



Product Guide

IncOder™

Inductive Angle Encoders



- No contacts
- No bearings
- No couplings
- No maintenance
- Absolute
- Compact
- Easy installation
- Dirt & water Immune
- Robust
- Integral electronics
- Digital output
- Economical



.....it ticks all the boxes



Zettlex IncOders are non-contact, absolute angle measuring devices. They use a unique inductive technique and may be considered as an inductive encoder.

IncOders are ideally suited to those applications that require precision measurement in harsh environments where electrical contacts, optical or capacitive devices may prove unreliable.

IncOders have 2 parts – a Stator and a Rotor. Each is shaped like a flat ring. The large through bore makes it easy to accommodate through shafts, slip rings, optic fibres, through cables etc.



The IncOder's Stator is powered and the Rotor is passive. The Stator contains all necessary power supply and signal processing electronics. The electrical output from the Stator shows the position of the Rotor relative to the Stator.

There is no requirement for compliant couplings and the Rotor & Stator can simply be screwed (& doweled if necessary) to the host product. Precise mechanical mounting is not required and there is no need to align bearings.

Operation is unaffected by condensation or dust. Robust aluminium alloy housings and monolithic constructions are used for both Rotor and Stator.

There are no contacting, delicate or wearing parts and so there is no requirement for periodic replacement, service or maintenance.

IncOders are used in a variety of applications including:-

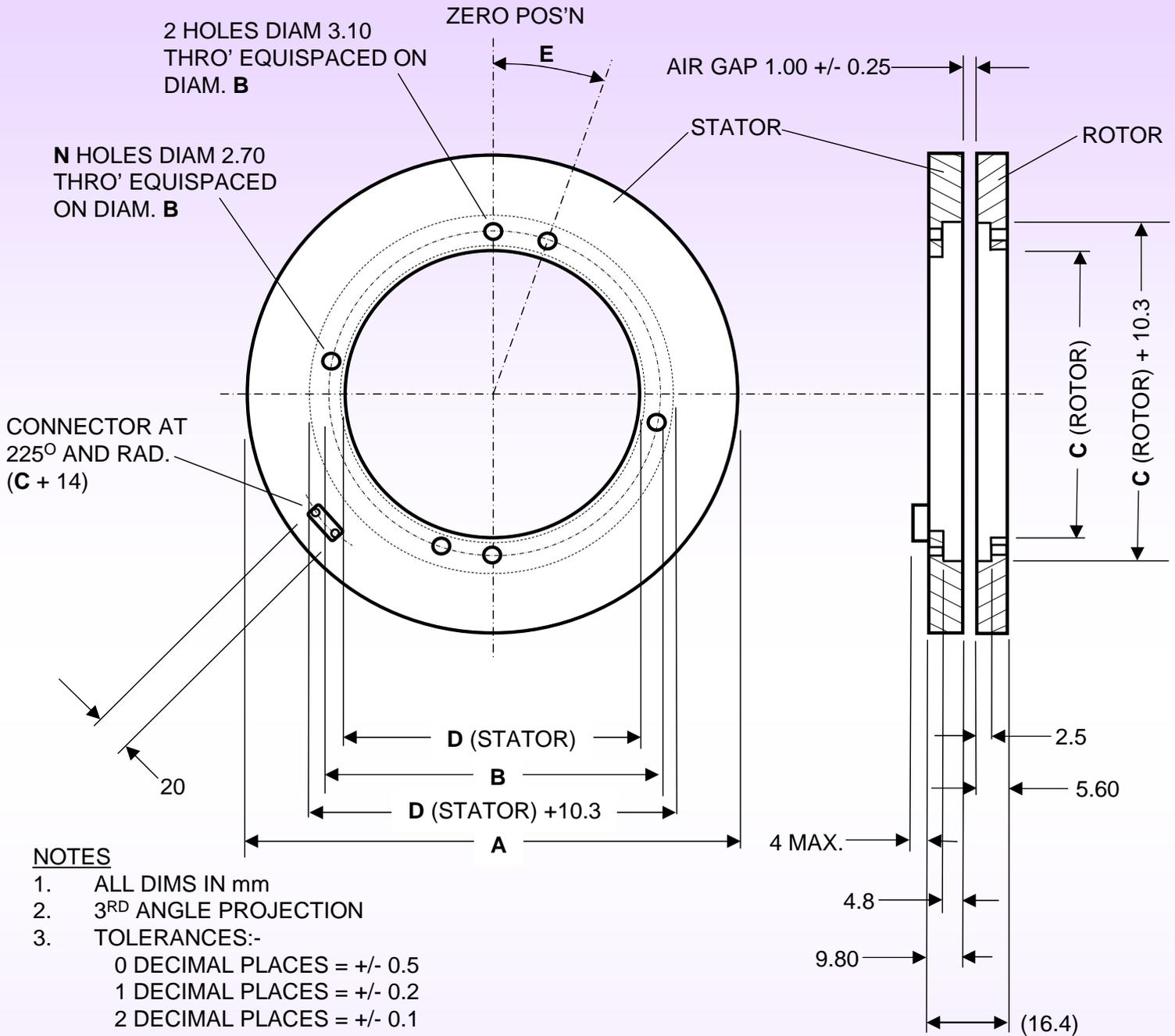


- Rotary joints & gimbals
- Actuator servos and motor encoders
- Robotic arms & CNC Machine tools
- Test & calibration equipment
- Light & heavy calibre weapons systems
- Antenna pointing devices & range finders
- Packaging & laboratory automation.

IncOders have a solid track record in safety related applications including airborne equipment.

IncOders can be readily customized to specific OEM requirements for power supply, electrical outputs, measurement performance, connectors, mounting arrangements, weight etc. Simply consult Zettlex for further information.





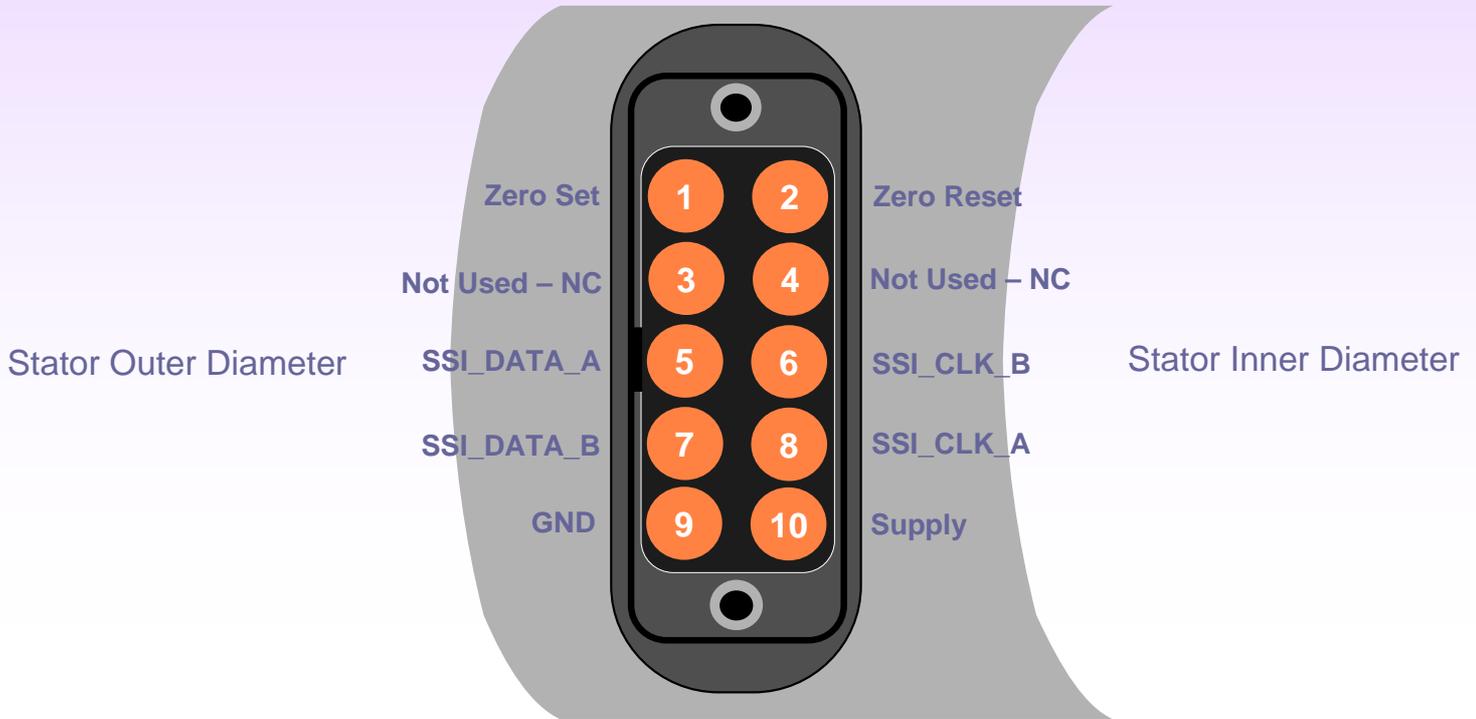
INC-3-75 INC-3-100 INC-3-125 INC-3-150 INC-3-175 INC-3-200 INC-3-225 INC-3-250

	INC-3-75	INC-3-100	INC-3-125	INC-3-150	INC-3-175	INC-3-200	INC-3-225	INC-3-250	
Dim. A - Outer Diameter	75 +/- 0.1	100 +/- 0.1	125 +/- 0.1	150 +/- 0.1	175 +/- 0.1	200 +/- 0.1	225 +/- 0.1	250 +/- 0.1	mm
Dim. B. - Pitch Circle Diameter	30.5 +/- 0.1	55.5 +/- 0.1	80.5 +/- 0.1	105.5 +/- 0.1	130.5 +/- 0.1	155.5 +/- 0.1	180.5 +/- 0.1	205.5 +/- 0.1	mm
Dim. C. - Rotor Inner Diameter	25 +/- 0.1	50 +/- 0.1	75 +/- 0.1	100 +/- 0.1	125 +/- 0.1	150 +/- 0.1	175 +/- 0.1	200 +/- 0.1	mm
Dim. D. - Stator Inner Diameter	25.8 +/- 0.1	50.8 +/- 0.1	75.8 +/- 0.1	100.8 +/- 0.1	125.8 +/- 0.1	150.8 +/- 0.1	175.8 +/- 0.1	200.8 +/- 0.1	mm
Dim E - Offset Angle from T.D.C.	30	30	30	30	30	30	30	20	Degrees
N Number of screw clearance holes	4	4	4	6	6	6	6	8	
Max. radial misalignment	0.25								mm
Max. axial misalignment	0.25 from nominal air-gap								mm
Rotor & stator fixings	Steel screws cap head M2.5 & steel dowels M3								

INC-3-75 INC-3-100 INC-3-125 INC-3-150 INC-3-175 INC-3-200 INC-3-225 INC-3-250

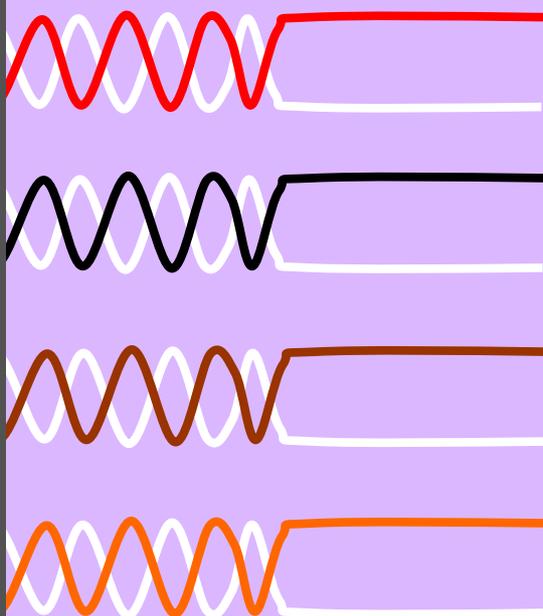
Materials									
Rotor and Stator housings	Exposed Surfaces:- Clear anodized aluminium alloy. Sensor surfaces: FR4 grade epoxy.								
Connector	PPS with Stainless Steel Screw Fixings and Gold & Tin Electrical Connections								
Measurement Performance									
Measurement	Absolute over Full-Scale of 360°								
Resolution	18	18	18	19	19	19	19	19	bits
Resolution	5	5	5	2.5	2.5	2.5	2.5	2.5	arc-seconds
Resolution	0.02424	0.02424	0.02424	0.01212	0.01212	0.01212	0.01212	0.01212	milliradians
Repeatability	≤1	≤1	≤1	≤1	≤1	≤1	≤1	≤1	(least sig. bit)
Repeatability	≤5	≤5	≤5	≤2.5	≤2.5	≤2.5	≤2.5	≤2.5	arc-seconds
Repeatability	0.02424	0.02424	0.02424	0.01212	0.01212	0.01212	0.01212	0.01212	milliradians
Linearity over Full-Scale	≤130	≤100	≤80	≤65	≤60	≤50	≤45	≤40	arc-seconds
Linearity over Full-Scale	≤0.63	≤0.49	≤0.39	≤0.32	≤0.29	≤0.24	≤0.22	≤0.20	milliradians
Latency	≤1 +/- 0.05								
Temp. coefficient	≤2								
Max. speed for angle measurement	1,000								
Max. physical speed	10,000								
Electrical interface									
Outputs	SSI (Serial Synchronous Interface) with 100kHz - 1MHz clock frequency								
Power Supply	10 to 16 (12 recommended) - <i>contact Zettlex for 24V or other ranges</i>								
Current Consumption	<75								
Reverse Polarity	PSU Reverse polarity protected to -16								
Connector on IncOder	Harwin Data Mate Vertical Plug with 2 Jack Screws Type M80 - 500 - 10 -42								
Mating Connector	Harwin Data Mate Vertical Socket Type M80 - 461 - 10 -(05 or 42) Crimp								
Zero Setting	Via Connector Pin - see connector details								
Zero Position Variation	≤1								
Power Up Time To 1st Measurement	≤50								
Cable Length	Recommended <10m - see notes on cable length vs. data rate								
Environmental									
Operating Temp.	Minus 40 to +85								
Storage Temp.	Minus 55 to +125								
IP Rating - Rotor & Stator	IP67 for 30 minutes (Installed with mechanically protected connector)								
IP Rating - Connector	IP54								
Humidity	RH0-99% non-condensing - <i>but unaffected by occasional condensation</i>								
Mechanical Impact Resistance	IK07 - <i>suitable for mechanical impacts from objects of >200gramms from 1m height</i>								
Shock	IEC 60068-2-6 100g for 11ms - <i>suitable for airborne, marine & armoured vehicles</i>								
Vibration	IEC 60068-2-6 20g for 10-2000Hz - <i>suitable for high vibration & airborne environments</i>								
Environmental pressure range	0 to 4								
Max. permissible press. change rate	1								
EMC Susceptibility	(Installed) Complies with IEC 6100-6-2 - <i>suitable for fitment in harsh EMC environments</i>								
EMC Emissions	(Installed) Complies with IEC 6100-6-4 - <i>suitable for fitment adjacent to e-m sensitive devices</i>								
Miscellaneous									
Mass Rotor	50	70	90	110	130	150	170	192	grams
Mass Stator	83	117	150	184	217	250	284	319	grams
Moment of Inertia Rotor	4.8E-05	1.3E-04	2.5E-04	4.4E-04	7.5E-04	1.2E-03	1.8E-03	2.5E-03	Kgm2
ITAR Restricted Components	Not used								
Approvals	Flammability Rating - UL94V-0 ; CE marked on Rotor & Stator ; RoHS Compliant								
Country of Manufacture	UK								

Connector pin diagram (View on Rear of Stator)



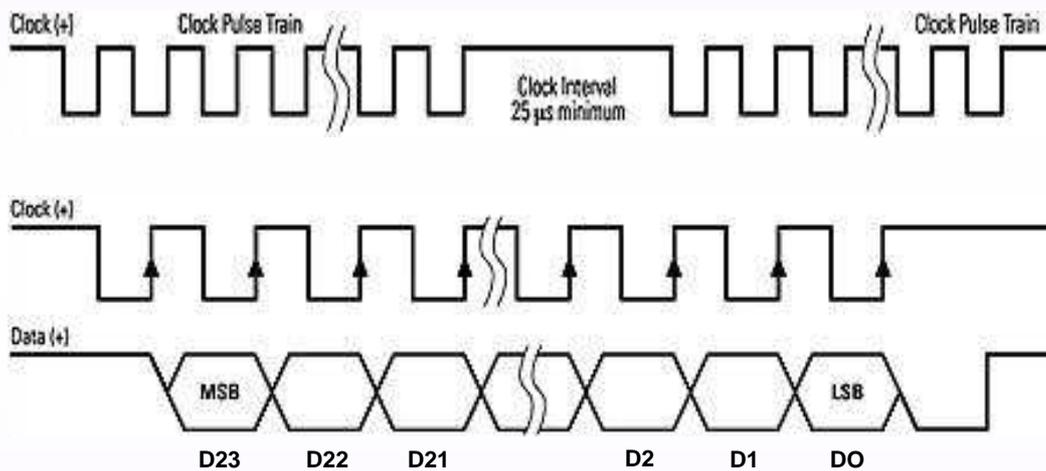
Wiring diagram

7mm Diam.
PVC Sheathed
4 pair Screened
Instrument
Cable (24 AWG)



SSI Communications. SSI is a widely used serial interface between an absolute position sensors and controllers. SSI uses a clock pulse train from a controller to initiate a gated output from the sensor. Position data is continually updated by the IncOder and made available to the SSI port. Between each clock pulse train there is a minimum dwell of 25 microseconds. Data is shifted out when the IncOder receives a clock pulse train from the controller. When the least significant bit (LSB) goes HIGH and the minimum dwell time has elapsed, a new read cycle is available. Refer to the diagrams below.

Asynchronous Mode (this Mode is used by IncOder) :- Sensor takes measurements at its fastest internal interrogation rate and provides information upon request. The internal sensor data buffer is updated only after a successful read cycle. An IncOder transmits 24 bits of data (D23, D22, D21.....D1, D0) with the most significant bit first. The most significant 2 bits are status flags. D23 indicates that the position data is valid ('1') or invalid ('0'). D22 indicates that the zero position is not set ('1') or set ('0'). The remaining bits, D22 to D0 hold the position data. If the resolution of the device is less than 22 bits then the most significant bits of D22 to D0 are set to zero. The Timing Diagram for SSI communications is shown below :-



Zero Point, Zero Set & Zero Reset. The datum from which angles are measured is referred to as the Zero Point. As supplied, the IncOder carries a factory Zero Point setting which is roughly the relative angle when both Stator & Rotor are at top dead centre (designated by their respective dowel positions). Pins 1 and 2 of the connector can be used to set and/or reset this value respectively. The Zero Set Pin (Pin 1) causes the current IncOder angle to be set as the Zero Point. The Zero Reset Pin (Pin 2) causes the original factory settings to be used as the Zero Point. Pins 1 and 2 should not be used during normal operation. The Zero Set or Zero Reset functions are activated by connecting the relevant Pin to 0V (Pin 9) for at least 1 second at power up.

Error Flagging. Timeout interval (from last rising clock to data line going high) 20 to 30 microseconds. Data line is low during timeout interval for normal operation. Data line is high during timeout interval in the event of an internal error.

Baud Rate & Cable Length. The longer the transmission distance (Cable Length) the slower the recommended Baud Rate. This table shows recommended Baud Rates vs. Cable Length.

Baud Rates For Data Transmission				
<i>Cable Length (ft.)</i>	<100	<200	<400	<800
<i>Baud Rate*</i>	<400 kHz	<300 kHz	<200kHz	<100 kHz

Frequently Asked Questions:-

1. How do IncOders work?

IncOders work in a similar way to resolvers. The IncOder Stator receives a DC power source and, in turn, produces a low power AC electromagnetic field between the Stator and Rotor. This AC field is modified as the Rotor rotates. The field is sensed by the Stator and the angle electronically computed using a ratiometric technique. Unlike resolvers, IncOders use laminar windings rather than wire spools. This enables higher measurement performance, compact form, low mass and low inertia.

2. Is IncOder truly absolute?

Yes. Position is measured absolutely and no motion is required at power up.

3. Surely radial misalignment results in inaccurate angle measurement?

If IncOders measured angle from a single point this would be true. However, IncOders use the full faces of both Rotor & Stator so any misalignments are nulled out by diametrically opposing factors.

4. What happens if Rotor or Stator are not installed to specification?

If Rotor or Stator are not installed to specification then measurement linearity will be affected. Operation is only prevented with gross installation errors of >2mm on radial or axial dimensions.

5. Can IncOders be used at <-40Celsius or >85Celsius?

Temperature limits are set by some of IncOder's electronic components rather than the measurement technique. The electronic components used in IncOder are rated to -40 or 85Celsius. However, some IncOders are successfully used outside these temperature limits following qualification by the users. At temperatures <-40Celsius the devices should either be constantly powered or allowed to warm up (from self heating) following cold start. At temperatures >85Celsius the duration of the elevated temperatures should be minimized.

6. What happens if the Rotor or Stator get wet?

Measurement performance is unaffected by humidity, moisture or condensation. IncOders will survive temporary immersion to depths of 10m of salt or fresh water. However, extended or frequent exposure to liquids should be avoided. Consult Zettlex in such applications for liquid immersion units.

7. How can an IncOder be calibrated?

Readings from an IncOder can be stored and compared to a reference in a look-up table in the host system. Such an arrangement will tend to null out any non-linearity due to inherent non-linearity or installation tolerances. Resolution and repeatability are unaffected by calibration.

8. Can IncOder be used for airborne applications?

Yes. IncOders are used in military manned and unmanned vehicles.

9. Can we route the cable out radially rather than axially?

Contact Zettlex.

10. Can an IncOder run with a 24V power supply and a different electrical output?

Contact Zettlex.

11. Are there lightweight IncOder versions?

Contact Zettlex.

12. Are IncOders suitable for use in harsh electromagnetic fields?

Yes. Many IncOders are used in close proximity to powerful sources of electromagnetic noise such as motors or transformers. IncOder's aluminium housing produces a Faraday cage effect around the internal electronics and the IncOders are designed so that any incoming radiated electromagnetic noise is self cancelling. If the cables carrying power and signals to and from IncOder are to be routed close to noise sources then shielded cable should be used.

13. Are IncOders affected by magnets?

No. Magnets produce DC fields. IncOder's operation is based on the detection of a highly specific AC frequency.

14. Do IncOders produce electromagnetic emissions?

Yes but the radiated emissions are small and limited to the internal sensor faces of an IncOder. The aluminium IncOder housing has a Faraday cage effect. IncOders are regularly used in close proximity to sensitive devices such as navigation aids which remain unaffected.

15. What happens to measurements if some dust, oil or water gets between Rotor and Stator?

Nothing.

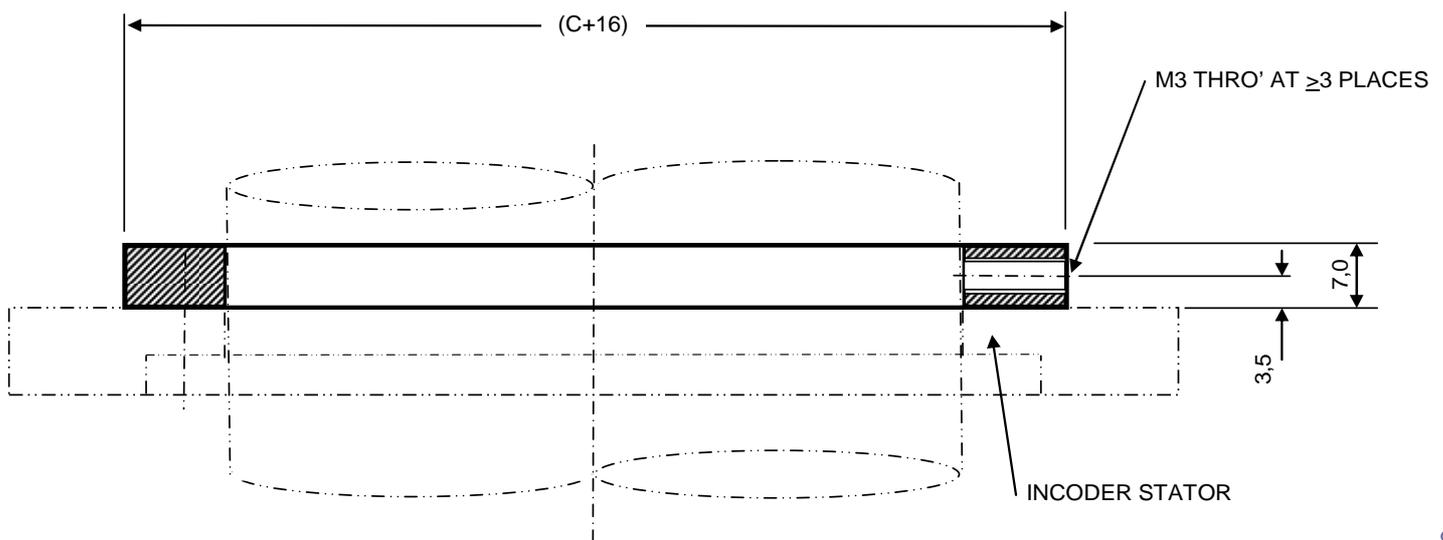
16. Can IncOders be used as a motor encoder?

Yes. The IncOder version specified here is suitable for motor encoders of ≤ 1000 r.p.m. For higher speeds please contact Zettlex for alternative higher speed outputs such as A/B pulses or 1V peak to peak sin/cos.

17. What happens if our tolerance stack up means we cannot achieve the gap setting tolerance?

Within limits, the IncOder's measurement resolution and repeatability will remain unchanged. If the air-gap tolerance is doubled from $\pm 0,25$ mm to $\pm 0,50$ mm the *quoted* measurement non-linearity should also double. For example, if a 250mm IncOder has an air-gap tolerance of $\pm 0,50$ mm the *quoted* linearity will increase from ± 40 arc-seconds to ± 80 arc-seconds.

If the tighter linearity is required then the air-gap tolerance should be maintained. A first option is to use shims but this may be undesirable. A second option is to fit a Collar at the rear of the Rotor, and to use grub screws to locate the Rotor to the shaft. If the IncOder is to be used in benign conditions or temporarily for experimental purposes, a single grub screw will suffice. In all other conditions a minimum of 3 grub screws should be used. Preferably the Collar should be a close fit to the through shaft. If vibration conditions are extreme a roll pin (sometimes referred to as a 'spring pin') should also be used. The Collar can then be fitted using the process described in #18 overleaf. Contact Zettlex for price & supply of anodized aluminium Collars, which we supply as a standard item.



18. How do we fit the Collar?

- Fit Collar to Rotor using M2,5 screws.
- Fit IncOder Stator & Rotor/Collar assembly around the shaft
- Fit IncOder Stator on to location dowels
- Secure Stator with screws – first taking up the slack, then tightening diametrically opposite screws
- Place 1mm thick plastic Setting Pieces between faces of Stator and Rotor/Collar assembly
- Abut the Rotor to the Setting Pieces
- Secure Collar using grub screws - tightening opposite screws- *akin to tightening wheel nuts on a car*
- Remove the Setting Pieces
- Check that gap is within 1,25 to 0,75mm.

19. Do IncOders carry out self checking?

Yes. IncOders carry out 10 self checks. If any of the self checks indicate an internal error then an error signal is generated (see earlier description of SSI comms & error flagging). The 10 self checks are:-

- Stator Continuity/Damage.
- Presence of Rotor.
- Rotor Continuity/Damage.
- Out of range Rotor.
- Gross electromagnetic malfunction.
- Window watchdog timer - this is reset multiple times per internal measurement cycle.
- Power on reset.
- Power on brownout reset.
- SSI timeout implemented for SSI clock input.
- Internal flash data memory value check and read/write timeouts (applies to Zero Set & Reset).



Ordering Information:-

IncOder (includes 1 Stator & 1 Rotor)

INC3 - XXX

Outer Diameter

075

100

125

150

175

200

225

250

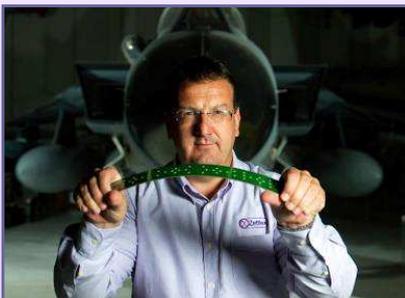
IncOder 2m long Cable

Mating connector and tinned wires on other end

INC3-CAB-2

Please order directly from Zettlex web-site at

www.zettlex.com/store.



Message from Mark Howard, Zettlex General Manager:

Ours is a simple business ethic: hard work, honesty & great customer service. I hope you will find our products useful.

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