AS33-M42M Series

42-bit Full Magnetic Energy Harvesting Multi-Turn Absolute Encoder Module

Description

The Broadcom® AS33-M42M series is an 18-bit single-turn (ST) absolute magnetic encoder with a 24-bit energy harvesting multi-turn (MT) counter. Hence, the encoder solution has a combined 42-bit absolute resolution. Design of the encoder features state-of-the-art energy harvesting MT technology and angular magnetic hall sensing with sophisticated signal conditioning algorithms. A single magnetic solution is thus responsible for both the ST and MT positions' generation; which greatly improves overall feedback system integrity and simplicity.

The key advantage of AS33-M42M series encoder is the patented energy-harvesting technology for revolution tracking. This technology converts rotating magnetic field into electrical energy, which powers the revolution tracking circuit. The beauty of energy harvesting technology is that the same amount of energy is generated independent of encoder rotation speed and direction. The generated energy is sufficient to power up the MT counter circuitry. Therefore, there is no loss of revolution count even in the absence of external power supply. On the other hand, when comparing to battery backed up MT counting, this technology does not require periodic maintenance of the battery backup components and the down time associated with it. Field servicing of the servo motor systems can then be minimized, which reduces the overall system cost over the service life of the system.

The AS33-M42M series encoder has a built-in communication protocol, which is supported by a full-duplex or half-duplex line transmissions drive, offering good noise immunity for a robust transmission of data up to 10 Mb/s even in harsh industrial applications. This magnetic technology-based encoder is robust against contamination such as dust and finger print on the sensing element. As a result, it requires less stringent control in production handling and harsh environment.

Features

- Patented Energy Harvesting technology
- Total 42-bit resolution with 18-bit single-turn and 24-bit multi-turn
- Low angular accuracy error of <0.1°
- Overall encoder outer diameter Ø33 mm and maximum height of 20 mm
- Built-in communication protocol (options):
  - SSI (2 MHz)
  - BiSS-C (10 MHz)
  - RS-485 half-duplex (2.5/5.0/10 MB/s)
- Built-in temperature sensor
- Operating temperature range –40°C to 115°C

Applications

- Small motors and linear actuators
- Robotic automation and engineering
- Drone and automated guide vehicles
- DC and AC servo motors
- Test and measurement equipment

NOTE: The Broadcom encoder is not recommended for use in life critical applications; for example, ABS braking systems, power steering, life support, and critical care systems and medical equipment. Contact sales representative if more clarification is needed.

Product Specifications

Table 1: Absolute Maximum Ratings

Parameters	Symbol	Min.	Typ.	Max.	Units	Remark[a]
Supply Voltage	VDD	–0.3	—	15	V	
Operating Temperature	T_J	–40	—	115	°C	
StorageTemperature	T_S	–40	—	115	°C	
Permissible Speed	—	—	—	12,000	rpm	Note [b]

a. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Stresses greater than the absolute maximum ratings may cause permanent damage to the device.

b. The encoder works reliably up until this permissible speed.

Recommended Operating Conditions

Table 2: Electrical Specification Over T_A = 25°C

Parameters	Conditions	Min.	Typ.	Max.	Units	Remark
Supply Voltage	—	4.5	—	5.5	V	AS33-M42M-x5x
		7	—	12.5	V	AS33-M42M-x7x
Supply Current	Without load	—	55	65	mA	AS33-M42M-x5x
		—	45	55	mA	AS33-M42M-x7x
System Accuracy	With electrical correction[a, b]	—	±0.087	—	Degree	

a. Under recommended magnetic shielding enclosure and calibration at ambient 25°C. Any wear and tear condition that might affect total indicated runout of motor shaft will cause encoder accuracy drift.

b. System accuracy measurement is conducted with direct mounting.

Table 3: Mechanical Specifications

Parameters	Conditions	Min.	Typ.	Max.	Units	Remark
Axial Misalignment	—	—	—	0.2	mm	
Radial Misalignment	—	—	—	0.2	mm	
Vibration	Per IEC 60068-2-6	—	—	10G	—	10~2000 Hz
Shock	Per IEC 60068-2-27	—	—	200G	—	6 ms; Half Sine

Table 4: Environmental Specifications

Parameters	Conditions	Min.	Typ.	Max.	Units	Remark
Relative Air Humidity	T_A = 60°C	—	90	—	RH%	Non-condensing
Electrostatic Discharge	Per IEC 61000-4-2	—	—	4	kV	Module level

Table 5: Internal Temperature Sensor Specifications

Parameters	Conditions	Min.	Typ.	Max.	Units	Remark
Resolution		—	1	—	°C	
Accuracy of evaluation circuit	25°C to 115°C	–5	—	5	°C	
	–40°C to 25°C	–7	—	7	°C	
Temperature range[a, b]		–40	—	125	°C	
Calculation Time		—	—	100	ms	

a. Temperature error alarm setting = 118°C. Temperature readout is second complement value.

b. Temperature sensor is not available for SSI version product.

Table 6: Encoder Specifications

Parameter	Remarks
Single turn Resolution	Programmable 17 bits or 18 bits (maximum 262,143 counts per revolution)
Multi-turn Resolution	Programmable 12, 14, 16, or 24 bits (maximum 16,777,215 counts)
Counting Direction	Default Setting: Increase with counter-clockwise (CCW) motor shaft rotation, view from encoder top. (Programmable to clockwise direction)
Initialization Time	500 ms

Protocol Specifications

SSI Specifications

Table 7: SSI Interface Line Drivers

Interface	Recommended Circuit	Remark
Shift Clock (SCLK)	Transmitter (P/N: ISL3295E)	
Data Output (DAT)	Receiver (P/N: ISL3283E)	

Table 8: SSI Timing Characteristics

Parameters	Symbol	Conditions	Min.	Typ.	Max.	Units	Remark
Clock Frequency	f_{CLK}	—	100	—	2000	kHz	
Clock Duty	DUT_{CLK}	—	—	50	—	%	
Monoflop Time	t_m	—	—	—	20	µs	
Pause Time	t_p	—	21	—	—	µs	

Table 9: SSI Data Field for 42-Bit Data

MT[23:0]	ST[17:0]	Status[0]	Alarm[0]

Figure 1: SSI Interface Timing Diagram
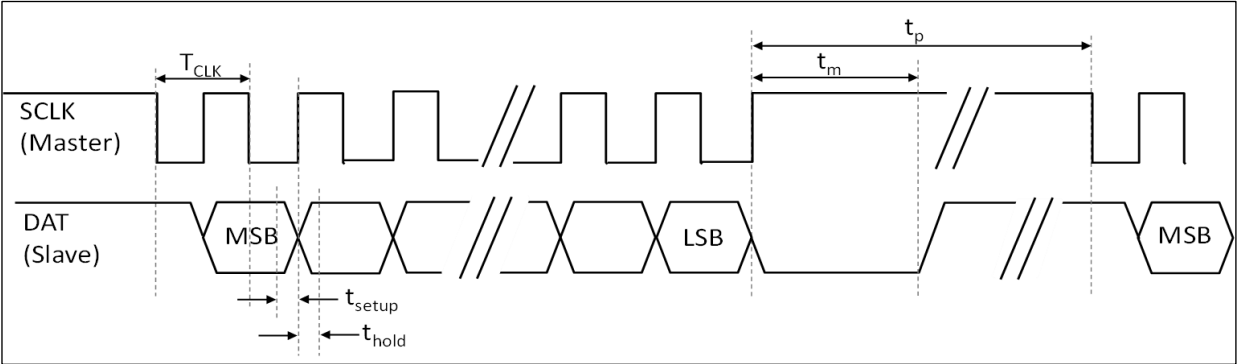
Position Zero Reset

Figure 2: A Pulse of >100 ms Resets the Full Position Value to Zero

ZERO RESET

100ms

Reset position set and position is reset to zero
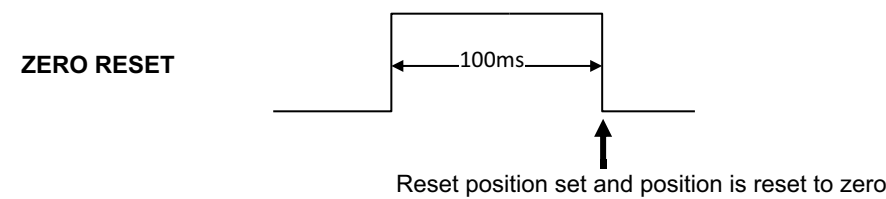
Table 10: Position Zero Reset Command

SSI Command	Signal
Position Zero Reset	Apply a minimum 100-ms Hi Pulse to the Zero Reset Pin (Pin 9), see Table 16 for the connector pinout.

BiSS-C Specifications

Table 11: BiSS-C Interface Transceivers

Interface	Recommended Circuit	Remark
Serial Clock (MA)	Transmitter (P/N: ISL3295E)	
Serial Data Output (SLO)	Receiver (P/N: ISL3283E)	

Table 12: BiSS-C Timing Characteristics

Parameters	Symbol	Conditions	Min.	Typ.	Max.	Units	Remark
MA Frequency	f_{MA}	—	0.08	—	10	MHz	
MA Duty	DUT_{CLK}	—	—	50	—	%	
Busy	T_{busy}	—	—	—	5	µs	
Timeout	$t_{BiSS-timeout}$	—	—	—	5	µs	
Frame to Frame	—	—	—	—	1	µs	

Table 13: BiSS-C Data Field

MT[23:0]	ST[17:0]	Error[0]	Warning[0]	CRC[5:0]

Figure 3: BiSS-C Interface Timing Diagram
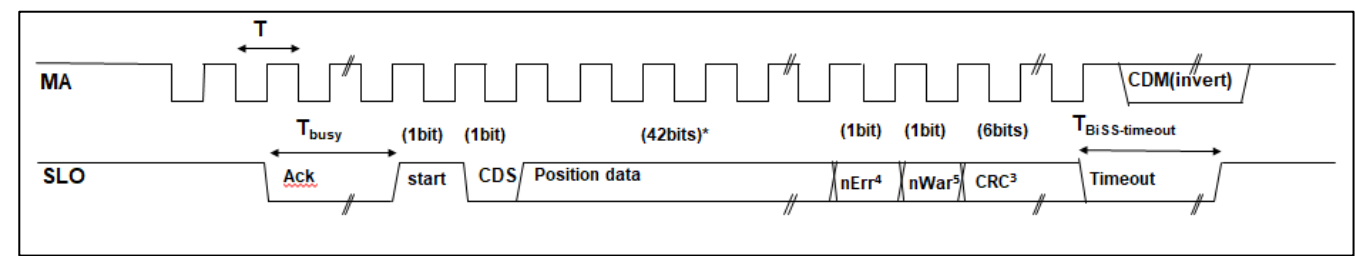
NOTE:

1. CRC Polynomial = Invert of (X6 + X1 + X0).
2. nErr bit is active low. (Combine all the Error Status and reflect in nErr bit.)
3. nWar bit is active low. (Combine all the Warning Status and reflect in nWar bit.)
4. Position data varies depending on single-turn and multi-turn resolution.

RS-485 Half-Duplex Specifications

Table 14: RS-485 Half-Duplex Interface Transceivers

Interface	Recommended Circuit	Remark
RS-485 Serial Data (DAT)	Receiver (P/N: ISL3283E)	
RS-485 Serial Data (DAT)	Transmitter (P/N: ISL3295E)	

Table 15: RS-485 Half-Duplex Timing Characteristic

Parameter	Condition	Min.	Typ.	Max.	Units	Remark
Communication Baud Rate	—	—	—	10	MHz	2.5, 5.0, 10.0 MHz
Frame length	—	—	10	—	Bit/Frame	
Jitter	—	—	—	100	ns	

Position Read Frame

Figure 4: Timing Characteristics of Enable, Request and Data Signals for Position Data Read
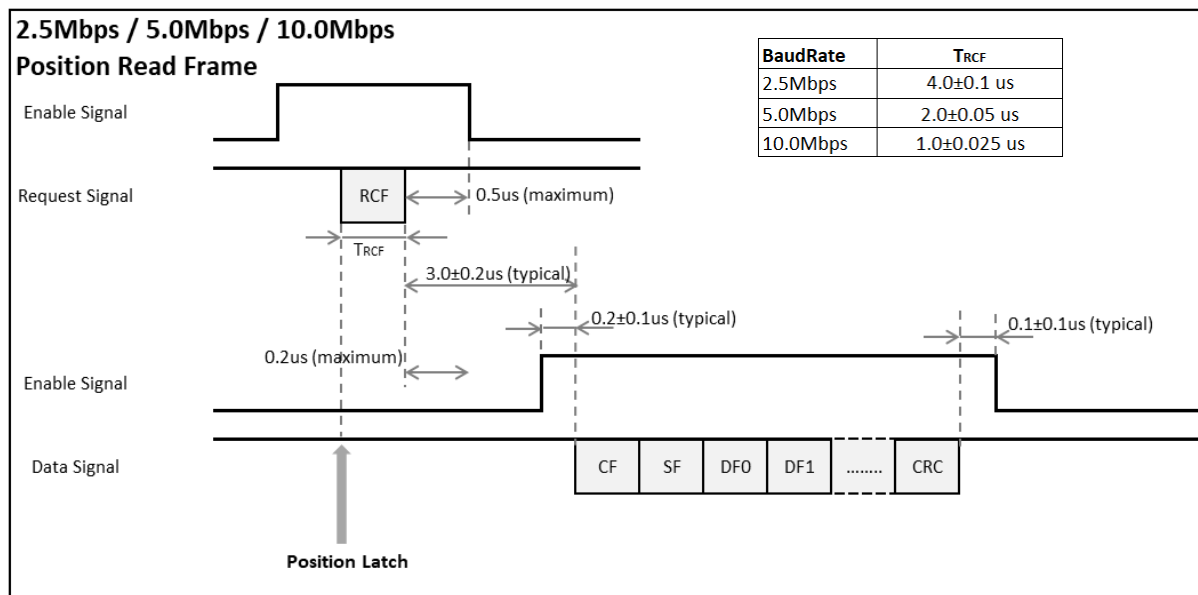
NOTE:

1. RCF: Request Control Field indicates the start of a transmission frame set.

2. CF: Control Field corresponds to the command frame issued by the master

3. SF: Status Field

4. DF0~DF7: Encoder Data Field

5. CRC: Cyclic Redundancy Check (CRC) frame

EEPROM Read/Write Frame

Figure 5: Timing Characteristics of Enable, Request and Data Signals for Memory Access
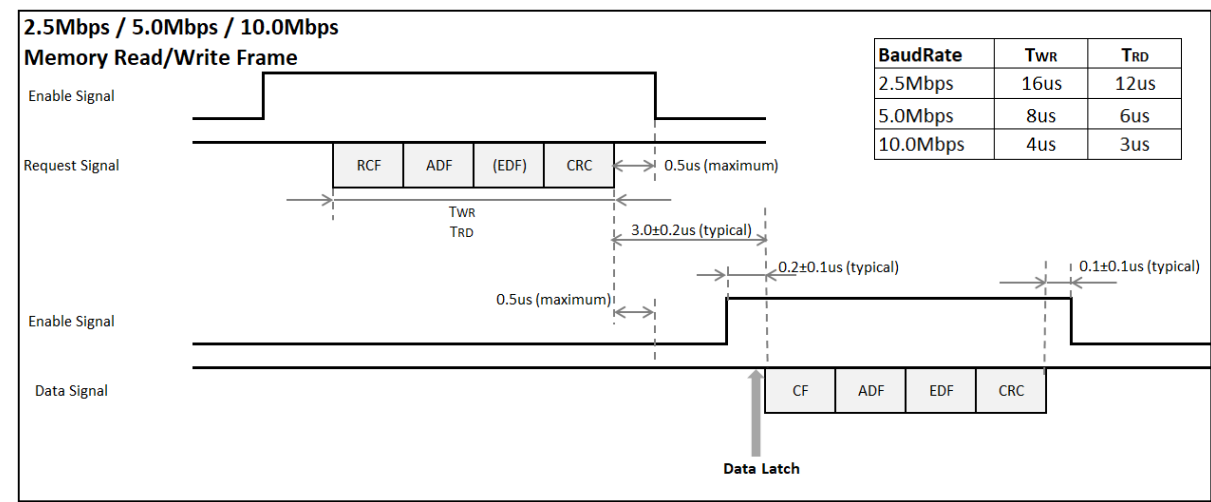
NOTE:

1. ADF: Address Data Fame indicates the memory location to Write.
2. EDF: Memory Data Frame contains the written/read data of the memory.

Register Communication and Assignment

Refer to the AS33-M42M RS485 software specification document for detailed information.

Electrical Pinout

Table 16: Connector Output Assignment

| Pin No	SSI	BiSS-C	RS485 half-duplex
1	GND	GND	GND
2	VDD	VDD	VDD
3	SCL-	MA-	NC(1)
4	SCL+	MA+	NC(1)
5	DOUT-	SLO-	DATA-
6	DOUT+	SLO+	DATA+
7	Cal 1[a]	Cal 1 / NC[a]	Cal 1 / NC[a]
8	Cal 2[a]	Cal 2 / NC[a]	Cal 2 / NC[a]
9	Zero Reset / Cal 3[b]	Cal 3 / NC[a]	Cal 3 / NC[a]
10	GND	GND	GND

a. Only for calibration process. Do not connect during operation (NC).

b. Zero Reset pin for SSI option only.

Figure 6: Pin 1 Location as Viewed from Encoder Top

Pin 1
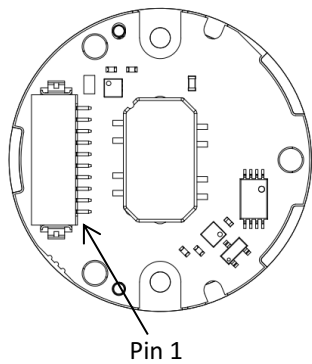
*Recommended mating connector:

- Hirose Part No: DF13-10S-1.25C (CL No. 536-0009-6-00)
- Hirose (Terminal Pin for Wire 26~30AWG): DF13-2630SCF (CL No.536-0300-5)

Mechanical Dimensions

Figure 7: Package Dimensions
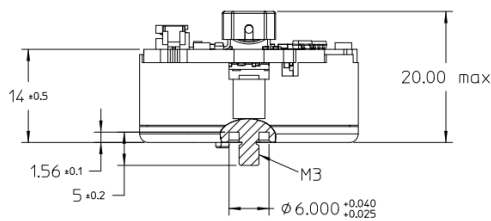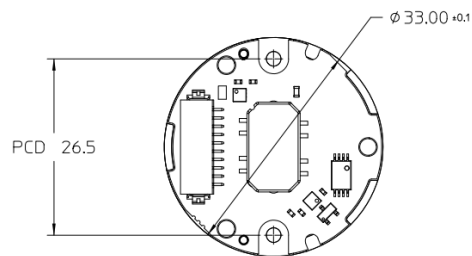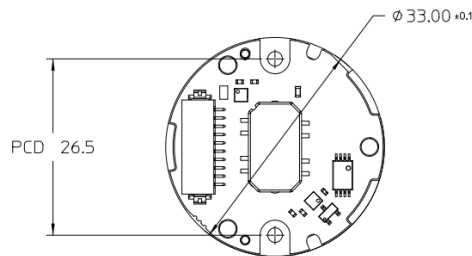
M3 Hub Screw
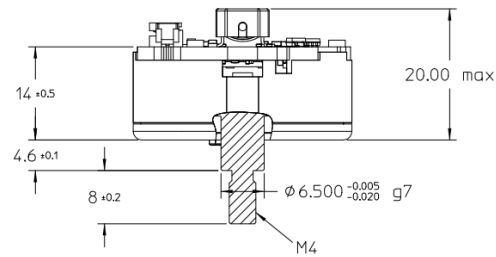
M4 Hub Screw

NOTE:

1. Dimensions are in millimeters.

2. Unless otherwise specified, all tolerances are within ±0.5 mm.

3. Use of a ferro-magnetic shaft may affect the magnetic system and hence encoder performance at the final applications. Users are advised to perform their own engineering assessments based on the actual use case.

Magnetic Shield Design Guidelines

To eliminate or minimize the influence of external magnetic field interference on encoder operation, use of shielding is mandatory. The recommended design of shielding made of 1.2-mm mild steel (SPCC) is shown in the following figure.

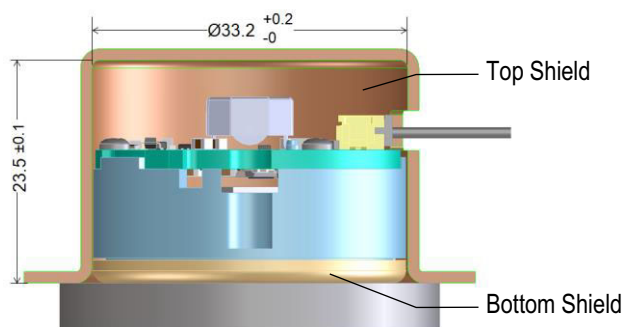**Figure 8: Recommended Magnetic Shield Design**

Shield Requirement
Minimum Thickness: 1.2mm
Material: Mild Steel
Process: Vacuum
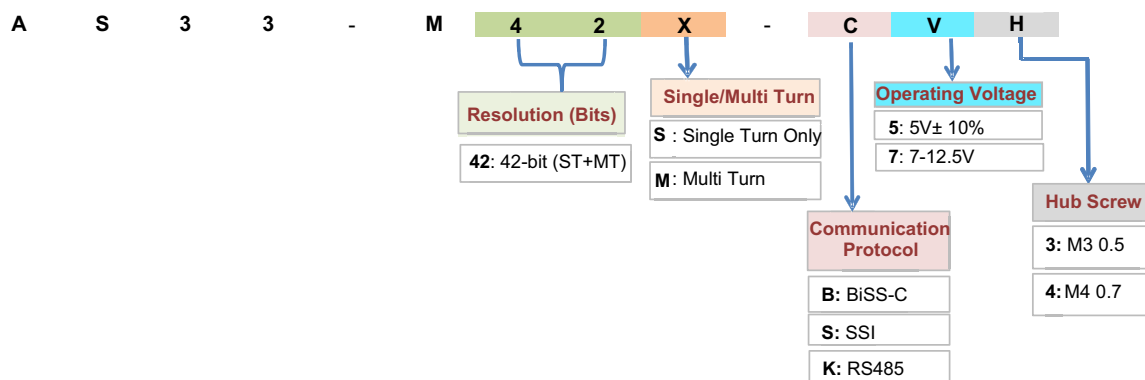Annealing at temperature
850°C for 1hour

NOTE:

1. External magnetic interference varies by the application and operating environment.
2. The customer conducts a proper study of external magnetic field to have an appropriate shield design for the targeted application.
3. Consult the factory for technical assistance.

Ordering Information

Encoder Part Numbers

A	S	3	3	-	M	**4**	**2**	**X**	-	**C**	**V**	**H**

Resolution (Bits)

42: 42-bit (ST+MT)

Single/Multi Turn

S : Single Turn Only

M : Multi Turn

Communication Protocol

B: BiSS-C

S: SSI

K: RS485

Operating Voltage

5: 5V± 10%

7: 7-12.5V

Hub Screw

3: M3 0.5

4: M4 0.7

Accessories and Tools

1. AS33-M42-010   Electronic Accuracy Calibration Kit
2. AS33-M42-023   Radial Centering Jig for M3 Hub
3. AS33-M42-024   Radial Centering Jig for M4 Hub
4. AS33-AC18   Benchtop Accuracy Calibration Station
5. AS33-C150   AS33 10-pin Mating Connector with 150-mm length cable

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

BROADCOM®

Lead (Pb) Free
RoHS 6 fully compliant

RoHS 6 fully compliant options available;
-xxxE denotes a lead-free product