AS37-H39B-Kxxx

39 Bits Battery Backup Multi-Turn Absolute Encoder with RS-485 Half-Duplex 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 Kxxx option of encoders is preloaded with the Avago developed protocol with RS-485 standard compliance with provided CRC and alarm status bits. The RS-485 half-duplex protocol is supported by a half-duplex line transmissions drive (RS-485), offering good noise immunity for more robust transmission of data at 2.5 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 RS-485 half-duplex 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^2PROM

Benefits

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

Applications

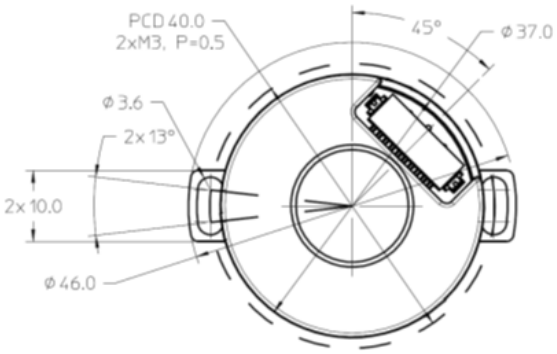
- Robotics
- Factory automation
- Linear positioning system
- CNC machine tool
- Medical and lab equipment
- Wind turbine

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.

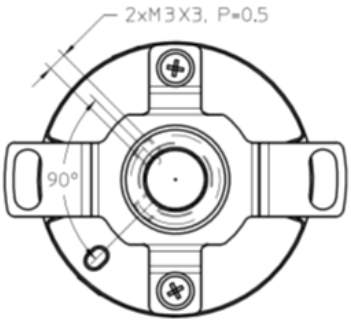
Mechanical Drawings

Option 1: Ø8-mm Hollow Blind Shaft

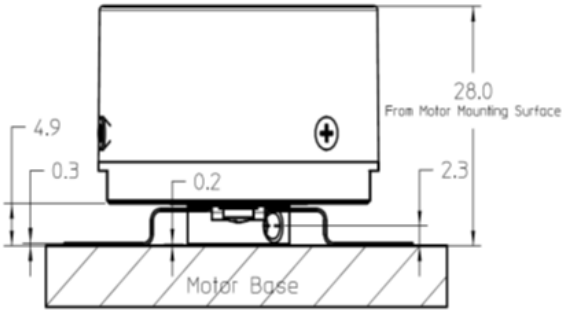
Package Dimensions



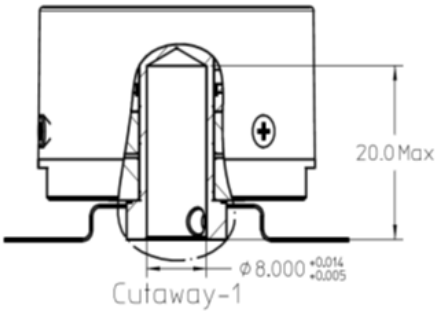
Front-1



Back-1

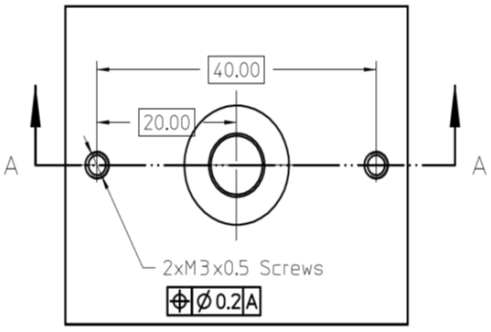


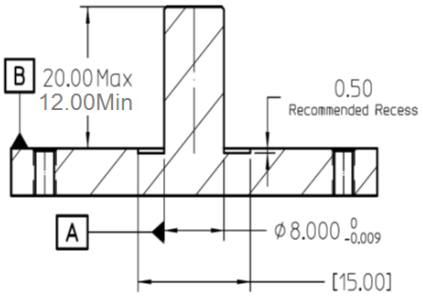
Bottom-1



Bottom-2

Recommended Shaft and Mounting Requirement



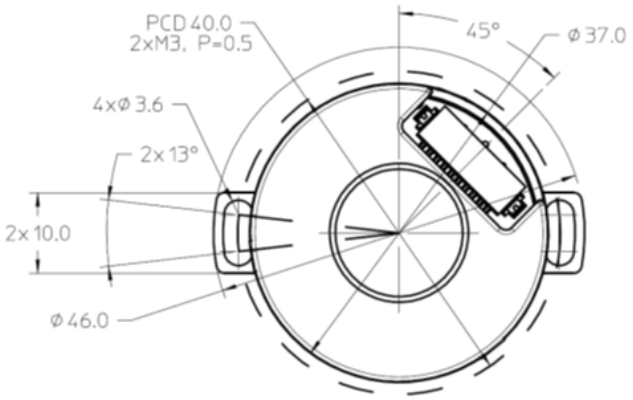


NOTE

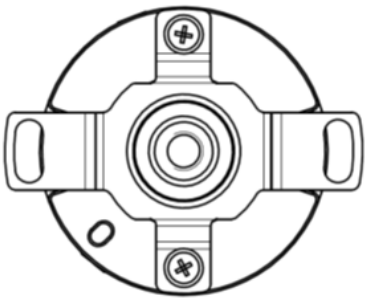
1. Dimensions are in millimeters.
2. Third angle projection.
3. Unless otherwise specified, all tolerances are within ±0.5 mm.
4. Recommended to have a recess on motor mounting surface to prevent encoder shaft interfere with motor base.

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

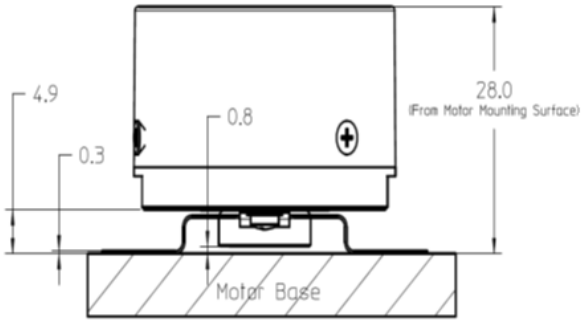
Package Dimensions



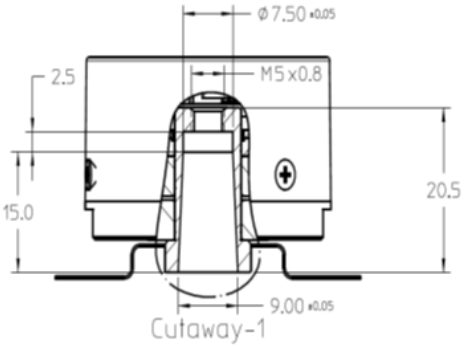
Front-1



Back-1

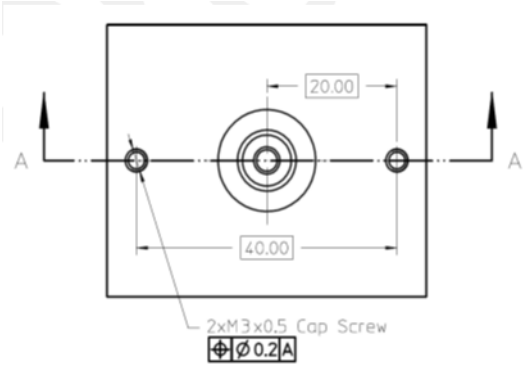


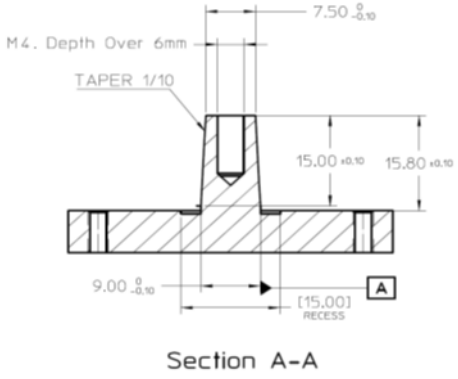
Bottom-1



Bottom-2

Recommended Shaft and Mounting Requirement





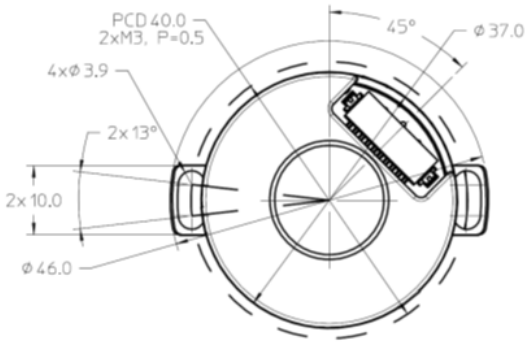
Section A-A

NOTE

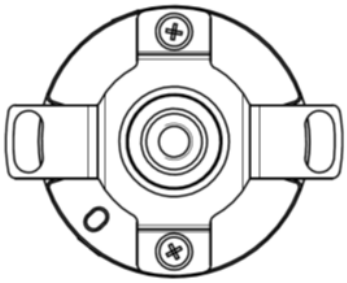
1. Dimensions are in millimeters.
2. Third angle projection.
3. Unless otherwise specified, all tolerances are within ±0.5 mm.
4. Recommended to have a recess on motor mounting surface to prevent encoder shaft interference with motor base.

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

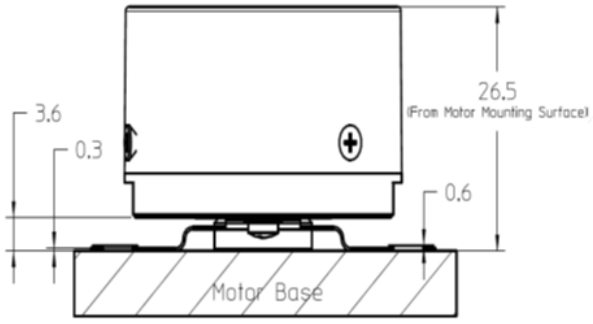
Package Dimensions



Front-1

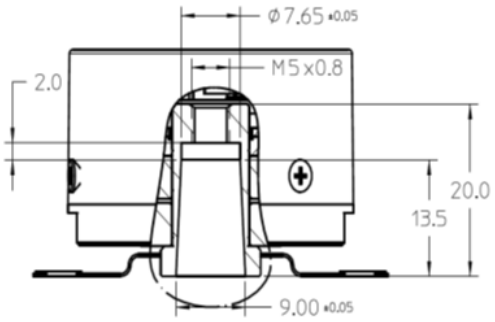


Back-1



Shaft End touching Motor Mounting Surface
(Motor need to recess)

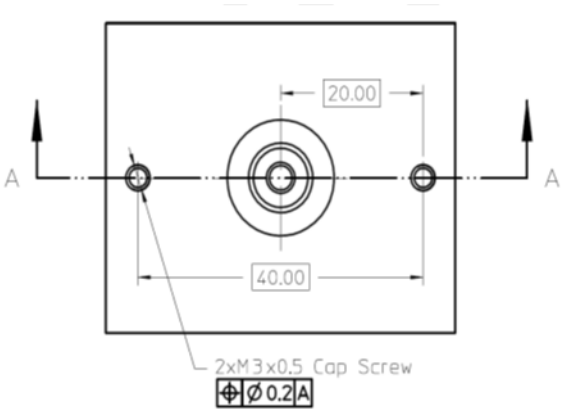
Bottom-1

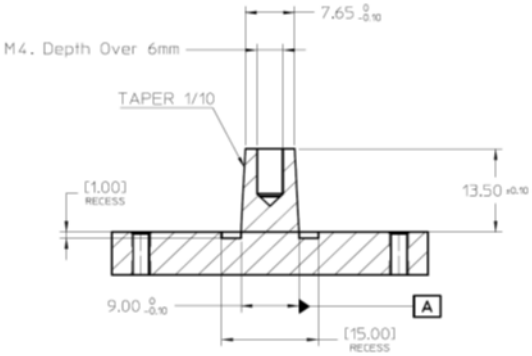


Cutaway-1

Bottom-2

Recommended Shaft and Mounting Requirement





Section A-A

NOTE

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.

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)[a]	–20 °C ~ 105 °C[b]	RS-485 half-duplex	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	Typ	Max	Unit
Current Consumption	Without load, Tamb = 25 °C	—	110	—	mA
Supply Voltage	—	4.5	5	5.5	V
Electrically Permissible Speed	—	—	—	6,000	min^{-1}
Electrically Permissible Acceleration	Normal mode	—	—	8.0×10^4	rad/s^2
	Battery mode	—	—	4.0×10^4	
External Battery Supply Voltage	—	3.6	—	4.5	V
Battery Mode Current Consumption	Tamb = 25 °C	—	95	—	µA

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^{-1}
Shaft Radial Play	—	—	—	±0.05	mm
Shaft Axial Play	—	—	—	±0.1	mm
Starting Torque	Tamb = 25 °C	—	—	9.8×10^{-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)	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	3.5 ± 0.2 µs
User-Accessible Memory Size	5K bits
Initialization Time[a]	<500 ms
Battery Alarm	3.1 V (typical)
Battery Error	2.9 V (typical)

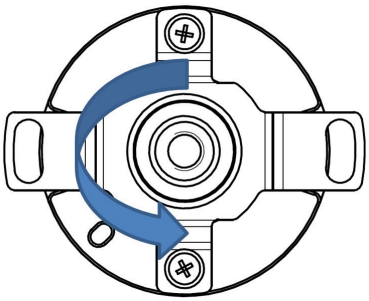
a. Initialization time is decided the time until possible to receive the request command after the alternation from battery mode to normal mode.

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



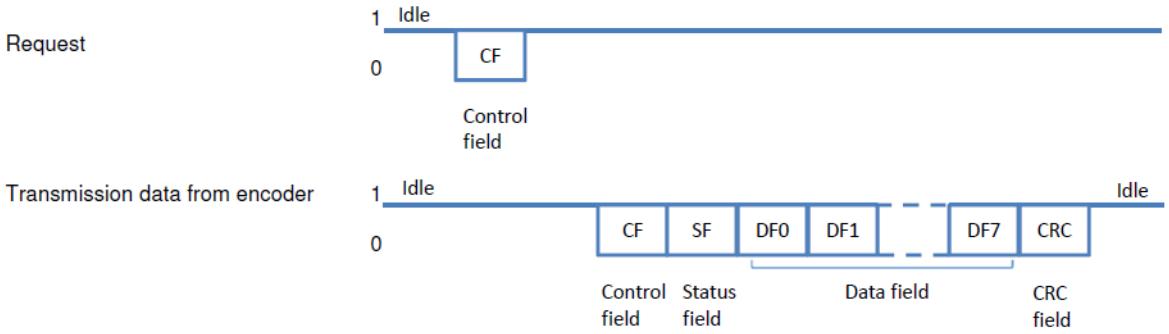
View from coupling side, shaft rotate CCW direction when the count is increasing.

Interface Protocol - RS-485 Half-Duplex

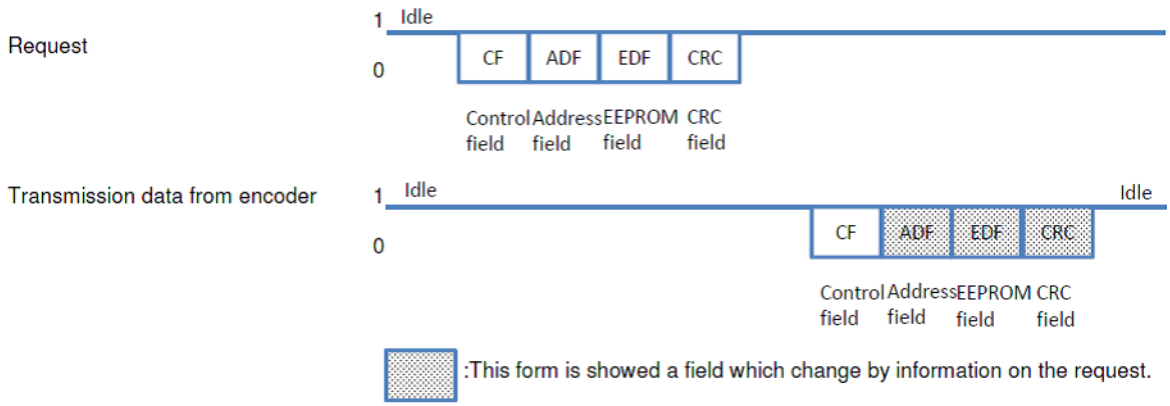
Item	Specification	Remarks
Communication Code	Binary	
Transmission Method	Differential Line Driver	RS-485 compatible
Receive Method	Differential Line Receiver	RS-485 compatible
Transmission Data	Single-turn Data	23 bits
	Multi-turn Data	16 bits
	Status Flag	■ Over Speed ■ ST Err ■ Counter Overflow ■ Multi-turn Err ■ Battery Error ■ Battery Alarm
Synchronous Method	Asynchronous	
CRC Method	CRC Polynomial: $G(X) = X^8 + 1$	
Communication Rate	2.5 Mbps	

Frame Format

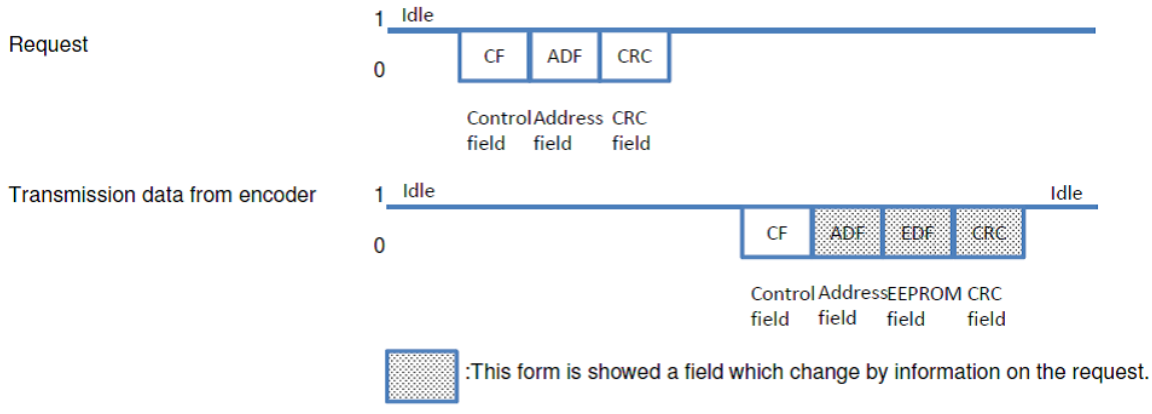
Data Readout from Encoder Operation



Memory Write Operation

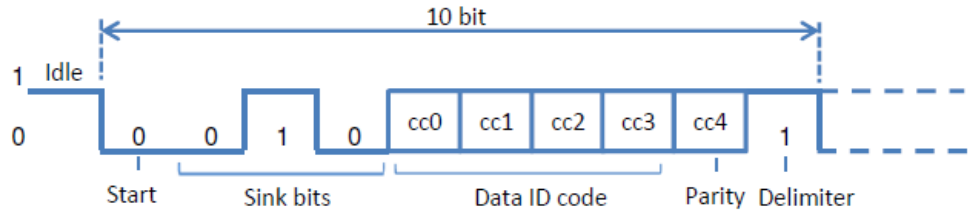


Memory Read Operation



Field Data Details

Control Field (CF)

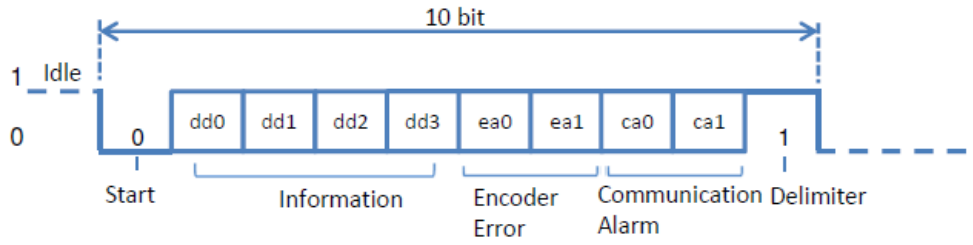


1. Start bit: Fixed to 0.
2. Sink code: Fixed to 010.
3. Data ID code: Defined as below table.
4. Parity bit: Parity for Data ID code as below table.
5. Delimiter: Fixed to 1.

Data ID Code and Parity Bit Table

Function	Data ID	Code				Parity
		cc0	cc1	cc2	cc3	cc4
Data Readout from Encoder Operation	Data ID 0	0	0	0	0	0
	Data ID 1	1	0	0	0	1
	Data ID 2	0	1	0	0	1
	Data ID 3	1	1	0	0	0
Memory Write Operation	Data ID 6	0	1	1	0	0
Memory Read Operation	Data ID D	1	0	1	1	1
Reset Operation	Data ID 7	1	1	1	0	1
	Data ID 8	0	0	0	1	1
	Data ID C	0	0	1	1	0

Status Field (SF)



1. Start bit: Fixed to 0.
2. Information: Fixed to 0000.
3. Encoder Error: Logic 1 is transmitted when any error occurs in encoder.

Bit	ea0	ea1
Logic when the error occurs	1	1
Description of error	ST Err	Logic-OR of Multi-turn Err, Battery Error, Battery Alarm

When an error occurs in the ea1 bit, request Data ID 3 to confirm ALMC status in the data frame as Over Speed and Counter Overflow alarms are not included in ea1.

4. Communication Alarm: Logic 1 is transmitted when any communication error occurs in encoder.

Bit	ca0	ca1
Logic when the error occurs	1	1
Description of error	Logic 1 is transmitted for wrong Parity error in Request frame. Parity bit in Request frame is located at cc4 of Data ID code.	Logic 1 is transmitted when Delimiter error in Request frame occurs.

5. Delimiter: Fixed to 1.

Data Field (DF0 to DF7)

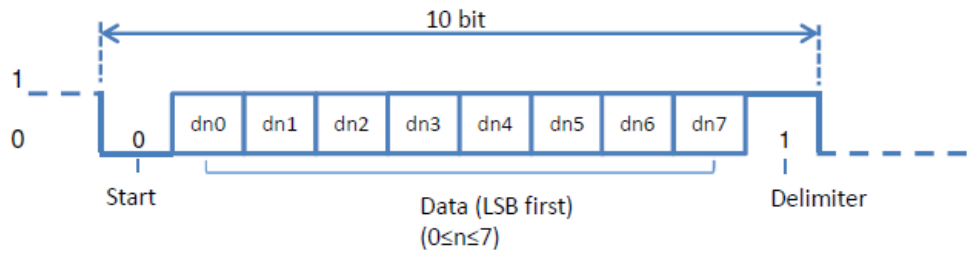
The relation between Data ID code and Data field is shown as below table.

Data ID Code	DF0	DF1	DF2	DF3	DF4	DF5	DF6	DF7
Data ID 0	ABS0	ABS1	ABS2					
Data ID 1	ABM0	ABM1	ABM2					
Data ID 2	ENID							
Data ID 3	ABS0	ABS1	ABS2	ENID	ABM0	ABM1	ABM2	ALMC
Data ID 7	ABS0	ABS1	ABS2					
Data ID 8	ABS0	ABS1	ABS2					
Data ID C	ABS0	ABS1	ABS2					

Notes:
Blank means no data to be transmitted.
ABS0 to ABS2: Absolute data for single-turn.
ABS0 is located to lower byte and ABS2 is located to higher byte.
For 23-bits single-turn resolution, MSB bits of ABS2 are always fixed to 0.
ABM0 to ABM2: Absolute data for Multi-turn.
ABM0 is located to lower byte, and ABM2 is located to higher byte.
For 16-bits multi-turn resolution, ABM2 is always fixed to 0.
ENID: Encoder ID
Encoder ID is always fixed to 17 h.
ALMC: Encoder error.

Bit	DF7-0	DF7-1	DF7-2	DF7-3	DF7-4	DF7-5	DF7-6	DF7-7
Alarm Name	Over Speed	0	ST Err	Counter Overflow	0	Multi-turn Err	Battery Error	Battery Alarm
Logic Active	1	—	1	1	—	1	1	1

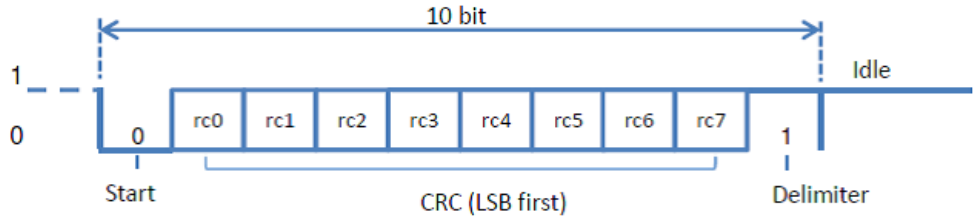
Structure for Each Data Field



1. Start bit: Fixed to 0.
2. Data: Send with LSB first.
3. Delimiter: Fixed to 1.

CRC Field (CRC)

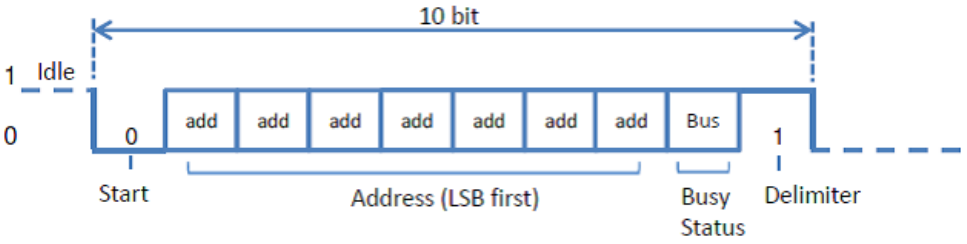
Structure for CRC field.



1. Start bit: Fixed to 0.
2. CRC: This CRC code checks by $G(X) = X^8 + 1$ (X = rc0 to rc7).
   CRC code is transmitted by LSB first.
   The code is calculated from all bits without Start bit and Delimiter bit of all fields except CRC field.
3. Delimiter: Fixed to 1.

Address Field (ADF) and EEPROM Field (EDF)

Structure for Address field and EEPROM field.



1. Start bit: Fixed to 0.
2. Address: Address of EEPROM (0 to 127 (decimal)) with LSB first.
   The page is specified in address 127, and it can access 0 to 126.
   Refer to the following Memory address map.

EEPROM Address	Page	Address	Remarks
000h ~ 27Fh	0	00h ~ 7Eh	User Area
	Page Selection	7Fh	
	1	00h ~ 7Eh	
	Page Selection	7Fh	
	2	00h ~ 7Eh	
	Page Selection	7Fh	
	3	00h ~ 7Eh	
	Page Selection	7Fh	
	4	00h ~ 7Eh	
	Page Selection	7Fh	
280h ~ 2FEh	5	00h ~ 7Eh	Avago Reservation Area (User prohibited write)
2FFh	Page Selection	7Fh	User Area
300h~ 37Eh	6	00h ~ 7Eh	Avago Reservation Area (User prohibited write)
37Fh	Page Selection	7Fh	User Area
380h ~ 3FEh	7	00h ~ 7Eh	Avago Reservation Area (User prohibited write)
3FFh	Page Selection	7Fh	User Area

Notes:
After page is changed, EEPROM can't access between 18 ms.
Busy status becomes to 1 during EEPROM access.
The default when power turn on is page 0.
Avago Reservation Area - User needs to consult Avago Technologies before accessing this area.

3. Busy status: Relationship between Busy Status and Transmission Data

	Request	Transmission Data from Encoder			Description
	Busy	Busy	ADF	EDF	
Read	0	0	ADF for Request	Proper data of EEPROM	Reading is valid.
		1	ADF for Request	00	Reading is invalid.
Write	0	0	ADF for Request	EDF from Request	Writing is valid.
		1	ADF for Request	00	Writing is invalid.

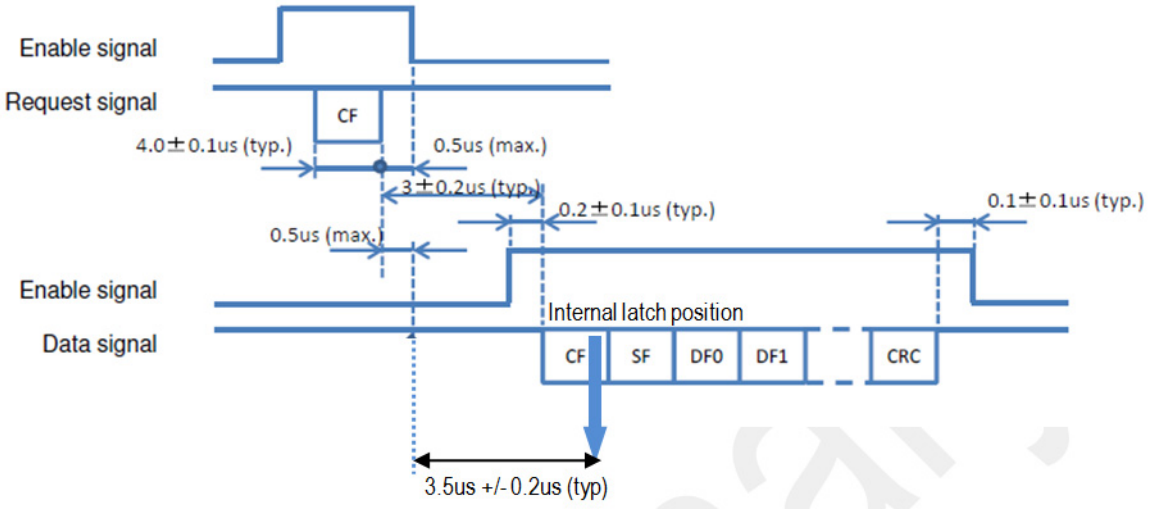
4. Delimiter: Fixed to 1.
5. EDF: 8 bits data with LSB first.

Alarm Status Field

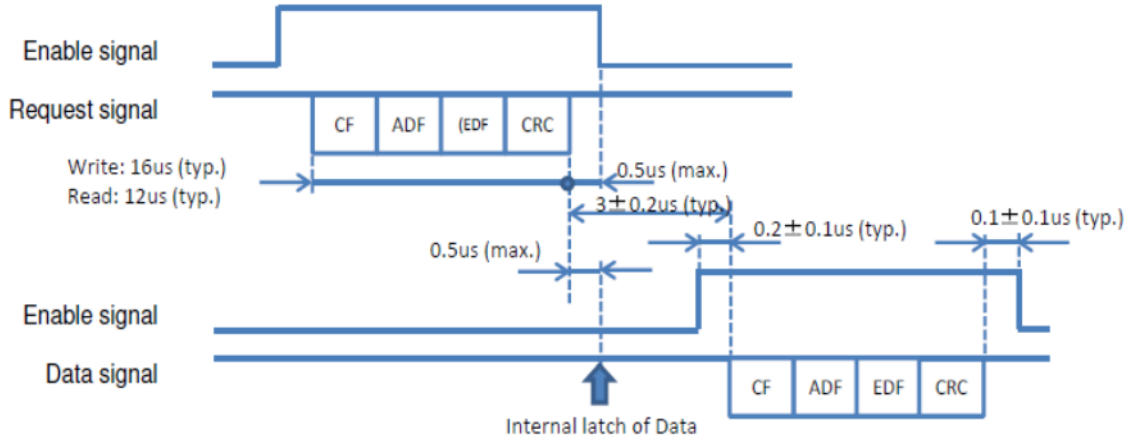
Bit	Alarm Status	Default Value	Description
0	Over Speed	0	To detect over speed and cause wrong MT counting. 1: Speed >6000 rpm and cause wrong MT data. 0: Speed <6000 rpm or speed >6000 rpm but not cause wrong MT data. Not define if speed >14000 rpm.
1	Reserved	0	Not used.
2	ST Err	0	To check integrity 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 ± 0.25 V. 0: Battery voltage is more than 2.9 ± 0.25 V.
7	Battery Alarm	0	To indicate health of battery. 1: Battery voltage is less than 3.1 ± 0.1 V. 0: Battery voltage is more than 3.1 ± 0.1 V.

Timing Diagram

Detection of Data Read Frame



Detection of Access Frame to EEPROM



Transmitting Request

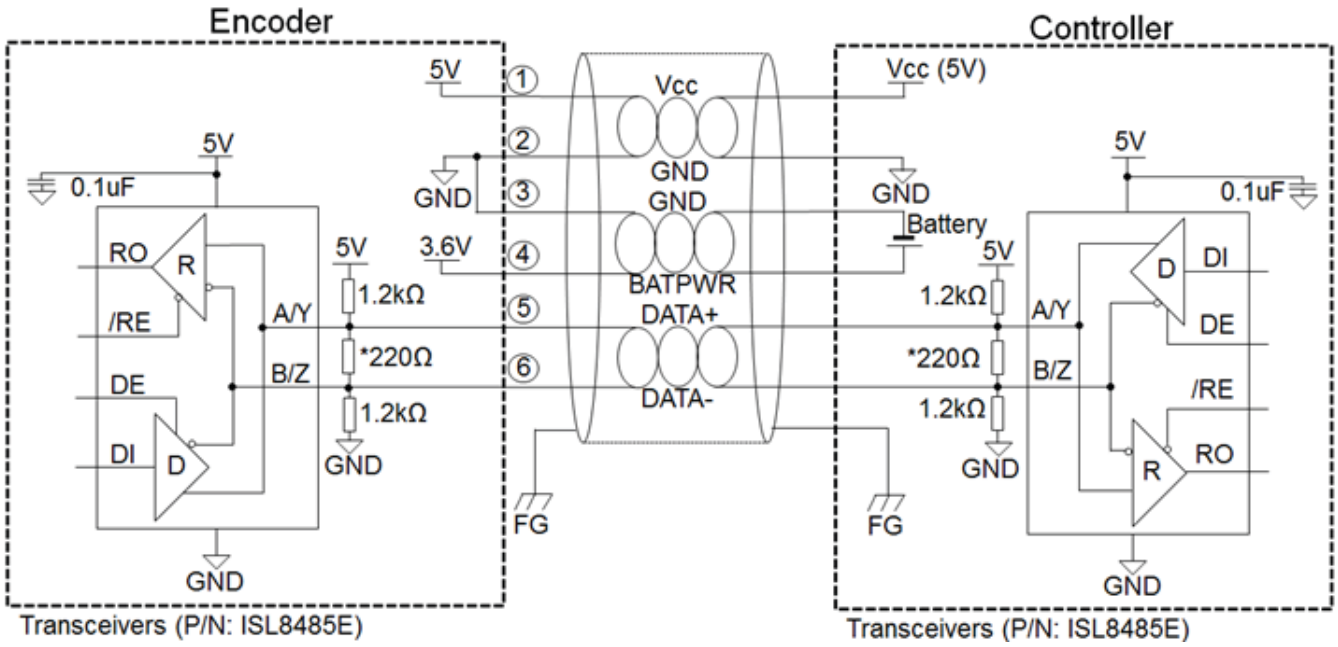
Function	Data ID	Description
Read Data	0, 1, 2, 3	Transmit Data ID to read position data, alarm status and encoder ID.
Reset ST Data	8	10 consecutive transmissions to Encoder at interval of 40 µs or more to reset ST data.
Reset MT Data and All Alarms	C	10 consecutive transmissions to Encoder at interval of 40 µs or more to reset MT data and all alarm status.
Reset All Alarm	7	10 consecutive transmissions to Encoder at interval of 40 µs or more to reset all alarm status.
Access to Memory	6	Writing 8 bits User Data to the designated address. (For confirming data, cycle power of encoder and read Data ID D.)
	D	8 bits User Data can be read from the designated address.

Typical Application

Interface	Circuit
Serial Data (DATA)	RS485/RS422 transceivers (P/N: ISL8485E)

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

Figure 2 Circuit Diagram of Transceiver

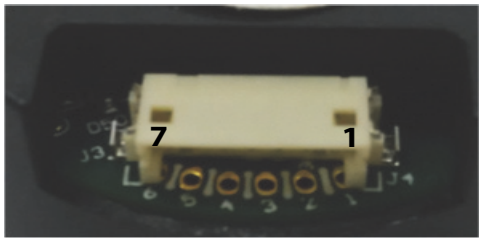


* Termination resistor, 220 Ω, is recommended but may depend on the characteristic impedance of cable used.

Connector Information

Pin	Description
1	VCC, Positive Supply
2	GND, Ground
3	GND (External Battery)
4	BATPWR (External Battery)
5	Data+
6	Data–
7	NC

Figure 3 Picture of Hirose Connector



Note:
Recommended mating connector:
Hirose Part No: DF13-7S-1.25C (CL No.536-0006-8)
Hirose (Terminal Pin for Wire 26~30AWG): DF13-2630SCF (CL No.536-0300-5)

Ordering Information

AS37-H39B- K XXX

Shaft OD (∅ mm)	Special Feature
06: 1/4 inch	**S:** Standard
12: 6mm	
13: 8mm	
21: 9 – 7.5mm	
22: 9 – 7.65mm	

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

For product information and a complete list of distributors, please go to our web site: www.broadcom.com.

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