

## IncOder CORE Series Datasheet

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# 1 General Information

## 1.1 Revision History

Revision	Release Date	Changes
1.0	Sep 29 2021	Initial Release

## 1.2 Disclaimers and limitations of liability

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## 2 Overview

IncOder CORE is a non-contact, lightweight absolute rotary encoder, fully-contained in an open frame printed circuit board kit. The ergonomic hollow bore design is suited for integration into rotary actuators. The position sensor utilizes a unique, field-proven inductive technique, that is insensitive to contamination, delivering robust and repeatable angle measurement performance.

The angle sensor can be installed quickly and simply, by mounting the rotor and stator pair into the host assembly by means of M2 screw mounting holes. With modest installation tolerances, a programmable zero set and no calibration required, the sensor can simply be screwed and doweled in place for fast and practical setup.

Each sensor includes a passive rotor target, paired with an active stator. The stator contains all the required processing electronics in a lightweight, stacked circuit board package. The stator features a 10-way Molex PicoClasp connector for power input and data output. The IncOder CORE can be configured with an axial or radial connector for optimised system design.

IncOder CORE can be configured during build to output up to 17-bits of absolute digital position data in a range of protocol options including SPI, BiSS-C, and SSI.



### 2.1 Features and Benefits

- Lightweight and compact PCB construction for reduced system weight and design envelope
- True absolute position output
- Proven reliable inductive position sensing
- Easy Installation
- No calibration
- Ergonomic hollow bore design optimized for use in rotary actuators
- Insensitive to contamination
- Configurable with a range of output options available
- Rapid derivative customisation

## 3 Specifications

System Data	
Measurement	Absolute over 360 °
Resolution	10-17 bits
Accuracy	±0.1 °
Installation (Gap, Max Radial Offset)	0.5 ± 0.2 mm, 0.2 mm
Max. Speed	10,000 rpm
Repeatability (within a single power cycle)	±1 LSB
Measurement Update Rate	10 kHz
Internal Position Update Period	100 μs
Thermal Drift Co-efficient	<1 ppm
Electrical Data	
Supply Voltage	4.5 - 5.5 VDC, 8 - 12 VDC
Current Consumption	<100 mA (typically <75 mA and does not change significantly with voltage supply)
Data I/O	RS422 Compatible, supports SSI, SPI, BiSS-C or ASI (asynchronous serial interface)
Reverse Polarity Protection	PSU Reverse polarity protected to 32 VDC
Power Up Time to 1st Measurement	<120 ms
BiSS Max. Clock Rate	2.5 MHz
SPI Max. Clock Rate	4 MHz
SSI Max. Clock Rate	2 MHz
Zero Setting	Zero Set / Zero Reset via Connector Pin

<b>Mechanical Data</b>	
Rotor OD	ø35.6 mm
Rotor Screw Hole PCD	ø36 mm
Stator OD	ø44 mm
Stator Screw Hole PCD	ø56.8 mm
ID	ø10.4 mm
Mass (Rotor, Stator, Total)	2.8 g, 11.8 g, 14.6 g (not including mounting hardware)
Mounting	M2 screw mount (fix rotor using c.sunk screws, stator using cap screws)
Connector	10-way Molex PicoClasp
<b>Environmental Data</b>	
IP Rating	IP00 (options for conformal coating available)
Operating Temperature	-20 °C to 85 °C
Storage Temperature	-40 °C to 105 °C
Contamination Immunity	Tolerant to dust, dirt, oily fingerprints.
Humidity	10-85 % RH Non-Condensing
<b>User Cable Data</b>	
Terminations	End A: Molex 10-way connector End B: Coated wires, stripped 1mm (max 1.3mm).
Standards	BS 3G 210
Wire Gauge	28 - 32 AWG
Wire Coating	PTFE coated
Sleeve	Polychloroprene sections

User Cable Data	
Length Tolerance	± 5 %

## 4 Storage And Handling

IncOder CORE is a precision encoder and has been designed to function in a wide range of applications and environments. To take full advantage of the encoder design, allow easy access to the sensor for service and/or replacement. For optimal performance and reliability:

- DO follow standard ESD precautions while handling the sensor.
- DO allow proper clearance for stator-rotor alignment.
- DO follow setup and alignment instructions for the encoder system.
- DO NOT store sensors in an uncontrolled environment.
- DO NOT electrically overstress the sensor (power supply ripple/noise).
- DO NOT intentionally “hot swap” the sensor if the device is energized.

### 4.1 Handling Considerations

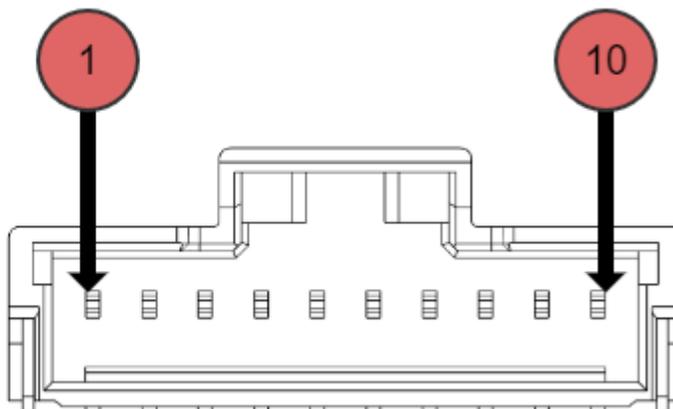
- Follow standard Electrostatic Discharge (ESD) precautions at all times.
- We advise correct use of earthed antistatic mats, earth straps and wrist straps when handling the device components.
- Gloved handling is not required but is recommended. If gloves are not used, hands should be clean.

### 4.2 Storage Considerations

When storing, only anti-static or static shielded packaging and storage media are advised to be used as primary or secondary packaging for the product.

## 5 Electrical Interface

### 5.1 Connector Overview



#### IncOder CORE Connector

Molex 10-way PicoClasp Connector

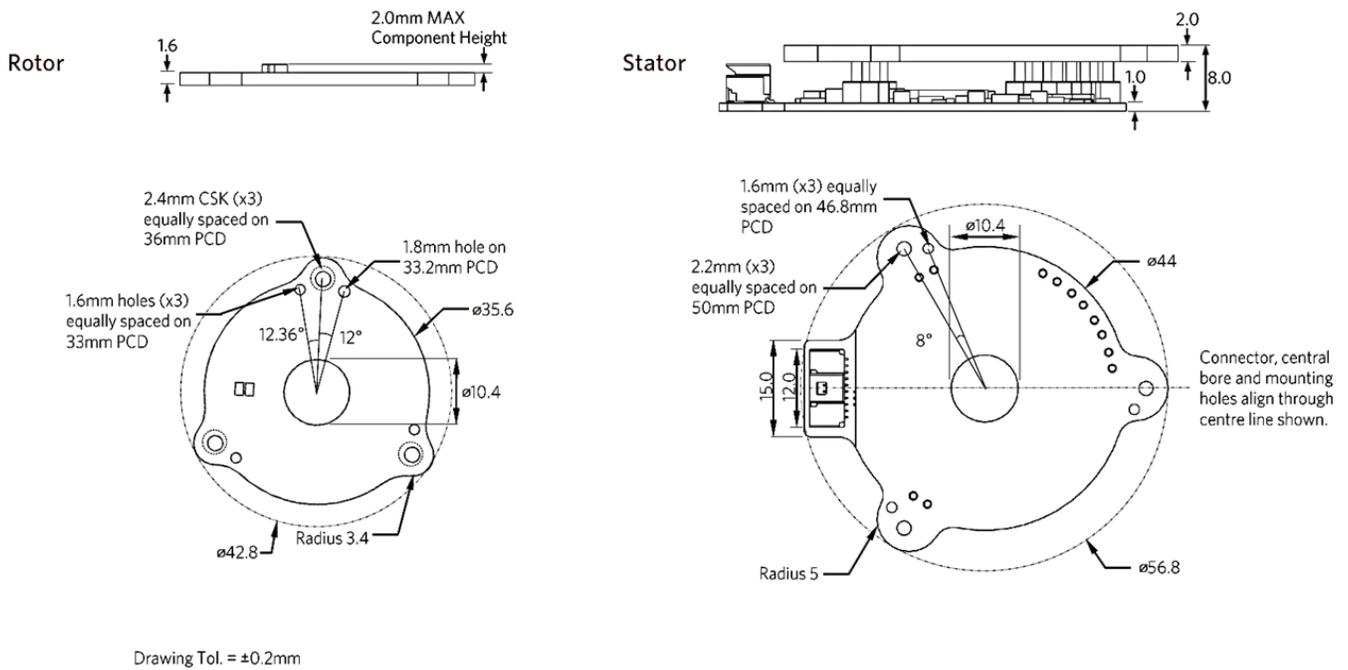
Pin	Signal	Function
1	Zero Set	Optional Zero Set function. To use, connect to electrical ground (<0.5V) for >3 seconds at power up but left unconnected (i.e. open circuit) during operation.
2	Zero Reset	Optional Zero Reset function. To use, connect to electrical ground (<0.5V) for >3 seconds at power up but left unconnected (i.e. open circuit) during operation.
3	Reserved	Reserved for future use.
4	Reserved	Reserved for future use.
5	DATA A	Absolute Encoder Output (Data A / Data +)
6	CLOCK A	Clock Input (Clock A / Clock +)
7	DATA B	Absolute Encoder Output (Data B / Data -)
8	CLOCK B	Clock Input (Clock B / Clock -)
9	0V	Digital signal ground.

10	$V_{\text{supply}}$	Supply 4.5-5.5V, 8-12V, <100mA
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## 6 Mechanical Dimensions

### 6.1 Mechanical Mounting Format

#### 6.1.1 Screw Mount Stator & Screw Mount Rotor - Product Option CORE-1

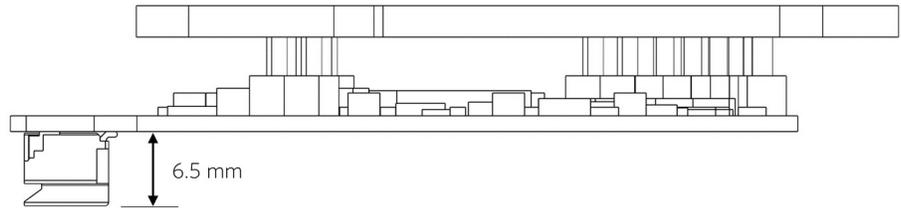


Note: Shown with Connection Option PR2.

## 6.2 Connection Options

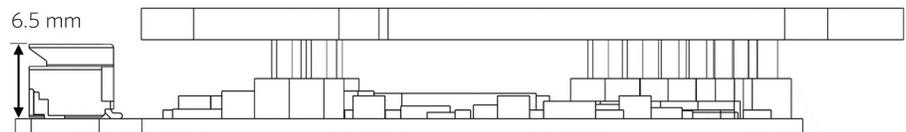
### Radial Connection Type 1 -

#### Product Option PR1



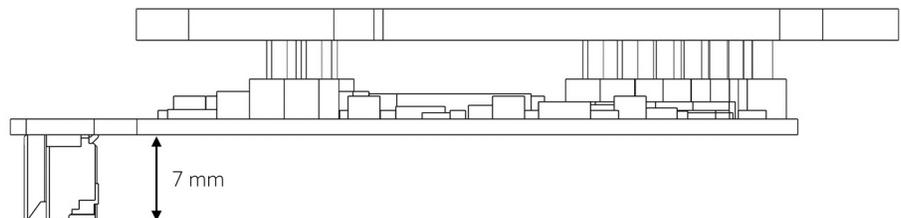
### Radial Connection Type 2 -

#### Product Option PR2



### Axial Connection Type 1 -

#### Product Option PA1



## 7 Installation

IncOder CORE is an unpackaged encoder requiring the user to design precision mounting features for integration of the position sensor within the host system assembly, taking into consideration alignment tolerances, mounting features, shielding and metal exclusion volume.

### 7.1 Mounting Features

IncOder CORE consists of a stator and rotor. Both components contain mounting features as outlined in Mechanical Dimensions, which includes screw mounting holes and alignment dowel holes. Recommended installation is to align and locate both the rotor and stator using the dowel features in the rotor and stator, and screw in place using the M2 screw holes provided. The rotor features countersunk screw holes, and an additional dowel hole for locating Zero Position. The stator features clearance screw holes for mounting with cap screws.

Note: It is recommended to mount the IncOder using non-metal spacers to ensure the Metal Exclusion Zone is established. See Metal Exclusion Zone section for details.

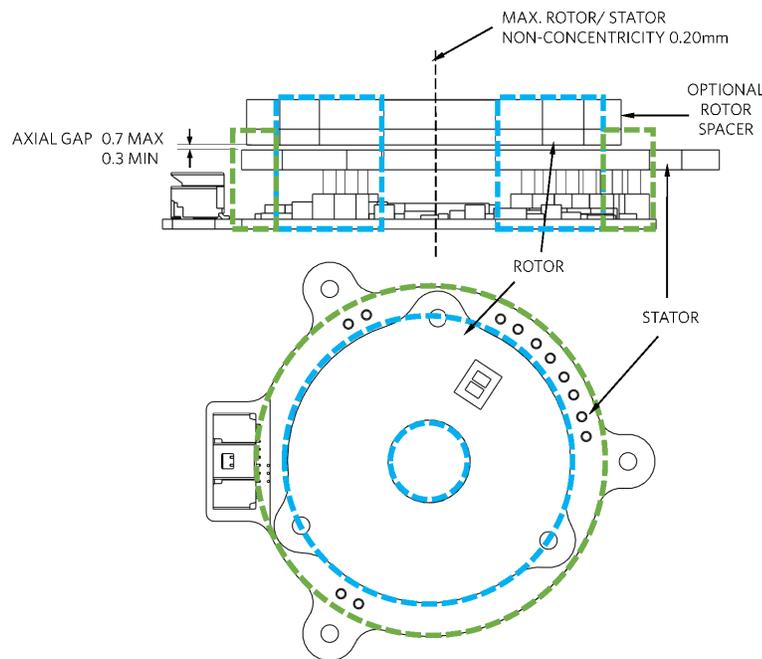
### 7.2 Alignment Tolerances

IncOder CORE consists of a rotor-stator pair. The rotor and stator should be mounted within the prescribed mounting tolerances. Provided axial gap and non-concentricity tolerances are maintained, then the stated measurement performance will be met.

Installation Tolerances	
Gap	$0.5 \pm 0.2$ mm
Non-concentricity	$\pm 0.2$ mm

### 7.3 Metal Exclusion Zone

The rotor and stator should be mounted within the prescribed mounting tolerances while also taking into consideration the Metal Exclusion Zone (blue and green dashed regions below). The Metal Exclusion Zone defines the volume in which metal should not be located. Failure to follow the prescribed guidance may result in a degradation of measurement performance.



### Blue Region

- Volume containing sensor windings and measurement field.
- Radial Boundaries: Rotor Mounting PCD ( $\varnothing 36\text{mm}$ ), to Rotor ID ( $\varnothing 10.4\text{mm}$ ).
- Vertical Boundaries: 3mm from rear face of rotor, to rear face of Stator E-board + isolation\*

### Green Region

- Volume containing pins connecting sensor antenna board with electronics board.
- Radial Boundaries: Stator OD ( $\varnothing 44\text{mm}$ ), to Rotor PCD ( $\varnothing 36\text{mm}$ ).
- Vertical Boundaries: Rear face of Rotor, to rear face of Stator E-board + isolation\*

\*Note: Ensure isolation of the stator e-board to host mechanics.

Other than the central host shaft; rotor mounting screws; and dowels, electrically conductive or magnetically permeable objects should not be located within 3mm of the rotor faces during operation. This metal exclusion zone could be established by designing and mounting the encoder with non-metal spacers as shown (not included). For specific guidance on incorporating IncOder CORE into your mechanical assembly, including where metal will be present within the exclusion zone, please contact Celera Motion (Zettlex).

## 7.4 Zero Position and Zero Setting

The Zero Point is the datum from which angle is measured. As supplied, the IncOder CORE carries a factory Zero Point setting. The zero point is within  $\pm 5^\circ$  of the "O" within the screen printed "IncOder" logo on the rotor, aligned with the same respective feature on the stator.

The Zero Point can be changed using the Zero Set and Zero Reset lines on the electrical interface. The Zero Set signal will set the current position as the Zero Point (held in memory when power is removed). Zero Reset signal will reset the Zero Point to the factory setting (held in memory when power is removed). To use, the relevant connection should be connected to electrical ground (<0.5V) for 3 seconds at power up but left unconnected (i.e. open circuit) during operation.

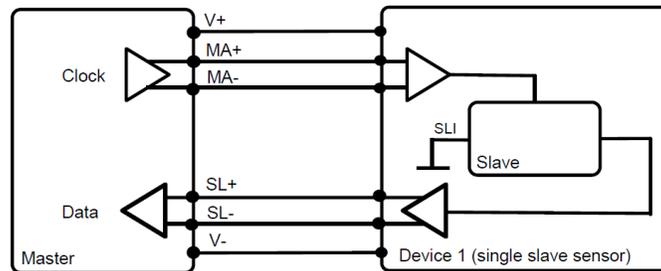
## 8 Communications

Notes:

- All digital communications interfaces conform to the RS422 standard.
- DATA & CLOCK inputs are not terminated with load resistors.

### 8.1 BiSS-C (unidirectional) Protocol

BiSS-C is a popular communications interface between controllers and position sensors. The IncOder BiSS-C interface is unidirectional and provides fast, compact, economic serial communications using RS422 (SSI) compatible hardware. The IncOder BiSS-C interface is a point to point configuration (a single device with a single slave), conforming to the requirements of BiSS-C Unidirectional. In this configuration, the IncOder is the only slave connected to the master (the host control system).



The Master transmits clock signals to the Slave via the MA line. The SL line carries the sensor data directly from the Slave back to the Master. The interface has only two unidirectional, differential lines (as the IncOder permanently connects the input SLI to '0'). Parameters for the individual data channels are specified below. These parameters can be pre-programmed in the controller and referenced via an ID or lookup table, or manually entered.

The IncOder implements a “pipelined” data output. The position (and status) returned in the SCD is from the position measurement triggered by the previous BiSS frame (provided that the frame repetition period is between 95µs and 140µs, as is described for the SPI1 protocol (see SPI Timing Information).

#### 8.1.1 BiSS-C (unidirectional) - Product Option BIS3

BIS3 Protocol Timing Parameters				
Symbol	Parameter	Min.	Max.	Unit
$1/T_{MA}$	Clock Frequency	600	2000	kHz
$T_{BISS-TIMEOUT}$	BiSS Timeout	15	20	µs

BIS3 Protocol Data Channel Parameters	
Number of Bits (SCD Length)	30 bits
Processing Time	12 Clock Cycles ( $12 \times T_{MA} \mu s$ )
Data Area Length & Alignment	24 bits
CRC	Width: 6 Bits Polynomial: 0x43 Initial Value: 0x00 Output Inverted

### 8.1.2 Data Area Definition

<b>MSB</b>										<b>LSB</b>	
D21	D20	D19	D18	D17	....	D3	D2	D1	D0	nE	nW

BIS3 Protocol Data Definition	
Symbol	Description
D21	Most significant bit of the position data (if IncOder resolution is <22 bits, the LSBs are set to '0').
D0	Least significant bit of the position data.
nE	'1' = position valid
nW	Always '1'

### 8.1.3 Example for 18 bits resolution:

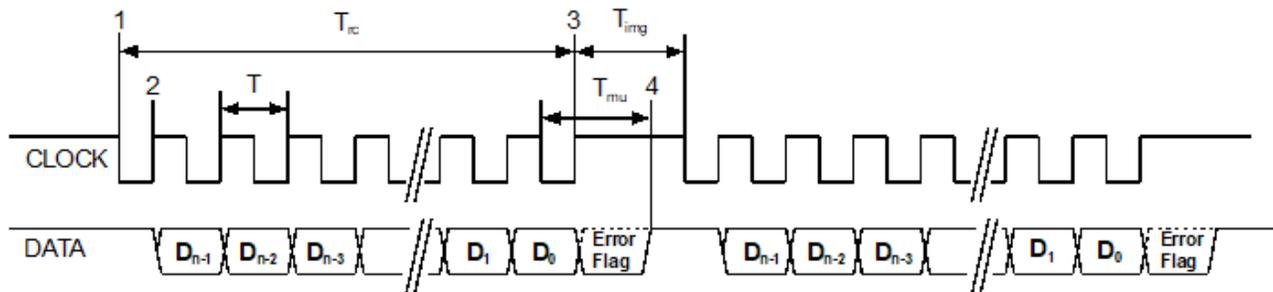
<b>MSB</b>										<b>LSB</b>	
D17	D16	D15	....	D1	D0	0	0	0	0	nE	nW

Note: For details regarding BIS1 and BIS2 legacy variants, please contact Celera Motion.

## 8.2 SSI - Synchronous Serial Interface Protocol

SSI is a widely used serial interface between position sensors and controllers. It is based on the RS-422 hardware standard and implements a differential output for the DATA and a differential input for the CLOCK. (Note that DATA outputs and CLOCK inputs are not terminated with load resistors.)

Synchronous SSI uses a clock sequence from a controller to initiate the transmission of position data from the sensor (a Read Cycle), with the latest position data (see Specifications for internal position update rate) available for transmission after each SSI Read Cycle is completed. See timing information below:-



1 SSI Timing Information

SSI Timing Parameters		
Symbol	Parameter	Description
T	Clock Period	$1/T = 100 \text{ kHz to } 2 \text{ MHz}$
$T_{rc}$	Read Cycle Time	Defined as $(n \times T) + (0.5 \times T)$
$T_{mu}$	Message Update Time	The time from last falling edge of clock to when new data is ready for transmission. $T_{mu} = 20\mu\text{s} \pm 1\mu\text{s}$ . The DATA line will be HIGH after this time indicating a new Read Cycle can be started.
$T_{img}$	Inter-message Gap Time	Must be $> T_{mu}$ otherwise position data will be indeterminate.
n	Number of Bits	The number of bits in the message (not including the Error Flag). In idle state CLOCK and DATA are both HIGH.

### Notes

1. The first falling edge after  $T_{mu}$  starts the Read Cycle and the transfer of data.
2. Each rising edge of the CLOCK transmits the next data bit of the message, starting with  $D_{n-1}$ .
3. After the last rising edge of the clock sequence, the data line is set by the Error Flag (if supported) for period  $T_{mu} - 0.5 \times T$

4. After  $T_{mU}$ , the latest position data is now available for transmission in the next Read Cycle – see Section 5.12 for position update rate.

Zettlex IncOders can support a variety of SSI protocol types in which data is transmitted depending on the requirements of the SSI controller. IncOder can be supplied with any of the following protocols – just choose what you need by selecting the relevant Product Option when ordering. If the protocol you require is not listed here then please consult Celera Motion or your local representative.

## 8.2.1 SSI - Product Options SSI1 to SSI9

SSI1 Protocol Data Definition (N = 24)			
Bit	Symbol	Definition	Description
D23	PV	Position Valid Flag	Set to 1 when data is valid, otherwise 0 (the inverse of the ERROR FLAG).
D22	ZPD	Zero Position Default Flag	Set to 1 when the Zero Point is at Factory Default, otherwise 0.
D21 - D0	PD[21:0]	Binary Position Data	Binary position data. If resolution of device is less than 22 bits, then the MSBs of this field are set to 0. The LSB of this field is in D0.  When PV is 0, PD[21:0] value is not defined.

SSI2 Protocol Data Definition (N = 24)			
Bit	Symbol	Definition	Description
D23-D2	PD[21:0]	Position Valid Flag	Binary position data. If resolution of device is less than 22 bits, then the MSBs of this field are set to 0. The LSB of this field is in D2. When Alarm bit is 1, PD[21:0] value is not defined.
D1	P	Parity Bit	0 indicates an even number of 1's in data (D23-D2), 1 indicates an odd number of 1's in data.
D0	A	Alarm Bit	0 indicates normal operation, 1 indicates error condition.

SSI3 Protocol Data Definition (N = 16)			
Bit	Symbol	Definition	Description

**SSI3 Protocol Data Definition (N = 16)**

D15-D0	PD[15:0]	Binary Position Data	<p>Binary position data. When error flag is 1, PD[15:0] value is not defined.</p> <p>Note: The use of SSI3 limits the measurement resolution to a maximum of 16 bits.</p>
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**SSI4 Protocol Data Definition (N = 32)**

Bit	Symbol	Definition	Description
D31	PV	Position Valid Flag	Set to 1 when position data valid, otherwise 0 (inverse of ERROR FLAG).
D30	ZPD	Zero Position Default Flag	Set to 1 when the Zero Point is at Factory Default, otherwise 0.
D29-D11	PD[18,0]	Binary Position Data	If resolution of device is less than 19 bits, then the MSBs of this field are set to 0. The LSB of this field is in D11. When PV is 0, PD[18:0] value is not defined.
D10-D0	TS[10,0]	Time Stamp Data	<p>The value of the Time Stamp counter when the position was measured. This data is always valid.</p> <p>The Time Stamp counter is a continuously incrementing counter in the range: 0.00ms to 20.47ms (at which point it restarts at 0.00ms). It has a resolution of 10us, with an accuracy better than 1% (based on the system oscillator).</p> <p>Note: the use of SSI4 limits the measurement resolution to a maximum of 19 bits.</p>

**SSI5 Protocol Data Definition (N = 16)**

Bit	Symbol	Definition	Description
D15-D0	PD[15:0]	Gray Code Position Data	<p>Gray Code Position Data. When error flag is 1, PD[15:0] value is not defined.</p> <p>Note: The use of SSI5 limits the measurement resolution to a maximum of 16 bits.</p>

**SSI6 Protocol Data Definition (N = 32)**

Bit	Symbol	Definition	Description
D31-D24	CRC[7:0]	Cyclic Redundancy Check	<p>CRC-8: To verify transmission, calculate the CRC of the bottom 24 bits of the message. The resulting CRC should be the same as the received CRC field.</p> <p>The following parameters define CRC-8:</p> <p>Polynomial 0x97</p> <p>Initial data 0x00</p> <p>MSB First (not reversed)</p> <p>No final XOR calculation</p>
D23	PV	Position Valid Flag	Set to 1 when position data is valid, otherwise 0 (the inverse of the ERROR FLAG).
D22	ZPD	Zero Position Default Flag	Set to 1 when the Zero Point is at Factory Default, otherwise 0.
D21-D0	PD[21:0]	Binary Position Data	<p>Binary position data. If resolution of device is less than 22 bits, then the MSBs of this field are set to 0. The LSB of this field is in D0.</p> <p>When PV is 0, PD[21:0] value is not defined.</p>

**SSI7 Protocol Data Definition (N = 30)**

Bit	Symbol	Definition	Description
D29-D24	-	'0'	Data always 0.
D23-D2	PD[21:0]	Binary Position Data	Binary position data. If resolution of device is less than 22 bits, then the MSBs of this field are set to 0. The LSB of this field is in D2. When Alarm bit is 1, PD[21:0] value is not defined.
D1	P	Parity Bit	<p>0 indicates an even number of 1's in data (D23-D2)</p> <p>1 indicates an odd number of 1's in data.</p>
D0	A	Alarm Bit	0 indicates normal operation, 1 indicates error condition.

**SSI8 Protocol Data Definition (N = 18)**

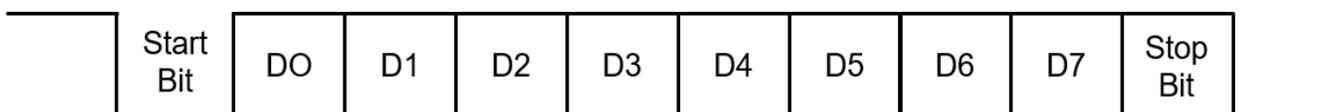
Bit	Symbol	Definition	Description
D17-D0	PD[17:0]	Gray Code Position Data	Gray code, position data. When ERROR FLAG is 1, PD[17:0] value is not defined.  Note: the use of SSI8 limits the measurement resolution to a maximum of 18 bits.

**SSI9 Protocol Data Definition (N = 32)**

Bit	Symbol	Definition	Description
D31	PV	Position Valid Flag	Set to 1 when position data valid, otherwise 0 (inverse of ERROR FLAG).
D30	ZPD	Zero Position Default Flag	Set to 1 when the Zero Point is at Factory Default, otherwise 0.
D29-D11	PD[18:0]	Binary Position Data	If resolution of device is <19 bits, then the MSBs of this field are set to 0. The LSB of this field is in D11. When PV is 0, PD[18:0] value is not defined.
D10-D0	TS[10:0]	Time Stamp Data	The value of the Time Stamp counter when the position was measured. This data is always valid. The Time Stamp counter is a continuously incrementing counter in the range: 0.00ms to 2.047ms (at which point it restarts at 0.00ms). It has a resolution of 1us, with an accuracy better than 1% (based on the system oscillator).

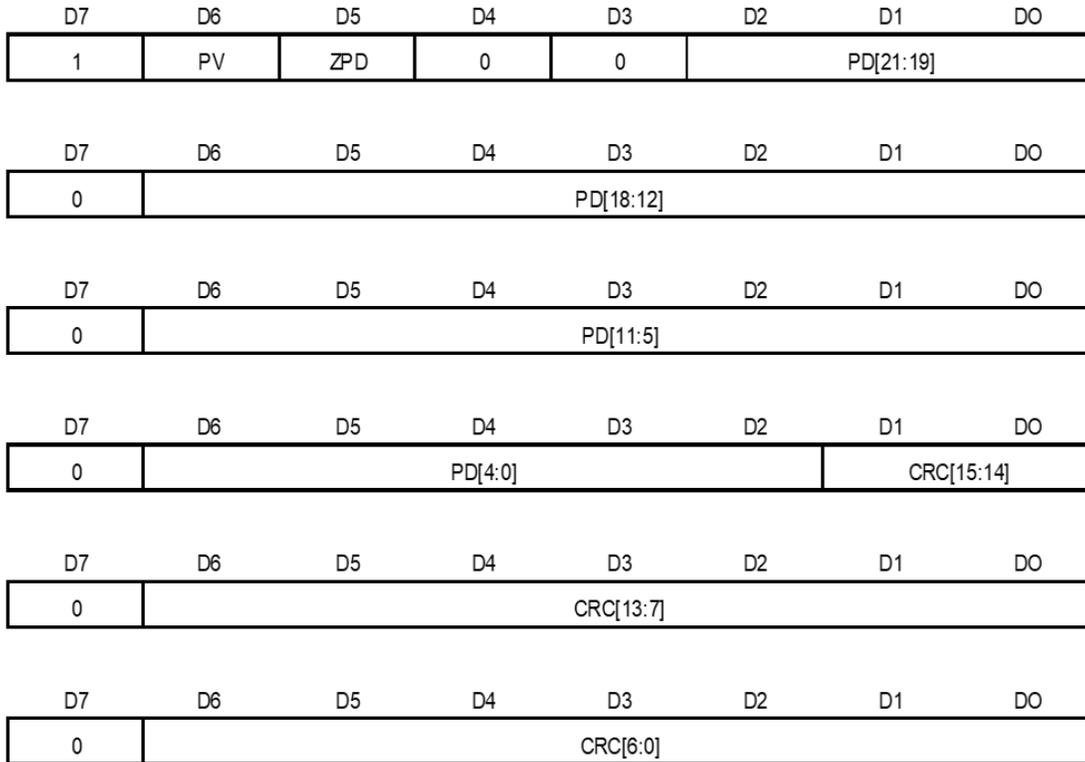
## 8.3 Asynchronous Serial Interface

This section describes the communications interface for IncOders with ASI1 and ASI2 serial protocols. Data is transmitted by the IncOder continuously formatted into Frames. Each Frame consists of a number of 8 bit data words. Each 8 Bit data word (or byte) is transmitted from a standard UART using N-8-1 (no parity, 8 data bits, 1 stop bit). ASI1 has a Baud rate of 230400 and ASI2 has a Baud rate of 921600. See below for the data format of each transmitted data word. ASI1 Frames are transmitted at a rate of 3.33kHz nominal. ASI2 frames are transmitted at a rate of 10kHz nominal (same rate as Internal Position Update Period).



### 8.3.1 Asynchronous Serial Interface - Product Options ASI1, ASI2

The following is the Asynchronous Serial Data protocol specified with the ASI1 or ASI2 Product Option. Each frame is defined as 6 bytes and the data format is defined as follows:



Note: D7[1] is transmitted first.

ASI1 / ASI2 Protocol Data Definition		
Symbol	Definition	Description
PV	Position Valid Flag	Set to 1 when position data valid, otherwise 0.
ZPD	Zero Position Default Flag	Set to 1 when the Zero Point is at Factory Default, otherwise 0.
PD[21:0]	IncOder Position Data	If resolution of device is <22 bits, then the MSBs of this field are set to 0. When PV is 0, PD[21:0] value is not defined.

CRC[15:0]	Cyclic Redundancy Check CRC-16	<p>To verify transmission, calculate the CRC of all 48 bits of the message but with CRC[15:0] set to 0. The resulting 16 bit CRC result should be the same as the received CRC[15:0].</p> <p>Use the following CRC-16 parameters:</p> <ul style="list-style-type: none"> <li>• Polynomial 0x8005</li> <li>• Initial Data 0x0000</li> <li>• MSB first (not reversed)</li> <li>• No final XOR calculation.</li> </ul>
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## 8.4 Serial Peripheral Interface

This section describes the communications interface for IncOders with SPI1 (Serial Peripheral Interface) serial protocols. SPI is a widely used serial interface between micro processors/controllers and peripherals. SPI uses a clock sequence from a master to control the transmission of data from the IncOder. IncOders with SPI data interface conform to the RS422 hardware specification.

SPI Clock Polarity is defined so that the CLOCK idle state is HIGH and the Clock Phase is defined so that the data is captured on the falling edge of CLOCK, and the data is propagated on the rising edge of CLOCK. This is commonly depicted as CPOL=1, CPHA=0 (also depicted as UCCKPL=1, UCCKPH=1).

For SPI communication interface, the acceptable clock frequency is 100kHz to 5MHz.

### 8.4.1 Serial Peripheral Interface (SPI) - Product Option SPI1

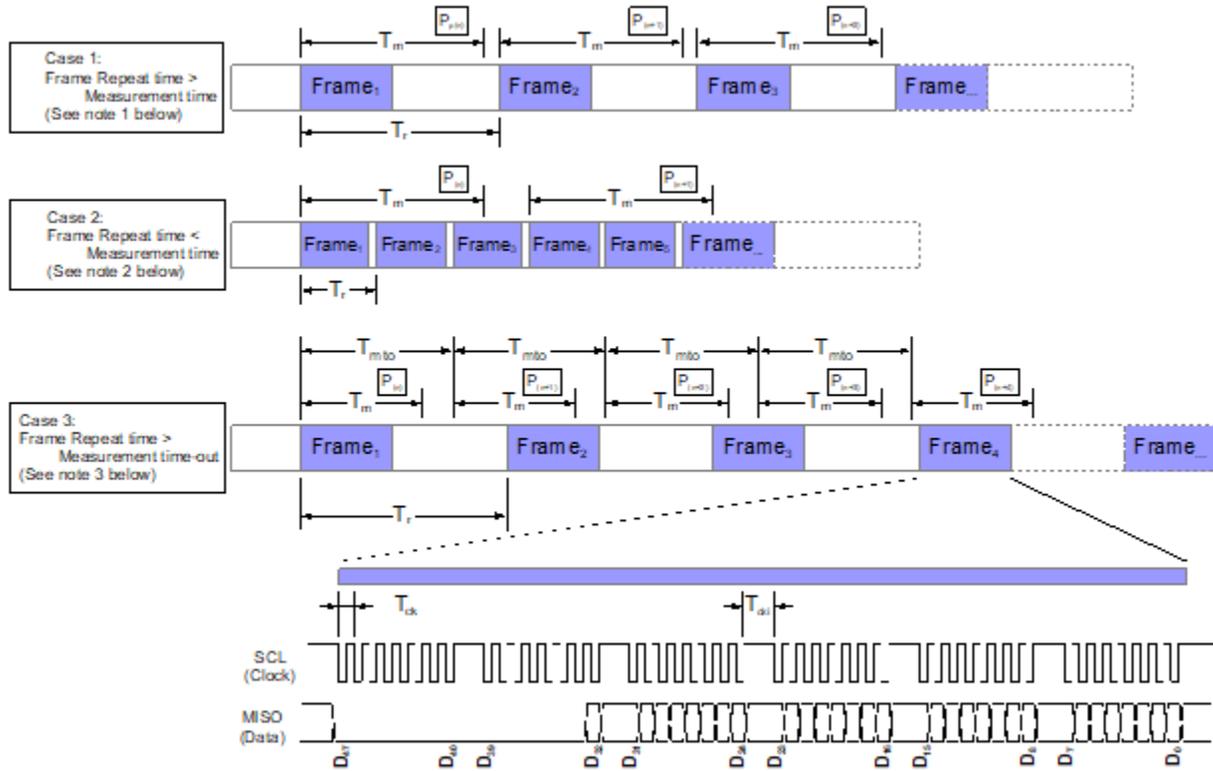
The SPI1 IncOder protocol specifies that each data frame consists of 6 bytes of data (each of 8 bits, 48 bits in total) containing the position, status flags and CRC.

SPI1 Protocol Data Definition			
Bit	Symbol	Definition	Description
D47-D33	SBZ	Set Bit to Zero	These bits will always be Zero.
D32	ZPD	Zero Position Default Flag	Set to 1 when the Zero Point is at Factory Default, otherwise 0.
D31	PV	Position Valid Flag	Set to 1 when the position data is valid, otherwise 0.
D30	PS	Position Synchronized Flag	Set to 1 when the position measurement was triggered by a previous SPI Frame. Set to 0 when the position measurement was triggered by a Measurement Time-out (see SPI Timing Information, Case 1). Use this flag to

### SPI1 Protocol Data Definition

			ensure that the IncOder has synchronised position measurements to the SPI Frames.
D29-D8	PD[21:0]	Binary Position Data	If resolution of device is less than 22 bits, then the most significant bits of this field are set to 0. The LSB of this field is in D0. When PV is 0, PD[21:0] value is not defined.
D7	SD	Stale Data Flag	Set to 1 when the position data has been transmitted at least once before. Set to 0 when the position data has not been transmitted before. Use this flag to detect when a new measurement has been completed (see SPI Timing Information, Case 2).
D6-D0	CRC[6:0]	Cyclic Redundancy Check	<p>To verify transmission, calculate the CRC of D7-D32. The CRC is calculated using a 32 bit word (or 4 bytes) with D7 shifted in to the Least Significant Bit and the 6 Most Significant Bits set to '0' as required.</p> <p>Use the following CRC-16 parameters:</p> <ul style="list-style-type: none"> <li>▪ Polynomial 0x5B</li> <li>▪ Initial Data 0x0000</li> <li>▪ MSB first (not reversed)</li> <li>▪ No final XOR calculation.</li> </ul>

### 8.4.2 SPI Timing Information



#### 2 SPI Timing Information

##### Timings Determined By Controller (SPI Master):

T <sub>ck</sub>	Clock Period	1/T = 100kHz to 5MHz
T <sub>cki</sub>	Clock Idle Period	Time between bytes during which CLOCK is idle. T <sub>cki</sub> should be < T <sub>ckiMAX</sub> = 10µs.
T <sub>r</sub>	Frame Repetition Rate	

##### Timings Determined By The IncOder (SPI Slave):

T <sub>m</sub>	Position Measurement Time	The time from the start of a position measurement to when the position and status is ready for transmission. 90µs ≤ T <sub>m</sub> ≤ 95µs
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**Timings Determined By The IncOder (SPI Slave):**

$T_{mto}$	Position Measurement Time-out	The time after a position measurement has been triggered that the IncOder will automatically trigger a new measurement.  $135\mu s \leq T_{mto} \leq 145\mu s.$
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Notes:

1. The IncOder will always attempt to trigger a new position measurement when a new SPI frame is started by the host. This will always be the case when  $T_r$  is greater than  $T_m$  and less than  $T_{mto}$ .
2. If a position measurement has already been triggered when a new SPI frame is started by the host, then a new position measurement will not be re-triggered. This may be the case when  $T_r$  is less than  $T_m$
3. If the Host does not start a new SPI frame within time  $T_{mto}$  from the previous frame (the case when  $T_r$  is greater than  $T_{mto}$ ), then the IncOder will automatically trigger a new position measurement.
4. In all cases, the IncOder will transmit the most recently completed measured position and status (see table below).
5. When CLOCK is idle for at least  $T_{ckimax}$ , then the IncOder SPI interface will reset. The first falling edge on CLOCK after  $T_{ckimax}$  will start the transmission of a new frame. This can be useful if the SPI host and slave (IncOder) lose Frame/Byte synchronisation (detected by invalid CRC).

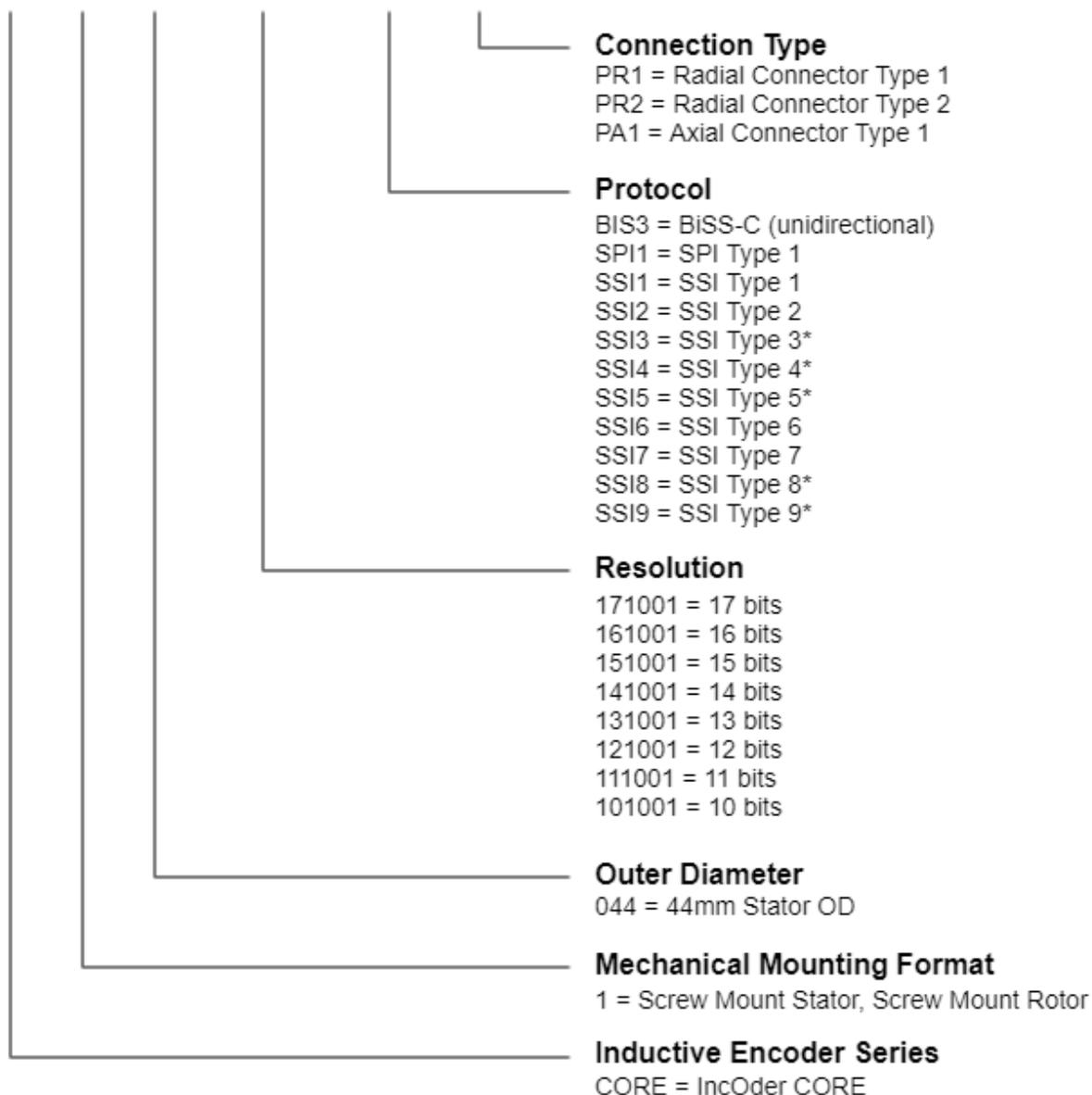
Frame Number	Position Transmitted (Case 1)	Position Transmitted (Case 2)	Position Transmitted (Case 3)
Frame 1	$P_{(n-1)}$	$P_{(n-1)}$	$P_{(n-1)}$
Frame 2	$P_{(n)}$	$P_{(n-1)}$	$P_{(n)}$
Frame 3	$P_{(n+1)}$	$P_{(n-1)}$	$P_{(n+1)}$
Frame 4		$P_{(n)}$	$P_{(n+3)}$
Frame 5		$P_{(n)}$	

## 9 How To Order

### 9.1 IncOder CORE Part Numbers

Note: IncOder is supplied as a rotor and stator pair. Mounting screws and dowels are not included.

#### **CORE - 1 - 044 - 171001 - BIS3 - PR1**



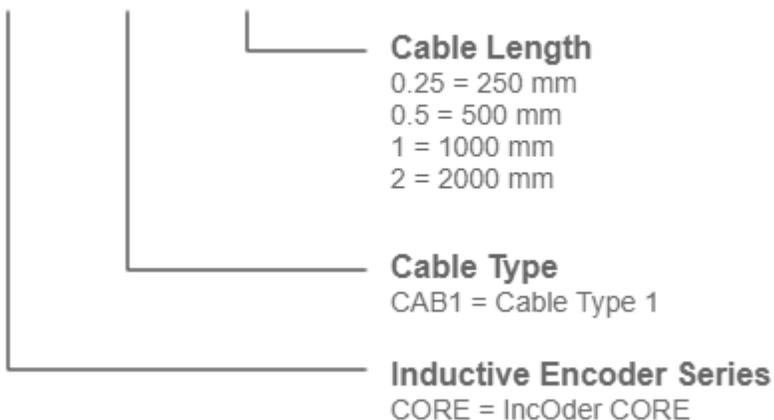
\*Maximum effective resolution limited by communications protocol - See SSI Protocol Options for details.

## 10 Cable Information

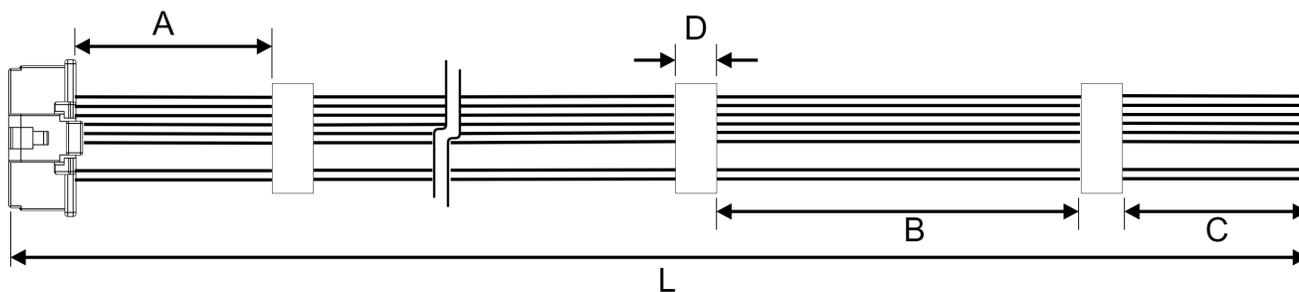
### 10.1 Cable Part Number

Mating connector and tinned wires on other end.

#### CORE - CAB1 - 0.25

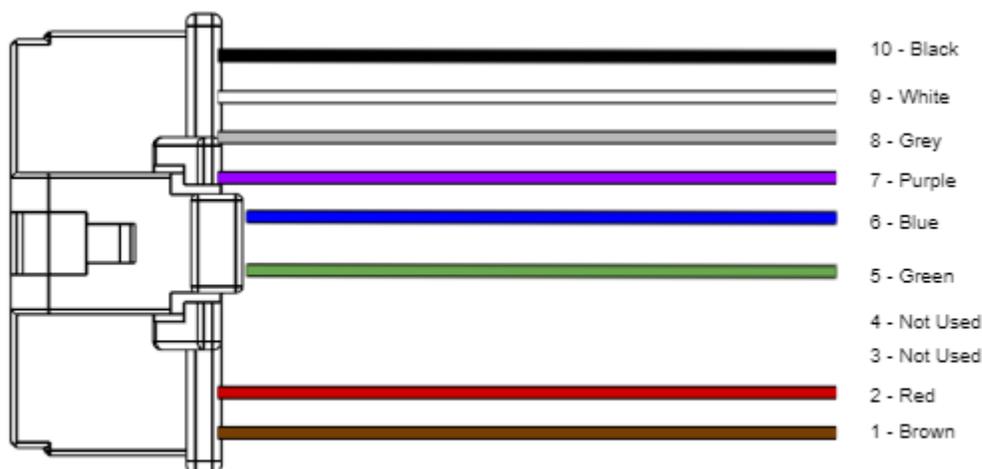


### 10.2 Cable Drawing



Symbol	Description
L	Total Cable Length ( +/- 5 % )
A	Rear-of-connector to edge-of-sleeve: 35 - 40 mm
B	Sleeves spaced every 100 - 150 mm (as required)
C	Edge-of-sleeve to wire-ends: 35 - 40 mm
D	Sleeve Width: 20 mm

## 10.3 Cable Wire Assignment



IncOder CORE Cable Connector			
Molex 10-way PicoClasp Connector			
Pin	Colour	Signal	Function
1	Brown	Zero Set	Optional Zero Set function. To use, connect to electrical ground (<0.5V) for >3 seconds at power up but left unconnected (i.e. open circuit) during operation.
2	Red	Zero Reset	Optional Zero Reset function. To use, connect to electrical ground (<0.5V) for >3 seconds at power up but left unconnected (i.e. open circuit) during operation.
3		Reserved	Reserved for future use.
4		Reserved	Reserved for future use.
5	Green	DATA A	Absolute Encoder Output (Data A / Data +)
6	Blue	CLOCK A	Clock Input (Clock A / Clock +)
7	Purple	DATA B	Absolute Encoder Output (Data B / Data -)
8	Grey	CLOCK B	Clock Input (Clock B / Clock -)
9	White	0V	Digital signal ground.

10	Black	$V_{\text{supply}}$	Supply 4.5-5.5V, 8-12V, <100mA
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## 11 Warranty / Remedy

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Do not use these products as safety or emergency stop devices or in any application where failure of the product could result in personal injury. Failure to comply to these instructions could result in death or serious injury.

### **WARNING. PERSONAL INJURY.**

Do not use these products in any application where there is the potential for combustion or explosion with flammable gases, dust or liquids. Failure to comply to these instructions could result in death or serious injury.