DATA SHEET

PAM7943

Axial 360 degree absolute Encoder

The axial encoder system PAM7943 consists of a 360 degree absolute encoder and a two-track axial magnetic disc which are assembled in a packaged, which can be mounted directly.
This system offers a true-power-on position measurement system with an resolution up to 24 bit.

Due to it's axial magnetic disc and the compact, very flat sensor module the system is ideally suited for use in robot joints or flat motors.

With the proven MR-sensor technology and integrated correction algorithms the PAM is a very robust and reliable solution with a high accuracy and repeatability.

Features

- Singleturn absolute
- Up to 24 bit resolution
- Calibration algorithms
- True-power-on
- Wide temperature range from –40°C up to +85°C
- BiSS, SSI, SPI, RS485 protocol interfaces

Advantages

- Compact design (axial)
- High accuracy
- Robust and reliable

Applications

- Off-axis applications
- Robotic joints
- Automated Guided Vehicles
- Flat electro motors

Product Overview

Article Name	Description
PAM7943ALA-EG	Axial 360 degree absolute encoder, RS485
PAM7943ALB-EG	Axial 360 degree absolute encoder, RS485
PAM7943AHC-EG	Axial 360 degree absolute encoder, SSI
PAM7943AGD-EG	Axial 360 degree absolute encoder, BISS

Quick Overview

Symbol	Parameter	min.	typ.	max.	Unit
V_{CC}	Supply voltage	4.75	5.0	5.25	V
I_C	Current consumption	100	125	150	mA
Res	Resolution Singleturn	-	24	-	bit
Acc	Accuracy	14	-	40	arcsec
T_{amb}	Operating temperature	-40	-	+85	°C

ESD

Electrical Data

T_{amb} = 25°C, V_{CC} = 5.0 V; unless otherwise specified

Symbol	Parameter	Conditions	min.	typ.	max.	Unit
V_{cc}	Supply voltage		4.75	5.0	5.25	V
F_{Pos}	Position Refresh Rate		-	18.0	-	kHz
I_A	Current	V_{CC} = 5.0 V	100.0	125.0	150.0	mA
t_{Start}	Start time		-	100.0	-	ms
T_{op}	Operating temperature		-40	-	+85	°C
$T_{storage}$	Storage temperature		-40	-	+105	°C

Mechanical Data [1)]

T_{amb} = 25°C; unless otherwise specified

Symbol	Parameter	Conditions	min.	typ.	max.	Unit
D_{out}	Outer diameter of the module		-	73.0	-	mm
D_{in}	Inner diameter of the module		17.0	-	23.0	mm
H	Height of the module		8.15	-	17.1	mm

[1)] more details in Fig. 2, Fig. 4, Fig. 6, Fig. 8

Performance Data

T_{amb} = +25°C, V_{CC} = 5.0 V, unless otherwise specified

Symbol	Parameter	Comment	Min.	Typ.	Max.	Unit
Acc_A	Accuracy[2)]		±15.0	-	±20.0	arcsec
Acc	Accuracy		-	±10.0	-	arcsec
Rep_A	Repeatability[2)]		-	-	±3.6	arcsec
Rep	Repeatability		-	±5.0	-	arcsec
Res	Resolution		-	24	-	bit
Speed	Maximum speed		-	10000	-	RPM
$Speed_B$	Maximum speed[3)]		-	1000	-	RPM
N	Noise		-	±0.0005	-	°

[2)] For PAM7943ALA-EG and PAM7943ALB-EG

[3)] For PAM7943ALB-EG

Environmental Data

Symbol	Conditions	min.	typ.	max.	Unit
Vibration resistance		-	-	785	m/s^2
Shock resistance		-	-	980	m/s^2
External magnetic field		-	-	±100	mT
Humidity		-	-	70	%

Pinout of the sensor module

Pad	Symbol	Parameter
1	V_{CC}	Supply Voltage
2	GND	GND
3	A_+	Signal connection
4	B_-	Inverted signal connection

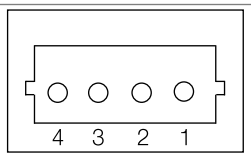


Fig. 1: Pinout of the PAM7943ALA-EG connector

Dimensions

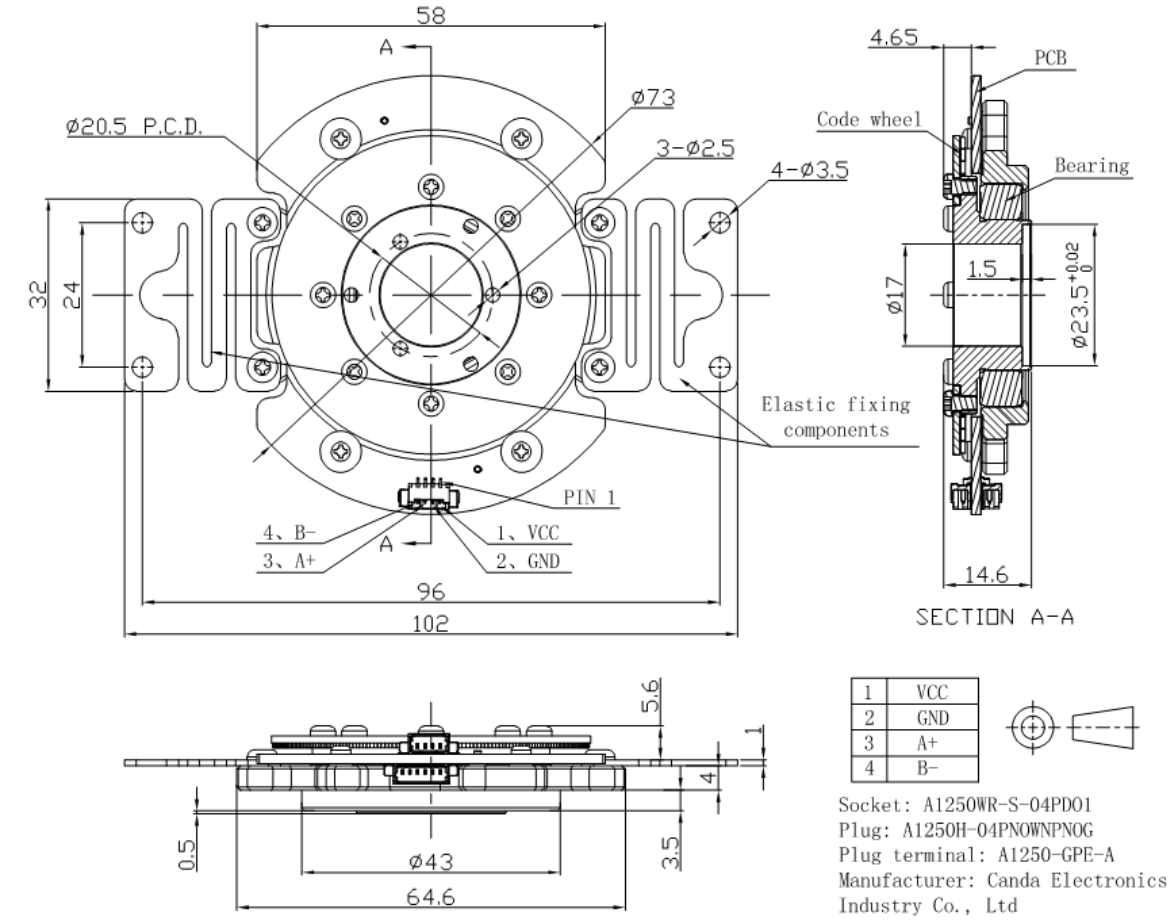


Fig. 2: Dimensions of PAM7943ALA-EG.

Pinout of the sensor module

Pad	Symbol	Parameter
1	V_{CC}	Supply Voltage
2	GND	GND
3	A_+	Signal connection
4	B_-	Inverted signal connection

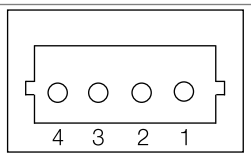


Fig. 3: Pinout of the PAM7943ALB-EG connector

Dimensions

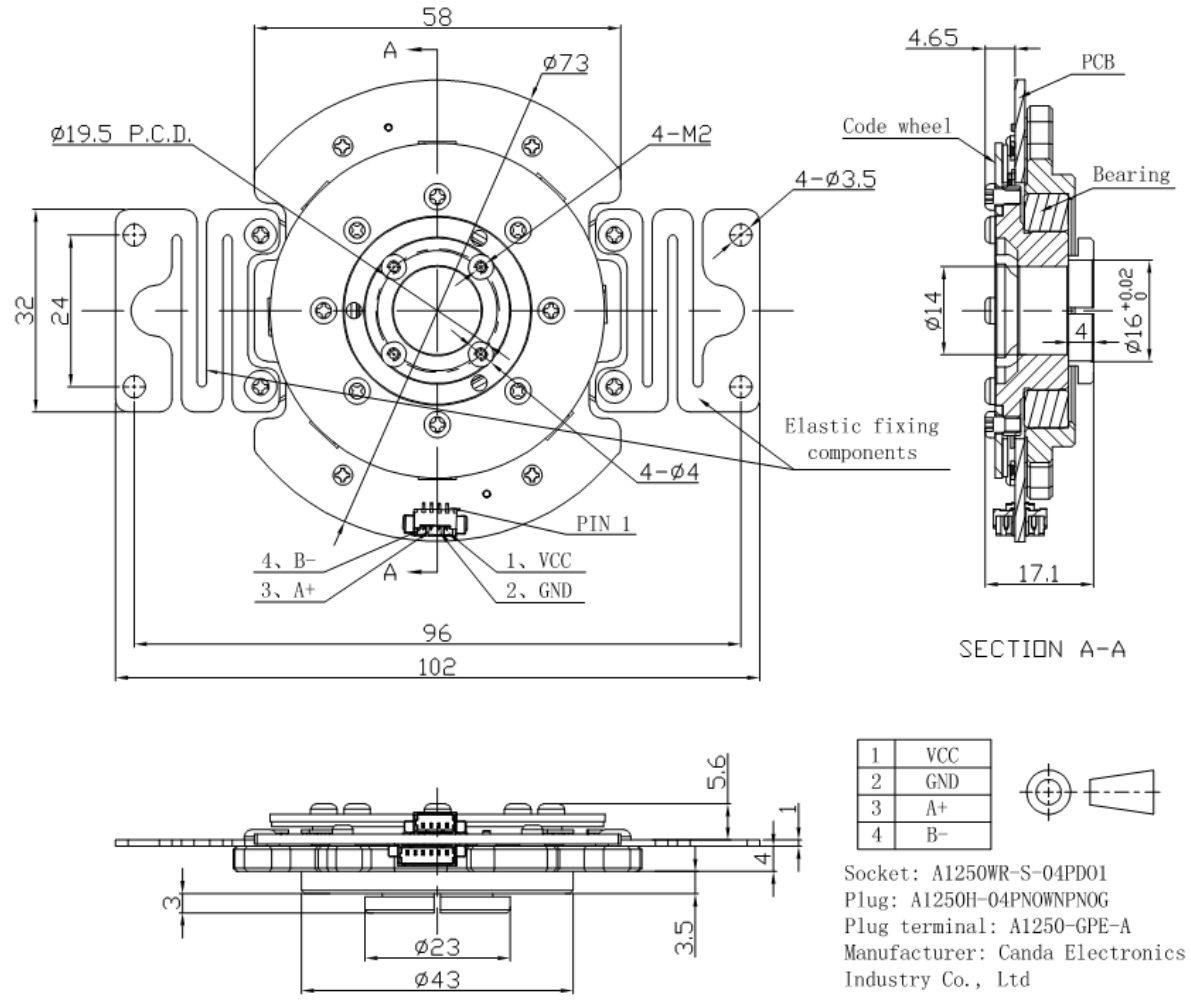


Fig. 4: Dimensions of PAM7943ALB-EG.

Pinout of the sensor module

Pad	Symbol	Parameter
1	V_{CC}	Supply Voltage
2	GND	Ground
3	NC	Not connected
4	NC	Not connected
5	Clk+	Clock signal
6	Clk-	Inverted clock signal
7	Dat+	Data signal
8	Dat-	Inverted data signal

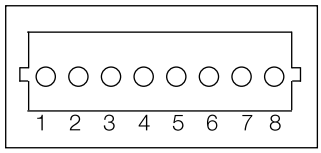


Fig. 5: Pinout of the PAM7943AHC-EG connector

Dimensions

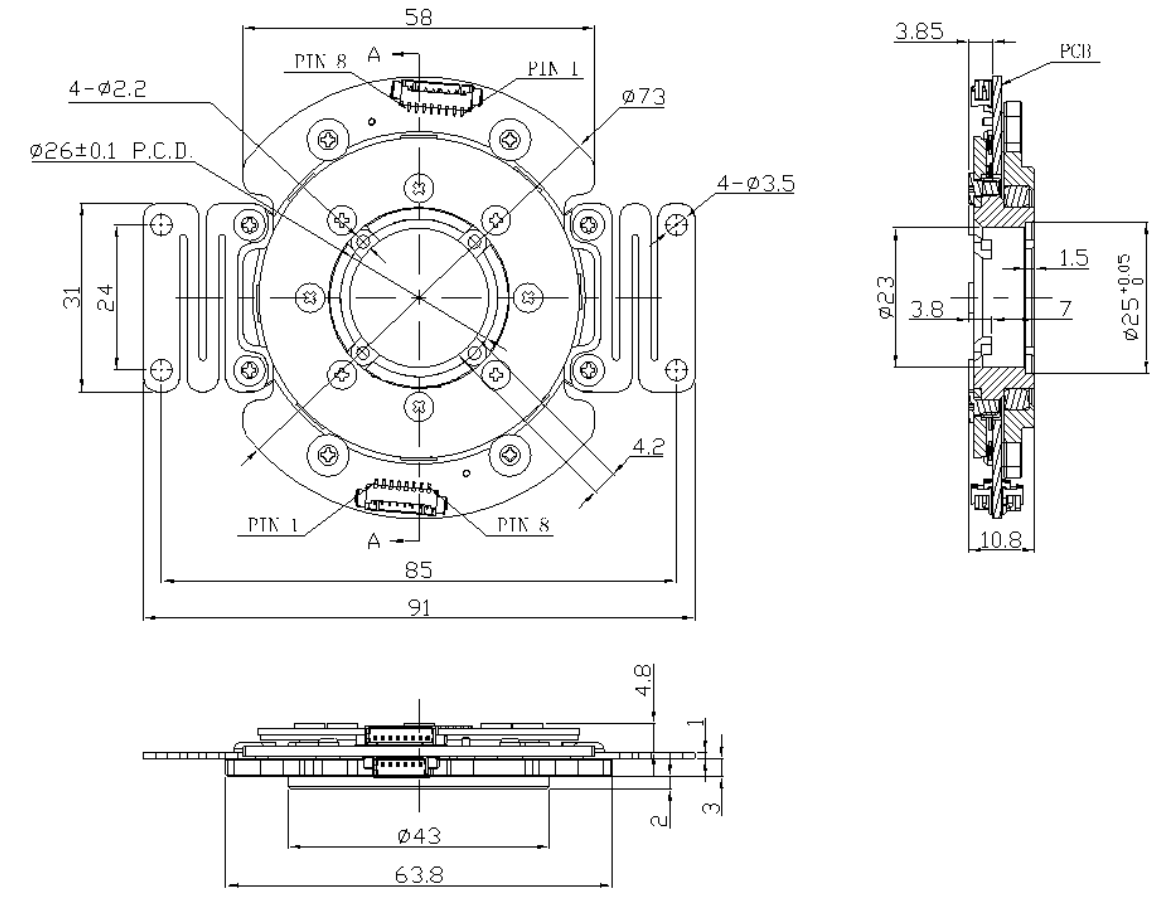


Fig. 6: Dimensions of PAM7943AHC-EG.

Pinout of the sensor module

Pad	Symbol	Parameter
1	V_{CC}	Supply Voltage
2	GND	Ground
3	NC	Not connected
4	NC	Not connected
5	Clk+	Clock signal
6	Clk-	Inverted clock signal
7	Dat+	Data signal
8	Dat-	Inverted data signal

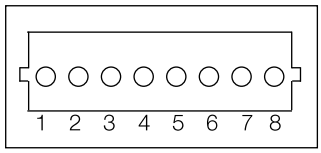


Fig. 7: Pinout of the PAM7943AGD-EG connector

Dimensions

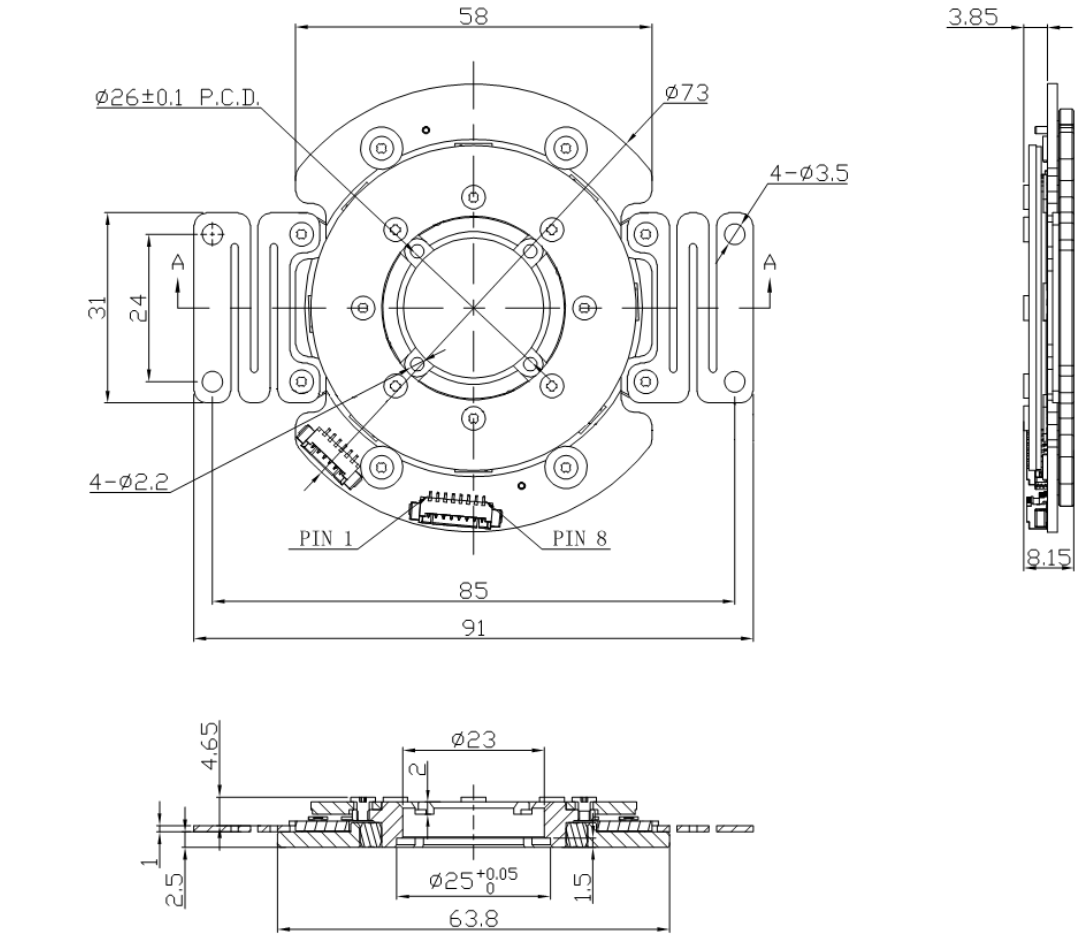


Fig. 8: Dimensions of PAM7943AGD-EG.

RS485 interface

The following chapter describes how the RS485 interface is working and how it is possible to receive the position information of the sensor.

Communication parameters

Baud rate	2.5M
Byte length	8 bits
Even-odd check	Not have
Stop bit	1
Flow control	Not have
Request pass, letter mode	Passive and corresponding communication

Frame format

Request command	Control field					
Transmission data from encoder	1 Byte	2 Byte	3 Byte	4 Byte	5 Byte	6 Byte
	Control field	Status field	Position data			CRC

Control field

Start bit	Sink code			Data ID code				ID parity	Delimiter
0	0	1	0	dc0	dc1	dc2	dc3	dc4	1

Status field

Start bit	Information				Encoder error		Communication error		Delimiter
0	sd0	sd1	sd2	sd3	er0	er1	cl0	cl1	1

Status bits

Bit number	Detailed status
bit12	flash_crc_error
bit13	magic_error
bit14	temp_alarm
bit15	chip_fflt
bit16	prbs_error

RS485 interface

Position data

Data ID	D0	D1	D2	D3	D4	D5	D6	D7
0x02	AS0	AS1	AS2					

CRC verification code[1)]

Start bit	CRC (LSB first)								Delimiter
0	cr0	cr1	cr2	cr3	cr4	cr5	cr6	cr7	1

1) CRC check code: G(x)=X8+1, (X=cr0-cr7)

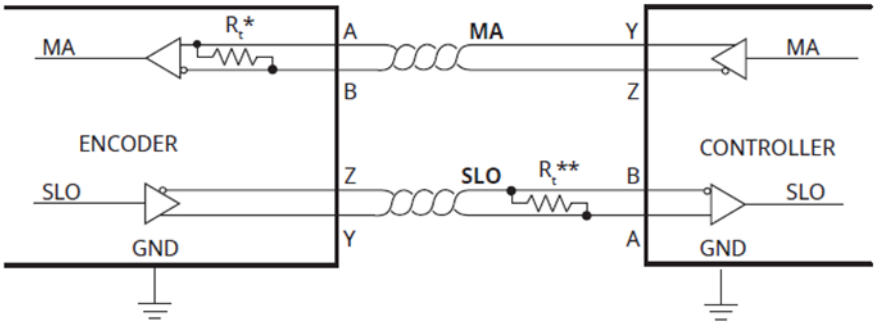
Data ID

Command	Data ID	Data ID code				ID parity
Readout of data	0x02	0	0	0	0	0
	0x8A	1	0	0	0	1
	0x92	0	1	0	0	1
	0x1A	1	1	0	0	0
Writing to EEPROM	0x32	0	1	1	0	0
Readout of EEPROM	0xEA	1	0	1	1	1
Reset	0xC2	0	0	0	1	1
	0x62	0	0	1	1	0

BISS interface

The encoder position is encoded in a 24-bit natural binary format, with data aligned to the left. Status information is provided via the BiSS C protocol. Two active-low status bits follow the position data, succeeded by an inverted CRC for data integrity.

Electrical connection



*) The MA and SLO lines are 5V RS422 compatible differential pairs. The termination resistor on the MA line is integrated inside the encoder.

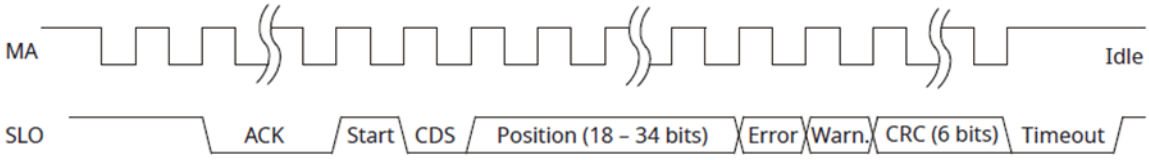
**) If the total cable length is more than 5 meters, it needs to be terminated at the controller. The cable has a nominal impedance of 120Ω.

Signal	
MA	Master clock, the maximum clock frequency is 2.5Mhz
SLO	The data is output on the rising edge of the MA

Output protection

Two mechanisms prevent excessive output current and power loss due to errors or bus collisions. Reverse current limiting on the output stage provides immediate protection against short circuits. In addition, if the chip temperature is too high, the thermal shutdown circuit forces the driver output into a high-impedance state.

Timing diagram



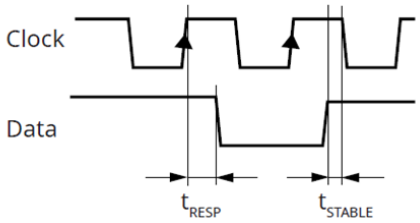
The MA is in a high state and communication starts at the first falling edge.
The encoder sets the SLO low at the second rising edge of the MA, and the ACK length is 1~30 bits.
When the encoder is ready for the next request cycle, it indicates this to the host by setting the SLO to high.
Absolute position and CRC data are provided in binary format and are first sent in MSB format.

Cable length compensation

The read head takes 170 ns to respond to the incoming clock (t_{RESP}). The change in the data signal is delayed by 170 ns after the rising edge of the clock line. The additional delay is caused by the time it takes for the signal to propagate through the cable to the read head and back (t_{PROP}). This delay is typically 14ns per 14 meters of cable. The total cable length from the encoder to the receiver must be considered.

Before a value can be latched, the data signal must be stable. Therefore, if the cable length is more than 1 meter and the clock frequency is higher than 1MHz, this delay must be compensated in the receiver (controller) to which the encoder is connected.

$$t_{DELAY} = t_{RESP} + t_{PROP} \times \text{cable length}$$



Status bits

Type	Value0	Value1	Description
Error	Location data is invalid	OK	Error bit activation is low. If it is low, the bit is invalid.
Warning	Location data is valid	OK	The warning bit is active low. If it is low, the encoder operation is close to its limit. The location is still valid, but the resolution and/or accuracy may be out of specification.

Communication parameters

Parameter	Value
MA frequency	Max. 2.5 MHz
ACK length	1-30 bit
Register access	No

The "Bandwidth" parameter is the mechanical bandwidth. AksIM samples at 18 kHz, so the mechanical change occurs faster than 9 kHz and the output cannot be detected (Nyquist's theorem). If the position request is faster than the sampling frequency, the AksIM encoder recalculates the position at the time of the request based on the current ring velocity.

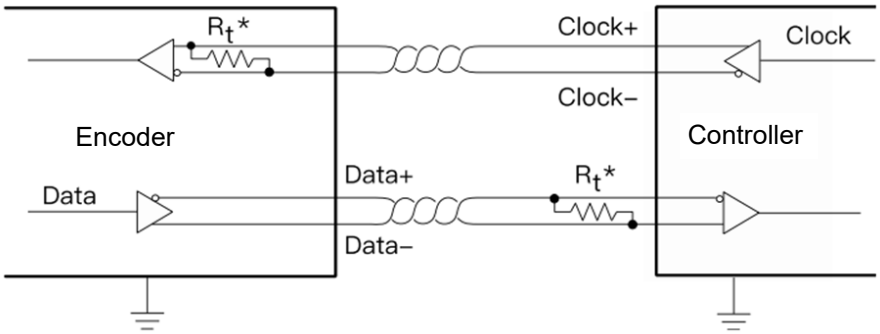
Packet description

24-bit position + 2-bit status + 6-bit CRC = 32-bit long packets.
The CRC calculation polynomial for position, error, and warning data is: x6 + x1 + 1. It is also denoted as 0x43. It is inverted and transmits the MSB first.

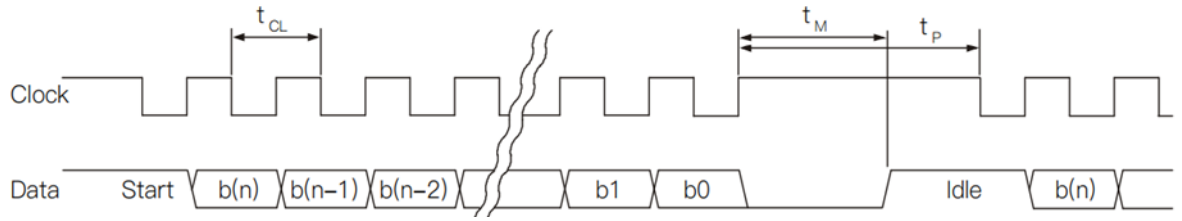
SSI interface

The following chapter describes how the SSI interface is working and how it is possible to receive the position information of the sensor.

Electrical connection



Timing diagram



The protocol uses a Clock to synchronize the acquisition of the clock sequence. When the first falling edge arrives, the system latches the current data and starts writing data to the Data line from the MSB (Most Significant Bit) at each rising edge of the Clock. On the controller side, data on the Data line is read at the falling edge of the Clock, and this process repeats until the LSB (Least Significant Bit) is read by the controller.
After the transmission is completed and the t_M transmission time has elapsed, the Data line will be set to a high level. The Clock signal must remain high until the next read operation is allowed, which is after the t_P time. t_{CL} must be less than tM, and during any read operation, the time can exceed tM to interrupt the read process.

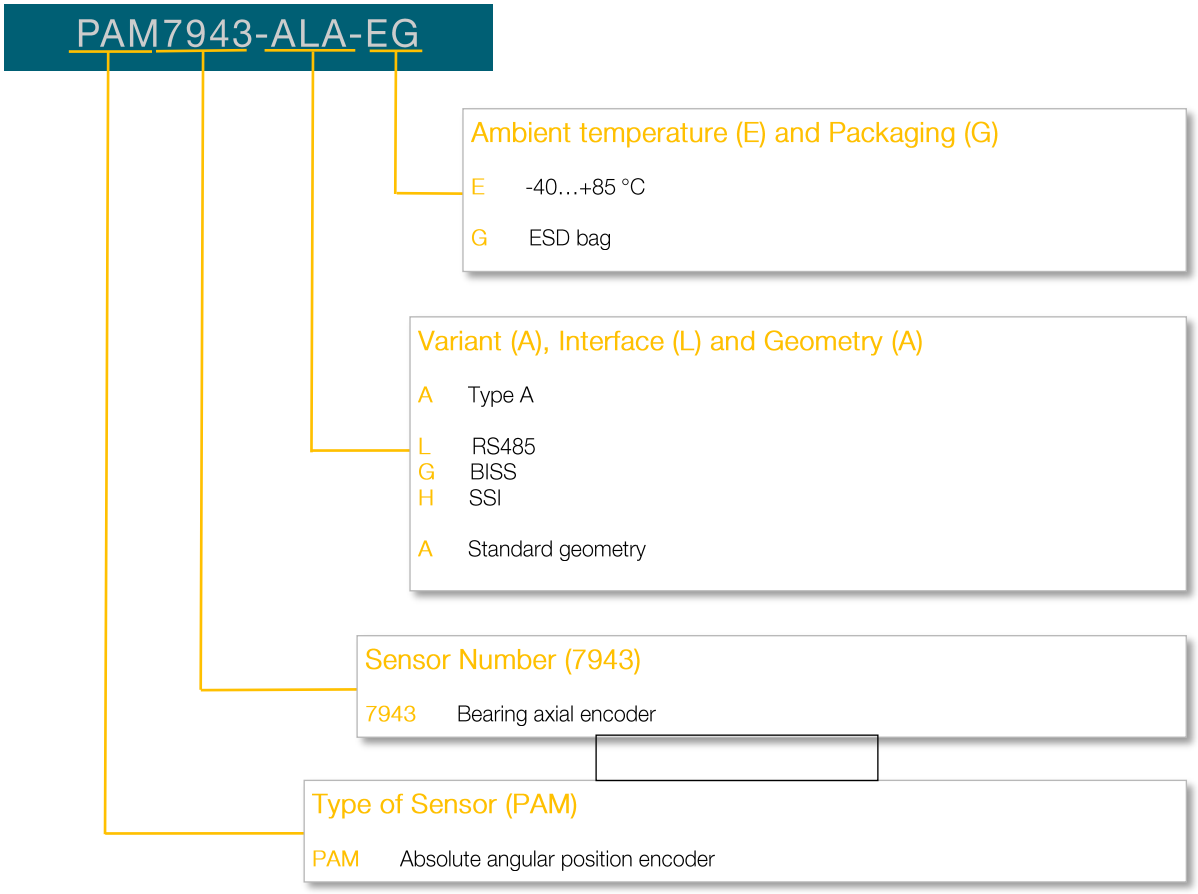
Timing parameters

Parameter	Symbol	Min	Typ	Max
Clock cycle	t_{CL}	400 ns	-	14 µs
Clock frequency	$1/t_{CL}$	110 kHz	-	1.5 MHz
Transfer time out	t_M	-	10 µs	-
Pause time	t_P	20 µs	-	-

Data format

Bit	B19:b0
Length	20 bits
Data	Lap angle

Additional Information on Ordering Code



General Information

Product Status

Article	Status
PAM7943ALA-EG	The product is under development.
PAM7943ALB-EG	The product is under development.
PAM7943AHC-EG	The product is under development.
PAM7943AGD-EG	The product is under development.
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.

Disclaimer

Sensitec GmbH reserves the right to make changes, without notice, in the products, including software, described or contained herein in order to improve design and/or performance. Information in this document is believed to be accurate and reliable. However, Sensitec GmbH does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. Sensitec GmbH takes no responsibility for the content in this document if provided by an information source outside of Sensitec products. In no event shall Sensitec GmbH be liable for any indirect, incidental, punitive, special or consequential damages (including but not limited to lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) irrespective the legal base the claims are based on, including but not limited to tort (including negligence), warranty, breach of contract, equity or any other legal theory. Notwithstanding any damages that customer might incur for any reason whatsoever, Sensitec product aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the General Terms and Conditions of Sale of Sensitec GmbH. Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights. Unless otherwise agreed upon in an individual agreement Sensitec products sold are subject to the General Terms and Conditions of Sales as published at www.sensitec.com. The use and/or application of our products in a military end use is explicitly prohibited. In the event of infringements, we reserve the right to take legal action, including but not limited to the assertion of claims for damages and/or the immediate termination of the business relationship.

General Information

Application Information

Applications that are described herein for any of these products are for illustrative purposes only.Sensitec GmbH makes no representation or warranty – whether expressed or implied – that such applications will be suitable for the specified use without further testing or modification. Customers are responsible for the design and operation of their applications and products using Sensitec products, and Sensitec GmbH accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the Sensitec product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products. Sensitec GmbH does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using Sensitec products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). Sensitec does not accept any liability in this respect.

Life Critical Applications

These products are not qualified for use in life support appliances, aeronautical applications or devices or systems where malfunction of these products can reasonably be expected to result in personal injury.

Copyright © by Sensitec GmbH, Germany

Changelist

Version	Description of the Change	Date
PAM7943.DSE.01	Add BISS and SSI description + 3 different geometries	04/2025
PAM7943.DSE.00	Original (pp. 1-5)	06/2024

Sensitec GmbH
Schanzenfeldstr. 2 • 35578 Wetzlar • Germany
Tel +49 (0) 6441 5291-0 • Fax +49 (0) 6441 5291-117
sensitec@sensitec.com • www.sensitec.com