PAM7944C

Battery-buffered axial 360 degree absolute multiturn Encoder

The axial encoder system PAM7944 consists of a 360 degree absolute encoder and a two-track axial magnetic .
This system offers a true-power-on position measurement system with an resolution up to 20 bit for single turn and 16 bit for battery buffered multi-turn.

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 algo-rithms the PAM is a very robust and reliable solution with a high accuracy and repeatability.

Features

- Multiturn absolute
- Up to 20 bit single turn resolu-tion and 16 bit multiturn
- Calibration algorithms
- True-power-on
- Wide temperature range from –40°C up to +85°C
- BISS and RS485 protocol inter-faces

Product Overview

Article Name	Description
PAM7944-CLAB-EG	Axial 360 degree absolute encoder, RS485
PAM7944-CGAB-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	-	20	-	bit
Res_{multi}	Resolution Multiturn	-	16	-	bit
Acc	Accuracy	-	±10	-	arcsec
T_{amb}	Operating temperature	-40	-	+85	°C

Advantages

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

Applications

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

ESD

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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		-	70.5	-	mm
D_{in}	Inner diameter of the module		-	51.0	-	mm
H	Height of the module		-	10.1	-	mm

[1] more details in Fig. 2 and Fig. 4

Performance Data

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

Symbol	Parameter	Comment	Min.	Typ.	Max.	Unit
Acc	Accuracy		-	±10.0	-	arcsec
Rep	Repeatability		-	±5.0	-	arcsec
Res_{Single}	Resolution single turn		-	20	-	bit
Res_{Multi}	Resolution multi turn		-	16	-	bit
Speed	Maximum speed[4]		-	10000	-	RPM
N	Noise		-	±0.0005	-	°

Environmental Data

Symbol	Conditions	min.	typ.	max.	Unit
Vibration resistance		-	-	785	m/s²
Shock resistance		-	-	980	m/s²
External magnetic field		-	-	±100	mT
Humidity		-	-	70	%

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Pinout of the sensor module

Pad	Symbol	Parameter
1	V_{CC}	Supply Voltage
2	GND	Ground
3	A+	Signal
4	B-	Inverted signal
5	BAT	Battery
6	GND	Ground
7	NC	Not connected
8	NC	Not connected
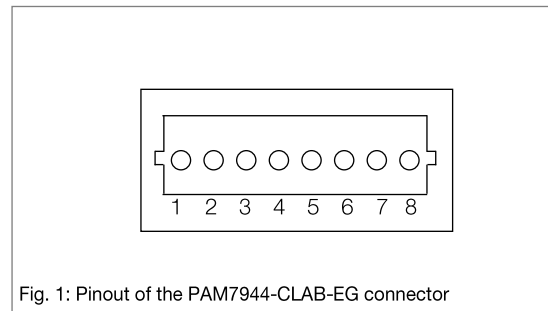
Fig. 1: Pinout of the PAM7944-CLAB-EG connector

Dimensions

200±50 µm between sensor surface and magnetic disc surface
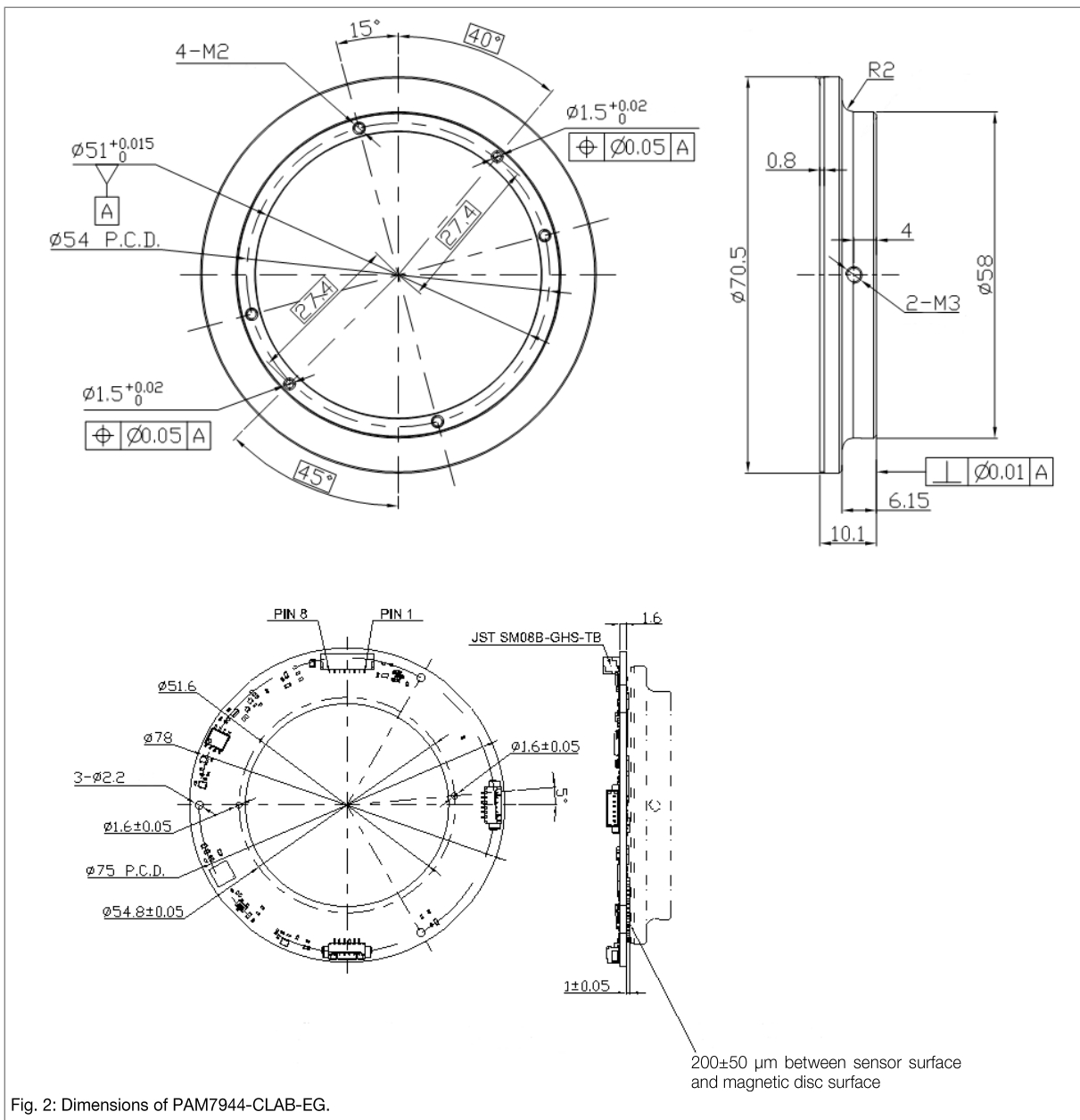
Fig. 2: Dimensions of PAM7944-CLAB-EG.

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Pinout of the sensor module

Pad	Symbol	Parameter
1	V_{CC}	Supply Voltage
2	GND	Ground
3	Clk-	Inverted clock signal
4	Clk+	Clock signal
5	Dat-	Inverted data signal
6	Dat+	Data signal
7	BAT	Battery
8	Res	Reset
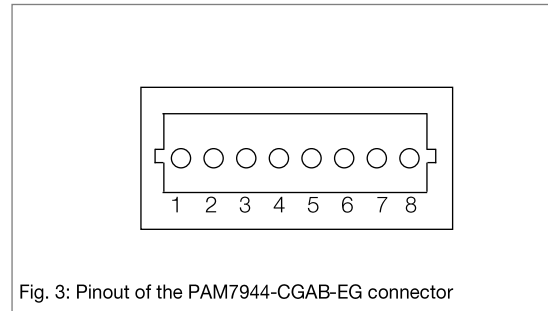
Fig. 3: Pinout of the PAM7944-CGAB-EG connector

Dimensions

200±50 µm between sensor surface and magnetic disc surface

Fig. 4: Dimensions of PAM7944-CGAB-EG.

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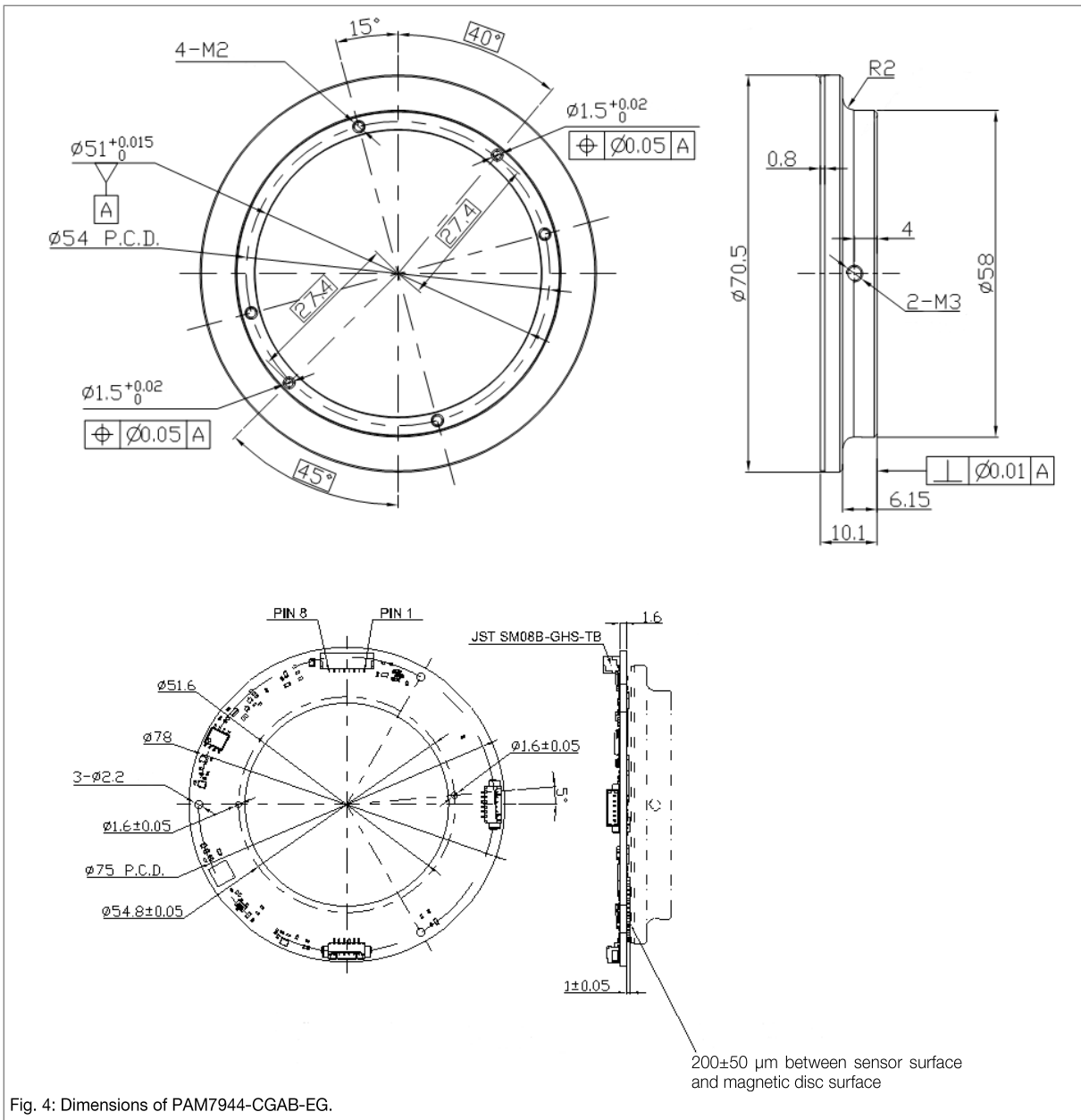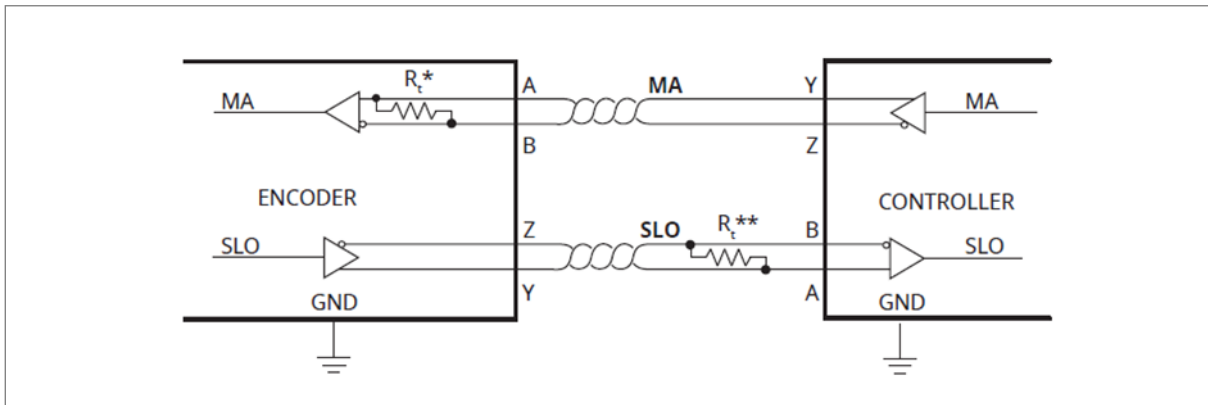## BISS interface

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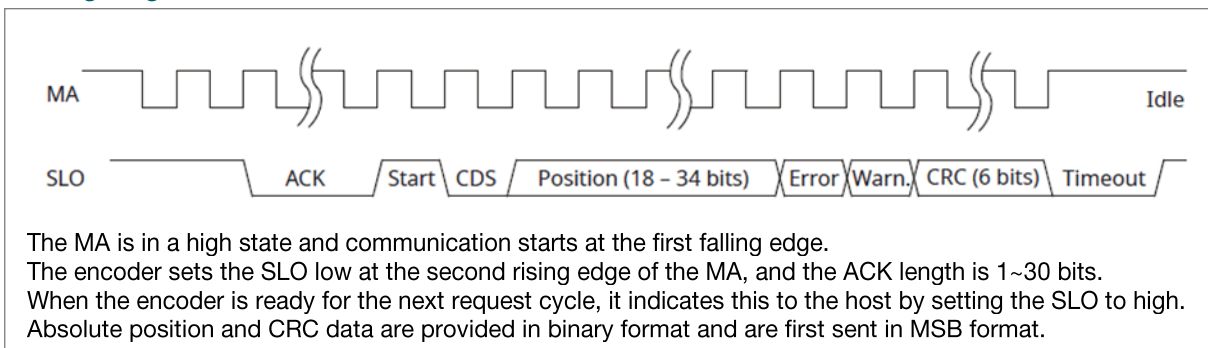
The MA is in a high state and communication starts at the first falling edge.
The encoder sets the SLO low at the second rising edge of the MA, and the ACK length is 1~30 bits.
When the encoder is ready for the next request cycle, it indicates this to the host by setting the SLO to high.
Absolute position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

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Cable length compensation

The read head takes 170 ns to respond to the incoming clock (tRESP). 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 (tPROP). 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.

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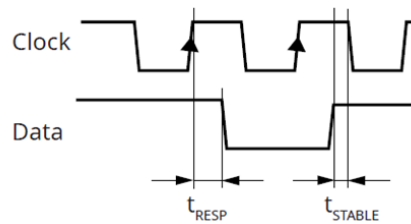
Status bits

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.

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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

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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

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Additional Information on Ordering Code

PAM7944-CLAB-EG

Ambient temperature (E) and Packaging (G)

E   -40…+85 °C

G   ESD bag

Variant (C), Interface (L), Geometry (A) and Version (B,optional)

E   Family C

L   RS485
G   BISS

B   Multiturn

Sensor Number (7943)

7944   360 absolute axial encoder

Type of Sensor (PAM)

PAM   Absolute angular position encoder

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General Information

Product Status

Article	Status
PAM7944-CLAB-EG	The product is under development.
PAM7944-CGAB-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.

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General Information

Application Information

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Changelist

Version	Description of the Change	Date
PAM7944C.DSE.00	Original (pp. 1-11)	04/2025

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