Over Speed Error

Address 73(0x49) – Warning Status [7:0]

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
	N/A						LED_Err Warning

Address 74(0x4A) – Encoder Clear Command

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
N/A				Warning clear	Error clear	ST clear	MT clear
				command	command	command	command

a. Encoder Clear Command operation.

a. Write 1 to execute one time clear command.

b. Only one command should be accessed for each time.

### **Error Status**

Bit	Alarm Status	Default Value	Description
0	Over Speed	0	To detect over speed and cause wrong MT counting.
			1: Speed >6000 rpm and cause wrong MT data.
			0: Speed <6000 rpm or speed >6000 rpm but not cause wrong MT data.
			Not define if speed >14000 rpm.
1	Reserved	0	Not used.
2	ST Err	0	To check integrity of ST position.
			1: Error in ST position.
			0: No error in ST position.
3	Counter Overflow	0	To indicate multi-turn counter overflow condition.
			1: Multi-turn counter overflow.
			0: Multi-turn counter not overflow.
4	Reserved	0	Not used.
5	Multi-turn Err	0	To check integrity of MT position.
			1: Error in MT position.
			0: No error in MT position.
6	Battery Error	0	To indicate end of battery life status.
			1: Battery voltage is less than 2.9 $\pm$ 0.25 V.
			0: Battery voltage is more than $2.9 \pm 0.25$ V.
7	Battery Alarm	0	To indicate health of battery.
			1: Battery voltage is less than 3.1 $\pm$ 0.1 V.
			0: Battery voltage is more than $3.1 \pm 0.1$ V.

### Warning Status

Bit	Alarm Status	Default Value	Description
0	LedErr	0	To indicate if LED current is out of operating range. 1: LED out of operating range. 0: LED within operating range.
1	LisErr	0	To check integrity of ADC Sin and Cos signals by means of Lissajous specifications. 1: Lissajous out of specification. 0: Lissajous within specification.
2	Reserved	0	Not used.
3	Reserved	0	Not used.
4	Reserved	0	Not used.
5	Reserved	0	Not used.
6	Reserved	0	Not used.
7	Reserved	0	Not used.

### **Typical Application**

Interface	Circuit
Serial Clock (MA)	Line Driver and Receiver Pairs (P/N: SN65LBC179Q)
Serial Data (SLO)	Line Driver and Receiver Pairs (P/N: SN65LBC179Q)

The following is an example of the circuit diagram of the transceiver.

#### Figure 7 Circuit Diagram of Transceiver



\* Termination resistor, 120  $\Omega$ , is recommended but may depend on the characteristic impedance of cable used.

### **Connector Information**

Pin	Description
1	VCC, Positive Supply
2	GND, Ground
3	GND (External Battery)
4	BATPWR (External Battery)
5	MA+
6	MA-
7	SLO+
8	SLO-
9	NC
10	NC

Note: Recommended mating connector: Hirose Part No: DF13-10S-1.25C (CL No.536-0006-8)

Hirose (Terminal Pin for Wire 26~30AWG): DF13-2630SCF (CL No.536-0300-5)

### **Ordering Information**



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

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