360˚ Rotary Sensor, 36mm Diameter

 Cambridge IC

Description

A resonant inductive position sensor for measuring over a full 360˚ of rotation. Works with CambridgeIC's Central Tracking Unit (CTU) family of single chip processors to provide high-quality position data to a host device.

The sensor is available as a blueprint in Gerber format, to enable integration with a customer's own PCB. It is also available as assembled sensors for evaluation, customer prototyping and low-volume production.

The sensor is highly tolerant of radial misalignment.

For applications requiring a physically smaller sensor or end shaft operation at smaller gaps, please see datasheet part no. 033-0002. For operation at larger gaps, or for through hole sensing, please see datasheet part no. 033-0015.

Features

- Simple non-contact target
- Large gaps & misalignment
- Full absolute sensing over 360˚
- Standard 4-layer PCB process
- 35mm diameter copper coil pattern
- Highly repeatable

Performance

- ±0.5˚ (±0.14%) Absolute Error at gap 1…8mm
- ±1.5˚ at Radial Misalignment 2mm, gap 1…3mm
- ±3˚ at Radial Misalignment 2mm, gap 1…7mm

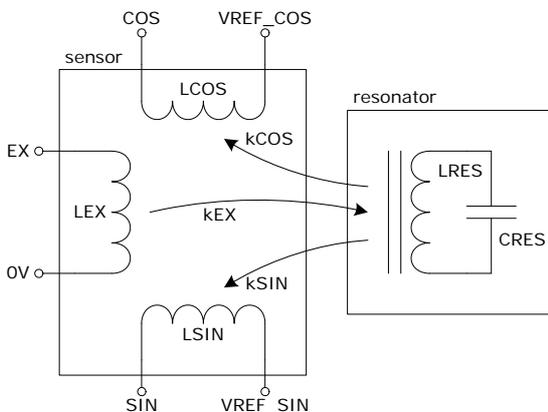| Product identification	
Part no.	**Description**
013-0012	Assembled sensor
013-6001	300mm ribbon connector
013-1005	Compatible target
010-0031	Sensor Blueprint

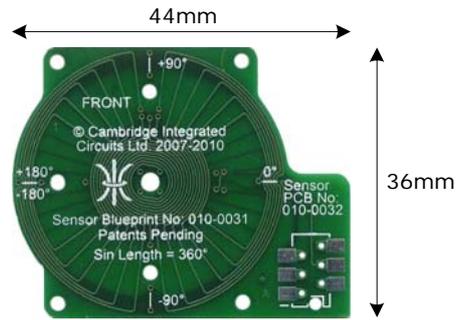**Figure 1 equivalent circuit**

Figure 2: assembled sensor 013-0012, approximate actual size, viewed from rear

Applications

- Motion control
- Actuator position feedback
- Precision front panel controls
- Contactless dial reading
- Valve position sensing
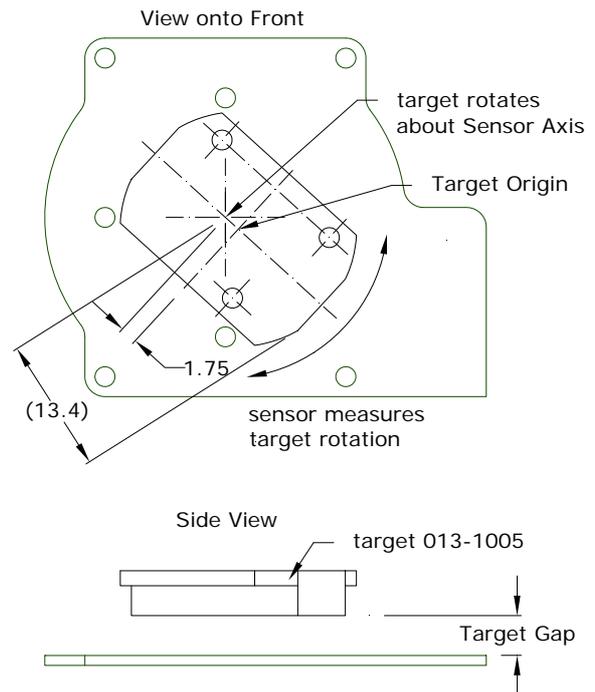- Absolute optical encoder replacement

View onto Front

target rotates about Sensor Axis

Target Origin

1.75

(13.4)

sensor measures target rotation

Side View

target 013-1005

Target Gap

Figure 3 target alignment
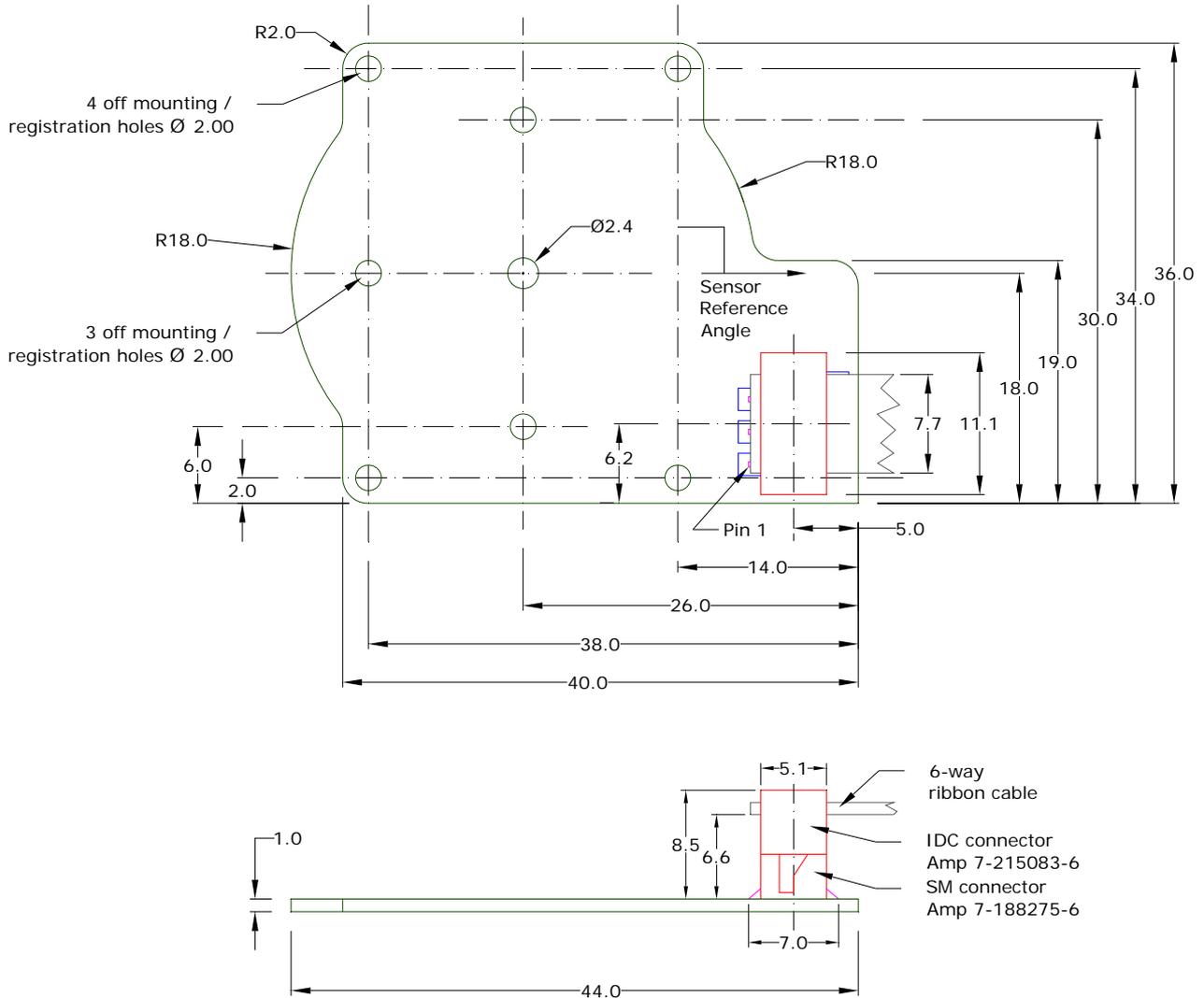
1 Assembled Sensor 013-0012

Figure 4 sensor board part number 013-0012 mated with connector 013-6001

2 Definitions

2.1 Transfer Function and Performance Metrics

The sensor is connected to a CTU chip which reports position as a 16-bit signed integer, here denoted *CtuReportedPositionI16*. The sensor's *Sin Length* parameter is 360˚, so the reported position may be converted to degrees using:

$$ReportedDegrees = \frac{CtuReportedPositionI16}{65536} \times 360°$$

Equation 1

The actual angle is defined relative to reference holes on the sensor and target, as illustrated in Figure 4 and Figure 6, so that:

$$ActualDegrees = TargetReferenceAngle - SensorReferenceAngle$$
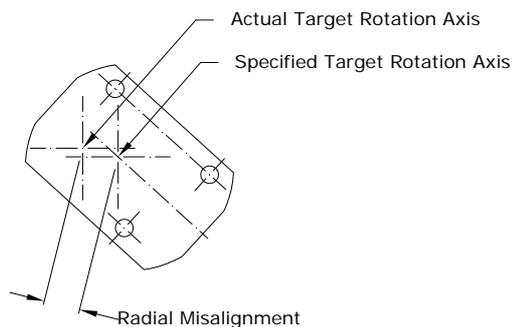
Equation 2

Actual Degrees is zero when the Target Reference Angle and Sensor Reference Angle are equal. Its direction is positive for anticlockwise target rotation when viewing the front of the sensor.

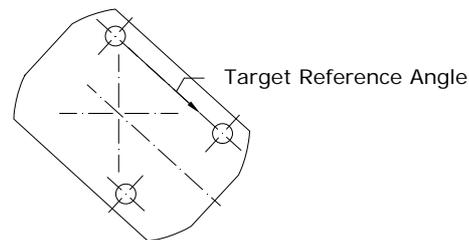Absolute Error is the difference between these two:

$$AbsoluteError = ReportedDegrees - ActualDegrees$$

Equation 3

2.2 Target Alignment

Figure 5 Definition of Radial Misalignment

Figure 6 Definition of Target Reference Angle

The sensor is designed to operate with a target aligned as in Figure 3. The Specified Target Rotation Axis is the Sensor Axis as shown in Figure 4. Radial Misalignment is defined as the radial distance between this axis and the Actual Target Rotation Axis, as illustrated in Figure 5.

The target 013-1005 includes an inductively coupled resonator whose magnetic axis runs through the Target Origin and nominally parallel to the two mounting holes shown at the top and to the right of Figure 6. The Target Reference Angle is defined along these two holes as illustrated in Figure 6. Target manufacturing tolerances result in small angular deviations between the actual magnetic axis and the Target Reference Angle: the Target Offset Angle. This document concerns the sensor alone, and performance is quoted excluding this Target Offset Angle.

The target may be located either at the front or rear of the sensor. It may be used either way up (it is free to rotate about the Target X Axis as defined in the target's datasheet).

3 Performance (End Shaft Operation)

This section illustrates performance of the rotary position sensor with the target aligned as in Figure 3. Note that the Target Origin is aligned 1.75mm from the Sensor Axis in order to optimise performance. Figures below are representative of assembled sensors available from CambridgeIC (as described in section 1) and of sensors built according to CambridgeIC's blueprint to the recommended specifications (section 5). Measurements are taken with a typical target (part number 013-1005) and CTU Development Board (part number 013-5006 using CambridgeIC's CAM204A chip).

3.1 Absolute Error

Figure 7 illustrates how Absolute Error depends on Target Gap and Radial Misalignment, for a typical sensor in free space:
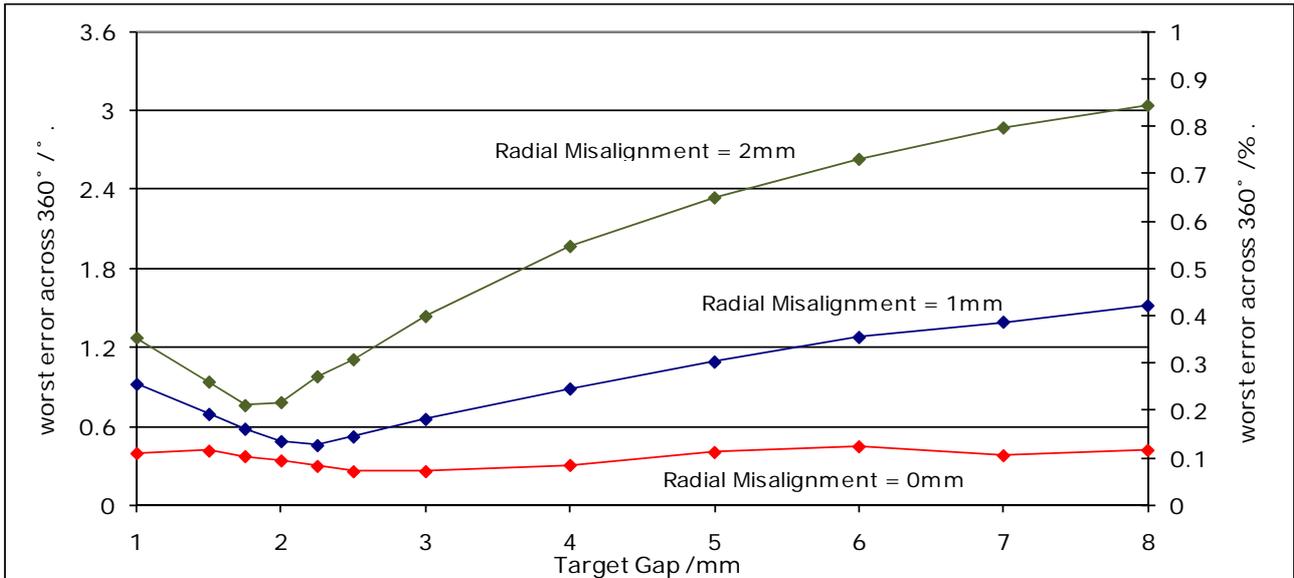

Figure 7 Absolute Error against Target Gap, misaligned by 0, 1 and 2mm

3.2 Amplitude

Amplitude is a measure of inductive signal coupling between the sensor and target. Higher values are preferable since they result in better resolution when the sensor is used with a CTU chip. Figure 8 illustrates how Amplitude changes with Target Gap for a typical sensor.
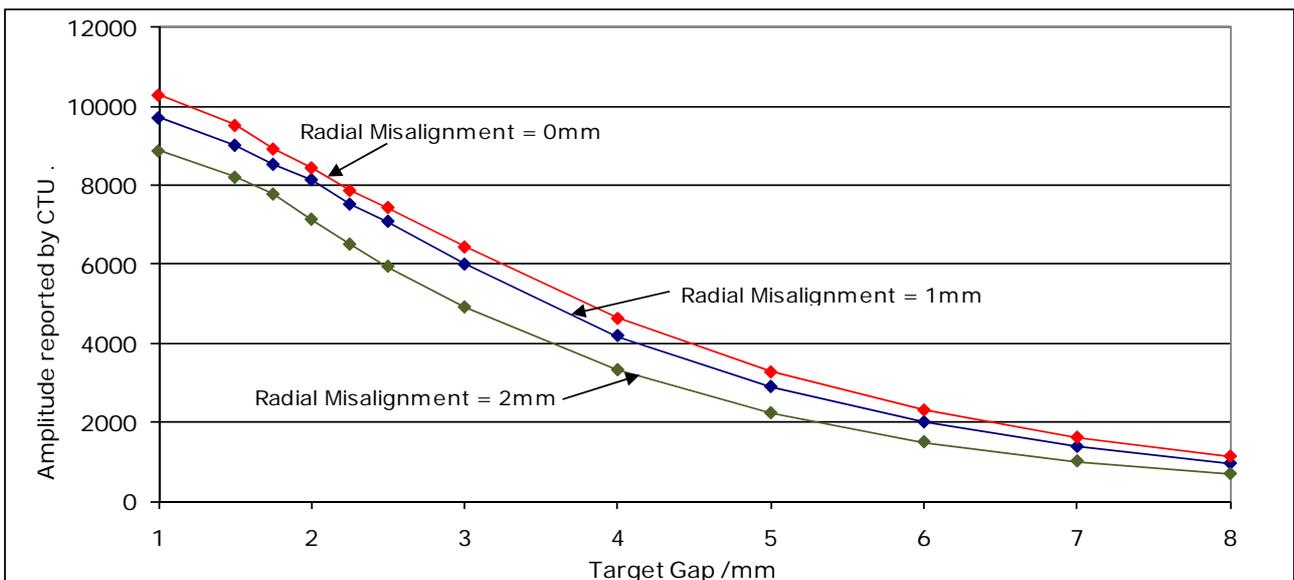

Figure 8 Amplitude reported by CTU against Target Gap, misaligned by 0, 1 and 2mm, free space

4 Sensor Blueprint 010-0031

4.1 Purpose

A Sensor Blueprint is data defining the pattern of conductors for building the sensor onto a PCB. A customer may build their own sensors for use with CambridgeIC's CTU chips, either as stand-alone sensors or combined with their own circuitry.

4.2 Fabrication Technology

The Sensor Blueprint is fabricated on a 4-layer PCB. Recommended copper thickness is shown in Table 1.

Table 1

Copper thickness	oz	μm
Minimum	0.5	18
Recommended	1	35

4.3 PCB Design Parameters

Table 2

PCB Design Rules	Minimum values used	
	mm	inches
Track width	0.2	0.0079
Gap between tracks	0.2	0.0079
Via land outer diameter	0.8	0.031
Drill hole diameter	0.4	0.016

4.4 Data Format

Sensor Blueprint is supplied as Gerber data is in RS-274-X format with the following settings: imperial, 2.4 precision and leading zero suppression.
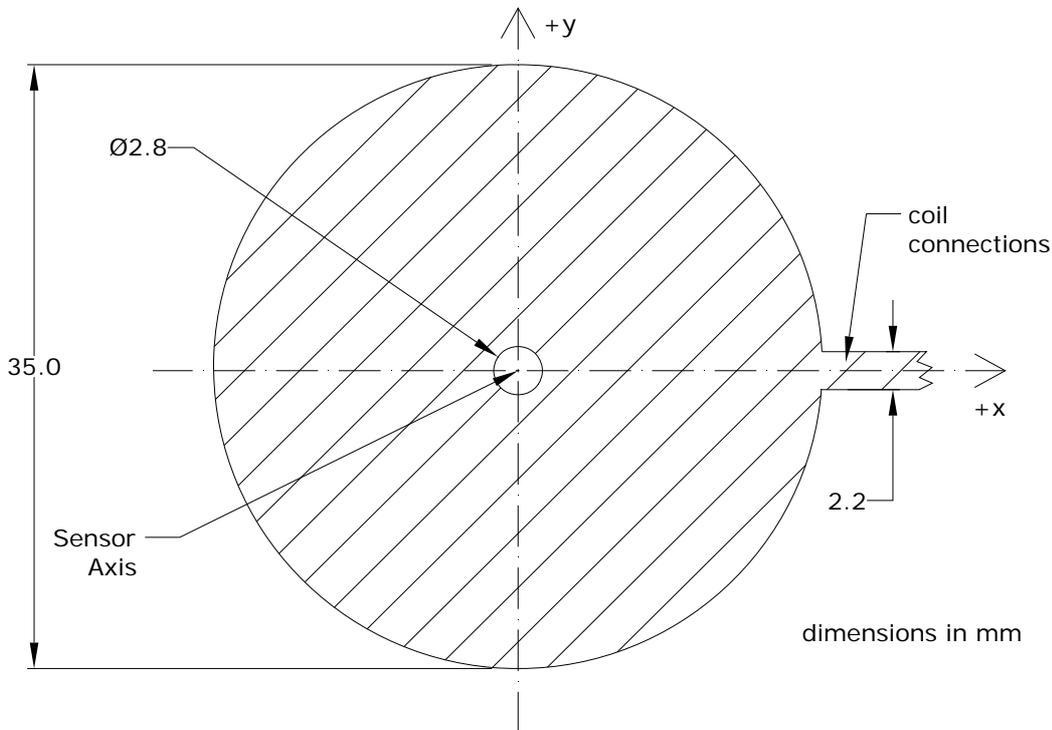

Figure 9 copper extents

4.5 PCB Integration

Figure 9 illustrates the extent of the copper pattern required to build the sensor on a PCB. The circular area is the sensor itself, with coil connections shown to the right. The coil pattern may be rotated or flipped to fit a customer's assembly, in which case the position reported by the CTU will be transformed accordingly.

When integrating with other electronic circuitry, a keep-out of 2mm is recommended all round the sensor's conductors. For this specific Sensor Blueprint,

a ground plane around the conductors is acceptable, if necessary for other circuitry.

4.6 Trace Connections

There are three pairs of tracks, which should be connected to the respective CTU circuit connections with the minimum practical trace lengths.

Please refer to the CAM204 datasheet for recommendations on track design for connecting sensors to CTU circuitry.

5 Environmental

Assembled sensor part number 013-0006 conforms to the following environmental specifications:

Item	Value	Comments
Minimum operating temperature	-40˚C	Limited by specification of connector
Maximum operating temperature	105˚C	
Maximum operating humidity	95%	Non-condensing

Sensors built to Sensor Blueprints can operate in more extreme conditions by choice of materials and encapsulation.

6 Document History

Revision	Date	Comments
0001	17 March 2010	First draft

7 Contact Information

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8 Legal

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