

Description

These arc sensors measure angle over a range of up to 100°. They measure the position of a target running along an arc, which allows sensor and target to be positioned away from the rotation axis ("off-axis"). This provides space for shafts, bearings and other machinery which needs to be positioned nearer the rotation axis.

Sensor designs are available with different Sensor Radius, so that customers may select the one which best fits their application.

The sensor is connected to a CambridgeIC CTU chip such as the CAM204, which combines the information from both sets of coils to deliver an absolute, high accuracy and high resolution output to a host system.

Features

- Full absolute sensing along 100° of arc
- 4-layer PCB process
- Target is sensed from FRONT or REAR of sensor
- Target may be positioned to the inside or outside
- Optimised for Type 4 CTU chip circuitry
- Functions with Type 1 circuitry, lower performance

Performance, Free Space

- Linearity Error < 0.4% at 0.5mm...1.5mm Gap, Target Inside, up to 1mm radial Misalignment
- Noise Free Resolution > 10.5 bits up to 1.5mm Gap
- Up to 1mm Radial Misalignment

Applications

- Angle sensing of Butterfly valves
- Surveillance camera tilt axis angle sensing
- Motorised antenna position feedback
- Vent angle sensing
- Vehicle suspension level sensing
- Measurement of handle position
- Actuator position feedback
- Optical and magnetic encoder replacement

Product identification	
Part no.	Description
013-0044	R25mm 100° Arc Sensor Assembly
013-0045	R30mm 100° Arc Sensor Assembly
013-0046	R36mm 100° Arc Sensor Assembly
013-0047	R48mm 100° Arc Sensor Assembly
013-0048	R68mm 100° Arc Sensor Assembly
013-0049	R100mm 100° Arc Sensor Assembly
013-1005	Standard Target
013-6001	6-way sensor connecting cable

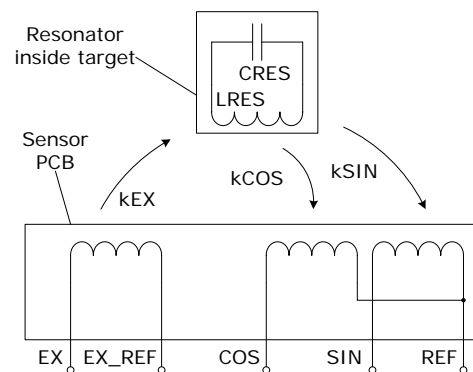


Figure 1 equivalent circuit

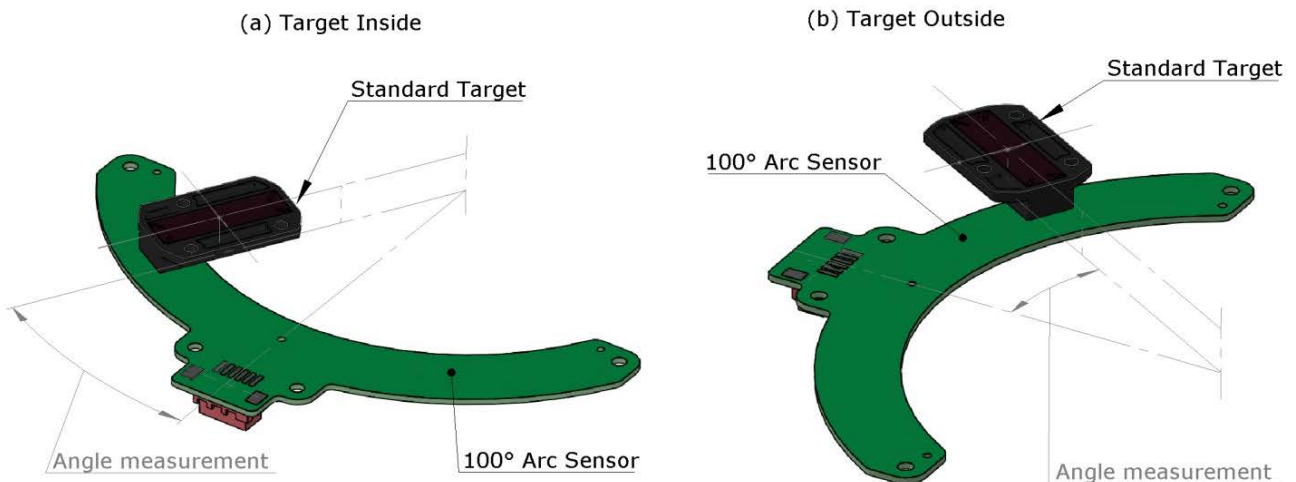


Figure 2 Arc sensors measure angle with target positioned either inside or outside the sensor

1 Assembled Sensor Mechanical Designs

100° Arc Sensors are available as assembled PCBs including connector. They are available in different sizes. The name of each sensor is based on the Sensor Radius. This refers to the centre radius of the sensor, half way between the inner and outer radii.

For example the R25mm 100° Arc Sensor has a Sensor Radius of 25.0mm. This is half way between the inner radius of 19.3mm and the outer radius of 30.7mm, see Figure 3.

Mechanical drawings for the different sizes available as standard are shown from Figure 3 to Figure 8.

Each sensor includes holes which may be used for mounting and/or alignment. The nominal location of the Sensor Axis is illustrated in each drawing, relative to nominal feature locations.

The Reference Direction is defined as perpendicular to the line joining Ref Hole A and Ref Hole B. The Reference Direction Line passes through a point mid-way between Ref Hole A and Ref Hole B. The Nominal Sensor Axis is located on the Reference Direction Line above that point. For example the R25mm 100° Arc Sensor's Nominal Sensor Axis is 5.9mm above the point mid-way between Ref Hole A and Ref Hole B. This figure is obtained from nominal dimensions, with the Sensor Axis 25mm above the centre of the Sensor Radius, adding 17.0mm from Sensor Radius to lower edge, and subtracting 36.1mm from lower edge to Ref Hole A and Ref Hole B.

The Nominal Sensor Axis and Ref Hole locations are provided and defined to help achieve best alignment when it is desirable, for example for best accuracy. In this case it is recommended to fit the assembled sensor over 1.0mm locating pins positioned at the nominal locations of Ref Hole A and Ref Hole B. Note that this is not always necessary, because the 100° Arc Sensors will operate with considerable misalignment.

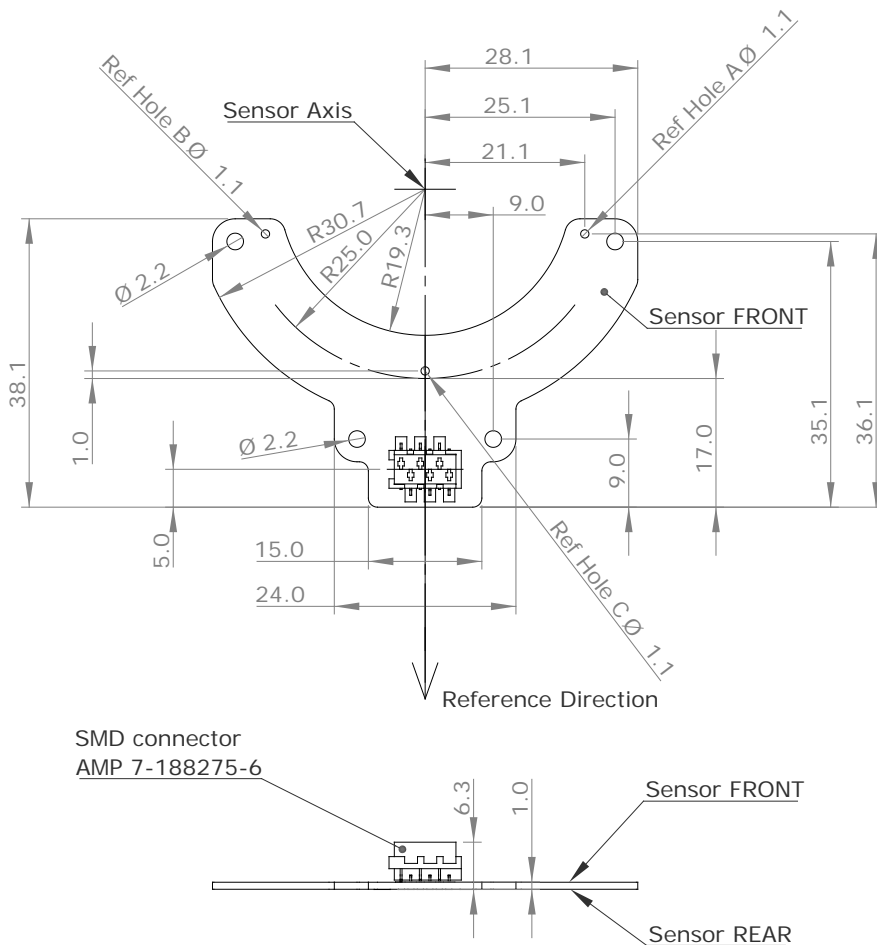


Figure 3 Mechanical drawing, R25mm 100° Arc Sensor Assembly 013-0044

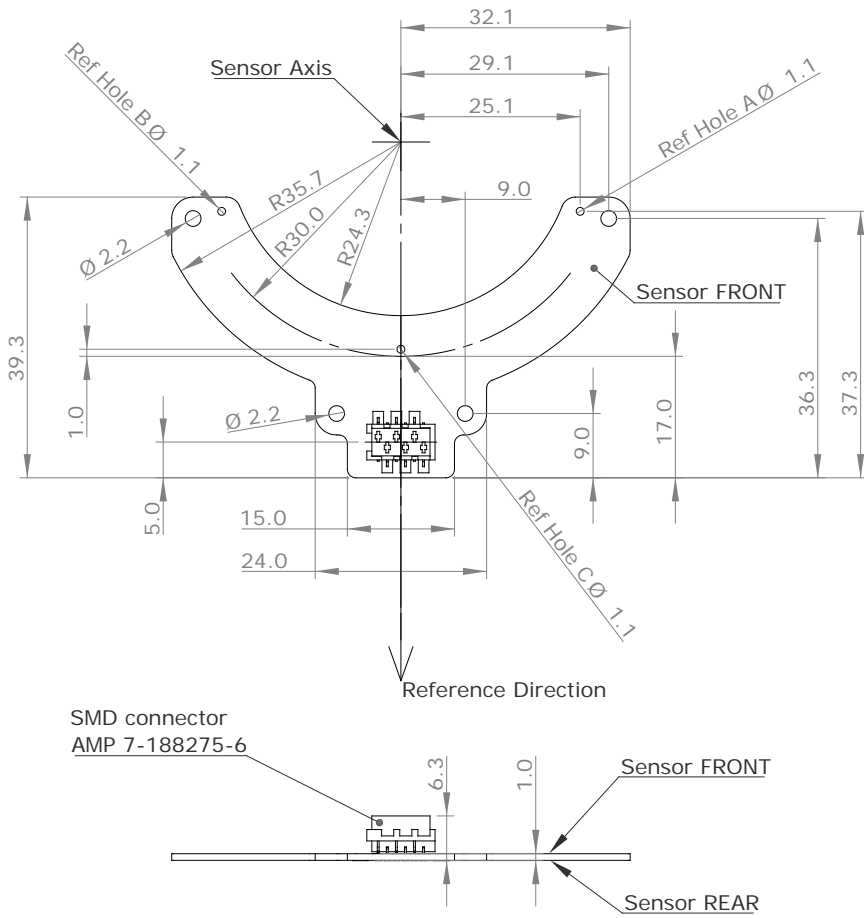


Figure 4 Mechanical drawing, R30mm 100° Arc Sensor Assembly 013-0045

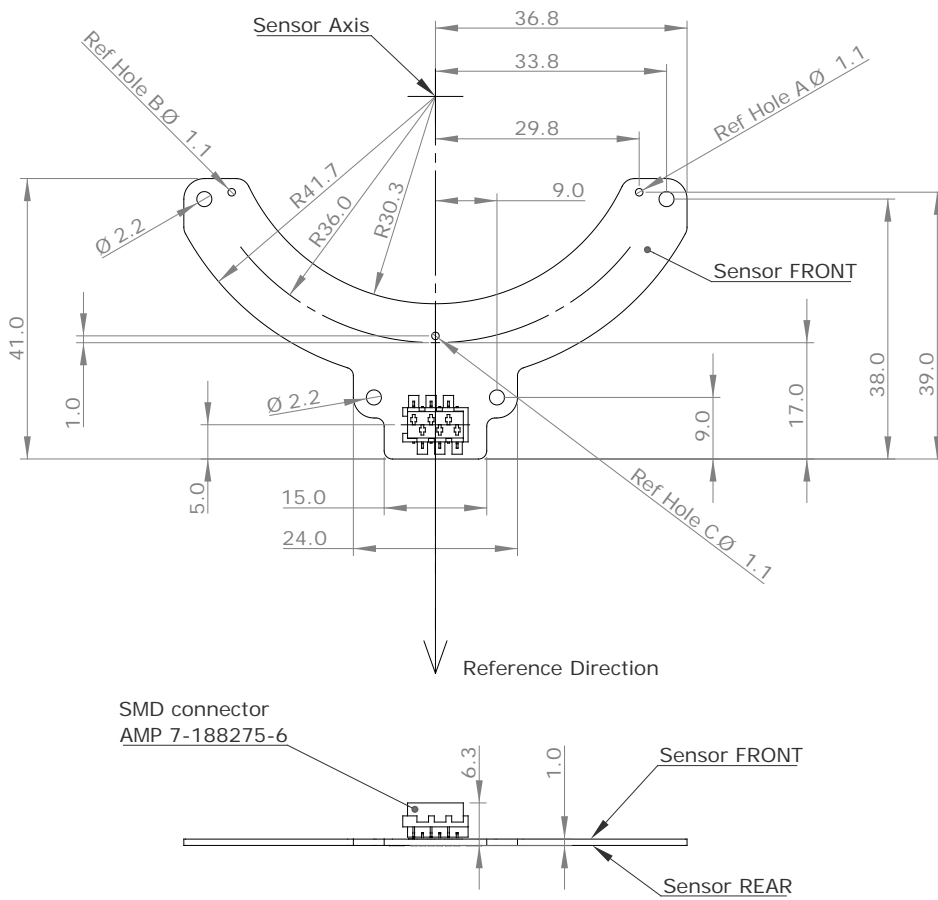


Figure 5 Mechanical drawing, R36mm 100° Arc Sensor Assembly 013-0046

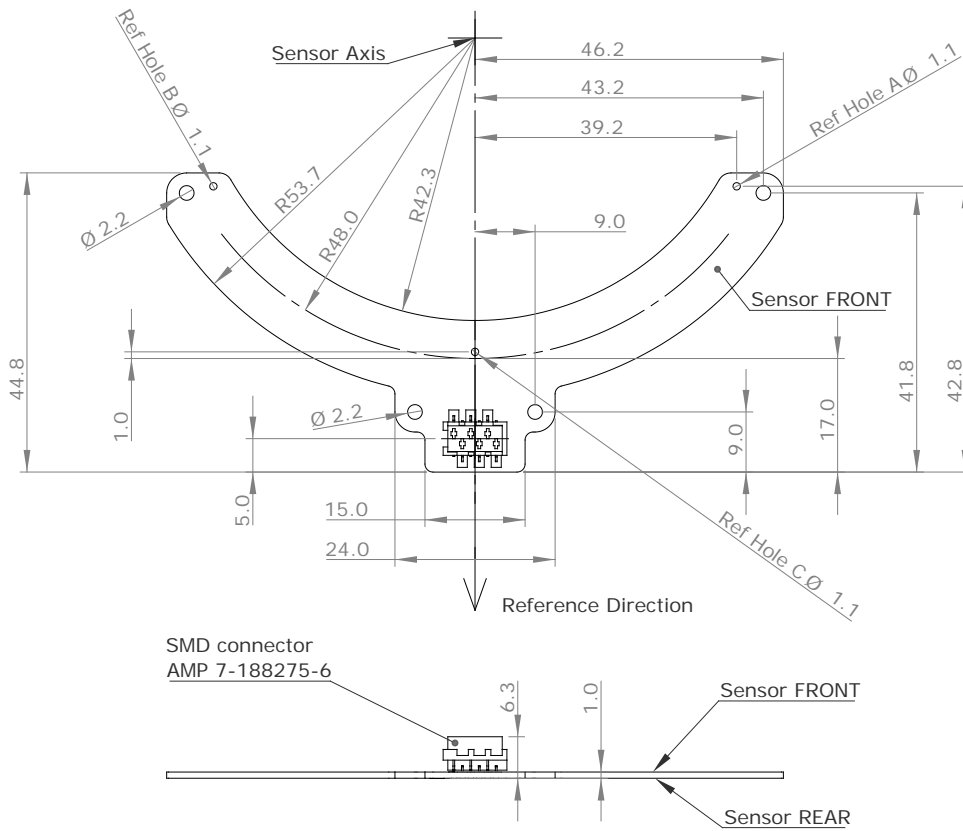


Figure 6 Mechanical drawing, R48mm 100° Arc Sensor Assembly 013-0047

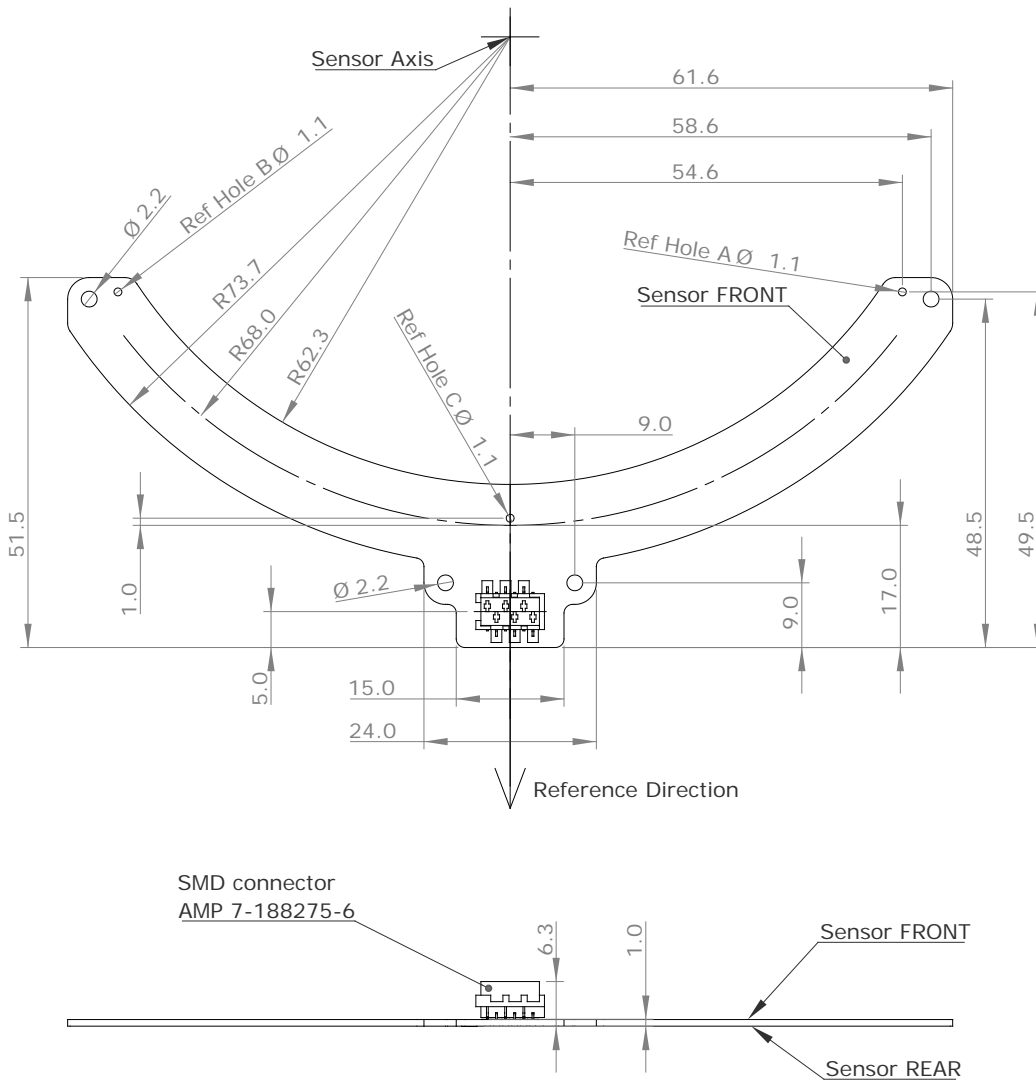


Figure 7 Mechanical drawing, R68mm 100° Arc Sensor Assembly 013-0048

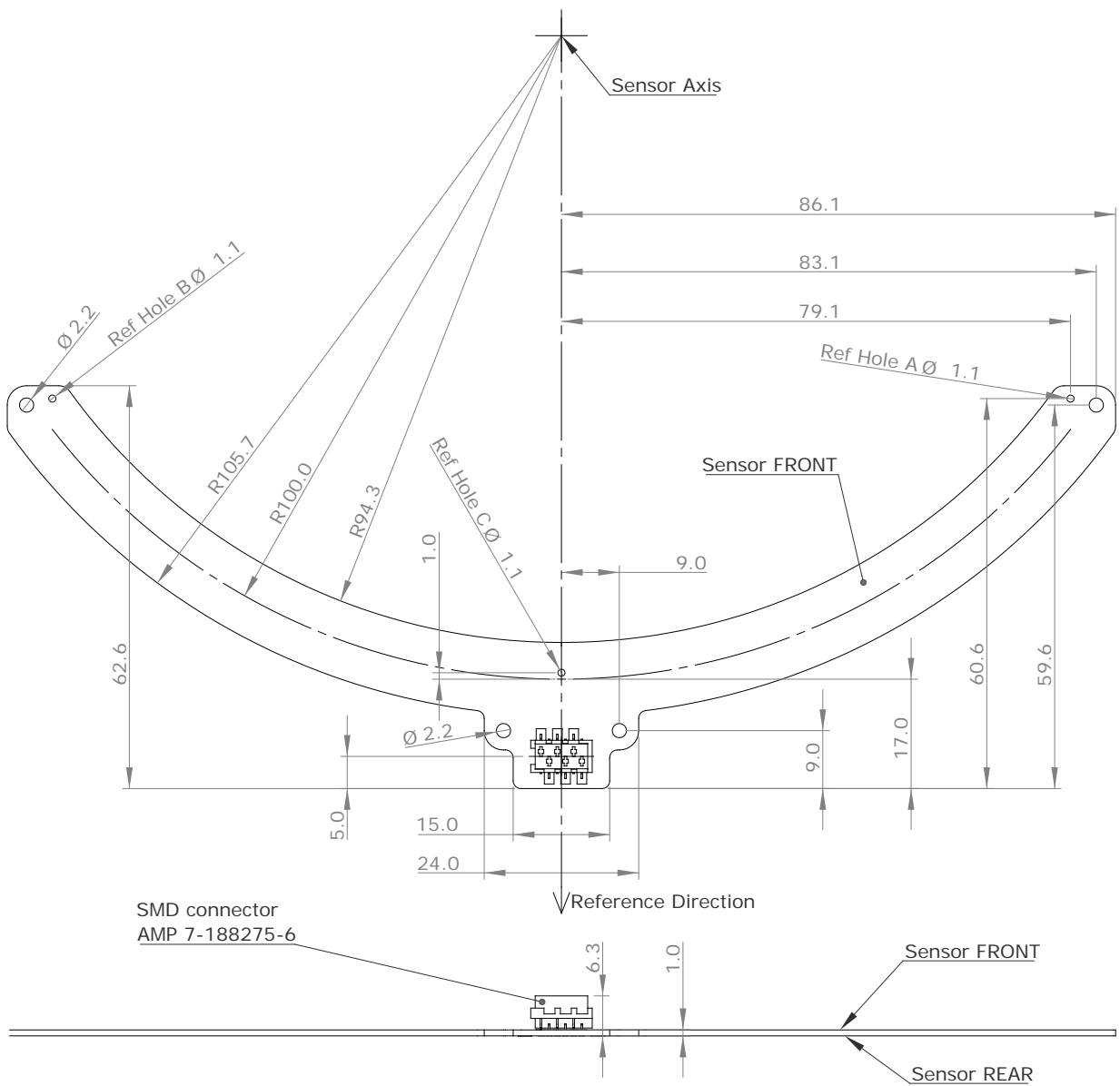


Figure 8 Mechanical drawing, R100mm 100° Arc Sensor Assembly 013-0049

The FRONT of the sensor PCBs is fitted with an SM connector AMP 7-188275-6, with pin numbering illustrated in Figure 9. The REAR includes a single row of 1.25mm pitch connecting pads that do not have a connector fitted. The pinout for both is shown in Table 1.

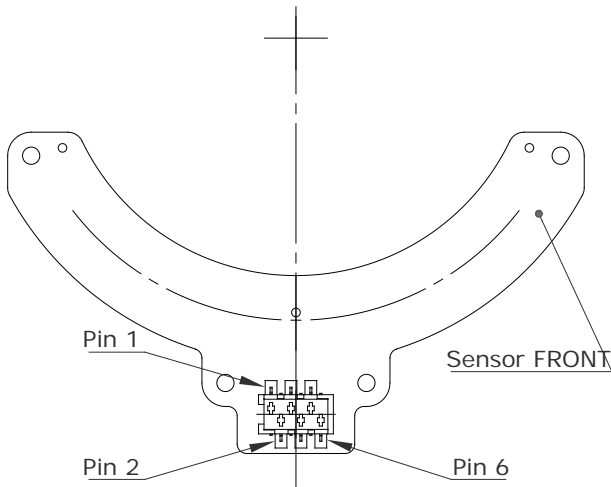


Figure 9 FRONT connector Pin numbering

Table 1 Sensor PCB electrical connections

Pin no	Sensor trace name	Type 1 circuitry connection	Type 4 circuitry connection
1	EX	EX	EX
2	EX REF	0V	VREF
3	Not connected		
4	COS	COS	COS
5	REF	VREF	VREF
6	SIN	SIN	SIN

2 Alignment between Sensor and Target

100° Arc Sensors are designed for use with CambridgeIC's Standard Target. The sensor measures the angular position of the target along the sensor's arc, without physical and electrical contact between the two. This section illustrates options for alignment between sensor and target.

This section applies to assembled sensors (section 1), and also to sensors built by customers to CambridgeIC Sensor Blueprints (section 7). When a customer bases their design on Sensor Blueprints there is an option to change connector scheme, board outline and the way connections are made to the sensor coils. This means the mechanical appearance of the sensor may change, compared to the figures in this section. However the Reference Direction, FRONT/REAR of the sensor and Sensor Radius are all still defined for a Sensor Blueprint, and the alignment of sensor and target only depends on these basic features.

100° Arc Sensors work with the standard target either adjacent the FRONT (Figure 10) or REAR (Figure 11 or Figure 12) of the sensor.

The standard target may either be positioned towards the inside (Figure 10 or Figure 11) or outside (Figure 12) of the sensor.

In all cases the target must be oriented so that the positive end of the target is adjacent the sensor. This is identified by its proximity to Target Hole A, marked in the figures.

The Target Origin is nominally at the geometric centre of the Standard Target and is defined further in its datasheet. The nominal location of the Target Origin is offset from the sensor radius by the Radial Alignment.

Sensors measure the angle of the target around their curved arc, and report this angular position to a host system. This nominally corresponds to Actual Angle, which is also defined in the figures below.

The Target X-Axis nominally runs through its long axis of symmetry which should nominally intersect the rotation axis. Small errors in the target's angular orientation have negligible effect.

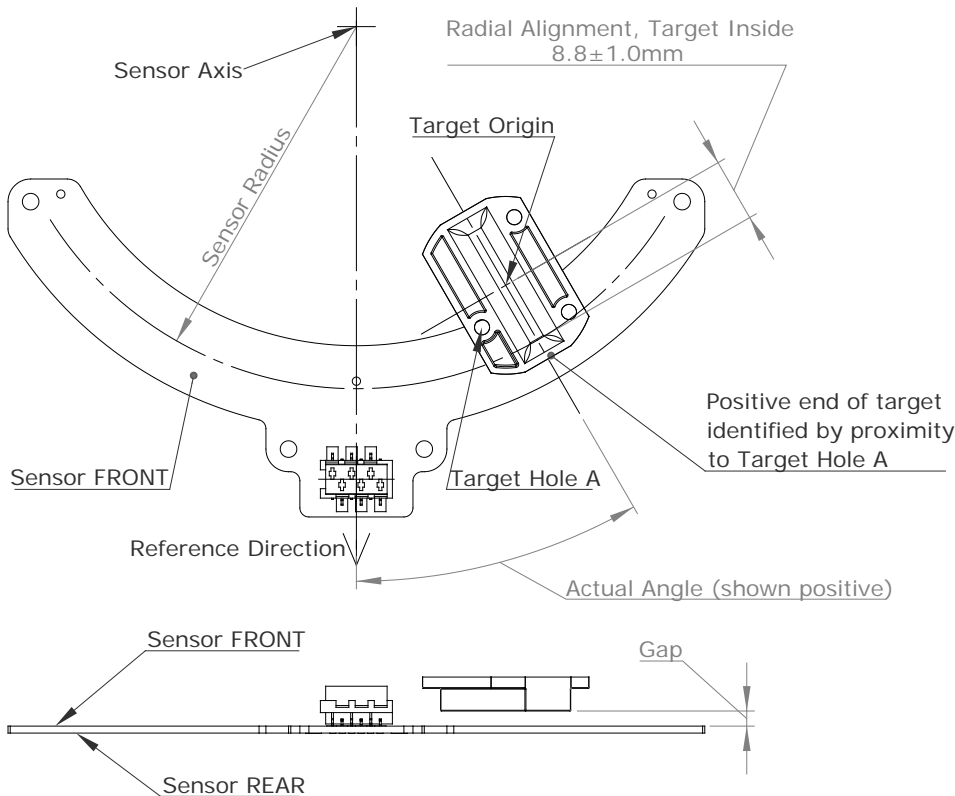


Figure 10 Alignment of sensor with target inside, and opposite sensor FRONT

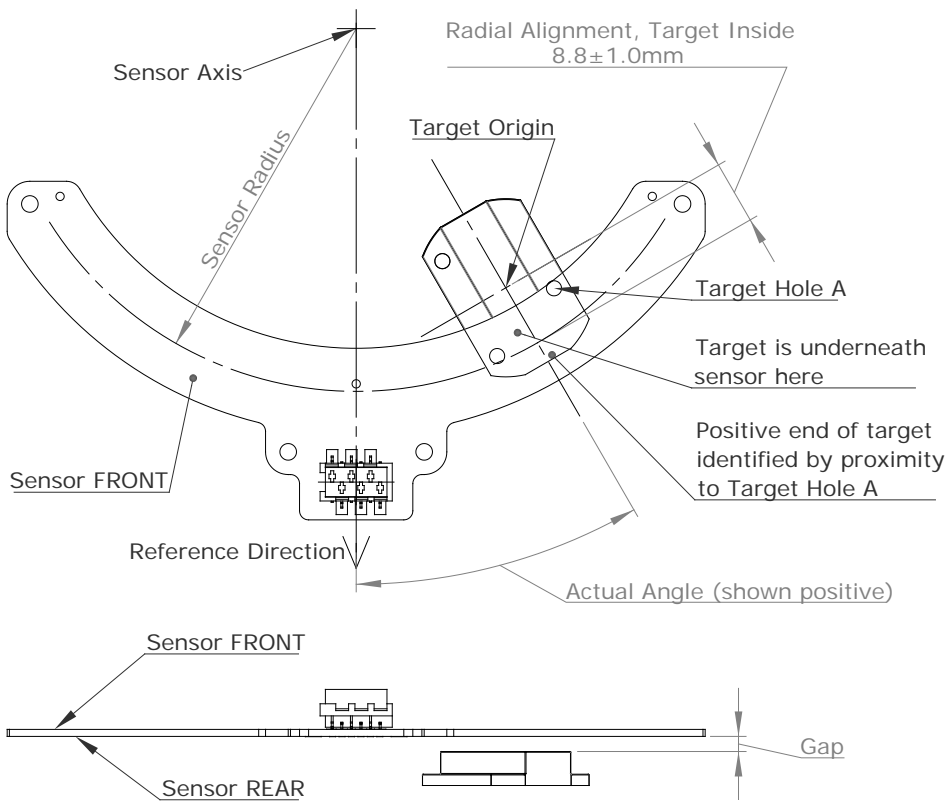


Figure 11 Alignment of sensor with target inside, and opposite sensor REAR

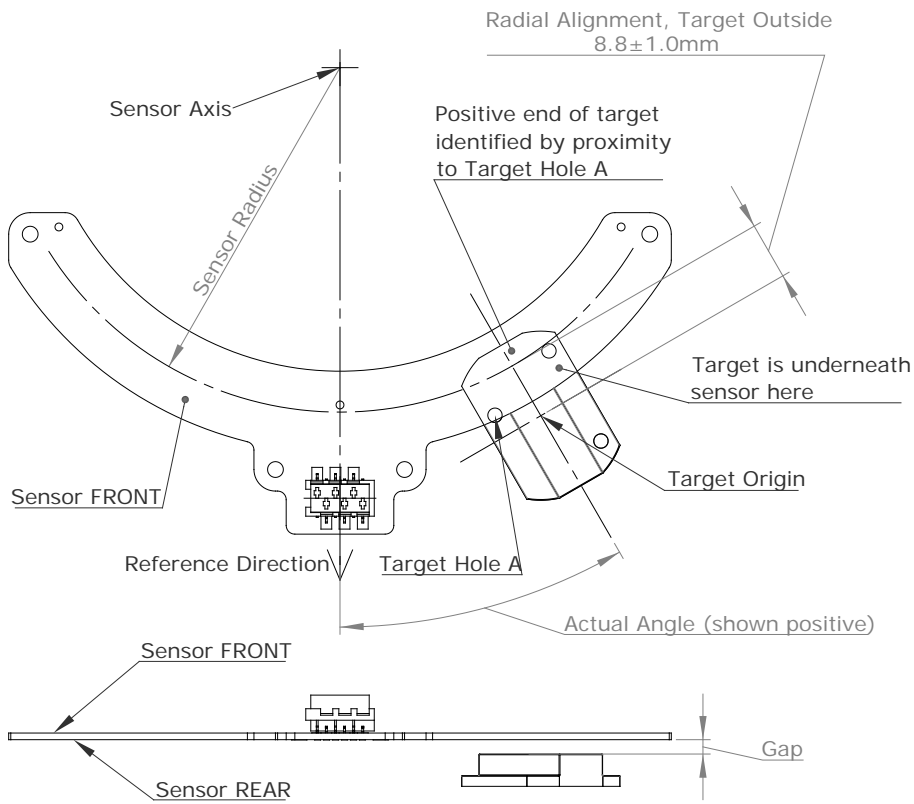


Figure 12 Alignment of sensor with target outside, and opposite sensor REAR

Arc sensors also function with the 11mm E-Core Target, for example part number 013-1020. This has the advantage of smaller size than the standard target. When used with the 11mm E-Core Target, linearity error is not so good, because sensors presented in this datasheet were optimised for the standard target. However other performance aspects including Noise Free Resolution and reproducibility are similar to the standard target, so this configuration may be suitable for applications having limited space available. The 11mm E-Core target also suits applications requiring close proximity to aluminium. The sensor and target should be aligned with the Target centered on the sensor, so that the Target Origin runs along the Sensor Radius, as illustrated in Figure 13.

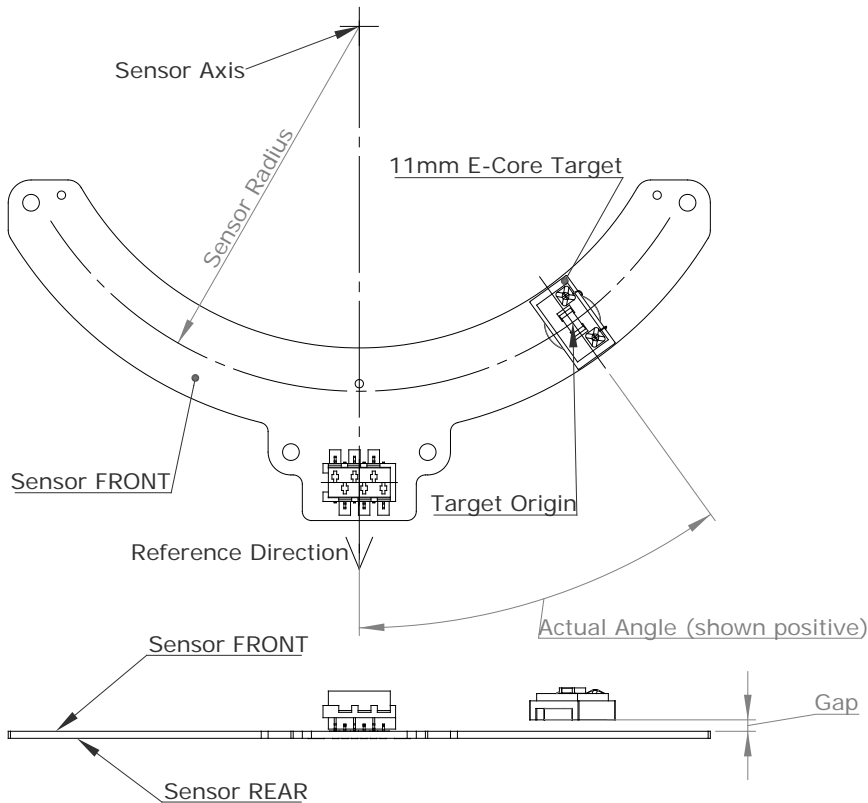


Figure 13 Alignment of sensor with E-Core Target

For applications requiring the 11mm E-Core Target with improved linearity performance, a custom arc sensor can be considered, with design optimised for that target. Please contact CambridgeIC.

3 Principle of Operation

Arc sensors comprise coils designed by CambridgeIC and implemented on a 4-layer PCB. A typical sensor coil arrangement is illustrated in Figure 14. This figure also shows the parts inside the target which the sensor detects: a resonant circuit comprising a coil wound around a ferrite rod and connected to a capacitor to form a resonant circuit.

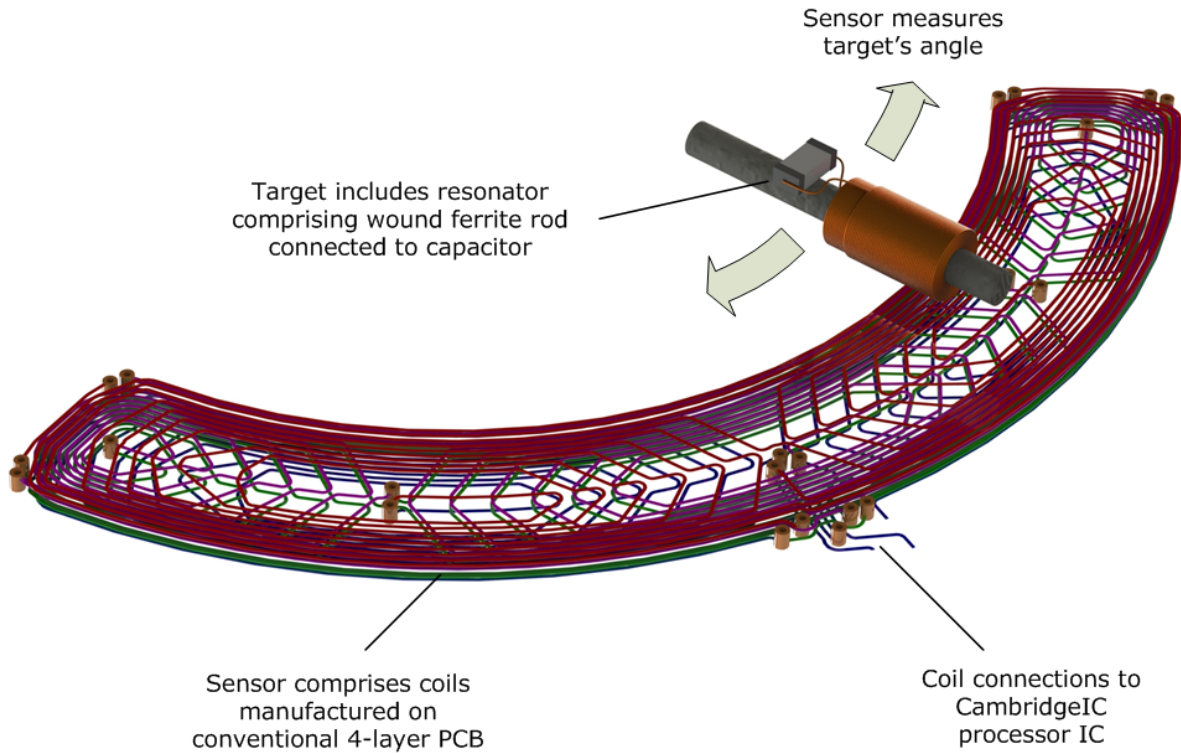


Figure 14 Sensor and target composition

The sensor coils are connected to a CambridgeIC processor chip, for example the CAM204. To take a measurement the chip first energises the resonator inside the target by passing an AC current in the sensor's excitation coil wound around its perimeter. The chip then removes the excitation current and "listens" to the EMFs generated in the patterned COS and SIN sensor coils by the resonator's ring-down. The processor chip then precisely detects these signals and performs a ratiometric calculation based on a 4-quadrant inverse tangent to determine the angular position of the target relative to the sensor.

Please refer to the Technology section of the CambridgeIC web site, www.cambridgeic.com/technology, for more details.

4 Definitions

4.1 Coordinate System

Arc sensors are designed to measure Actual Angle, as defined in the figures of section 2.

The figures in section 2 also dimension Radial Alignment, nominally 8.8mm for the standard target. Radial Misalignment is the difference between actual Radial Alignment and this nominal value.

The Gap dimension is the distance between the target and the adjacent face of the sensor PCB.

4.2 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 CTU chip also reports a VALID flag to indicate when the resonator is in range. These vary with Actual Position as illustrated in Figure 15.

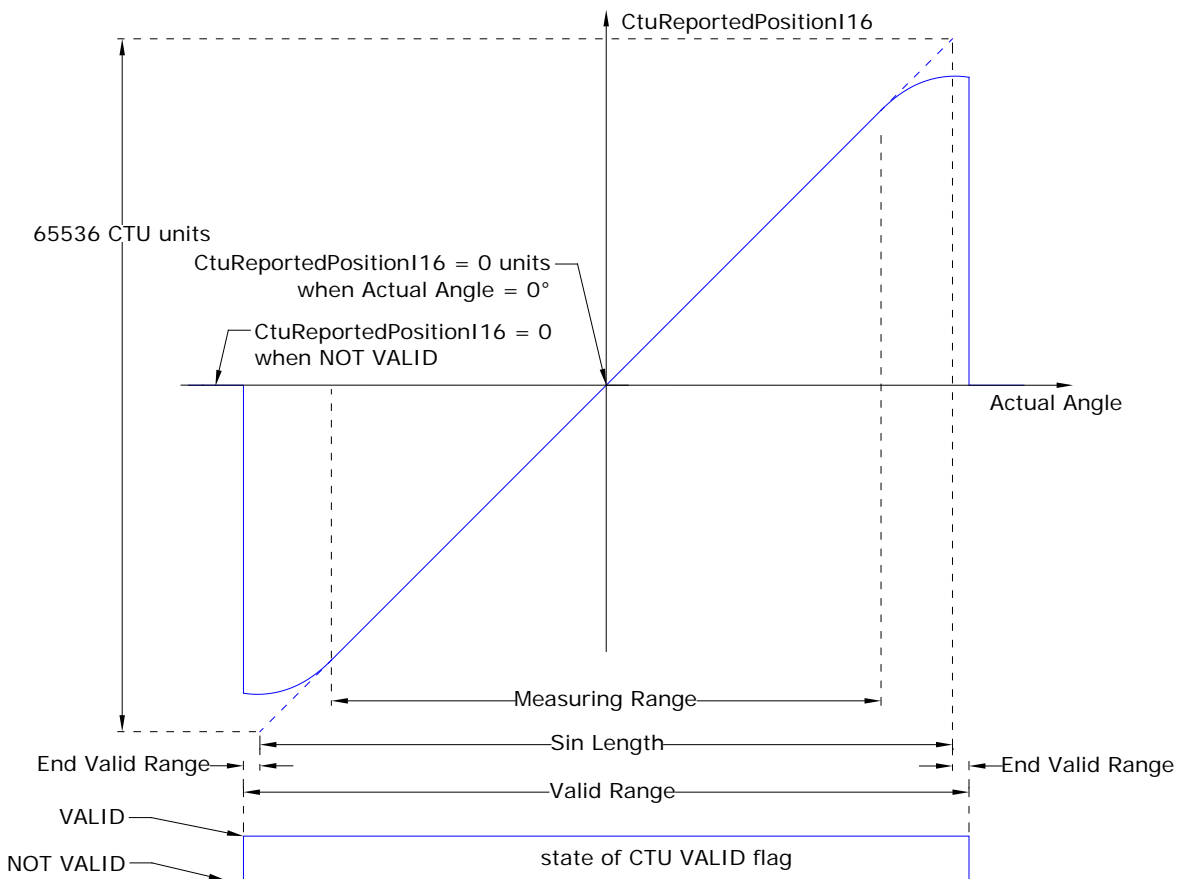


Figure 15 Transfer function (not to scale)

The VALID Range is the distance over which the CTU reports VALID. When VALID, *CtuReportedPositionI16* varies with Actual Angle as shown. The slope of the transfer function is defined by the *SinLength* parameter. The Measuring Range is the distance over which full performance is quoted. The Valid Range exceeds the Measuring Range by an amount End Valid Range each side, so that the sensor’s output can be VALID throughout the Measuring Range.

The CTU chip’s position output may be converted to reported angle in physical units using:

$$Reported\ Angle = \frac{CtuReportedPositionI16}{65536} \times SinLength$$

Equation 1

This figure is nominally equal to the Actual Angle defined in section 4.1. The figures differ due to random noise, Linearity Error and Offset Error:

$$\text{Reported Angle} - \text{Actual Angle} = \text{Random Noise} + \text{Linearity Error} + \text{Offset Error}$$

Equation 2

4.3 Random Noise and Resolution

Random noise is inherent in any analog measurement. The random noise present in the CTU's reported angle measurements can be considered Gaussian (*well behaved noise*). There are two general measures of Random Noise, Peak to Peak Noise and Standard Deviation. Defining Peak to Peak Noise such that it encompasses 99.9% of samples (100% is physically impossible due to the statistical nature of noise) yields the following relationship:

$$\text{Peak to Peak Noise} = 6.6 \times \text{Standard Deviation}$$

Equation 3

Another common measure of noise used in encoders is Noise Free Resolution, which is related to Peak to Peak Noise as follows:

$$\text{Noise Free Resolution} = \log_2 \frac{\text{Measuring Range}}{\text{Peak to Peak Noise}}$$

Equation 4

Noise Free Resolution can be improved by averaging raw samples from a CTU, or applying some other digital filter to the samples. Averaging 2^N samples increases Noise Free Resolution by $N/2$ bits. So averaging 4 samples ($N=2$) improves Noise Free Resolution by 1 bit, and averaging 16 ($N=4$) samples improves Noise Free Resolution by 2 bits. Measurements of Linearity Error and Offset Error are separated from Random Noise by averaging in this way.

4.4 Linearity Error and Offset Error

Linearity Error is the deviation of the transfer function from a best fit straight line. Strictly, the figures quoted in this datasheet are based on a best fit straight line whose slope and offset are adjusted to minimise the maximum magnitude of Linearity Error, so that the maximum positive and negative linearity departures have equal magnitude.

The slope of the best fit straight line is the SinLength parameter whose values are presented in section 5.3. Its value can also change due to a small stretch error inherent in the PCB manufacturing process.

There are two main contributions to Offset Error: one from the sensor and one from the target.

The target's contribution to Offset Error is the mechanical tolerance with which the Target Origin can be located relative to appropriate alignment features, and therefore depends on how these features are designed.

The sensor's contribution to Offset Error is mainly due to the PCB manufacturing process, in particular linear misregistration of copper layers relative to chosen registration features, and sensor PCB stretch error between the reference feature and Sensor Origin.

5 Performance

Figures below are representative of assembled sensor PCBs and sensor PCBs built to Sensor Blueprints (section 7). Measurements are taken with a typical standard target PN 013-1005, and Type 4 CAM204 CTU Circuitry (see CAM204 datasheet, grade A components), at room temperature and in Free Space. Sensors are mounted flush against a flat surface for test purposes.

Measurements are presented as a function of Gap. Unless otherwise stated, values presented below are worst case across radial misalignment of up to 1.0mm.

Where the difference is significant, measurements are presented separately for Target Inside (Figure 10, Figure 11) and Target Outside (Figure 12).

5.1 End Valid Range

End Valid Range is the angle each side of the Measuring Range over which the CTU chip's output remains VALID, as shown in Figure 15. It is a function of Gap and Sensor Radius and as illustrated in Figure 16 below.

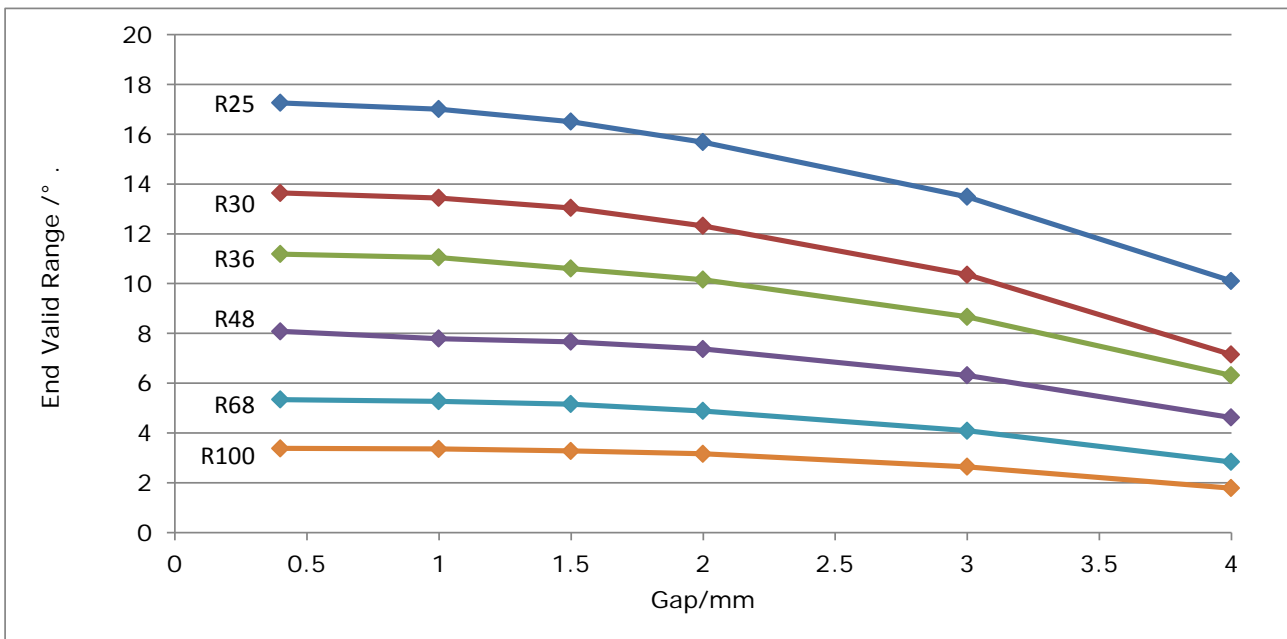


Figure 16 End Valid Range as a function of Gap for each Sensor Radius

To determine the Valid Range, add 2 times the End Valid Range to the Measuring Range (100°). For example at 1.5mm gap, the R30 sensor's End Valid Range taken from Figure 16 is 13°. So the Valid Range is $2 * 13° + 100° = 126°$.

5.2 Linearity Error

Linearity Error is defined in section 4.4. Its value is a function of Gap, and the value improves as Radial Misalignment is minimised. Linearity Error is minimised for the Target Inside configuration, see Figure 17.

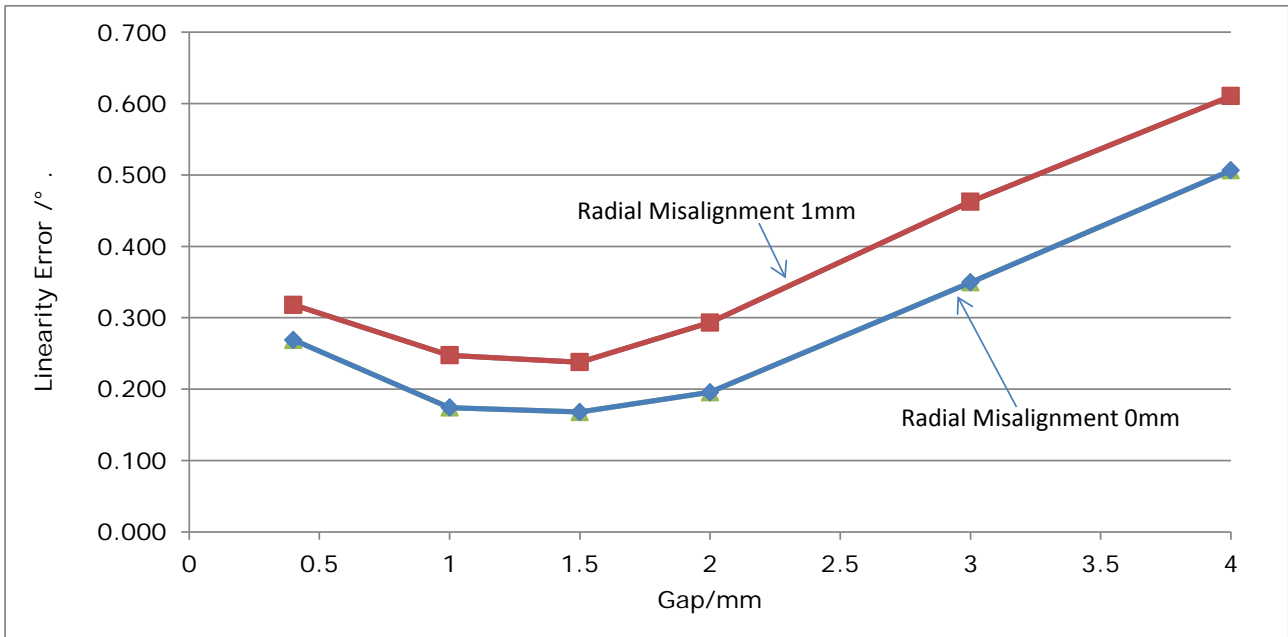


Figure 17 Linearity Error as a function of Gap and Radial Misalignment, Target Inside

Linearity Error is slightly higher for the Target Outside configuration, Figure 18. This is because the coil designs for sensors covered by this datasheet were optimised for the Target Inside configuration.

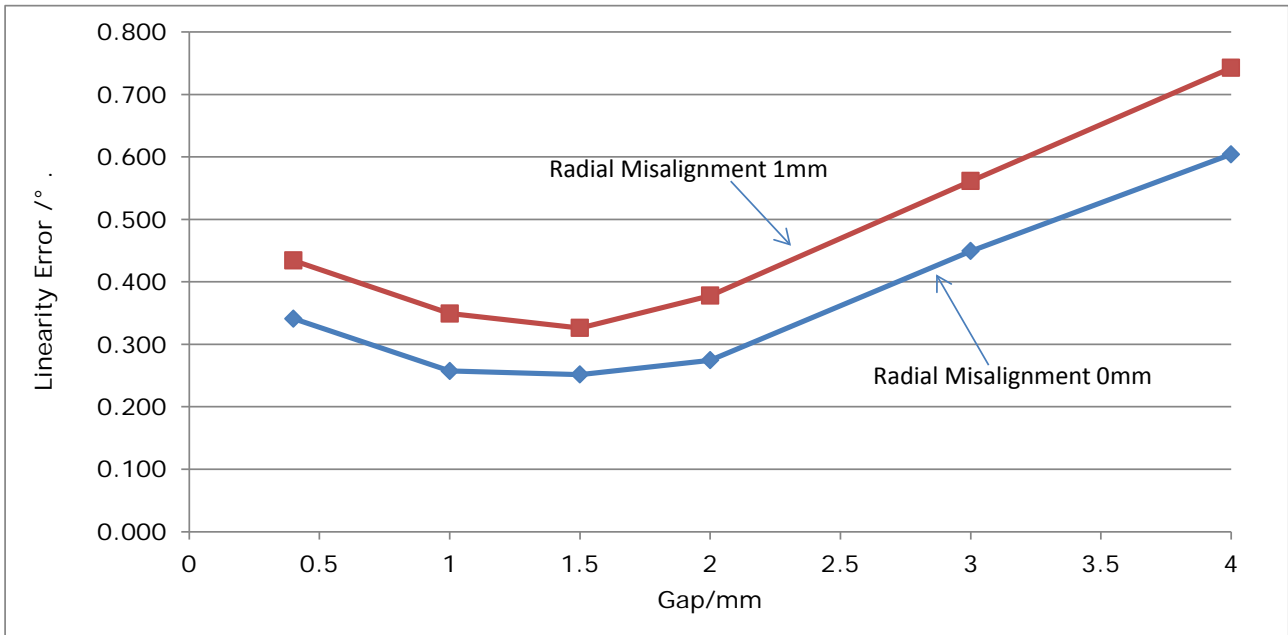


Figure 18 Linearity Error as a function of Gap and Radial Misalignment, Target Outside

The values presented in Figure 17 and Figure 18 are the worst across Sensor Radius.

5.3 SinLength Value

The SinLength parameter can be used to scale from CTU units (CtuReportedPositionI16) to the physical angle units using Equation 1.

Table 2 lists values for SinLength for each Sensor Radius, for the Target Inside configuration. Values are for a Gap of 1mm. There is a small change in SinLength as Gap increases, and the table also includes the fractional change per mm as a percentage of the SinLength value.

Table 2 SinLength, Target Inside

Sensor Radius / mm	SinLength Value / ° 1mm gap	Fractional change per mm Gap
25	140.9	0.6%
30	134.2	0.5%
36	128.8	0.3%
48	122.6	0.3%
68	117.4	0.2%
100	113.7	0.1%

Table 3 is the same data for the Target Outside configuration.

Table 3, Target Outside

Sensor Radius / mm	SinLength Value / ° 1mm gap	Fractional change per mm Gap
25	141.9	1.0%
30	135.1	0.8%
36	129.2	0.6%
48	122.5	0.5%
68	117.4	0.4%
100	113.7	0.2%

In most cases the exact Gap between sensor and target will be unknown, because it varies from system to system due to tolerances. It is recommended to use the SinLength value appropriate to the nominal Gap, to yield the best estimate of Actual Angle in physical units. Where the nominal Gap is not 1mm, the SinLength value can be extrapolated from...

$$\text{SinLength} = \text{SinLength}(1\text{mm}) \times \left[1 + (\text{Nominal Gap} - 1\text{mm}) \times \frac{\text{Fractional Change Per mm}}{100\%} \right]$$

Equation 5

For example the R36 sensor used with Target Inside has a SinLength value of 128.8° at 1mm gap. The change in SinLength value with gap is 0.3%/mm. So if the nominal Gap is 0.5mm, the best SinLength value to use is...

$$\begin{aligned} \text{SinLength}(\text{Target Inside, R36, 0.5mm Gap}) &= 128.8^\circ \times \left[1 + (0.5 - 1) \times \frac{0.3\%}{100\%} \right] \\ &= 128.6^\circ \end{aligned}$$

Assembled sensors include a SinLength value printed in silk screen, and these printed values are approximate and for convenience.

SinLength values can also vary slightly from sensor to sensor due to PCB fabrication stretch error, typically up to ±0.1%.

5.4 Amplitude

In addition to reporting position, the CTU chip also reports Amplitude. Amplitude is a useful measure of system health, and reduces with Gap as shown in Figure 19.

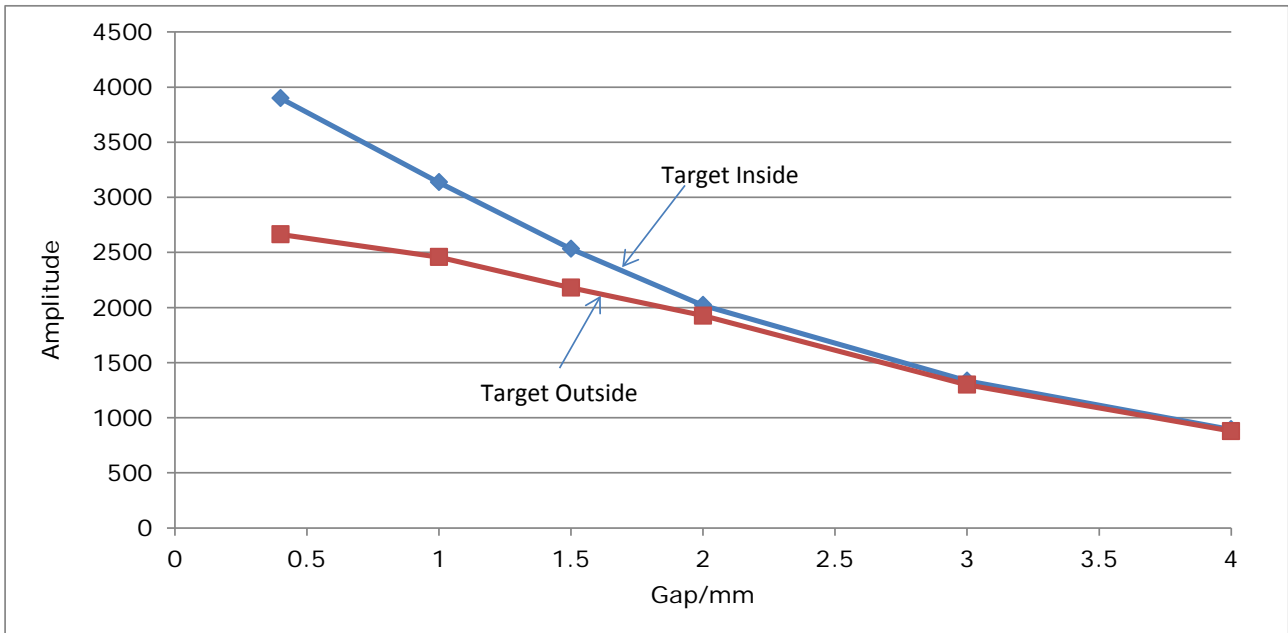


Figure 19 Minimum Reported Amplitude as a function of Gap, free space

Amplitude also reduces with the presence of nearby metal, and sensor installations should be checked to ensure any reduction is not excessive. See also section 6.

5.5 Noise Free Resolution

Noise Free Resolution is defined in section 4.3. It is a function of the signal level detected by the CTU chip. It therefore reduces with Gap and metal proximity in a similar way to Reported Amplitude as illustrated in Figure 20.

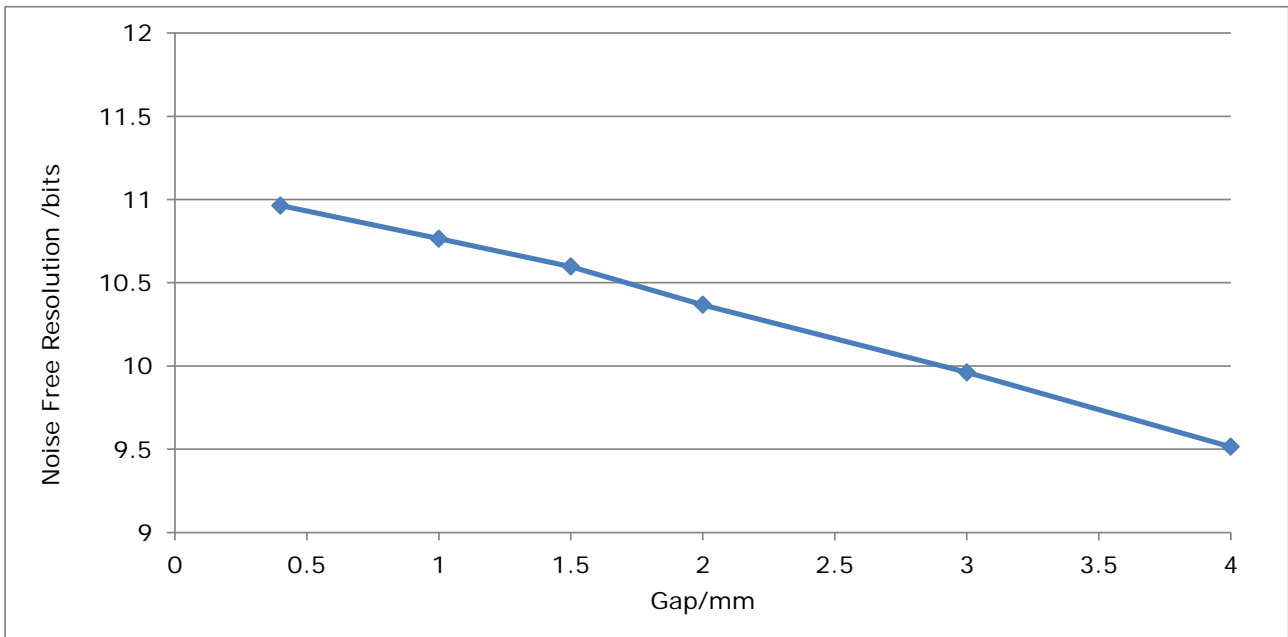


Figure 20 Noise Free Resolution as a function of Gap, CAM204 CTU chip, free space

Quoted Noise Free Resolution is based on single measurements from a CTU chip. The host may average (or otherwise digitally filter) measurements to yield a higher resolution than shown above, at the expense of greater latency.

6 Integration Near Metal

6.1 Background

As with all resonant inductive sensors, Arc Sensors and their targets can be integrated near metal providing the metal's influence is not excessive.

Nearby metal can cause additional linearity error, although the effect is usually small, especially when the metal is in a plane at a constant distance from the sensor.

The metal must not dampen the resonator's Q-factor excessively, and distort fields such that coupling factor is reduced excessively, otherwise Amplitude will be significantly reduced. Low Amplitude causes low Noise Free Resolution. When Amplitude is reduced to 50% of its original value, Noise Free Resolution will reduce by approximately 1 bit. In extreme cases Amplitude may fall below the CTU chip's minimum Amplitude for reporting VALID.

The target's resonant frequency F_{res} when integrated with the customer's product must also remain within the tuning limits of the CTU it will be used with, typically $187.5\text{kHz} \pm 7\%$ for the CAM204. F_{res} is a function of the metal environment inside the product. When there is very little metal nearby, F_{res} will equal the target's free space resonant frequency. When there is metal nearby, F_{res} will shift. For non-ferrous, highly conductive materials such as aluminium and brass, F_{res} increases as metal approaches.

Small metal objects such as fixing screws have less effect than larger objects and metal surfaces. Assembled Arc sensors can be mounted using steel M2 screws with barely noticeable effect on Amplitude, for example.

The effect of a product's fixed metal environment is highly reproducible and can be established by experiment, for example using CambridgeIC's CTU Demo application and appropriate sensor, target and CTU Development Board.

Large areas of aluminium, brass or copper near the sensor and target can be tolerated, as illustrated in the following subsections. However these materials must be at least 0.2mm thick, otherwise their conductivity is insufficient to repel magnetic fields efficiently and Amplitude is reduced more than the values illustrated.

The sensor and its target tolerate aluminium and brass nearby much better than steel, iron, titanium or stainless steel. It is recommended to cover any large areas of iron, titanium or stainless steel near the sensor and target with an aluminium screen at least 0.2mm thick.

Please refer to the CambridgeIC white paper "Resonant Frequency Centering" for more details, including practical approaches for testing and analysis.

The following sections illustrate the effect of aluminium parts near the sensor and target. Brass and copper will behave similarly.

6.2 Aluminium Distance Definitions

The measurements presented later in this section are based on the definitions of Figure 21.

In Figure 21(a), a planar piece of aluminium is positioned behind the sensor, on the opposite side of the sensor to the target. The distance from sensor to aluminium is denoted *Distance to Aluminium Behind Sensor*.

In Figure 21(b), a planar piece of aluminium is positioned behind the target, on the opposite side to the sensor. The distance from target to aluminium is denoted *Distance to Aluminium Behind Target*.

In Figure 21(c), aluminium is positioned around the curved edge of the sensor opposite the target. In this example the aluminium is adjacent the outer edge, with the Target Inside configuration of Figure 10 or Figure 11. Alternatively the aluminium may be positioned adjacent the inner edge with the Target Outside configuration of Figure 12. In both cases the radial distance from sensor PCB edge to aluminium is denoted *Distance Aluminium to Sensor Edge*.

In Figure 21(d), aluminium is positioned adjacent the edge of the target furthest from the sensor. In this example the aluminium is inside of the sensor, with the Target Inside configuration of Figure 10 or Figure 11. Alternatively the aluminium may be positioned adjacent the outside with the Target Outside configuration of Figure 12. In both cases the radial distance from sensor PCB edge to aluminium is denoted *Distance Aluminium to Target Edge*.

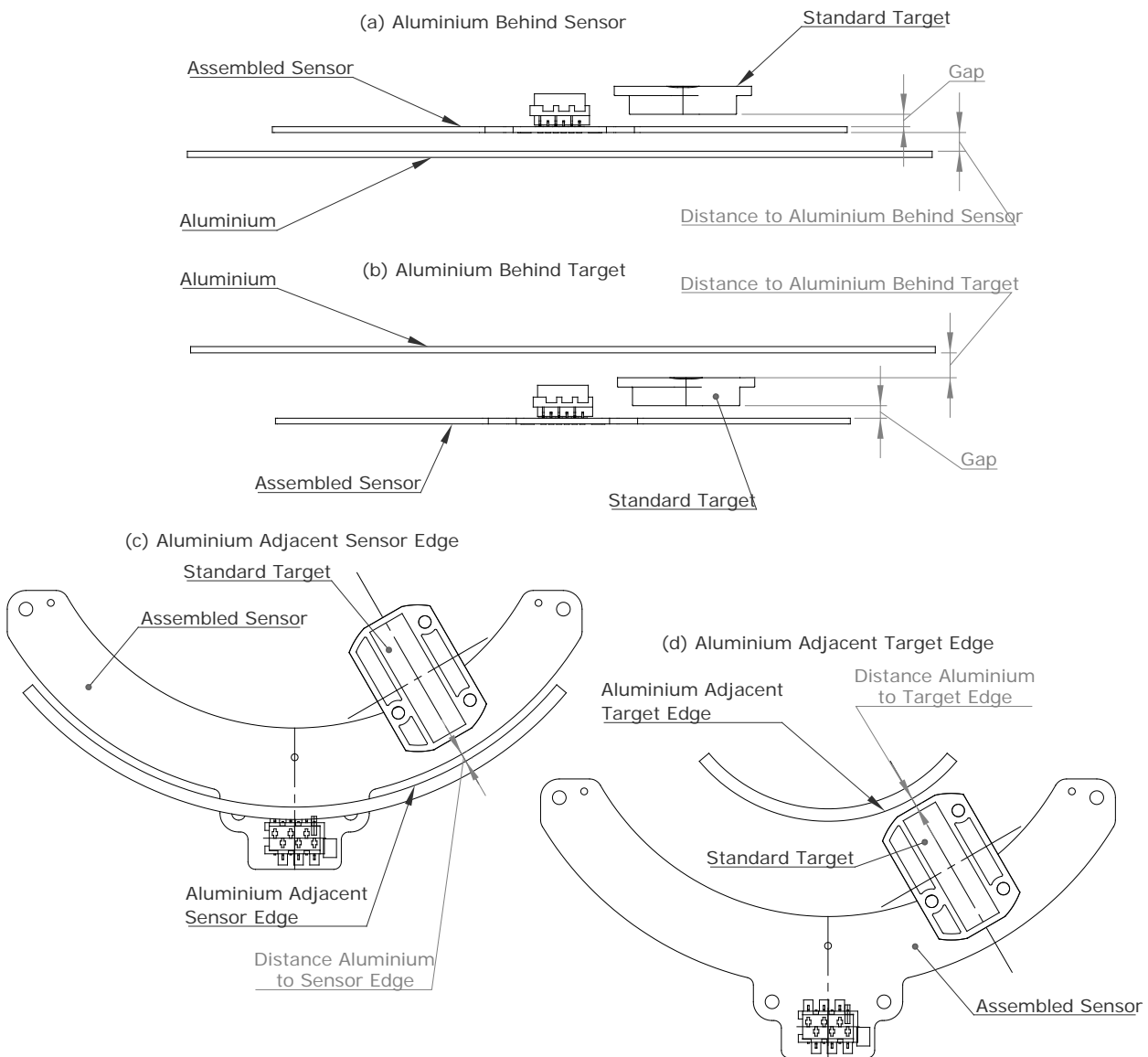


Figure 21 Aluminium distance definitions

6.3 Effect of Aluminium on Amplitude

Figure 22 illustrates the effect of nearby aluminium on Amplitude, as reported by the CTU chip connected to an Arc Sensor. Measurements are for an R48 sensor with Target Inside, but are also representative of other Sensor Radii and when arranged with Target Outside.

The graph includes 4 data series, one for each of the aluminium configurations illustrated in Figure 21.

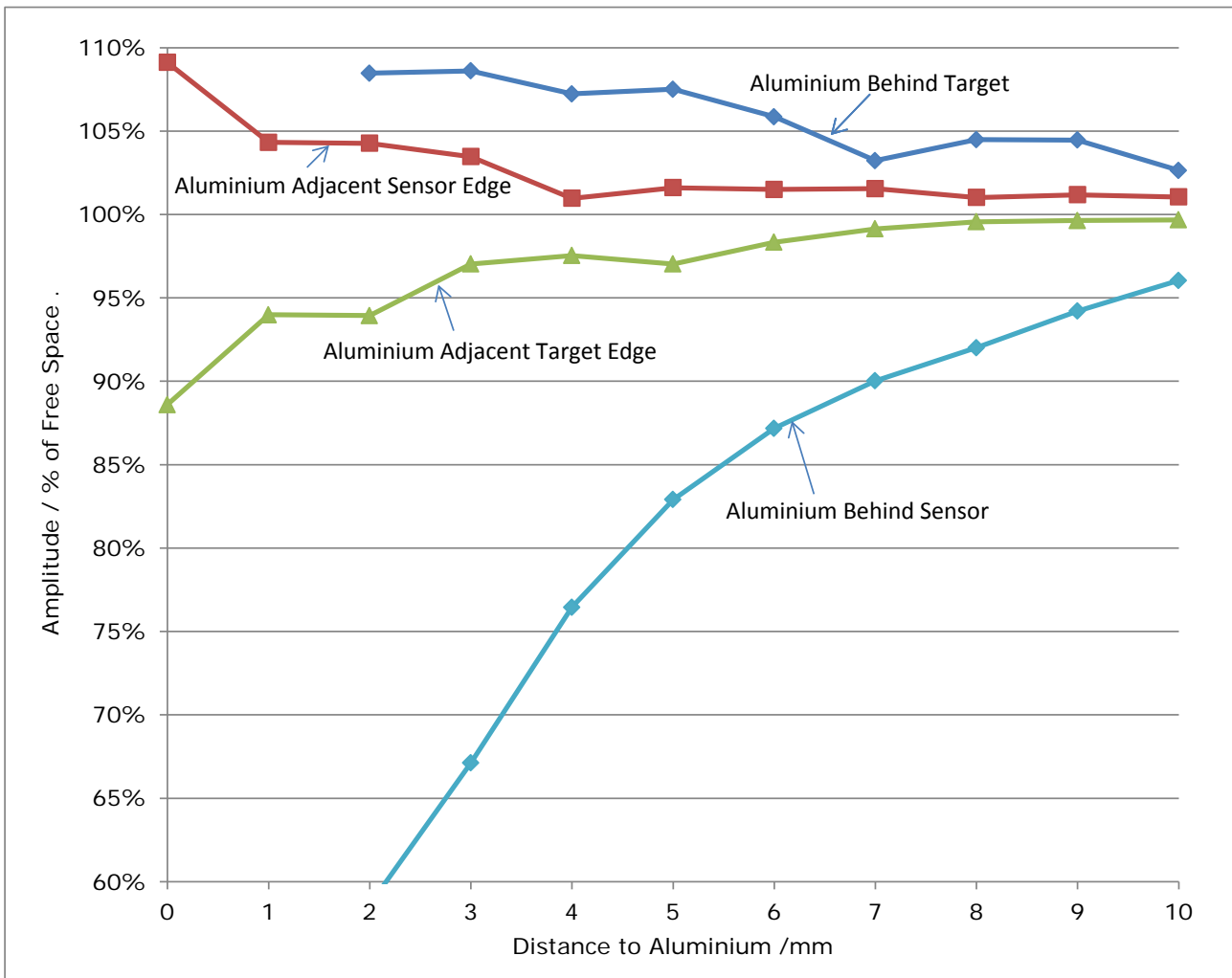


Figure 22 Effect of Aluminium on Amplitude

Aluminium behind the sensor, as in Figure 21(a), has the greatest effect on Amplitude. For example Amplitude is reduced to 67% of its Free Space value with a Distance to Aluminium Behind Sensor of 3mm. This is equivalent to a loss of 0.6 bits of Noise Free Resolution.

Note that when aluminium is positioned behind the target or adjacent the sensor edge, Amplitude is actually increased a small amount.

In an installation where aluminium is positioned along 2 or more edges, its effect may be estimated by multiplying the effect of each edge individually. For example if there is aluminium 3mm behind the sensor (Amplitude drops to 67%) and 2mm from the target edge (Amplitude drops to 94%), the effect of both is approximately $67\% \times 94\% = 63\%$.

The figures in this section are only a guide to the effect of Aluminium on Arc Sensor integration. It is recommended to check how a product's metal environment actually affects Amplitude when physical parts are available to test with.

6.4 Effect of Aluminium on Frequency

Figure 23 illustrates the effect of nearby aluminium on target frequency, as measured with the CTU chip connected to an Arc Sensor. Measurements are for an R48 sensor with Target Inside, but are also representative of other Sensor Radii and when arranged with Target Outside.

The graph includes 4 data series, one for each of the aluminium configurations illustrated in Figure 21.

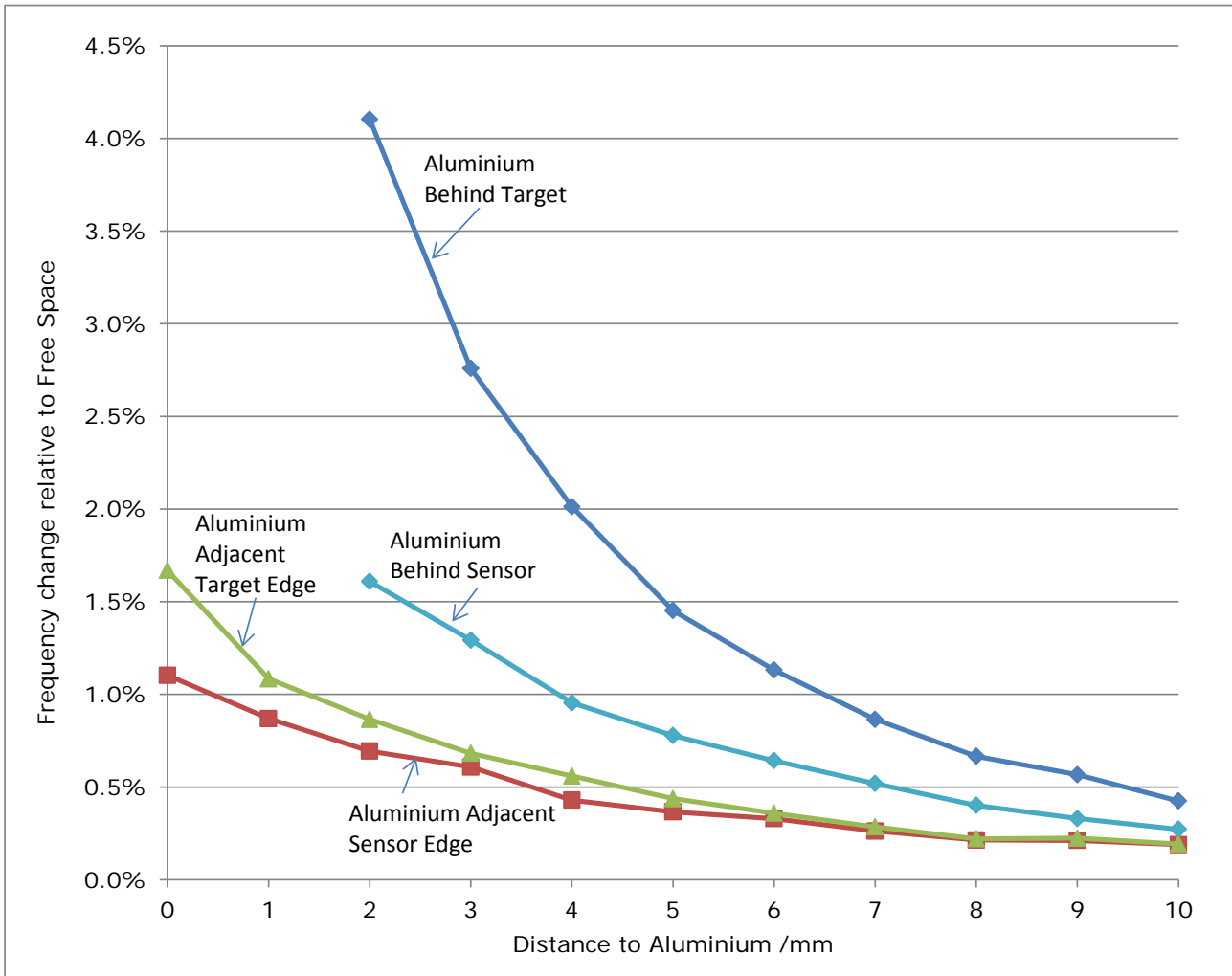


Figure 23 Effect of Aluminium on Frequency

Aluminium behind the target, as in Figure 21(b), has the greatest effect on target frequency. For example target frequency is increased by 2.7% with Distance to Aluminium Behind Target of 3mm. This is near the maximum allowable for operation with the CAM204 chip across a temperature range of -40°C to +85°C – please see the CambridgeIC white paper “Resonant Frequency Centering” for more details.

In an installation where aluminium is positioned along 2 or more edges, its effect may be estimated by adding the effect of each edge individually. For example if there is aluminium 4mm behind the target (frequency increases by 2%) and 1mm from the sensor edge (frequency increases by 0.8%), the effect of both is a target frequency increase of approximately 2% + 0.8% = 2.8%.

7 Sensor Blueprints

7.1 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 Cambridge IC's CTU chips, either as stand-alone sensors or combined with their own circuitry.

7.2 Fabrication Technology

100° Arc Sensor Blueprints are fabricated on a 4-layer PCB. Recommended copper thickness is shown in Table 4.

Table 4

Copper thickness	oz	µm
Minimum	0.8	28
Recommended	1	35

7.3 PCB Design Parameters

Table 5

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

7.4 Sensor Blueprint Part Numbers

Table 6 lists part numbers for each Sensor Blueprint, together with the Copper Angle Extent of Figure 24.

Table 6

Part no.	Description	Copper Angle Extent
010-0119	R25mm 100° Arc Sensor Blueprint	135.6°
010-0121	R30mm 100° Arc Sensor Blueprint	128.2°
010-0123	R36mm 100° Arc Sensor Blueprint	122.6°
010-0125	R48mm 100° Arc Sensor Blueprint	116.2°
010-0127	R68mm 100° Arc Sensor Blueprint	111.0°
010-0129	R100mm 100° Arc Sensor Blueprint	107.2°

7.5 PCB Integration

Figure 24 illustrates the extent of the copper pattern required to build the sensor on a PCB. The shaded area is the sensor itself. 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.

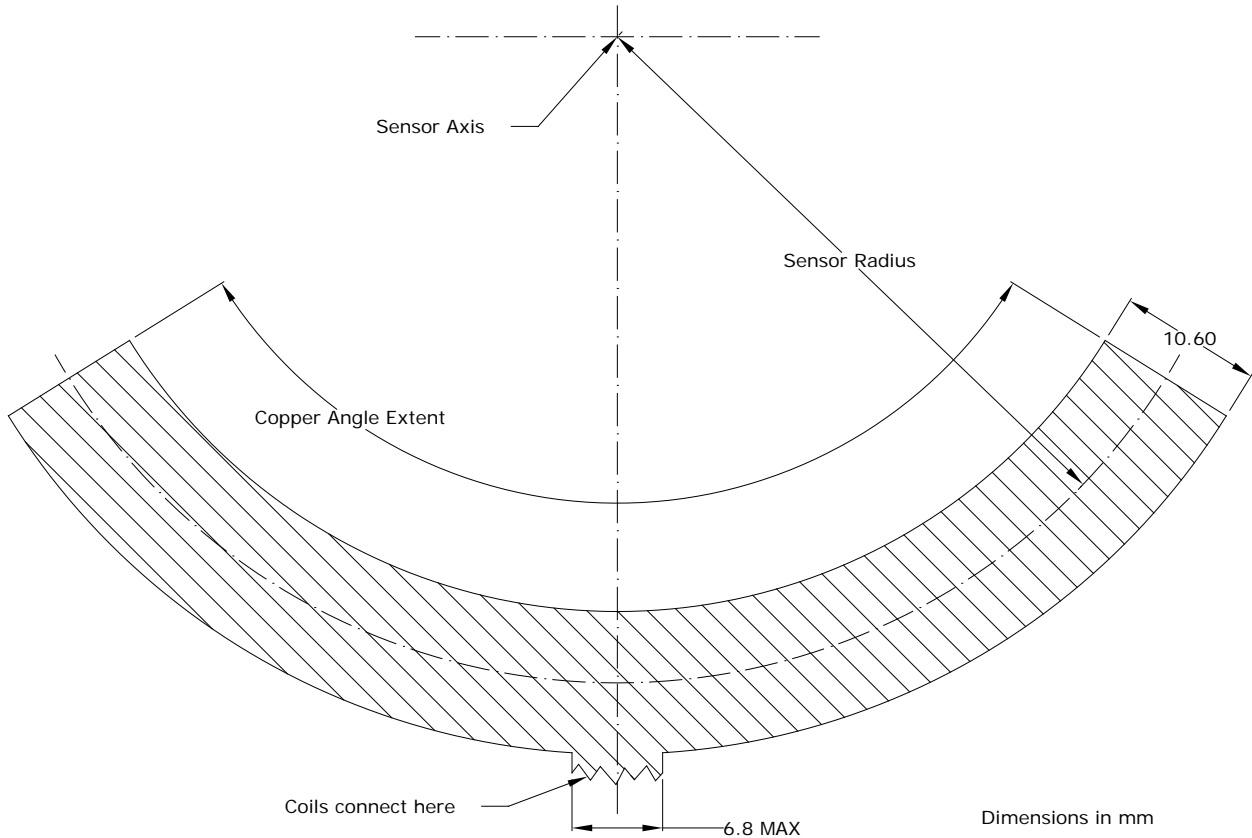


Figure 24 Sensor Blueprint copper extents

When integrating with other electronic circuitry, a keep-out of 3mm is recommended all around the sensor's conductors. Copper traces surrounding the sensor must not include a complete loop, otherwise these may appear as a "shorted turn" to the sensor's excitation coil and Amplitude may be reduced dramatically.

7.6 Data Format

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

7.7 Trace Connections

There are 3 pairs of tracks (EX, COS, SIN and their respective VREF connections), which should be connected to the respective CTU circuit connections with the minimum practical trace lengths.

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

8 Environmental

Assembled sensors conform to the following environmental specifications:

Item		Comments
Minimum operating temperature	-40°C	Sensor limited by the connector
Maximum operating temperature	85°C	
Maximum operating humidity	95%	Non-condensing

The maximum operating temperature of the sensor PCB may be increased if a customer manufactures their own sensor PCB to CambridgeIC's design, and uses an alternative, higher temperature, connecting method.

9 RoHS Compliance

CambridgeIC certifies, to the best of its knowledge and understanding that Assembled Arc Sensor part numbers 013-0044 to 013-0049 inclusive are in compliance with EU RoHS, China RoHS and Korea RoHS.

10 Document History

Revision	Date	Comments
0001	13 June 2017	First draft

11 Contact Information

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12 Legal

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The design of the sensor, comprising each of the patterned copper layers, drill locations, silk screens, assembly layers and board outline are protected by copyright.