Datasheet

35AT-CZxxxx Series

High Resolution Single-Turn Absolute Encoder

Introduction

35AT-CZ BiSS-C Series encoder is a high-resolution optical absolute encoder produced by Broadcom Wuxi, which offers 17 to 25 bits single turn absolute angular position. The 35AT-CZ BiSS-C series encoder is a house encoder consisting of a patterned disk, a light source, and photosensitive elements to translate the mechanical motion into electrical signals. The 35AT-CZ BiSS-C option of encoders come with a full-duplex BiSS-C communication protocol, supported by a full-duplex differential line transmissions driver and receiver, offering good noise immunity for a robust transmission of data up to10MHz clock rate in harsh industrial applications.

As the product is intended for industrial applications, ESD protection circuitry has been designed by meeting the industry standard of IEC-61000-4-2 class 4.

Features

• 17, 22, 23, 24 or 25 bits single turn counting options available

• Built-in BiSS-C full-duplex communication protocol

• Up to 10MHz communication clock speed

• Ø37 mm OD and typical mounting height of 28 mm

Benefits

• High resolution and high measurement accuracy for better speed ripple control.

• Immediate position detection upon power up without the need of system homing.

• 9mm (1:10) hollow taper shaft design for China Servo Motor market.

• 8mm blind hollow shaft design option is available.

• Small OD and low assembly height for ease of integration to small size motors.

Applications

• Robotics

• Factory automation

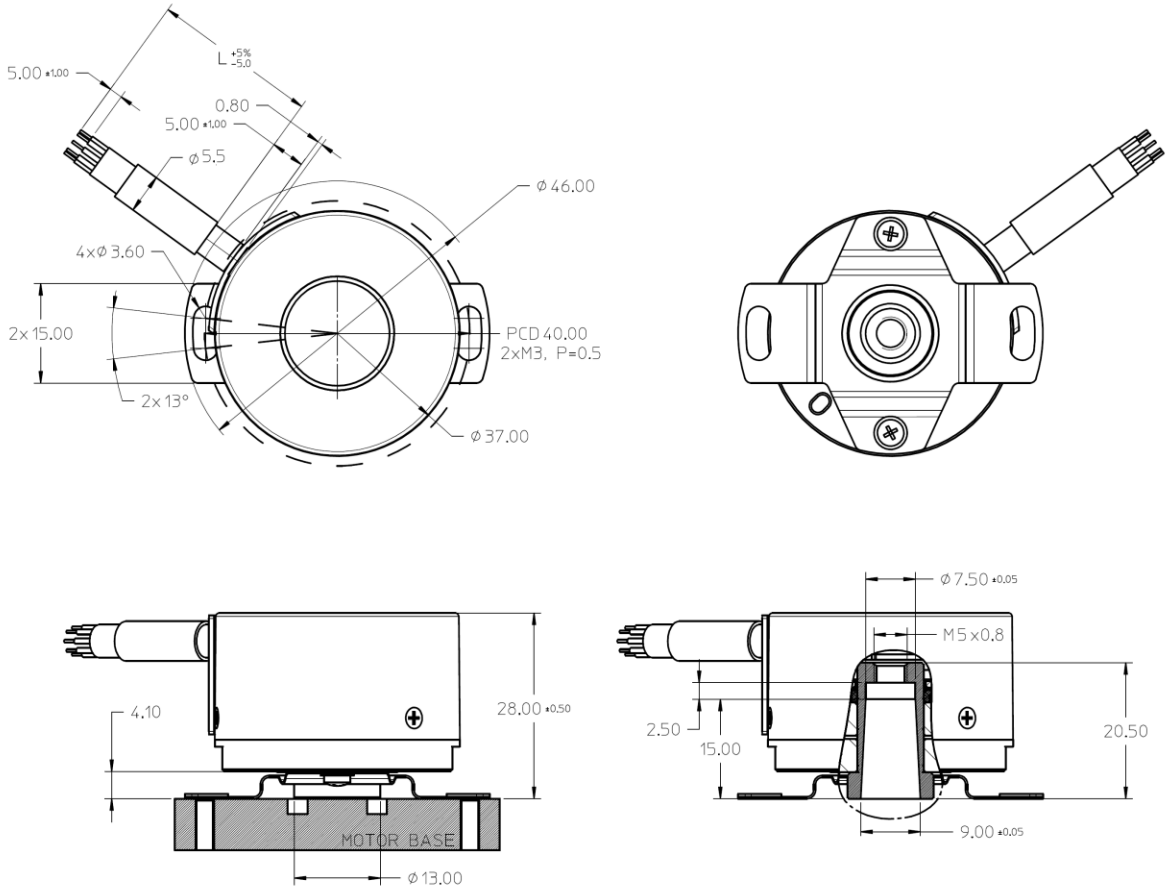
• CNC machine tool

NOTE

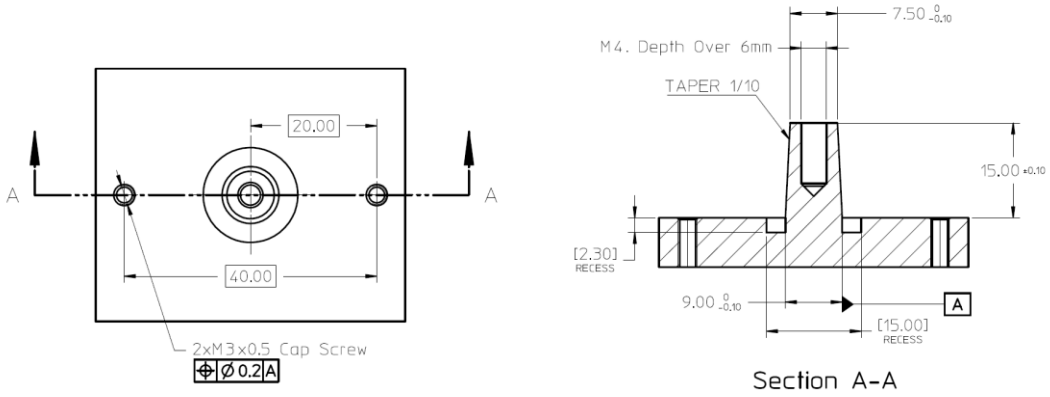
Broadcom Wuxi encoders are not specifically designed or manufactured for use in any specific device. Customers are solely responsible for determining the suitability of this product for its intended application and solely liable for all loss, damage, expense or liability in connection with such use. Please contact Broadcom Wuxi sales representative if more clarification is needed.

Mechanical Outlines

Standard Taper Shaft Option (Φ9-Φ7.5mm; 1:10) [Cable length= L]; Coupling PCD= 40mm



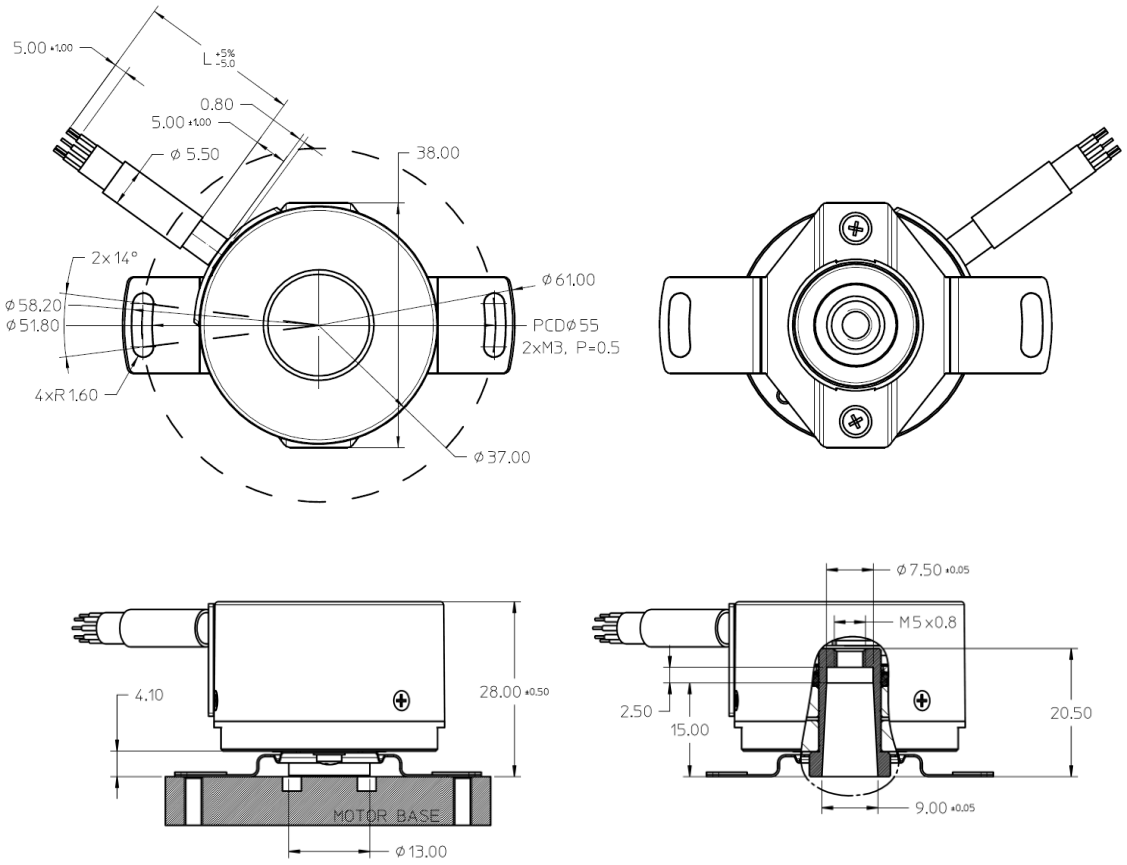
Recommended Shaft and Mounting Requirements



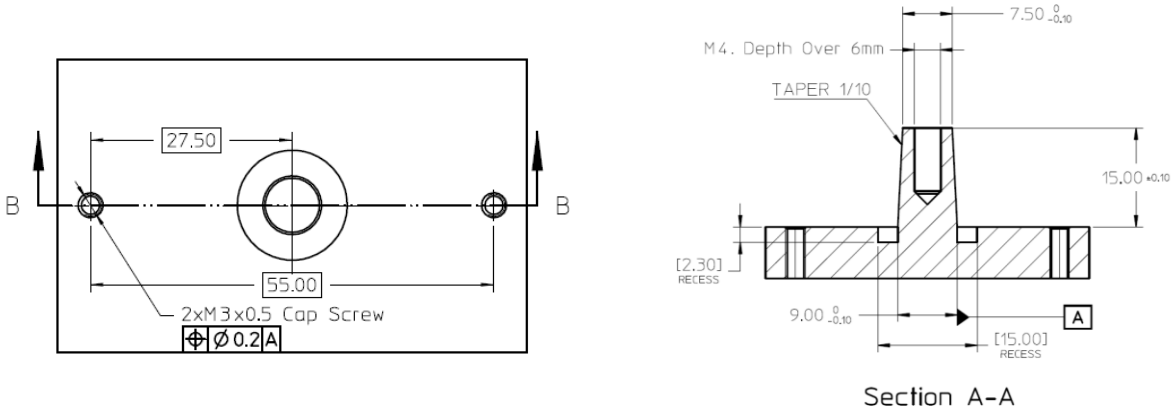
NOTE

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.

Standard Taper Shaft Option (Φ9-Φ7.5mm; 1:10) [Cable length= L]; Coupling PCD= 55mm



Recommended Shaft and Mounting Requirements



NOTE

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.

Product Specifications

Electrical Specifications

Parameters	Conditions	Min	Typ	Max	Units
Current Consumption	Without load, T_{amb} = 25˚C		50		mA
Supply Voltage, V_{CC}		4.5	5	5.5	V
Electrically Permissible Speed				8,000	rpm
Electrically Permissible Acceleration	Normal mode (1)			$8.0x10^4$	rad/s^2
Recommended Cable Length	Twisted pair, shielded			30	M
Temperature sensor accuracy	At T_{amb} = 120 °C	–	±3	–	°C
Encoder ready upon power up				500	ms

NOTE

1. Normal mode: Encoder operates on encoder main power supply.

Power Supply Considerations

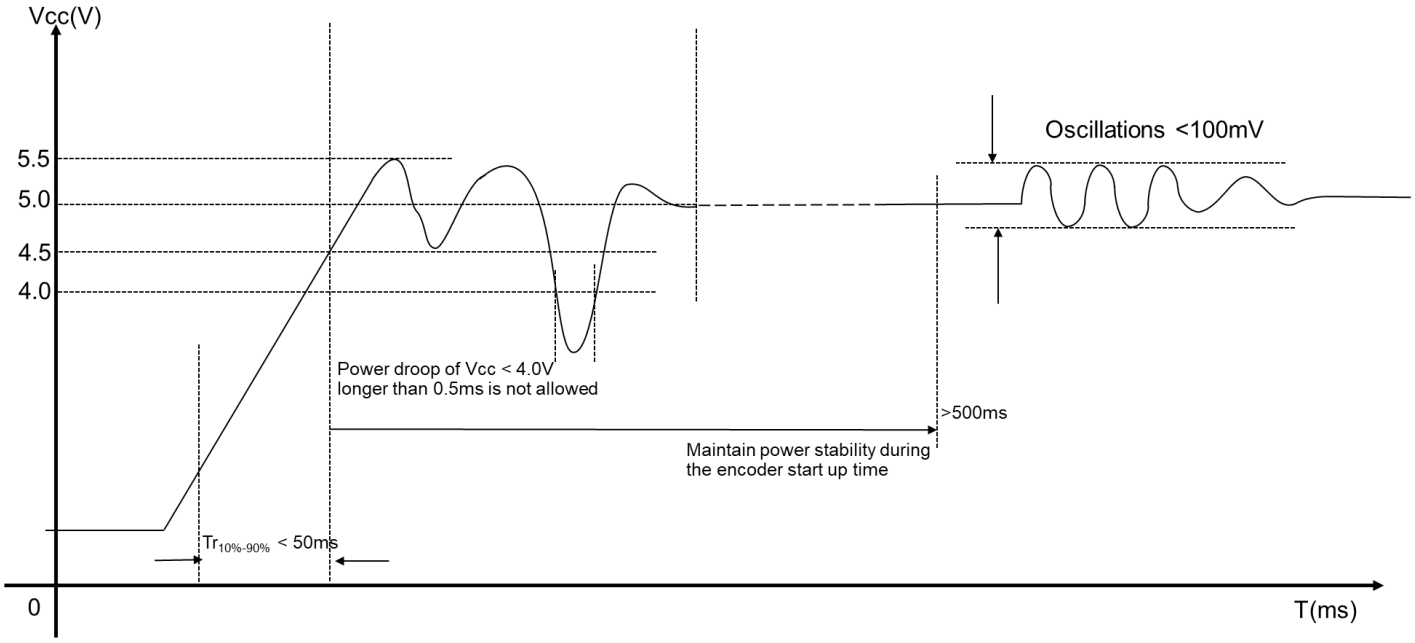


Figure 1 Encoder power up considerations

NOTE

1. Power droop during the initial power up should be avoided.
2. Power up rise time of <50ms is recommended.
3. Encoder communication ready after 500ms.

Mechanical Specifications

Parameters	Conditions	Min	Typ	Max	Units
System Accuracy	With electrical correction, T_{amb} = 25˚C		±50		Arc-sec
Mechanical Permissible Speed				8,000	min^{-1}
Shaft Radial Play				+/-0.05	mm
Shaft Axial Play				+/- 0.1	mm
Starting torque	T_{amb} = 25˚C			$9.8x10^{-3}$	N.m

Environmental Specifications

Parameters	Conditions	Min	Typ	Max	Units
Storage Temperature		-20	-	105	°C
Operating Temperature		-20	-	105	°C
Relative Air Humidity (Non-Condensing)	T_{amb} = 40˚C, Per IEC 61800-2	-	-	90	RH%
Ingress Protection	After assembly to customer motor, Class 2	-	IP50	-	
Vibration	Per IEC 60068-2-6	10G; 10~2000Hz			
Shock	Per IEC 60068-2-27	6ms; Half Sine; 200G			
Discharge of Static Electricity (ESD)	Per IEC 61000-4-2	± 8kV contact discharge, ± 12kV air discharge			-
Electrical Fast Transient / Burst Immunity	Per IEC 61000-4-4, Capacitive Coupling	± 2 kV / 5 kHz / 15ms			-
Dielectric Resistance	AC 500V, 1Min	Leakage <0.3			mA
Insulation Resistance	DC 500V	20			MΩ

Encoder Specifications

Parameter	Remarks
Resolution	Single Turn: 17 (131,072 counts) to 25 Bits (33,554,432 counts)
Counting Direction	Increase with clockwise shaft rotation, view from coupling end (Figure 1)
User accessible Memory size	5K bits

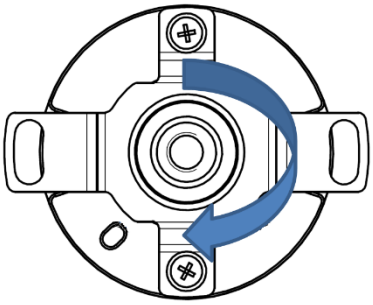
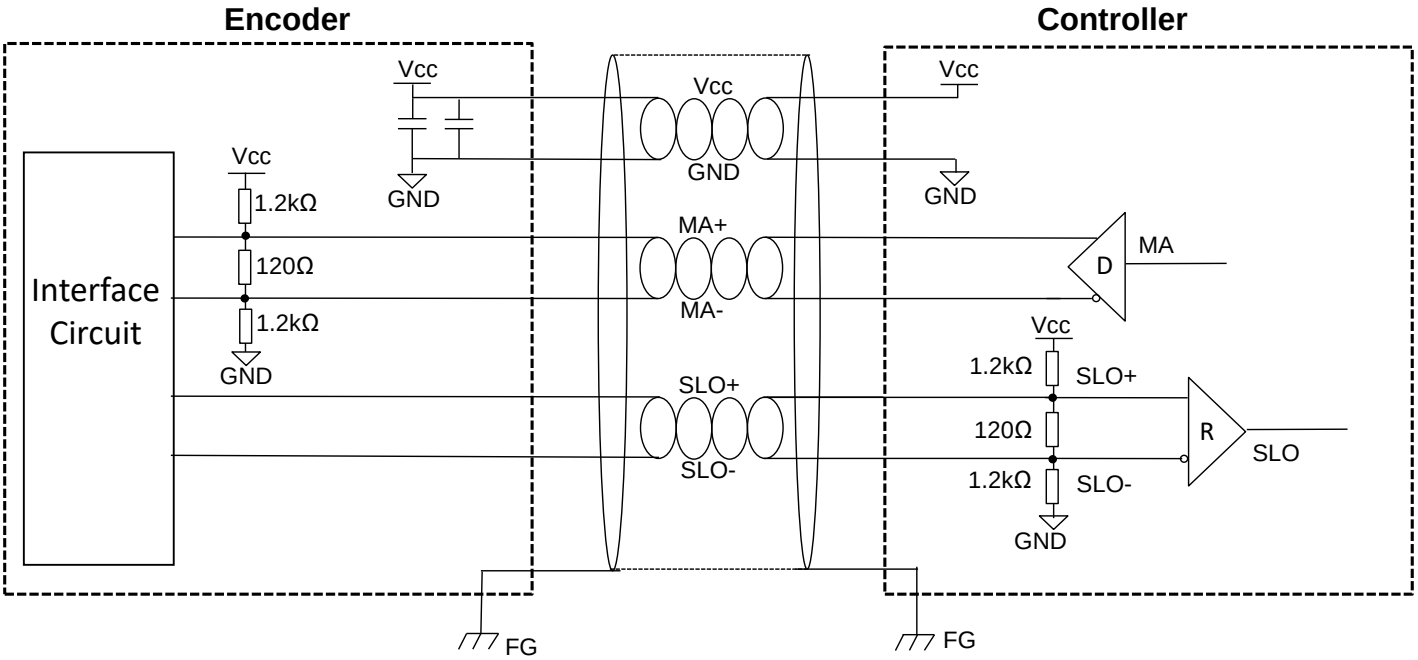


Figure 2 Counting direction

Typical Electrical Connection

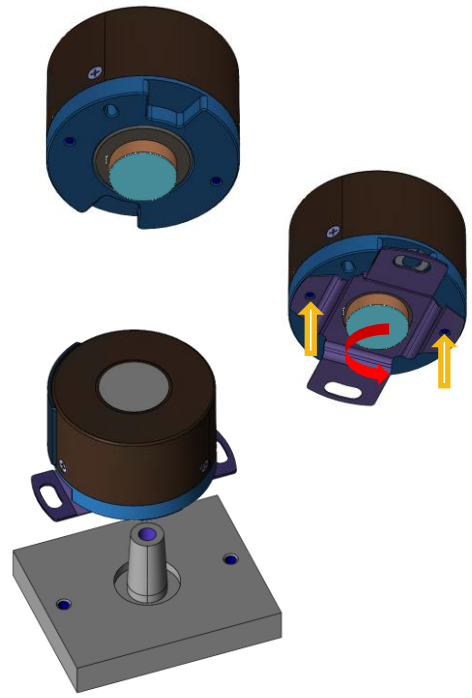


NOTE

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 controller (servo driver), up to 30m in length.

3. It is recommended to connect encoder chassis and cable shield to frame ground (FG) in application for enhanced noise immunity in harsh operating condition.
4. To prevent undesirable signal reflections, the termination resistor is needed. Termination resistor, *120ohm 1/4W is recommended but may depend on the characteristic impedance of cable used.

Recommended Encoder Assembly Steps – Taper Shaft Options



Step 1:

Assemble the supplied flexible coupling plate with the two pieces of M2.6 x 5 screws (property class 4.6).

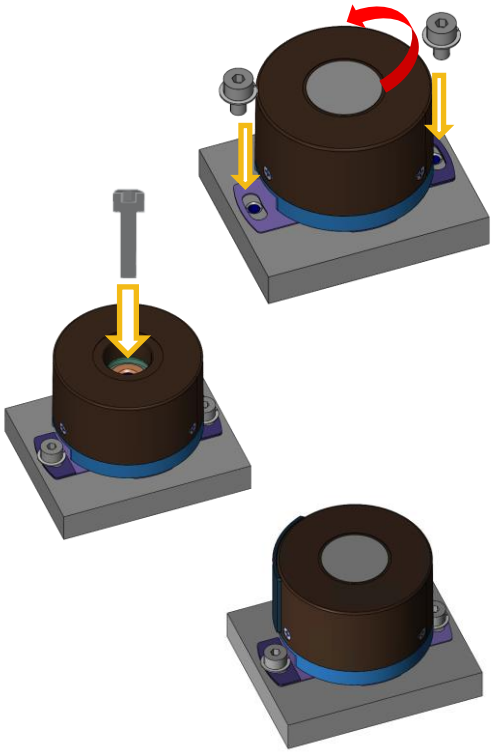
Recommended tightening torque 4 +/- 0.2 kgf.cm.

Remove the sticker from bottom shaft carefully. Do not poke or damage the sticker as it will create contamination to encoder.

Step 2:

Slide encoder taper shaft over motor shaft until the taper shaft of encoder is fully touching on the motor shaft.

Remove the sticker from top cover carefully. Do not poke or damage the sticker as it will create contamination to encoder.



Step 3:

If necessary, perform a minor adjustment on the encoder orientation (M3 slot allows +/-5 degrees rotation). This is followed by fastening both the M3 coupling mounting screws. Recommended tightening torque with socket head cap screw:

9 +/- 1 kgf.cm (property class 8.8 screw) or
4.8 +/- 0.2 kgf.cm (property class 4.6 screw)

Recommend to use spring washer and flat washer. Apply screw thread lock fluid to better secure the coupling plate, e.g. Threebond 1401.

Step 4:

Fasten the M4 socket head cap screw on top to the encoder shaft. Recommended tightening torque:

18 +/- 2 kgf.cm (property class 8.8 screw) or
10 +/- 0.2 kgf.cm (property class 4.6 screw)

Seal the housing opening hole immediately by using the provided polyester film sticker. Make sure the hole is fully covered by sticker for dust protection.

Remarks: To remove the encoder from motor shaft, an M5 X 40mm screw is needed to eject encoder shaft from motor shaft.

General Specification of BiSS-C Serial Communication

Table 1 General Specification of Serial Communication

Interface	Symbol	Recommended Circuit
Serial Clock	MA or SCLK	Transmitter (P/N: ISL3295E) or equivalent
Serial Data Output	SLO or DATA	Receiver (P/N: ISL3283E) or equivalent

Table 2 BiSS-C Timing Characteristics

Parameter	Symbol	Condition	Min	Typ.	Max	Units	Notes
MA Frequency	f_{MA}		0.08		10	MHz	
MA Duty	DUT_{CLK}	-	-	50	-	%	
Busy Timeout Frame to Frame	T_{busy} $t_{BiSS\text{-}timeout}$	5MHz < f_{MA} ≤ 10MHz	-	$2/f_{MA}$	-	µs	1
		100kHz ≤ f_{MA} ≤ 5MHz	-	$1/f_{MA}$	-		
			$1.5/f_{MA}$		5		
		-	-	-	1		
Encoder Initialization Time					500	ms	

NOTE

1. Refer to Figure 3 for timing description

BiSS-C Data Field

ST[24:0]	Error[0]	Warning[0]	CRC[5:0]

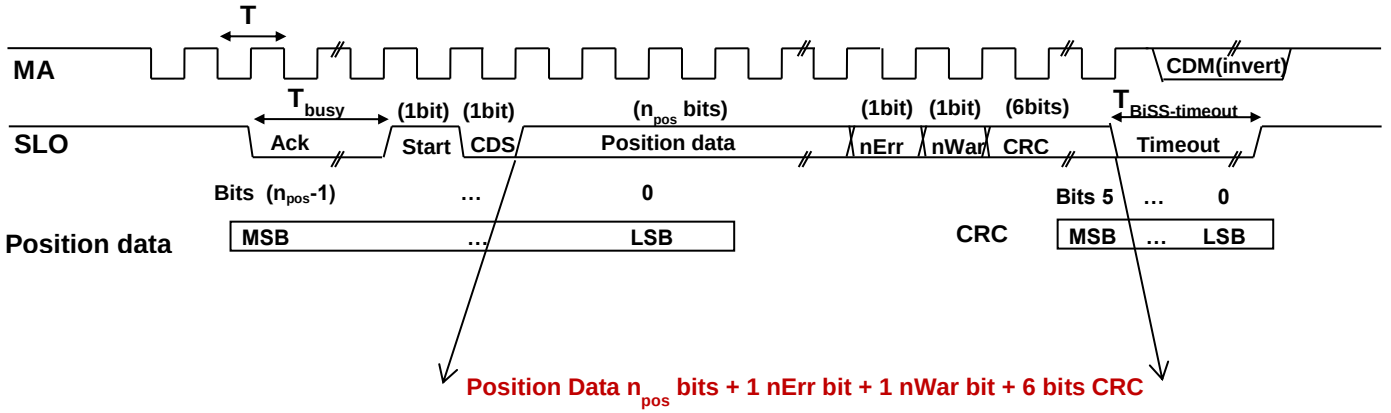


Figure 3 BiSS-C Interface Timing Diagram

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)
4. Position data varies depending on Single-turn resolution.

Absolute Single-turn Resolution

ST Resolutions: 17, 22, 23, 24, 25 bits

Encoder Memory Area

The 35AT-CZ encoder includes an external EEPROM device, which is available as user area. The memory data are kept in a non-volatile memory. There are additional register banks reserved for system areas that are protected against accidental writing during operation. Permissible EEPROM writing cycle for these banks is 1,000 times.

Table 3 User Memory Area

Bank [decimal]	Address [hex]	Remarks
0 to 9	0x00~0x3F	User Area
10 to 17	0x00~0x3F	Non-volatile memories for system area
18 to 21	0x00~0x3F	Volatile memories reserved for encoder system use
22 to 27	0x00~0x3F	Broadcom Reserved Area
- (BiSS Direct Register)	40h	Bank Selection
	41h	(User prohibited write)
	42h~43h	Profile ID (hexadecimal) (User prohibited write)
	44h~47h	Serial Number (User prohibited write)
	48h~4Ah	Encoder Status and Command Registers (see Table 4)
	4Bh-74h	Client Register (Reserved)
	75h	Temperature Register (see Table 5)
	76h-77h	Client Register (Broadcom Reserved)
	78h~7Dh	Device ID (hexadecimal) (User prohibited write)
	7Eh~7Fh	Manufacturer ID (414F hexadecimal) (User prohibited write)

NOTE

1. Total 10 banks with 64 addresses each are allocated for user access.
2. The active page numbers are specified in address 0x40, bank change is done by writing to address 0x40.
3. Typical EEPROM read time is 200µs minimum.

Table 4 Definition of BiSS-C Encoder Status Bits and Clear Command

Address 72(0x48) – Error Status [7:0]								
Option	**Bit7**	**Bit6**	**Bit5**	**Bit4**	**Bit3**	**Bit2**	**Bit1**	**Bit0**
ST	"N/A"				"N/A"	ST Error | MLS Error	Memory Error	"N/A"
Address 73(0x49) – Warning Status [7:0]								
"N/A"					"N/A"	Temp Error	Lissajous (Incremental) Error	LED Error
Address 74(0x4A) – Encoder Clear Command [1] ; Bit2 = Alarm Clear, Bit1 = ST zero offset, Bit0 = MT zero offset								
"N/A"						Alarm Clear	ST Zero Offset	"N/A"

NOTE

1. Write "1" to execute one time clear command. Only one command bit should be triggered for each time.

Temperature Sensor

The temperature data (TEMP) is available by accessing memory either of the two registers addresses. Examples of the temperature data in 2's complement values are listed in Table 5.

Table 5 Definition of Temperature Value and Alarm Bit

	Bank Selection	Address		Bits	Remark
	(Dec)	(Hex)	(Dec)		
Temperature value	-	75	117	Bit [7:0]	2's complement (-1℃ to -64℃), maximum positive value is 191℃.
Temperature alarm	-	49	73	Bit 2	To indicate the temperature exceed the maximum preset limit. 1: temperature above preset limit. 0: temperature below preset limit.

Cable Output Assignment

Wire	Color	Description
1	Red	VCC, Encoder Supply
2	Black	GND, Ground
3	Brown	MA+/SCLK+ (Clock Positive Line from Host)
4	Brown/Black	MA-/SCLK- (Clock Negative Line from Host)
5	White	SLO+/DATA+ (Data Positive Line from Client)
6	White/Black	SLO-/DATA-(Data Negative Line from Client)
7	Cable Shield Strand	Cable Shield, Connect to Chassis

Dos and Don’ts

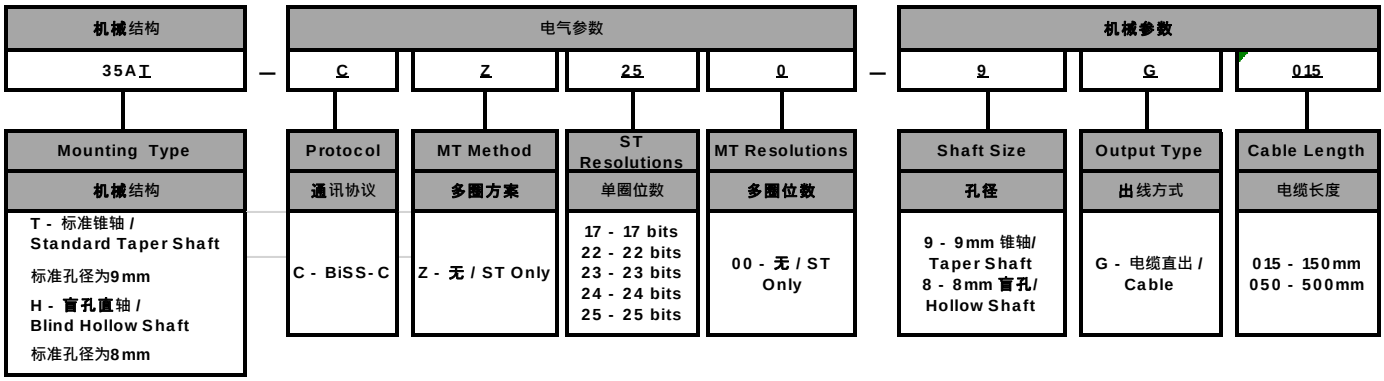
Do

1. Ensure clean environment during installation. Provide adequate protection from dust and moisture when use in harsh environment.
1. Ensure encoder housing opening hole is fully covered with sticker to avoid any contamination to encoder.
2. Ensure encoder power supply is within 5V +/- 10%. Avoid sudden drop or surge in the power supply line, including upon power up.
3. Ensure cable output configuration is per datasheet.
4. Observe all ESD precaution when performing installation or handling the encoder.
5. Ensure to use recommend screw type as per mounting guideline in order to avoid generating any brass debris which will create contamination to encoder.

Don’t

1. Do not overload transceiver 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 for encoder main power.
5. Do not operate encoder under extreme temperature over time.
6. Do not poke or damage the encoder sticker.

Ordering Information



NOTE 注意

1. "T" 标准孔径为 9mm, “H”和"K"标准孔径为 8mm
2. 本编码器产品出厂是单独附板簧，有 PCD40 及 PCD55 两种规格可选，下单时请注明所需板簧规格
3. 关于产品订单和交货时间,请咨询博通无锡工厂