

N33 Series Datasheet

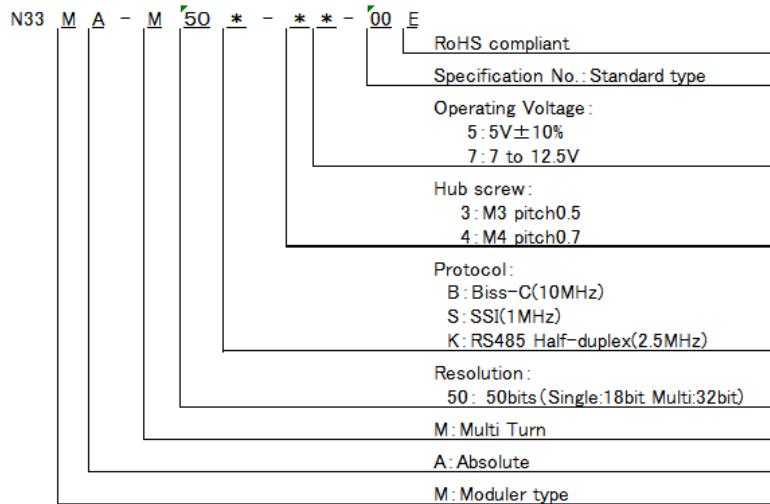
N33MA-M50 Series

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



Datasheet

Encoder Part Numbers



1. Introduction

1.1 Description

N33MA-M50 series encoder is an absolute magnetic encoder, which offers 18-bit single-turn (ST) and 32-bit multi-turn (MT) counts, hence a combined 50-bit high resolution encoder. Design of the encoder features state of the art Energy Harvesting Multi-turn technology. To improve system integrity and simplicity, a single magnetic solution is responsible for both ST and MT positions generation.

The key advantage of N33MA-M50 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 multi-turn counter circuitry. Therefore, no loss of revolution count even in the absence of external power supply. 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.

N33MA-M50 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 more robust transmission of data up to 10Mbps in harsh industrial applications. Being a magnetic technology-based encoder, it 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.

1.2 Operating Theory

N33MA-M50 series encoder contains two major blocks, which are MT revolution tracking block and ST absolute position block. Both MT and ST blocks are based on magnetic technology. The MT block employs energy harvesting technology whilst the ST block implements magnetic sensor for absolute position generation.

When encoder is powered up, encoder absolute position is generated by synchronizing the MT revolution count to the ST absolute position; and henceforth tracked by the ST absolute position.

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1.2 Features

- Patented Energy Harvesting technology
- Total 50-bit resolution with 18-bit single-turn and 32-bit multi-turn
- Overall encoder outer diameter Ø33 mm and maximum height of 20 mm
- Built-in communication protocol (option): SSI, BiSS C & RS-485 half-duplex
- Built-in temperature sensor
- Operating temperature range -40°C to 115°C.

1.3 Benefits

- No battery or capacitor required for position detection during power failure
- Immediate position detection on power up
- Cost effective solution
- Robust environment

1.4 Applications

- Small motors and linear Actuator
- Robotic automation and Engineering
- Drone
- Test and Measurement Equipment

Note: The encoder is not recommended for use in life critical applications, e.g. ABS braking systems, power steering, life support and critical care systems and medical equipment. Please contact sales representative if more clarification is needed.

2. Product Specifications

Table 1. Absolute Maximum Rating

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

Parameters	Symbol	Min	typ	Max	Unit	Remark
Supply Voltage	V _{DD}	-0.3		15	V	
Operating temperature	T _J	-40		115	°C	
Storage temperature	T _s	-40		115	°C	
Permissible Speed	-	-	-	12,000	rpm	Note (1)

Recommended Operating Conditions

Table 2. Electrical Specification Over T_{amb} = 25°C

Parameters	Conditions	Min	Typ	Max	Unit	Remark
Supply Voltage	-	4.5	-	5.5	V	N33MA-M50-x5x
		7	-	12.5	V	N33MA-M50-x7x
Supply Current	Without load	-	80	90	mA	N33MA-M50-x5x
		-	65	75	mA	N33MA-M50-x7x
System Accuracy	With electrical correction ⁽²⁾	-	±0.087	-	deg	At 25°C
		-	-	±0.35	deg	Over -40°C to 115°C and 12000RPM

Table 3. Mechanical Specifications

Parameters	Conditions	Min	Typ	Max	Unit	Remark
Max axial shaft play	-	-	-	±0.2	mm	
Max radial shaft play	-	-	-	±0.05	mm	
Vibration	Per IEC 60068-2-6	-	-	10G; 10~2000Hz	-	
Shock	Per IEC 60068-2-27	-	-	6ms; Half Sine; 200G	-	

Table 4. Environmental Specifications

Parameters	Conditions	Min	Typ	Max	Units	Remark
Relative Air Humidity (Non-Condensing)	T _{amb} = 60°C	-	90	-	RH%	
Electrostatic Discharge (Module level)	Per IEC 61000-4-2	-	-	±4	kV	

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 ^{(3) (4)}		-40	-	125	°C	Note (3) (4)
Calculation Time		-	-	100	ms	

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Table 6. Encoder Specifications

Parameter	Remarks
Single turn Resolution	Single-turn 18 bits (262143 counts)
Multi-turn Resolution	Multi-turn 32 bits (4294967295 counts)
Counting Direction	Increase with counter-clockwise (CCW) motor shaft rotation, view from encoder top
Initialization Time	<1s

Note:

- (1) Encoder works reliably up till this permissible speed.
- (2) Under recommended magnetic shielding enclosure and calibration at ambient 25°C
- (3) Temperature error alarm setting = 115°C
- (4) Temperature sensor is not available for SSI option product.
- (5) Exposure to absolute maximum rating conditions for extended periods may affect reliability; and stress greater than the absolute maximum rating may cause permanent damage to the device.

3. Protocol Specifications

3.1 SSI Specifications

Table 7. SSI Interface

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

Table 8. SSI Timing Characteristics

Parameters	Symbol	Conditions	Min	Typ	Max	Unit	Remark
Clock frequency	f_{CLK}	-	100	-	1000	kHz	
Clock duty	DUT_{CLK}	-	-	50	-	%	
Monoflop time	t_m	-	-	-	20	μs	
Pause time	t_p	-	21	-	-	μs	

Table 9. SSI Data Field

MT[31:0]	ST[17:0]	Status[0]	Alarm[0]
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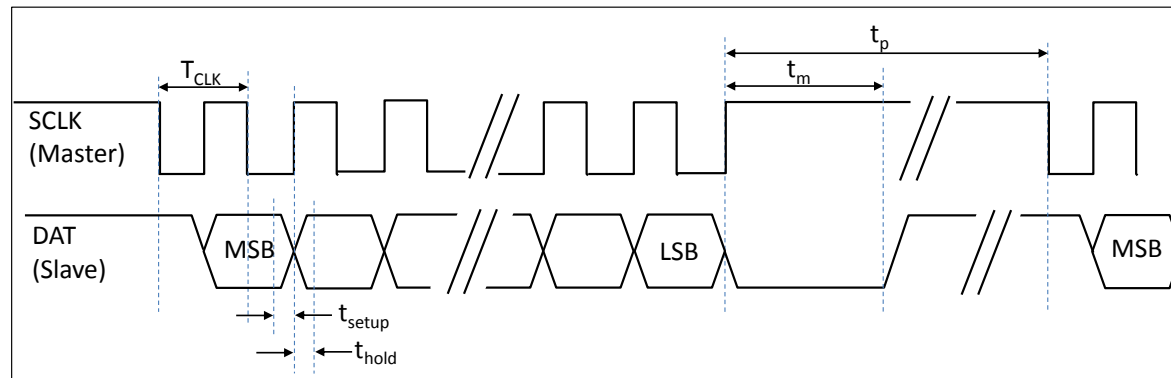


Figure 1. SSI Interface Timing Diagram

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3.2 BiSS C Specifications

Table 10. BiSS C Interface

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

Table 11. BiSS C Timing Characteristics

Parameters	Symbol	Conditions	Min	Typ	Max	Unit	Remark
MA frequency	f_{MA}	-	0.5	-	10	MHz	
MA duty	DUT_{CLK}	-	-	50	-	%	
Busy	T_{busy}	-	$2/f_{MA} + 27.3\mu s$	-	$18/f_{MA} + 27.6\mu s$	μs	
Timeout	$t_{BiSS-timeout}$	-	2	-	5	μs	
Frame to Frame			9		-	μs	

Table 12. BiSS C Data Field

MT[31:0]	ST[17:0]	Error[0]	Warning[0]	CRC[5:0]
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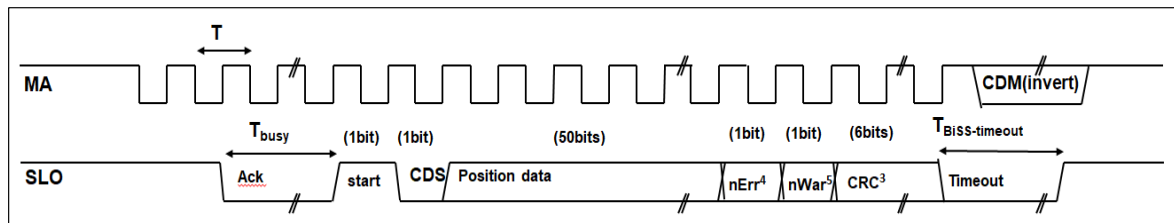


Figure 2. BiSS C Interface Timing Diagram

Note:

1. CRC Polynomial = Invert of $(X^6 + X^1 + X^0)$.
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)

BiSS C Command list

Command	Register
8-bit Temperature Readout	Read address 0x75
50-bit Position Zero Reset	Write address 0x4A with data 0x03

Register Communication and Assignment

Please refer to BiSS C Interface Protocol Description Rev C6 document for detail information.

https://www.ichaus.de/upload/pdf/BiSS_C_protocol_C6en.pdf

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3.3 RS-485 Half-Duplex Specifications

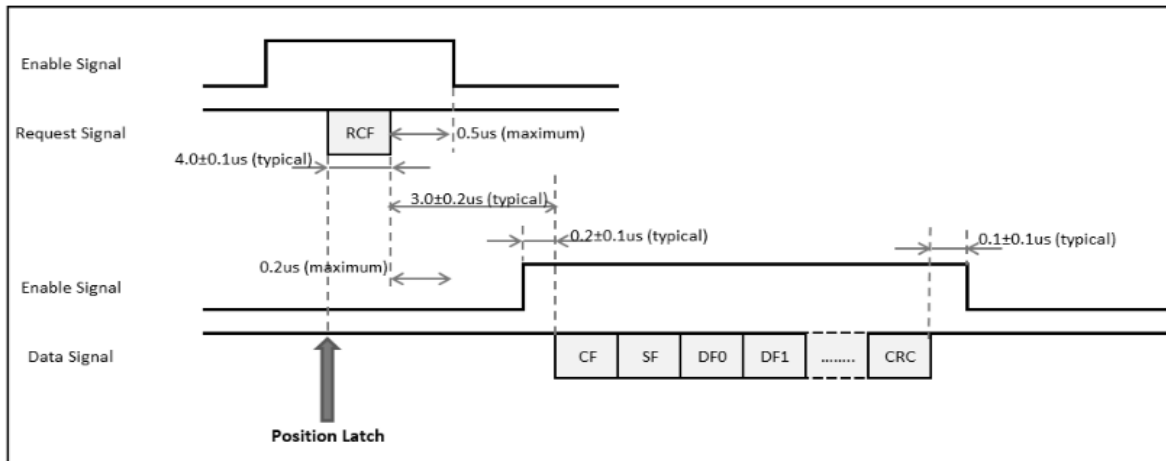
Table 13. RS-485 half Duplex interface

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

Table 14. RS-485 Half-Duplex Timing Characteristic

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

Position Read Frame



EEPROM Read/Write Frame

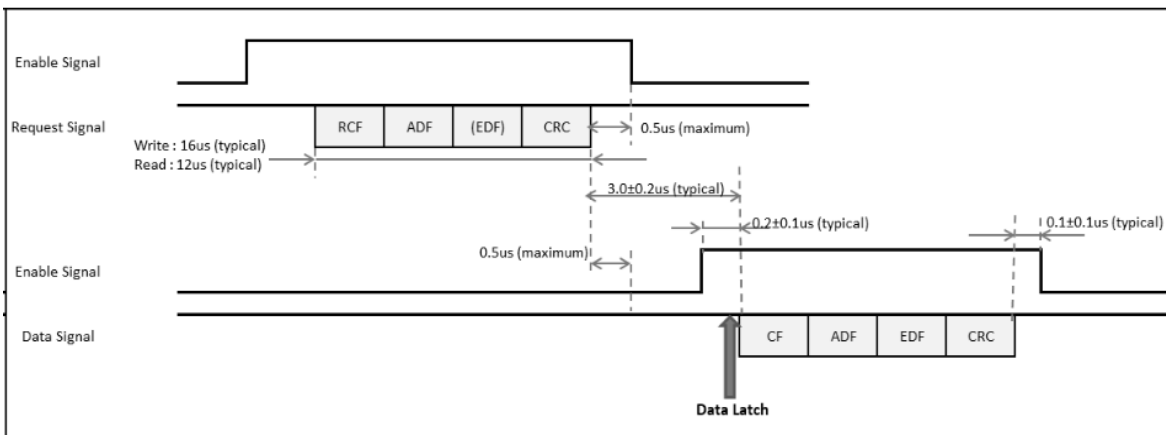


Figure 3. Timing Characteristics of Enable, Request and Data Signals

Register Communication and Assignment

Please refer to N33MA-M50 software specification document for details information.

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Table 15. Connector Output Assignment

Pin No	SSI	BiSS C	RS485 half-duplex
1	GND	GND	GND
2	VDD	VDD	VDD
3	SCLK-	MA-	NC
4	SCLK+	MA+	NC
5	DAT-	SLO-	DATA-
6	DAT+	SLO+	DATA+
7	UART RX	NC	NC
8	UART TX	NC	NC
9	Zero reset	NC	NC
10	GND	GND	GND

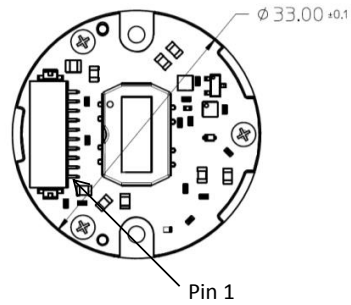


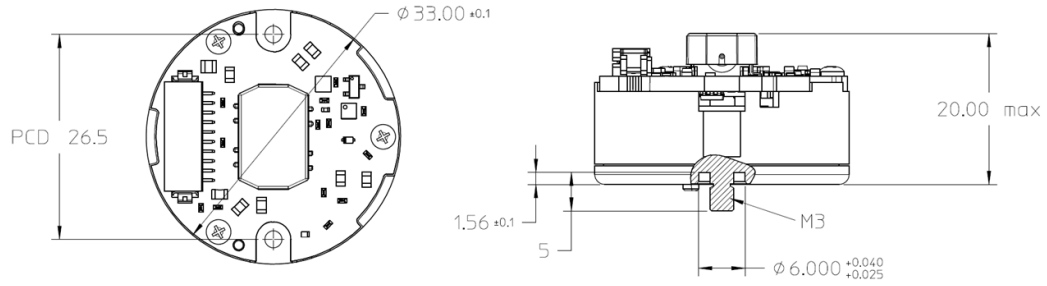
Figure 4. Pin 1 location viewed from encoder top

*Recommended mating connector:

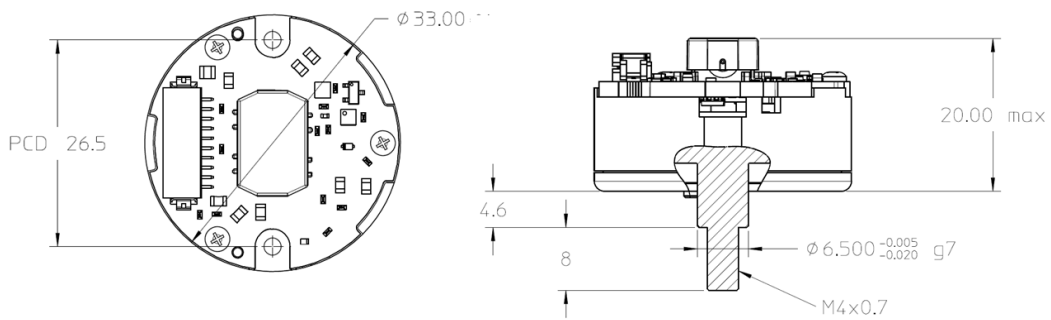
Hirose Part No: DF13-10S-1.25C (CL No.536-0006-8)

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

4. Mechanical Dimensions



M3 Hub Screw



M4 Hub Screw

Figure 5. Package dimensions

Note:

1. Dimensions are in millimeters
2. Unless otherwise specified, all tolerances are within ± 0.5 mm
3. DO NOT USE FERRO-MAGNETIC SHAFT FOR THE MOTOR

5. Magnetic Shield Design Guidelines

In order to eliminate or minimize the influence of external magnetic field interference on encoder operation, use of shielding is mandatory. A recommended design of shielding made of 1.2mm mild steel (SPCC) is given in Figure 6.

Shield Requirement
 Minimum Thickness: 1.2mm
 Material: Ferromagnetic

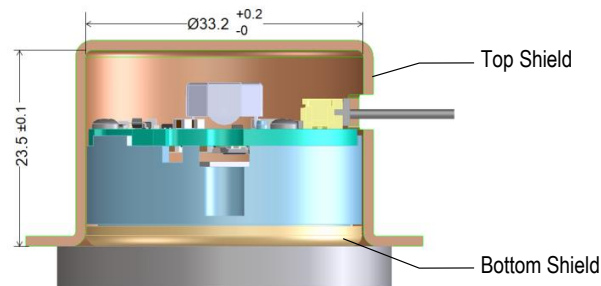


Figure 6. Recommended Magnetic Shield Design

Note:

1. External magnetic 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.

Calibration Kit Tools

1. Electronic Accuracy Calibration Kit
2. Radial Centering Jig

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