iC-RB Series (Abstract)

preliminary

HIGH-RESOLUTION OPTICAL SAFETY ENCODER

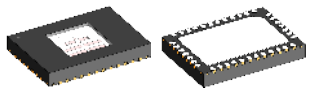
FEATURES

- Separate and independent 2-channel scanning
- Control/Safety Channel scan different positions of the code disc
- Fixed code disc diameters of 26.5 mm or 42.5 mm
- Control Channel (CC) features:
  - 10-bit Pseudo-random Code (PRC)
  - 14-bit S&H SAR interpolator (1024 CPR sine/cosine)
  - BiSS interface
  - MT interface (SSI)
  - Pin-selectable modes of operation
  - Diagnostics (e.g sin/cos amplitude monitor)
- Safety Channel (SC) features:
  - 10-bit Pseudo-random Code (PRC)
  - 5-bit real-time interpolator (1024 CPR sine/cosine)
  - BiSS/SPI interface
  - MT interface (SSI)
  - Configuration via BiSS, SPI and I²C from ext. EEPROM
  - Diagnostics (e.g sin/cos AC monitor)
  - On-chip temperature sensor

APPLICATIONS

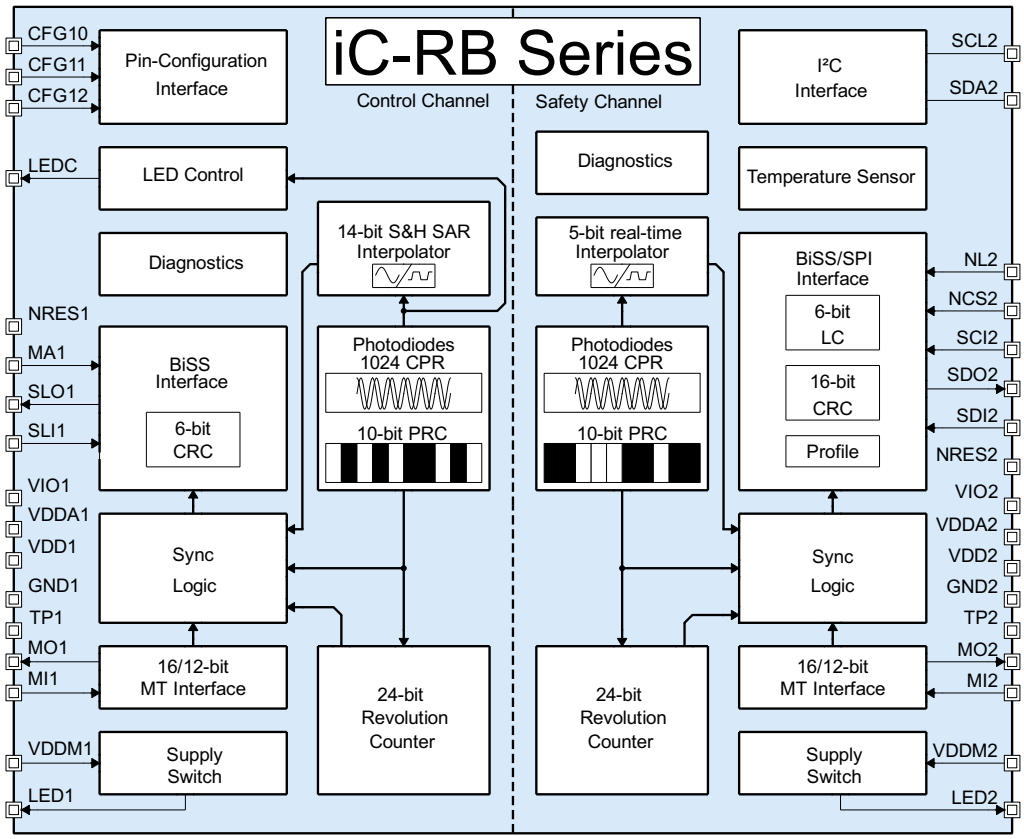
- High resolution optical single-chip encoder (24-bit CPW)
- Functional safety encoder
- Singleturn and multiturn encoders for motor feedback

PACKAGES



38-pin optoQFN
7.0 mm x 5.0 mm x 1.0 mm
RoHS compliant

BLOCK DIAGRAM



DESCRIPTION

iC-RB is an advanced high-resolution optical sensor IC for transmissive encoders, with integrated photodiodes for reliable and redundant scanning of a code disc with 2 different tracks:

1. Incremental track (1024 CPR sine/cosine)
2. Pseudo-random Code track (10-bit PRC)

iC-RB is divided into two autonomous channels called Control Channel (CC) and Safety Channel (SC).

The Safety Channel generates a 15-bit absolute position value by scanning the absolute 10-bit PRC track and the incremental track (1024 CPR sine/cosine). In doing so, the scanning of the PRC is synchronized with the 1024 CPR sine/cosine signals, which are further resolved by a 5-bit real-time interpolator.

The Control Channel operates in the same way, except that the sin/cos signals are further resolved by a 14-bit S&H SAR interpolator. Thus the Control Channel generates a 24-bit absolute position value, meaning the position data generation is redundant for a 15-bit resolution: the Control Channel generates the Control Position Word (CPW), and the Safety Channel the Safety Position Word (SPW).

The 24-bit absolute position value of the CPW is output via a serial BiSS Interface using a 6-bit CRC. The 15-bit absolute position value of the SPW is output via a serial BiSS/SPI Interface using a 16-bit CRC and 6-bit sign-of-life counter (LC).

Each channel uses its absolute 10-bit PRC track photodiodes to capture and count revolutions (embedded 24-bit revolution counter). These revolution counters can be supplied from an independent external energy source (e.g. a battery).

An optional multiturn value (12 bit or 16 bit) can be read by the Control Channel and the Safety Channel through the MT interface of each channel, using the SSI protocol. This multiturn data is synchronized to the internally generated singleturn absolute value.

All integrated photosensors used for the incremental scanning of sine/cosine signals are arranged as an *HD Phased Array*, providing excellent signal fidelity at relaxed alignment tolerances.

For safety-related applications the appropriate Safety Implementation Manual has to be considered.

General notice on materials under excessive conditions
Epoxy resins (such as solder resists, IC package and injection molding materials, as well as adhesives) may show discoloration, yellowing, and general surface changes when exposed long-term to high temperatures, humidity, irradiation, or due to thermal treatments for soldering and other manufacturing processes.

Equally, standard molding materials used for IC packages can show visible changes induced by irradiation, among others when exposed to light of shorter wavelengths, for instance, blue light. Such surface effects caused by visible or IR LED light are rated to be of cosmetic nature, without influence on the chip's function, its specifications or reliability.

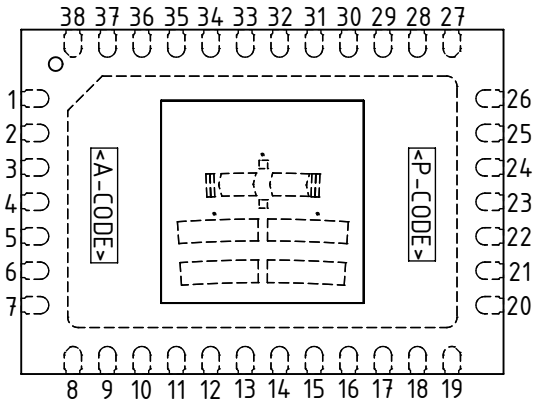
Note that any other materials used in the system (e.g. varnish, glue, code disc) should also be verified for irradiation effects.

General notice on application-specific programming
Parameters defined in the datasheet represent supplier's attentive tests and validations, but - by principle - do not imply any warranty or guarantee as to their accuracy, completeness or correctness under all application conditions. In particular, setup conditions, register settings and power-up have to be thoroughly validated by the user within his specific application environment and requirements (system responsibility).

The chip's performance in application is impacted by system conditions like the quality of the optical target, the illumination, temperature and mechanical stress, sensor alignment and initial calibration.

PACKAGING INFORMATION

PIN CONFIGURATION
oQFN38-7x5



PIN FUNCTIONS

No.	Name	Function
1	VDDM1	+3 V...+5 V MT Supply Voltage [7] (CC [3])
2	VIO1	+2.5 V...+5 V I/O Supply Voltage [6] (CC)
3	n.c. [1]	
4	TP1	Test Input 1 (CC)
5	NRES1	REBOOT input/indication output (CC)
6	MO1	MT Interface, clock output (CC)
7	MI1	MT Interface, data input (CC)
8	CFG12	Configuration Input 2 (CC)
9	CFG11	Configuration Input 1 (CC)
10	CFG10	Configuration Input 0 (CC)

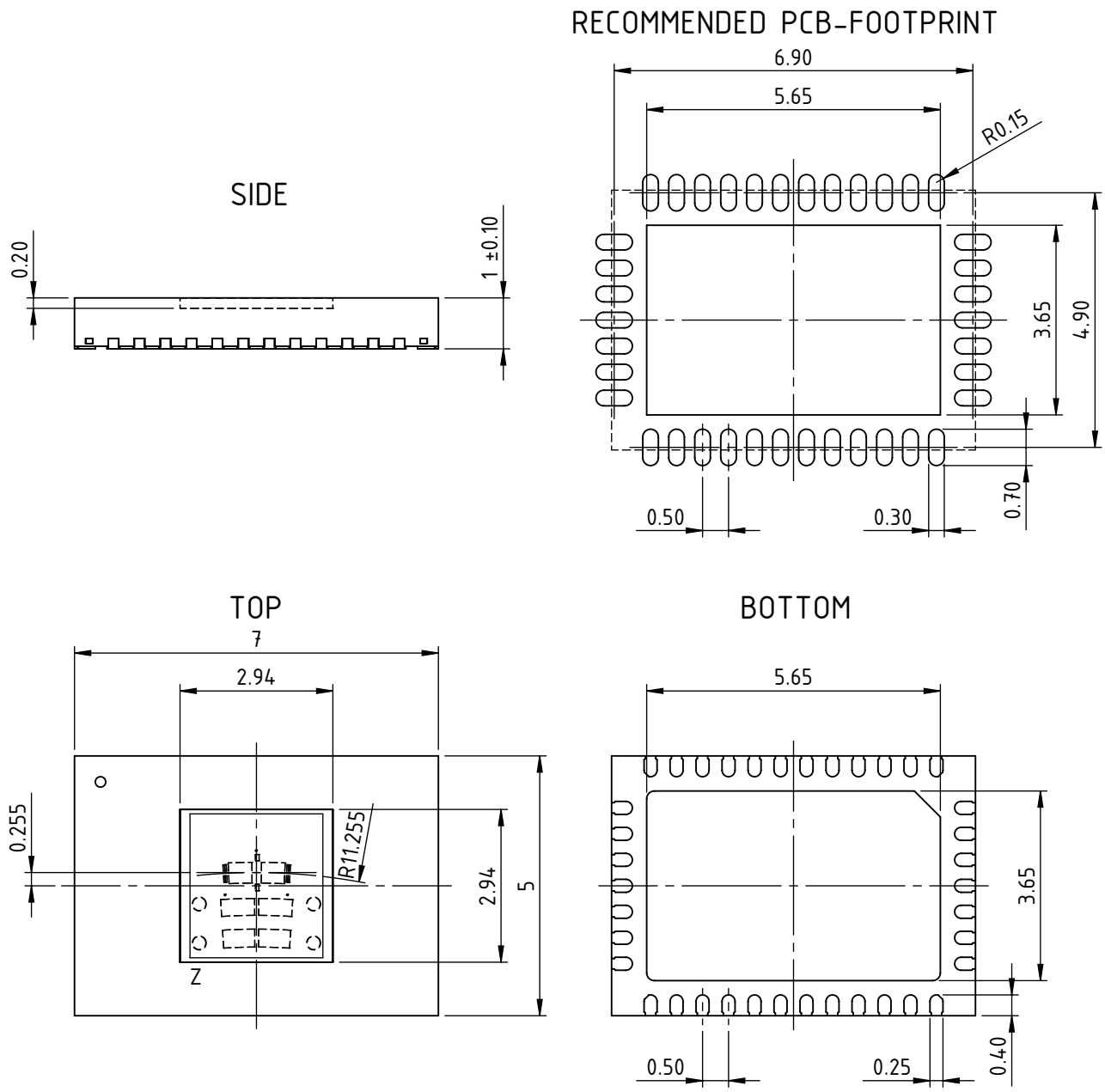
PIN FUNCTIONS

No.	Name	Function
11	MA1	BiSS Interface, clock input (CC)
12	SLO1	BiSS Interface, data output (CC)
13	SLI1	BiSS Interface, data input (CC)
14	SCL2	I²C Interface, clock line (SC [4])
15	SDA2	I²C Interface, data line (SC)
16	SDO2	BiSS/SPI Interface, data output (SC)
17	SCI2	BiSS/SPI Interface, clock input (SC)
18	SDI2	BiSS/SPI Interface, data input (SC)
19	n.c.	
20	NCS2	SPI Interface, chip select input [2] (SC)
21	NL2	SPI Interface, latch input [2] (SC)
22	MI2	MT Interface, data input (SC)
23	MO2	MT Interface, clock output (SC)
24	NRES2	REBOOT input/indication output (SC)
25	TP2	Test Input 2 (SC)
26	VIO2	+2.5 V...+5 V I/O Supply Voltage [6] (SC)
27	VDDM2	+3 V...+5 V MT Supply Voltage [7] (SC)
28	VDDA2	+5 V Supply Voltage Analog [6] (SC)
29	VDD2	+5 V Supply Voltage Digital [6] (SC)
30	GND2	Ground (SC)
31	LED2	LED Flashing Output [5] (MT) (SC)
32	n.c.	
33	n.c.	
34	LED1	LED Flashing Output [5] (MT) (CC)
35	GND1	Ground (CC)
36	VDD1	+5 V Supply Voltage Digital [6] (CC)
37	VDDA1	+5 V Supply Voltage Analog [6] (CC)
38	LEDC	LED Control Output [5] (CC)

IC top marking: <P-CODE> = product code, <A-CODE> = assembly code (subject to changes);
[1] Pin numbers marked n.c. are not connected.
[2] Pin is low active.
[3] **CC: Control Channel** Grounding all channel pins should be considered if not in use.
[4] **SC: Safety Channel** Grounding all channel pins should be considered if not in use.
[5] High-side current source output. If the battery-buffered MT function is not in use, connect LED1 to GND1, respectively LED2 to GND2.
[6] Open-drain output
[7] Supply voltage input must be blocked with a capacitor of at least 100 nF close to the chip's supply terminals.
[8] Supply voltage input must be blocked with a capacitor of at least 1 µF close to the chip's supply terminals. If the battery-buffered MT function is not in use, connect VDDM1 to VDDA1, respectively VDDM2 to VDDA2. Refer to footnote 5 for LED1, and LED2.

To better EMI immunity, unused pins should be wired externally according to the built-in pull-up/pull-down.
TP1/2 must be connected to GND1/2.
GND1 and GND2 must be connected to each other.
The thermal pad of the oQFN package (bottom side) must be connected by a single link to GND1 or GND2. A current flow across the paddle is not permissible.

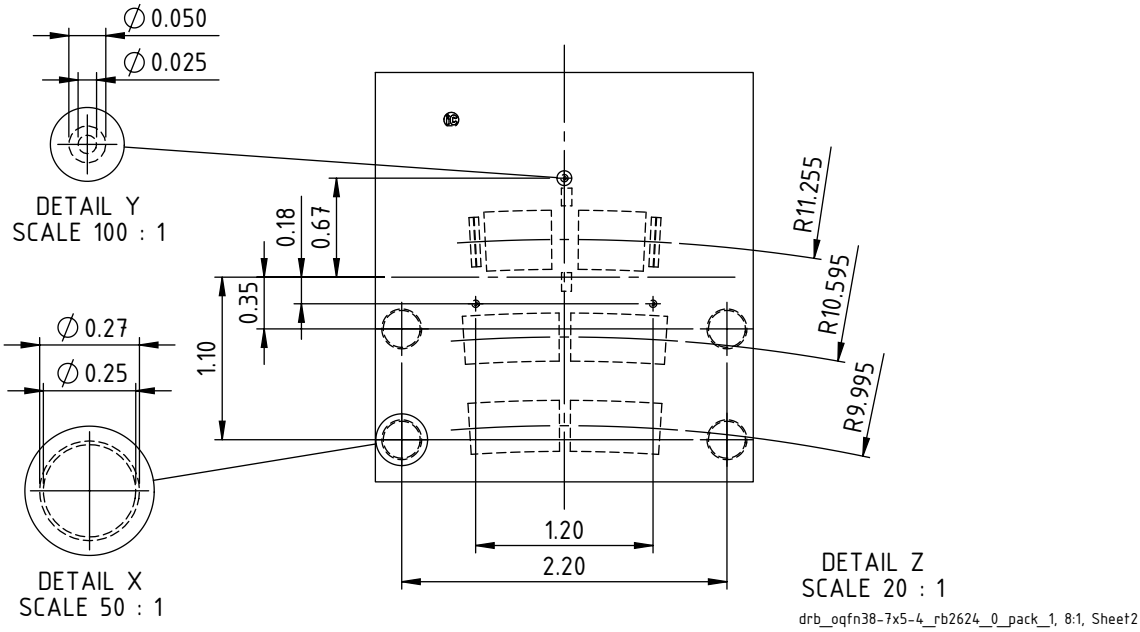
PACKAGE DIMENSIONS : iC-RB2624 oQFN38-7x5



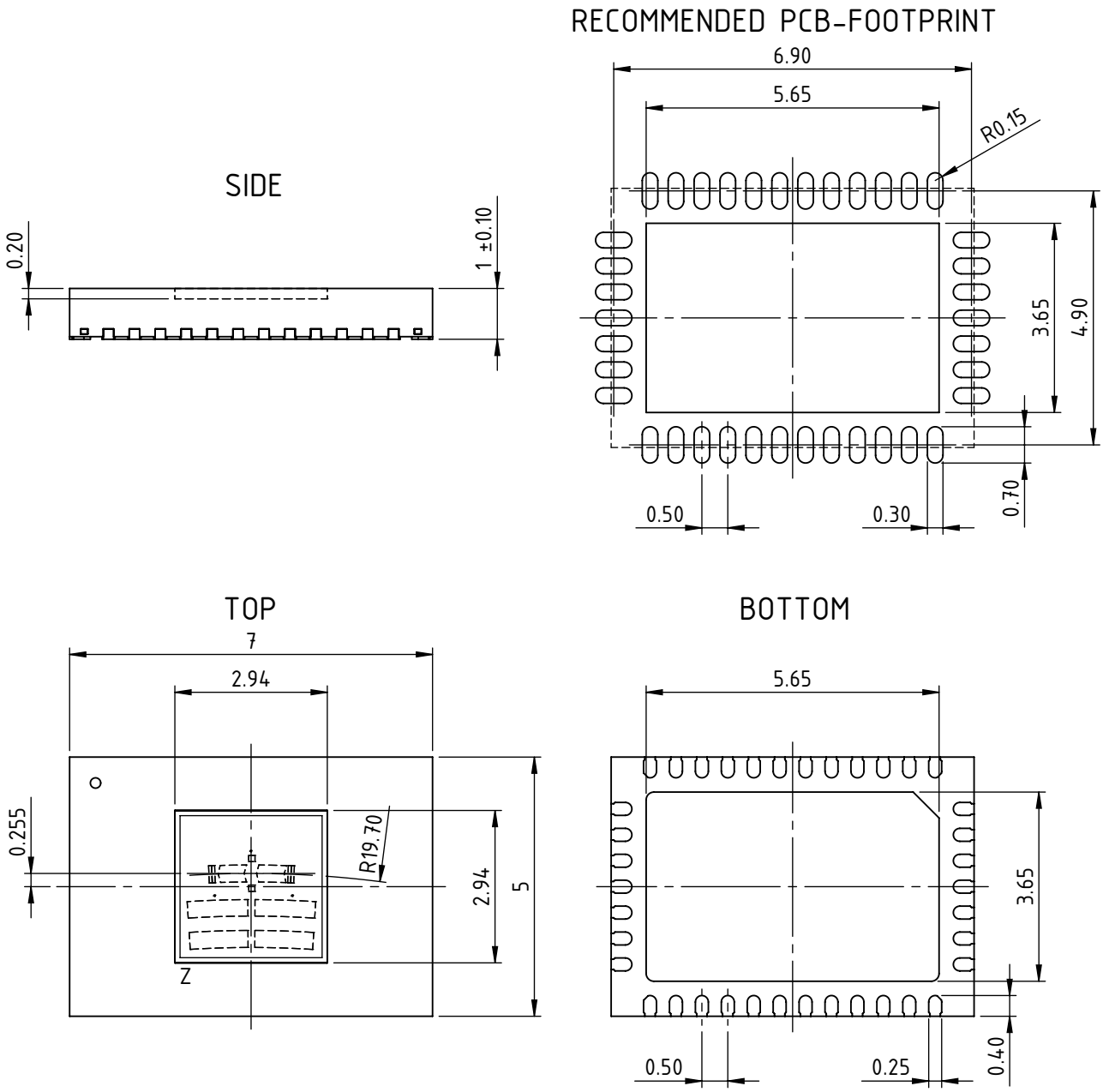
All dimensions given in mm. General tolerances of form and position according to JEDEC MO-220.
Positional tolerance of sensor pattern: ±70µm / ±0.6° (with respect to center of backside pad).
Maximum molding excess +10µm / -75µm versus surface of glass. Small pits in the mold surface, which may occasionally appear due to the manufacturing process, are cosmetic in nature and do not affect reliability.

drb_oqfn38-7x5-4_rb2624_0_pack_1, 8:1, Sheet1

LAYOUT DETAILS: iC-RB2624



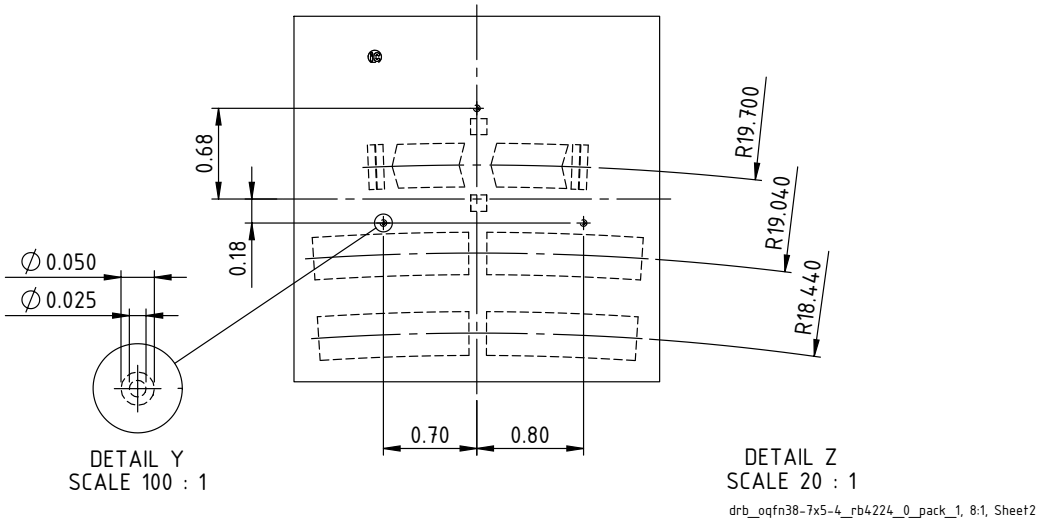
PACKAGE DIMENSIONS : iC-RB4224 oQFN38-7x5



All dimensions given in mm. General tolerances of form and position according to JEDEC MO-220.
Positional tolerance of sensor pattern: ±70µm / ±0.6° (with respect to center of backside pad).
Maximum molding excess +10µm / -75µm versus surface of glass. Small pits in the mold surface, which may occasionally appear due to the manufacturing process, are cosmetic in nature and do not affect reliability.

drb_oqfn38-7x5-4_rb4224_0_pack_1, 8:1, Sheet1

LAYOUT DETAILS: iC-RB4224



SYSTEM OVERVIEW

Overview

The iC-RB is divided into two sections called the Control Channel (CC) and the Safety Channel (SC): each section decodes the absolute singleturn position from the code disc (CPW and SPW).
The code disc contains 2 different tracks: 1 incremental track of 1024 CPR, 1 absolute Pseudo-random Code track (10-bit PRC).
The two channels are on the same substrate, but are separated by a trench. Each channel features its own photodiodes for scanning the tracks of the code disc. Due to this, the absolute singleturn position is generated from two different code sections of the code disc. The following figure shows the general data flow.

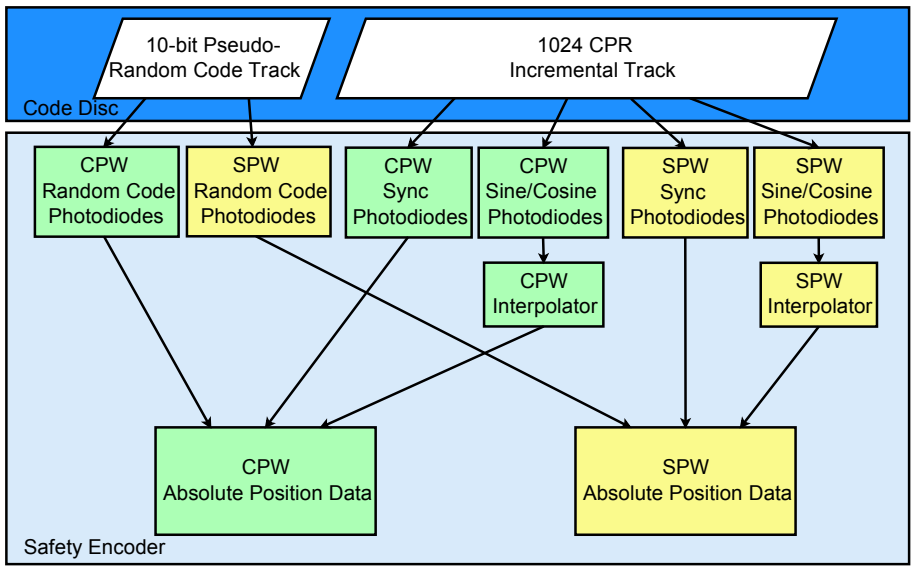


Figure 1: Principle data flow

According to the chip's sine/cosine photosensor layout, a phase-shift exists between the 2 different sine/cosine tracks as shown in Figure 2.

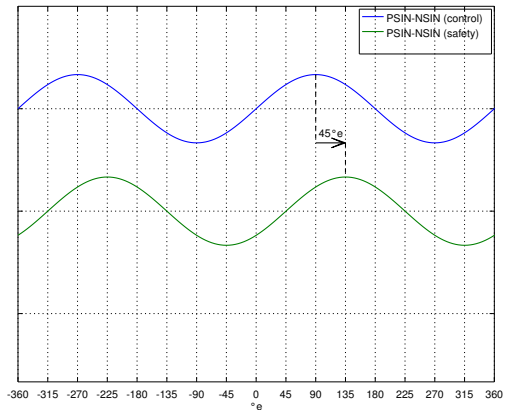


Figure 2: Sine/Cosine phase-shift, °e = with reference to one electrical period

As for the sine/cosine photosensors, there is also a permanent difference between the two 10-bit Pseudo-random code values. The PRC sensor sections are arranged to give a constant difference of 11.125 LSB, with respect to a 10-bit resolution.

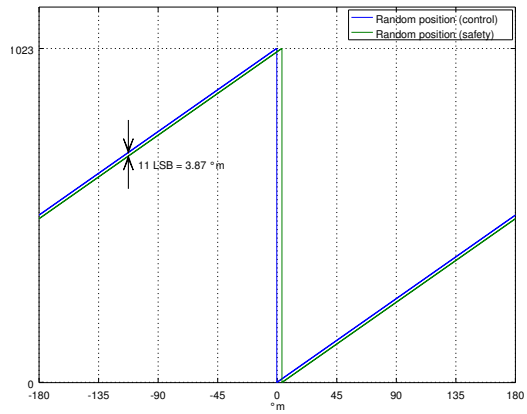


Figure 3: PRC position difference, °m = with reference to one mechanical revolution

Since the two position words are generated completely independently of each other, iC-RB is suitable for use in safety-related applications. The system requirements and restrictions described in the corresponding Safety Implementation Manual has to be considered.

For safety-related applications the appropriate Safety Implementation Manual has to be considered.

Control Channel (CC)
The Control Channel consists of the following blocks:

- Photodiodes with amplifiers for 1024 CPR sin/cos signals
- Photodiodes with amplifiers and comparators for 10-bit PRC scanning
- 14-bit S&H SAR interpolator for the sin/cos signals of 1024 CPR
- Multiturn section
- Serial BiSS interface for position data output and configuration
- Pin-configuration inputs CFG10, CFG11, CFG12
- Diagnostics (e.g. sin/cos amplitude monitor)
- LED control output (based on the 1024 CPR signals)

The generated position word of the Control Channel is called Control Position Word (CPW).

Safety Channel (SC)
The Safety Channel consists of the following blocks:

- Photodiodes with amplifiers for 1024 CPR sin/cos signals
- Photodiodes with amplifiers and comparators for 10-bit PRC scanning
- 5-bit real-time interpolator for the sin/cos signals of 1024 CPR
- Multiturn section
- Serial interface (BiSS/SSI, SPI) for position data output and configuration
- Serial I^2C interface for configuration
- Diagnostics (e.g. sin/cos AC monitor)
- Temperature sensor

The generated position word of the Safety Channel is called Safety Position Word (SPW).