

38HA-MS01

39 Bits Multi-Turn Absolute House Encoder with BiSS-C mode Output



Application Note

Introduction

This application note serves as an application reference for the 38HA-MS series high-resolution optical absolute encoder, which offers 23-bits single turn and 16-bits multi-turn counts, hence a combined 39 bits high resolution. The 38HA-MS 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 38HA-MS01 option encoders are preloaded with BiSS-C communication protocol with 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 10Mbps in harsh industrial application.

The key advantage of the 38HA-MS 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 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. 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 38HA-MS series is also compliant with IP50 per IEC 60529 standard.

Operating Theory

Structures wise, the encoder contains 2 main functional blocks, which is the single-turn optical engine block and the energy-harvesting multi-turn counter block. The single-turn engine comprises a 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 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 even in the absence of external power supply.

Application

38HA-MS series can be widely used in the following applications:

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

38HA-MS01 Application Note

1. Mounting Requirement and Guideline

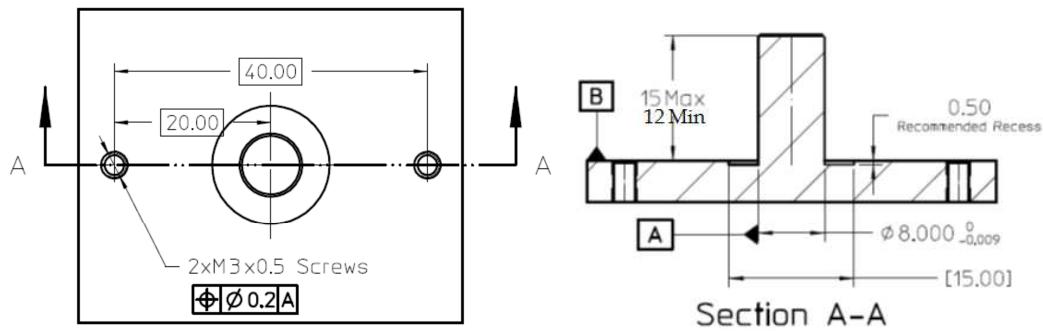
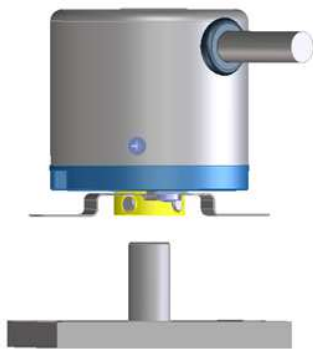


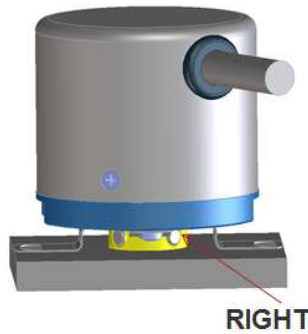
Figure 1: Recommended shaft and mounting holes

Notes:

1. Dimensions are in millimeters.
2. 3rd 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.



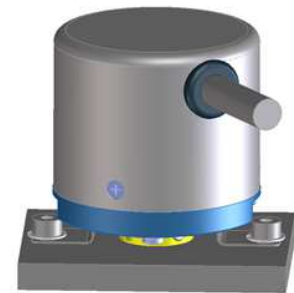
Step 1:
Slide encoder hollow shaft into motor shaft until the coupling plate is touching the motor base.



Step 2:
Fasten the M3X3 set screw on the right, followed by the set screw on the left.

Recommended to apply thread lock fluid to better secure the set screws.

Recommended screw driver torque: 0.35Nm with 45H steel cup point M3 set screw



Step 3:
If necessary, perform a minor adjustment on the encoder orientation (M3 slot allows +/-5 degree rotation). Follow by fastening both the M3 coupling mounting screws.

Recommended to use spring washer and flat washer. Apply thread lock fluid to better secure the coupling plate.

Recommended screw driver torque: 1Nm with M3 socket head cap screw.

2. Recommended Magnetic Shield Design

To eliminate external magnetic field interference, it is recommended to add the motor cap as figure 2 shows for shielding.

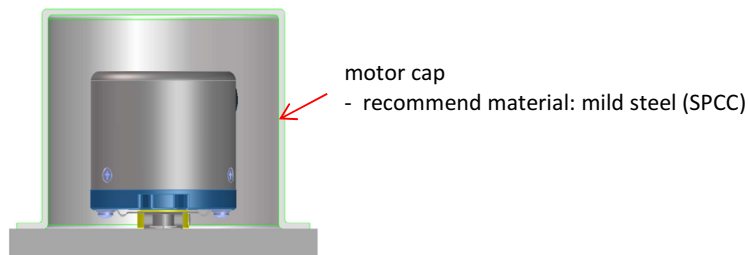


Figure 2: Add motor cap as shield

Note:

- 1) External magnetic field interference varies by the application and operating environment.
- 2) Proper study of external magnetic field and appropriate shield design is needed.
- 3) Consult factory for technical assistance.

3. Cable Information

Pin	Color	Description
1	RED	VCC, +5V
2	BLACK	GND, Ground
3	BROWN	MA+
4	WHITE	MA-
5	ORANGE	SLO+
6	BLUE	SLO-

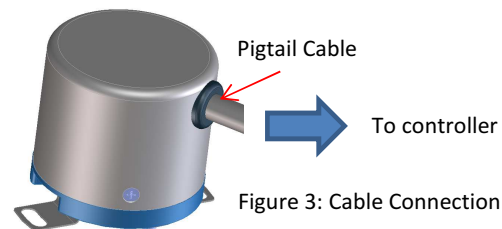


Figure 3: Cable Connection

Note: Cable provided is approximate 200mm (included pigtail length) with AWG28.

4. Recommended I/O Connection

- 1) It is strongly recommended to provide encoder power supply, Vcc within 4.5V ~ 5.5V. Typical value is 5V.
- 2) For best noise immunity, it is recommended to use twisted-pairs shielded cable for connection to servo driver.
- 3) It is recommended to connect both ends of the shield wire to FG (frame ground) to enhance noise immunity in harsh environments.
- 4) To prevent undesirable signal reflections, the termination resistors typical value is 120ohm (1/4W). Termination resistance value is depending on the characteristic impedance of cabled used.

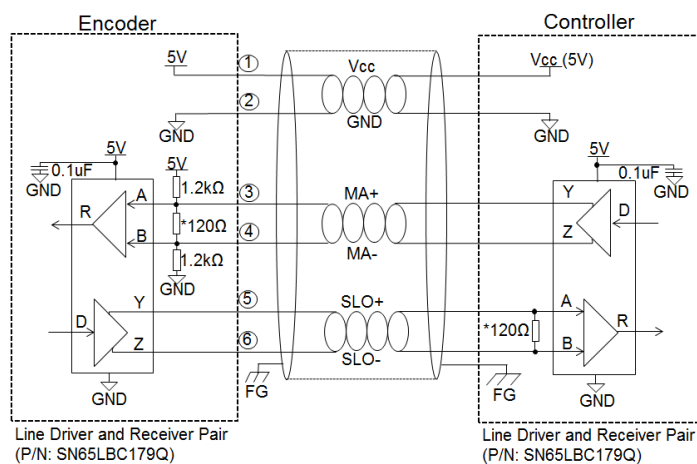


Figure 4: Circuit diagram of transceiver

38HA-MS01 Application Note

5. Interface protocol – BiSS-C

5.1 Data Communication

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

5.2 Timing Characteristic

Parameter	Symbol	Condition	Min	Typ.	Max	Units	Notes
MA Frequency	f_{MA}		0.08		10	MHz	1
Busy	T_{busy}		$2/f_{MA} + 3.35\mu s$		$2.5/f_{MA} + 3.75\mu s$	μs	2
Timeout	$t_{BISS-timeout}$		$1.5/f_{MA}$		$1.5/f_{MA} + 90ns$	ns	2
Encoder initialization time				500		ms	

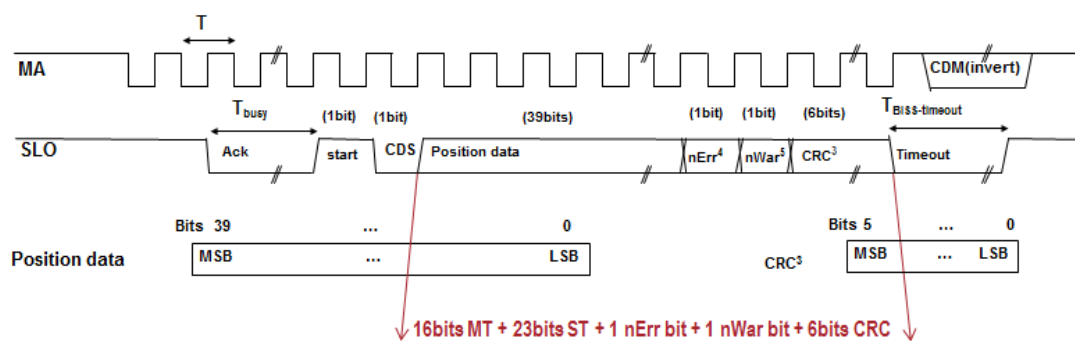


Figure 5: Timing Characteristics of MA and SLO

Note:

1. MA low-time = $0.50/f_{MA}$; high-time = $0.50/f_{MA}$.
2. Refer to Figure 5 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)

38HA-MS01 Application Note

5.3 Register Communication and Assignment

Please refer to BiSS-C Interface Protocol Description Rev C5 document for detail information of BiSS-C Register Communication and Assignment.

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 are kept in non-volatile memory.

Memory Map (Non-Volatile Memory)

EEPROM Address	BiSS C		Remarks
	Bank	address	
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	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 Slave Register Description - user area)
		78h~7Dh	Device ID (User prohibited write)
		7Eh~7Fh	Manufacturer ID (User prohibited write)

Note:

- 1) EDS-Bank is not available.
- 2) Reservation Area – User needs to consult NEMICON before access to this area.

38HA-MS01 Application Note

5.4 Slave Register Description

Address 72(0x48) – Error Status [7:0]

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
"N/A"			MLSErr Error	Multi-turnErr Error	SErr Error	MemoryErr Error	XCErr Error

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

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

Address 74(0x4A) – Encoder Clear Command

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

*Encoder Clear Command operation.

- a. Write 1 to execute one time clear command.
- b. Only one command should be access for each time.

6. Alarm Definition

No.	Alarms	Alarms Definition
1	XCErr	To indicate multi-turn block hardware miscount. 1: hardware miscount occur 0: no hardware miscount
2	MemoryErr	To indicate eeprom content loading status upon encoder power up. 1: Fail to load EEPROM memory data 0: Success to load EEPROM memory data
3	SErr	To check integrity of ST position. 1: error in ST position 0: no error in ST position
4	Multi-turn Err	To check integrity of MT position. 1: error in MT position 0: no error in MT position
5	MLSErr	To detect error in MLS (Mcode) generation. 1: MLS code error. 0: MLS code good.
6	LedErr	To indicate if LED current is out of operating range. 1: LED out of operating range. 0: LED within operating range.
7	LisErr	To check integrity of ADC Sin & Cos signals by means of Lissajous specifications. 1: Lissajous out of specification. 0: Lissajous within specification.

7. Trouble shooting guide

ID	Issues	Causes	Counter Measure
1	No signal output	Encoder power supply too low	Check if Vcc versus ground potential is within 4.5~5.5V
		Poor connectivity between encoder cable to customer connector	Check cable and customer connector connectivity
		Wrong wire connection assignment	Check connector wire connection assignment
		Detector IC faulty/shorted	Consult factory
		Line driver and receiver pairs faulty/shorted	Consult factory
2	Encoder high current consumption (>200mA at 25°C)	LED faulty/ shorted	Consult factory
		Detector IC faulty/shorted	Consult factory
		Line driver and receiver pairs faulty/shorted	Consult factory
3	XCErr triggered	Multi-turn block faulty	Consult factory
4	MemoryErr triggered	Memory block faulty	Consult factory
5	SErr triggered	Single turn block faulty	Consult factory
6	Multi-turn Err triggered	Multi-turn block faulty	Consult factory
7	MLSErr alarm triggered	LED faulty	Consult factory
		Codewheel issue	Consult factory
		Single turn block faulty	Consult factory
8	LedErr triggered	LED faulty	Consult factory
9	LisErr triggered	LED faulty	Consult factory
		Codewheel issue	Consult factory
		Single turn block faulty	Consult factory

8. DO and DON'T

DO

- 1) Ensure clean environment during installation.
- 2) Ensure main power supply is within 5V +/- 10%.
- 3) Provide adequate protection from dust and moisture when use in harsh environment.
- 4) Ensure pin configuration is per datasheet.

DON'T

- 1) Do not overload line driver by using wrong termination resistor.
- 2) Do not hammer encoder shaft into motor shaft during installation.
- 3) Do not deform coupling plate during installation.
- 4) Do not reverse the power source polarity.
- 5) Do not operate encoder under extreme temperature over time.

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