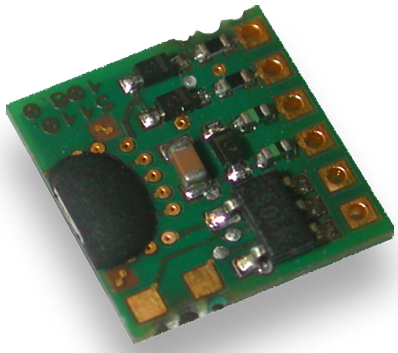
SENSITEC
MAGNETORESISTIVE SENSORS

DATA SHEET

EBI7904CAx-DA-IF

Incremental FixPitch Sensor Module



The sensor module EBI7904CAx-DA-IF contains an AMR (Anisotropic MagnetoResistive) FixPitch sensor and a high resolution 13-bit interpolation-IC. The AL798 AMR FixPitch sensor with PurePitch technology is designed for a magnetic scale with 1 mm magnetic pole pitch. This combination of a magnetic scale with 1 mm pitch and the electronic module delivers two 90 degree phase-shifted rectangular signals A and B (see Fig. 1).

The sensor module is calibrated, which has the advantage that you get a higher absolute accuracy and a lower deviation of flanks.

It is possible to configure the resolution up to 8192 flanks per mm through the configuration interface of the processing unit.

Different preconfigured sensor modules are available (see table, product overview, on page 8).

Product Overview

Article	Description
EBI7904CAx-DA-IF	Incremental module for 1 mm pitch with programmable resolution

For order information see page 8.

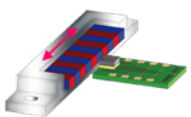
Quick Reference Guide

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage	4.5	5	5.5	V
I_C	Current consumption	14	16	18	mA
A	Resolution (flank to flank)[1) 2)]	125	-	0.122	µm
F	Flanks per mm [1) 2)]	8	-	8192	-
T_{amb}	Ambient temperature	-25	-	+85	°C

1) Depends on programmed resolution.

2) One magnetic pole (with 1 mm pitch) corresponds to 360 degree (see page 5 for more information).

Measurement Setup

Depiction	Configuration	Application
	Linear magnetic scale with fixed pole length (pitch); sensors mounted perpendicularly to the magnetic track on the scale.	Incremental length measurement
	Magnetic pole ring with fixed pitch; sensor mounted on substrate radially to the pole ring; sensor surface in plane with the pole ring.	Incremental angle measurement at the shaft circumference

Features

- Adjustable resolution up to 8192 flanks / mm
- A/B output signal (TTL)
- FixPitch sensor
- Temperature range from -25 °C to +85 °C

Advantages

- Small size
- Adjustable hysteresis
- Error detection (amplitude and frequency)
- Calibrated sensor module for higher absolute accuracy and lower deviation of the flanks

Applications

Incremental encoder for linear or rotary movements in various applications, for example:

- Motor integrated encoder
- Motor feedback system
- Linear position measurement

ESD

RoHS-Compliant www.sensitec.com

Absolute Maximum Ratings Values

In accordance with the absolute maximum rating system (IEC60134).

Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Supply voltage	-0.3	+6.0	V
T_{amb}	Ambient temperature	-25	+85	°C
T_{stg}	Storage temperature	-25	+85	°C

Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Data

T_{amb} = 25 °C; H_{ext} = 20 kA/m; V_{CC} = 5 V; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage		4.5	5.0	5.5	V
I_C	Current consumption	No load	14	16	18	mA
A	Resolution (flank to flank) [1]		125	-	0.122	µm
F	Flanks per mm [1]		8	-	8192	-
T_{amb}	Ambient temperature		-25	-	+85	°C
Hys	Hysteresis [2]		0	1.95	15.63	µm
$I_{out,pin}$	Current per output (source and sink)		-10	-	+10	mA
V_{outH}	Output high level	I_{source} = 4 mA	4.6	-	5.0	V
V_{outL}	Output low level	I_{sink} = 4 mA	0.0	-	0.4	V
t_{Lat}	Latency		-	0.25	-	µs

[1] Depends on programmed resolution.

[2] Programmable feature, see table on page 4 for more information. 1.95 µm default value.

Accuracy of the Module

T_{amb} = 25 °C; ideal magnetic scale; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
INL	Absolute accuracy [1]		-	±0.95	±1.4	µm
ΔΠ	Deviation of pulse width [2]		-	-	±10	%
Δφ	Deviation of phase shift [2]		-	-	±10	%

[1] Related to input signal of 1 mm pitch.

[2] Related to a signal period of the rectangular output signal.

Mechanical Data

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Δd	Working distance (scale surface ↔ sensor)	Depends on magnetic scale	-	300	-	µm

Typical Performance Graphs

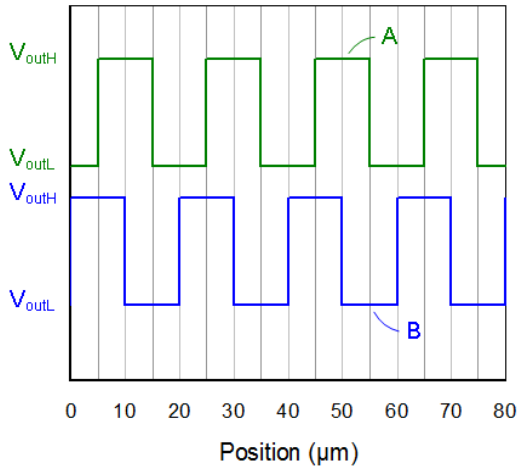


Fig. 1: The typical output signals depend on rotational direction.

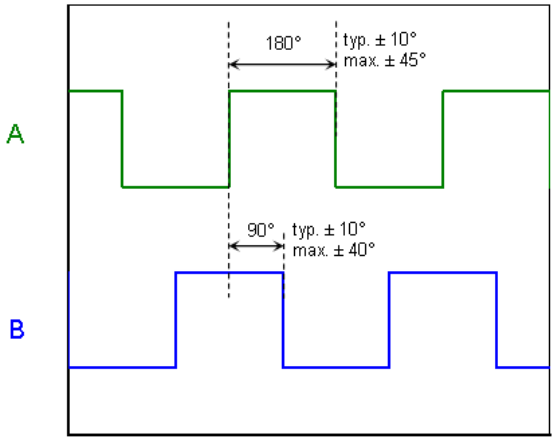


Fig. 2: Pulse width deviation and phase shift. (Magnetic scale based on Tromaflex® material).

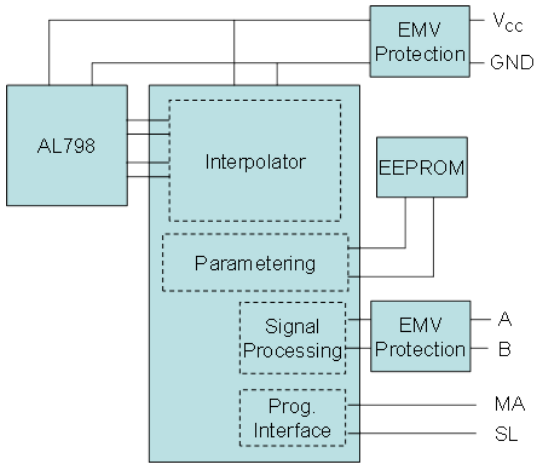


Fig. 3: Functional block diagram.

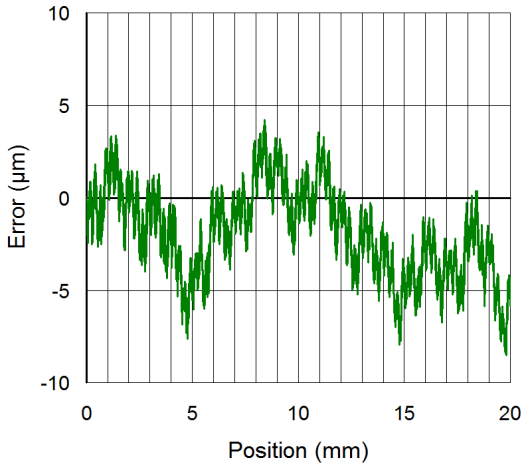


Fig. 4: Typical error per magnetic scale length. (Magnetic scale based on Tromaflex® material).

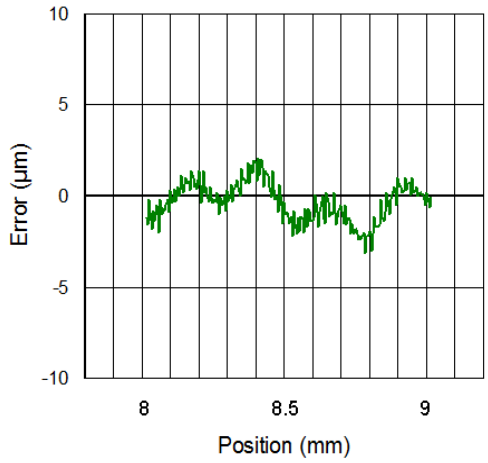


Fig. 5: Typical error per pitch. (Magnetic scale based on Tromaflex® material).

Tromaflex® consists of a mixture of a highly coercive magnetic powder (barium or strontium ferrite) with a high quality flexible plastic. Tromaflex® is a registered trademark of the Max Baermann Ltd., Germany.

Programmable Parameters of EBI7904CAx-DA-IF

The input frequency depends on the number of poles and the rotation speed. For more information see page 5. Input signal period of 360° corresponds to 1 mm.

Resolution (binary)			Resolution (decadal)		
Flanks per mm	Interpolation factor (IPF)	Resulting maximal input frequency [1] f_{in}	Flanks per mm	Interpolation factor (IPF)	Resulting maximal input frequency [1] f_{in}
8	2	162 kHz	40	10	4.1 kHz
16	4	81.3 kHz	50	12.5	6.5 kHz
32	8	40.6 kHz	80	20	4.1 kHz
64	16	20.3 kHz	160	40	4.1 kHz
128	32	10.2 kHz	200	50	6.5 kHz
256	64	5.1 kHz	320	80	4.1 kHz
512	128	2.54 kHz	400	100	3.2 kHz
1024	256	1.27 kHz	500	125	2.6 kHz
2048	512	634 Hz	800	200	1.6 kHz
4096	1024	317 Hz	1000	250	1.3 kHz
8192	2048	158 Hz	1600	400	812 Hz
			2000	500	650 Hz

[1] It is possible to adjust the oscillator for higher input frequency.

Hysteresis

Hysteresis	Effect accuracy	Effect output stability	Description
0 µm	High accuracy	Low output stability	A higher hysteresis provides a more stable output but decreases the absolute accuracy. The resulting absolute angular error corresponds to half the hysteresis.
0.244 µm	↑	↓	
0.488 µm			
0.977 µm			
1.95 µm [1]			
3.91 µm			
15.625 µm	Low accuracy	High output stability	

[1] Default configuration.

Calculation of the Resolution at a Pole Ring for a Turn

For example a magnetizable ring, magnetized with 8 north poles and 8 south poles.
Per magnetic pole the sensor generates a sine and a cosine period of 360 degrees (electrical). A turn of the pole ring at 360° (mechanical) will be subdivided in 16 sine- and 16 cosine periods.
It follows, that 1 magnetic pole corresponds to 22.5 degree.
With a programmed resolution of 64 flanks per magnetic pole you will get a resolution of 0.35 degree over a full 360 degree mechanical turn of the pole ring.

$resolution_{360}$ - Resolution over one 360° turn of the pole ring
$resolution_{prog}$ - programmed resolution in flanks
n - number of poles (per revolution)

$$resolution_{360} = \frac{360°}{n \cdot resolution_{prog}}$$

Input Frequency and Output Frequency at the Application

1. The input frequency depends on the number of poles, the pitch and on the rotational speed.

a) pole ring

f_i - input frequency in Hz
n - number of poles (per revolution)
R - rotation speed in rpm

$$f_i = \frac{(n \times R)}{60}$$

Example: pole ring with 50 poles and rotating speed 1000 rpm

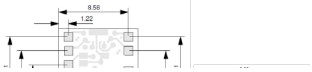
$$f_i = \frac{(50 \times 1000)}{60} = 833.3 Hz$$

b) linear scale

f_i - input frequency in Hz
p - pole pitch in mm
v - velocity in m/s

$$f_i = \frac{v}{p} \times 1000$$

Example: linear scale with 1 mm pitch, velocity 2 meters per second



2. The output frequency depends on the input frequency and the programmed resolution.

f_i - input frequency in Hz
f_o - output frequency in Hz
res - programmed resolution

$$f_0 = f_i \times \frac{res}{4}$$

Example: input frequency is 1260 Hz, programmed resolution 8

$$f_i = 1260 \ x \ \frac{8}{4} = 2520 \ Hz$$

Pinning

Pad	Symbol	Parameter
1	MA	Master (Clock)
2	SLO	Slave (Data)
3	GND	Ground
4	V_{CC}	Supply voltage
5	A	Output signal A
6	B	Output signal B
a	SCL	Clock EEPROM
b	SDA	Data EEPROM

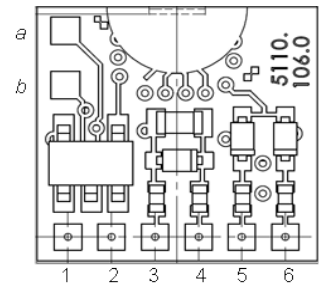


Fig. 6: Pinning of EBI7904CAx-DA-IF.

Dimensions

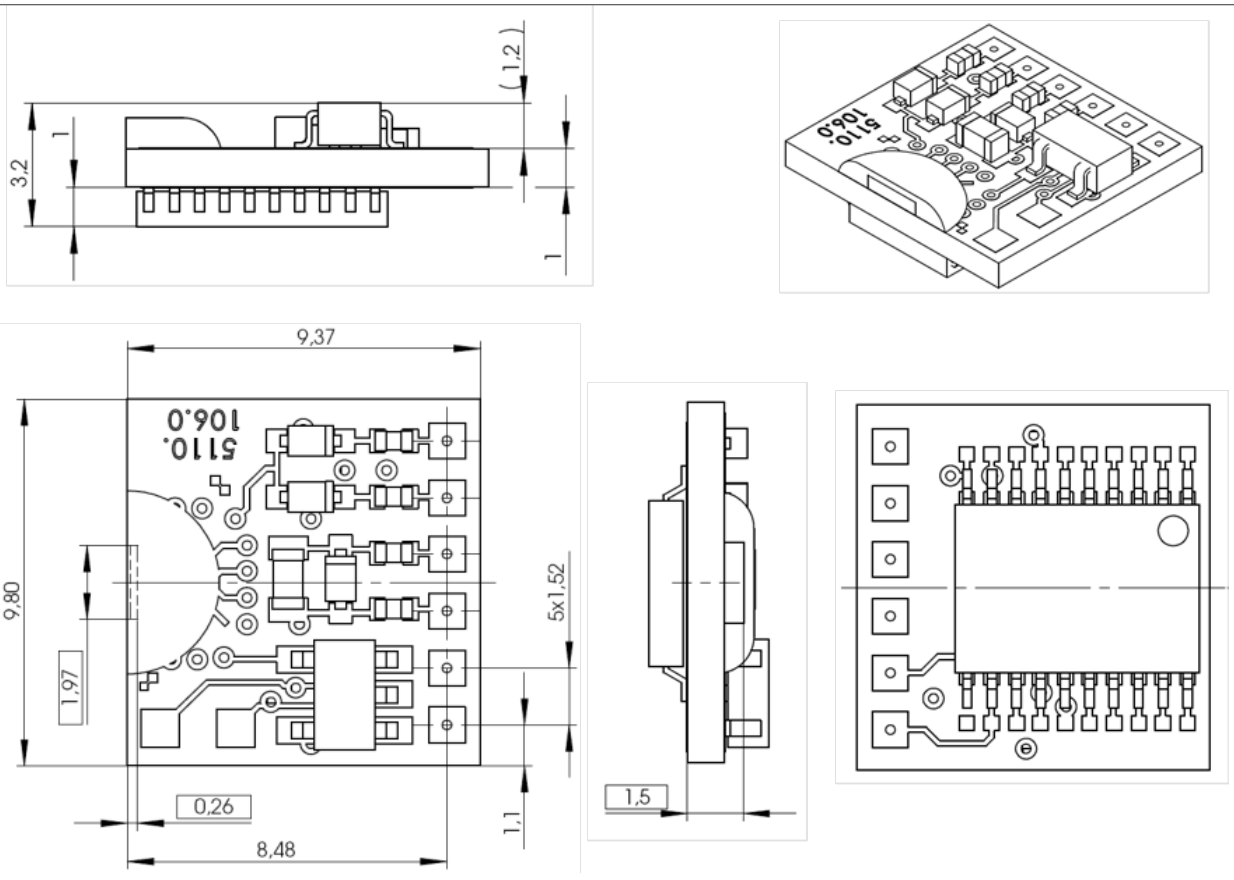


Fig. 7: PCB outline (all dimensions in mm unless otherwise specified).

Detailed Pin Description

Pad	Symbol	Parameter	Description	Additional information
1	MA	Master (Clock)	BiSS-Interface (Master) / SSI-Interface (Clock)	BiSS-Interface (visit http://www.biss-ic.de for more information). Optional SSI-Output configurable.
2	SLO	Slave (Data)	BiSS-Interface (Slave) / SSI-Interface (Data)	
3	GND	Ground	Ground	
4	V_{CC}	Supply voltage	Supply voltage	Typically 5 V (4.5 V to 5.5 V)
5	A	Output signal A	Rectangular TTL-Signal for quad-count	See page 3, Fig. 1 for signal and phase relationship. A change of the direction changes the phase between A and B.
6	B	Output signal B	Rectangular TTL-Signal for quad-count	
a	SCL	Clock EEPROM	Clock for EEPROM access	Direct EEPROM access. Address 0 to 15 for configuration of the interpolator.
b	SDA	Data EEPROM	Data for EEPORM access (read and write)	Do not change any values at byte 0 to 15 without knowing exactly what you are doing.

Application Information to connect the Module

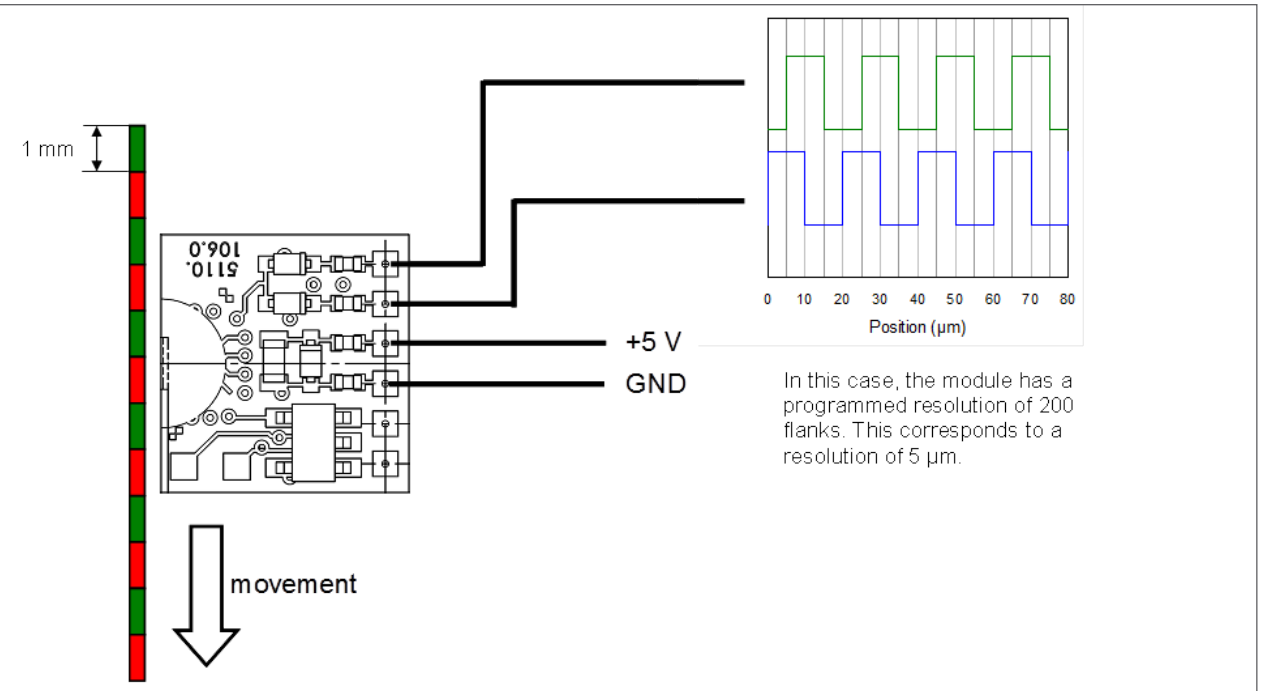
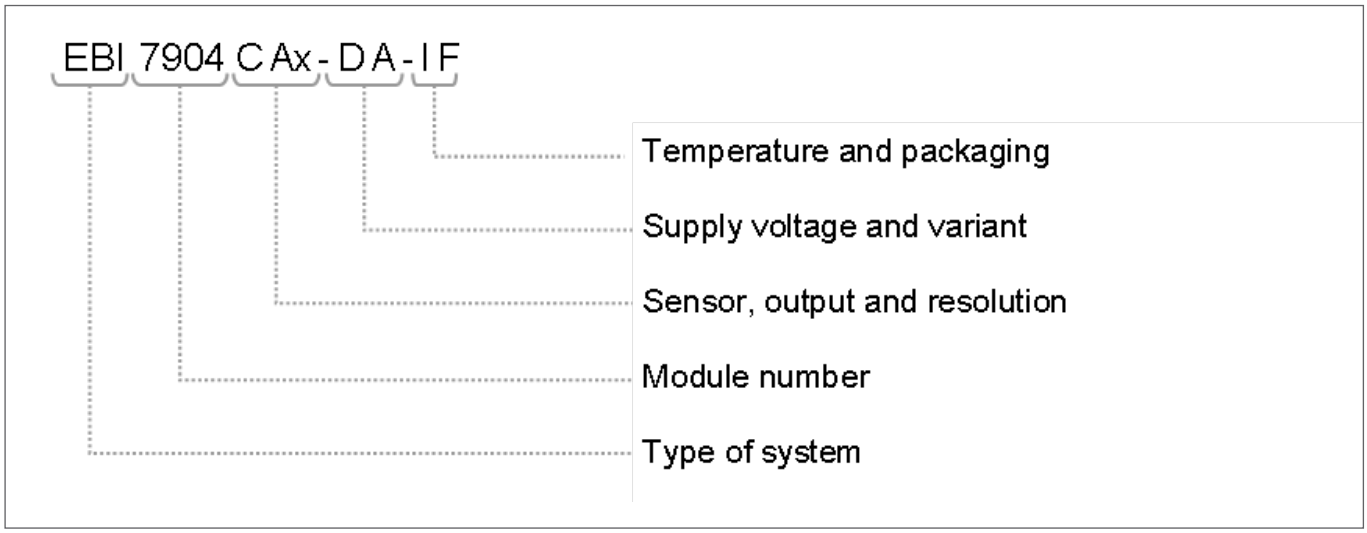


Fig. 8: Typical pin assignment for incremental measurement.

Order Code



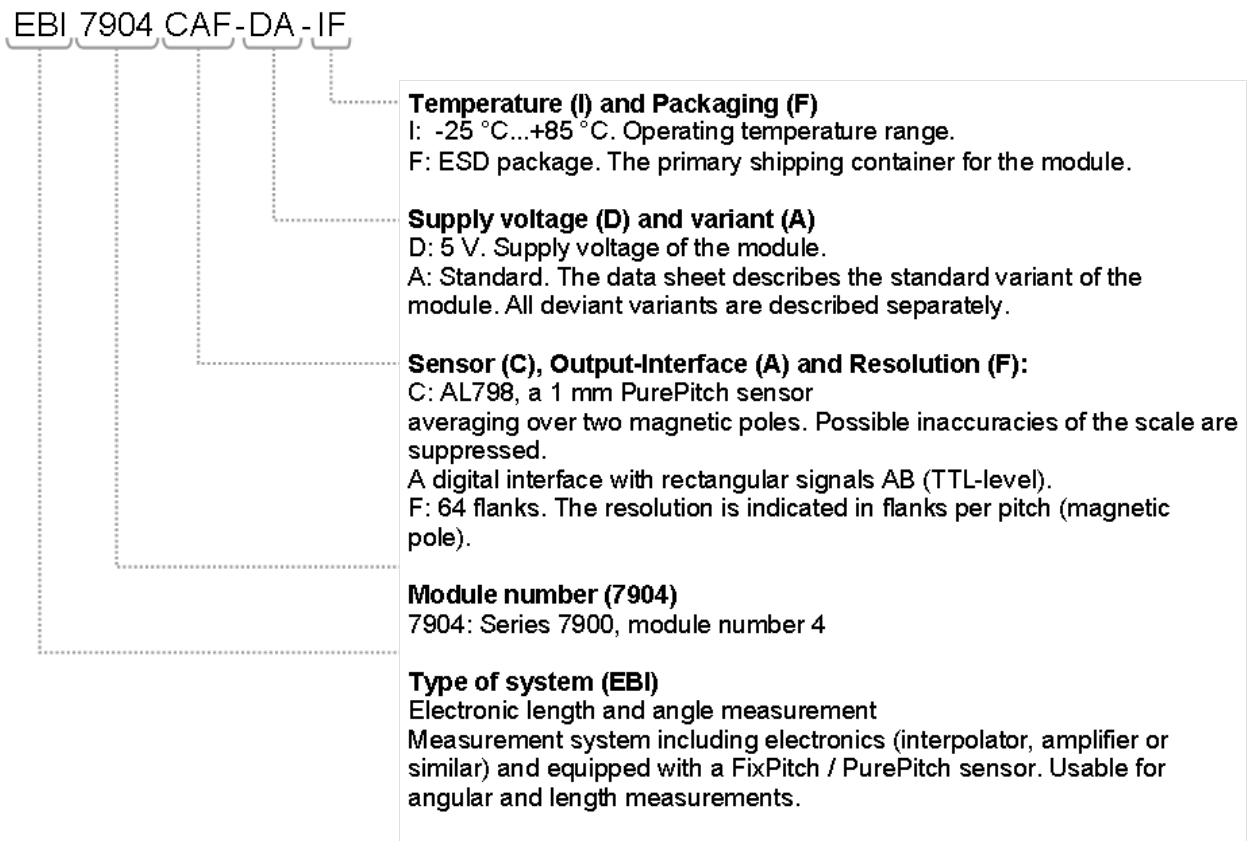
Product Overview - Standard Products

Resolution Flanks per pitch	Interpolation factor	Article description	Article number
8	2	EBI7904CAB-DA-IF	5112.2110.0
32	8	EBI7904CAE-DA-IF	5112.2111.0
64	16	EBI7904CAF-DA-IF	5112.2112.0
128	32	EBI7904CAI-DA-IF	5112.2113.0
200	50	EBI7904CAJ-DA-IF	5112.2114.0
1000	250	EBI7904CAN-DA-IF	5112.2115.0
2000	500	EBI7904CAP-DA-IF	5112.2116.0
4096	1024	EBI7904CAQ-DA-IF	5112.2117.0
8192	2048	EBI7904CAR-DA-IF	5112.2118.0

Product Overview - Special Products

Article description	Flanks per mm	Special feature	Article number
EBI7904CAN-DB-IF	1000	Hysteresis 0.35 deg	5112.2120.0
EBI7904CAN-DC-IF	1000	FCTR 4202	5112.2121.0

Additional Information on Ordering Code



Special Design Features

PerfectWave

Sensors with PerfectWave design provide the best signal quality, highest accuracy and optimal sensor linearity by filtering out higher harmonics in the signal. The linearity of the sensor is assured, even for weak magnetic field measurement.

PurePitch

In PurePitch sensors the FixPitch principle is extended over several poles in order to increase accuracy still further. This arrangement reduces the influence of errors in the measurement scale and improves the immunity to interference fields.

General Information

Product Status

The product is in series production.

Note: The status of the product may have changed since this data sheet was published. The latest information is available on the internet at www.sensitec.com.

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Changelist

Version	Description of the Change	Date
EBI7904CAx-DA.DSE.05	Disclaimer supplement	06/2022
EBI7904CAx-DA.DSE.04	Change of corporate design (pp. 1-11)	01/2022
EBI7904CAx-DA.DSE.00	Original (pp. 1-11)	06/2012

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