

# PLUTO

Safety-PLC

Manual  
Absolute encoders

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# 1 General

To the Pluto CAN bus up to 16 absolute encoders can be connected. One of the Pluto units on the bus must have software option for communication with the encoders. This special Pluto sends cyclic a sync telegram, which trigs all encoders on the bus to read the position and send a telegram with the position value back to the bus. The special Pluto can read the encoder telegrams and evaluate them. With block functions in the PLC code it is then possible to make a dual channel function with two encoders. Out of this the user gets failsafe values for position and speed including stand still monitoring and over speed detection.

The encoders are standard absolute encoders with modified software to meet the safety requirements.

## 1.1 Reaction time

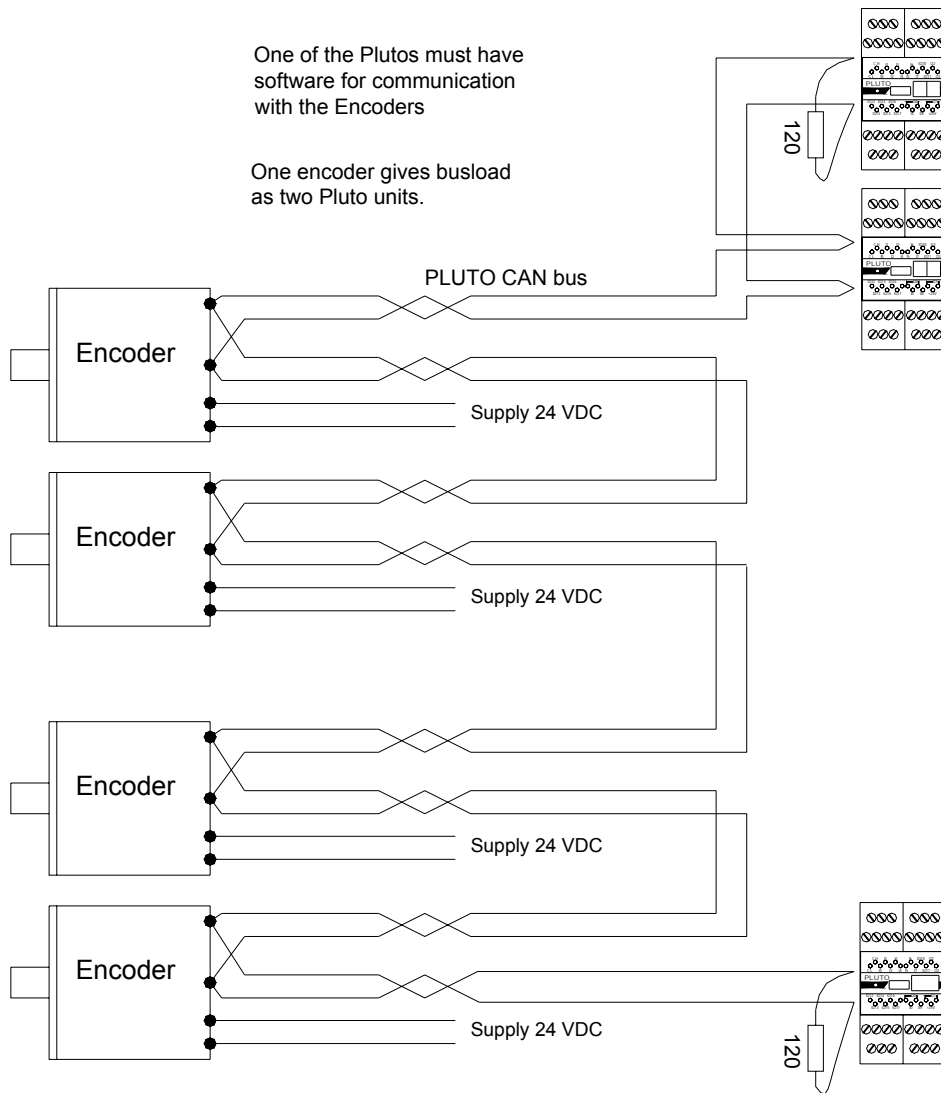
The encoders are read every 10 ms. The system tolerates that a single reading of an encoder fails, but if two or more fails, it leads to failure alarm. This leads to the response times as below.

### **Response time:**

Normal conditions: 11 ms + program execution time  $\approx$  14 ms

By fault: 31 ms + program execution time  $\approx$  34 ms

## 2 Electrical



Connection of CAN bus

### 2.1 CAN bus data

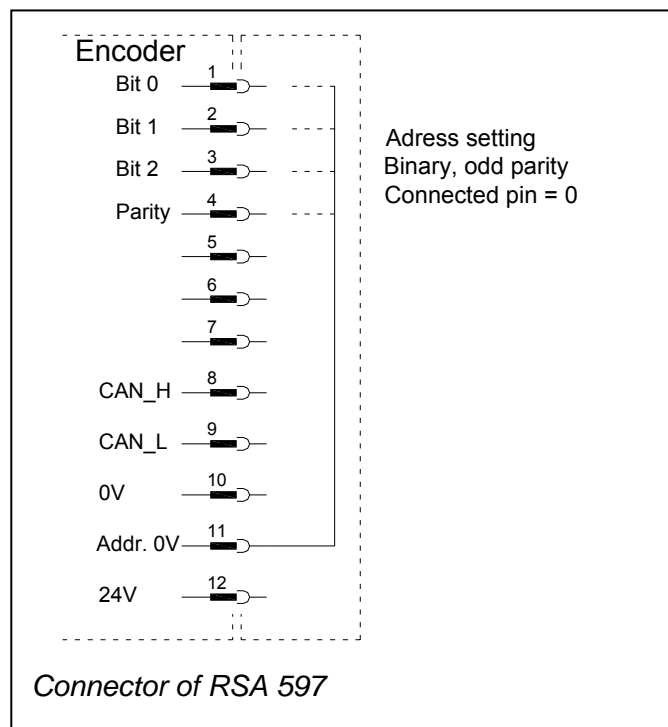
Each encoder loads the bus as two Pluto units. This leads to that with a certain CAN speed, the maximum amount of Pluto units will be reduced by two for each encoder. For example a Pluto-buss running with 250 kbit/s and 4 encoders can have 14-24 Pluto units instead of 22-32.

For bus data as cable length / baudrate, amount of bus nodes, etc., see Pluto - Operating instructions - Hardware.

### 3 Singleturn encoder RSA 597



The singleturn encoder is equipped a 12-pin connector. Besides connection of power supply and CAN bus it is also used for setting the address with jumpers.



#### 3.1 Address setting

The encoder must be addressed 1-8 by connecting pin 1...4 with pin 11 in the connector. By exchange of encoder the addressing will automatically be made by fitting the connector.

Addr.	Pin 4 Parity	Pin 3 Bit 2	Pin 2 Bit 1	Pin 1 Bit 0
1	0	0	0	1
2	0	0	1	0
3	1	0	1	1
4	0	1	0	0
5	1	1	0	1
6	1	1	1	0
7	0	1	1	1
8	1	0	0	0

1 = Not connected  
0 = Connected to pin 11.

Example: Encoder address 3 – Pin 3 connected to Pin 11 and Pin 1,2,4 not connected

Baudrate: 125, 250, 500, 800 kbit/s or 1 Mbit/s. (Default Pluto setting 400kbit/s is not possible)  
At delivery the encoders are set to 500 kbps

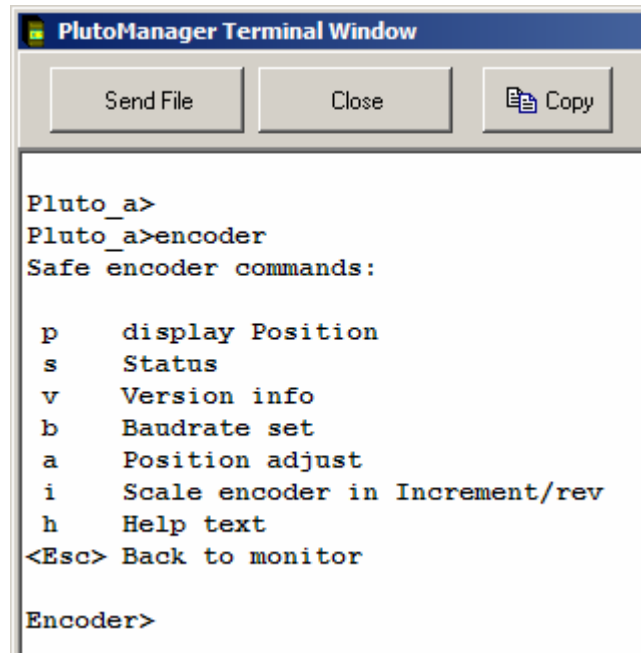
### 3.2 Software settings

An encoder can be adjusted from Pluto by using Terminal Window in Pluto Manager.

By connection the prompt Pluto\_A> shall be visible.

Type 'encoder' for entering the encoder menu where it is possible to change baudrate (B), set the current position (A) and rescale the encoder (I).

NOTE: If an encoder with wrong baud rate is connected to a running Pluto buss the CAN-bus communication fails.



#### 3.2.1 Baudrate

```

Encoder>
Encoder>baud rate set
Encoder node address? (1-16) 1
Desired baudrate ?(125/250/500/800/1000) 500
Command was successful - encoder must be powered on/off
Encoder>
    
```

#### 3.2.2 Scale

Example of setting the scale to degrees.

```

Encoder>
Encoder>increment/rev scaling
Encoder node address? (1-16) 1
Wanted increments/rev? 360
Direction: ClockWise/AntiClockWise? (c/a)c
Encoder is singleturn
This will rescale the encoder - Are you sure? (y/n)y
Encoder rescaled!
Total resolution=          360 (ClockWise direction)
Encoder>
    
```

#### 3.2.3 Position adjustment

The current position is set to 90.

```

Encoder>
Encoder>adjust encoder position
Encoder node address? (1-16) 1
Wanted encoder position 90
This will adjust the encoder position - Are you sure? (y/n)y
Encoder adjusted!
Encoder>
    
```

### 3.3 Speed limit

By use of single turn encoder for speed monitoring the maximum allowed rotating speed is limited to 50 rev/s = 3000 rpm. If the speed is exceeded the speed value will be negative.

**Note:** It must be secured by limitations in application that the maximum speed is not exceeded or that no dangerous situations can occur if it does.

Examples of such limitations are: An induction motor which speed is limited by the frequency or a hydraulic cylinder which is limited by a maximum pump capacity.

### 3.4 Technical data

Type designation: RSA 597

Interface: CAN04

Article number, Leine&Linde: 535503-01

Article number, Jokab: 20-070-36

Encoder data	
Type	RSA 597
Operating temperature	-40°C .. +70°C
Storage temperature	-30°C .. +70°C
Ingress protection class	IP-67 according to IEC 60529
At shaft inlet	IP-66 according to IEC 60529
Vibration (55 to 2000Hz)	< 300 m/s <sup>2</sup> according to IEC 60068-2-6 <sup>(1)</sup>
Shock (6ms)	< 2000 m/s <sup>2</sup> according to IEC 60068-2-27
Cover material	Aluminium
Cover surface treatment	Coated and cromated or anodized
Weight	Approx. 300g
Accuracy and resolution	
Resolution	13 Bit, 8192 positions per revolution
Accuracy	± ½ LSB

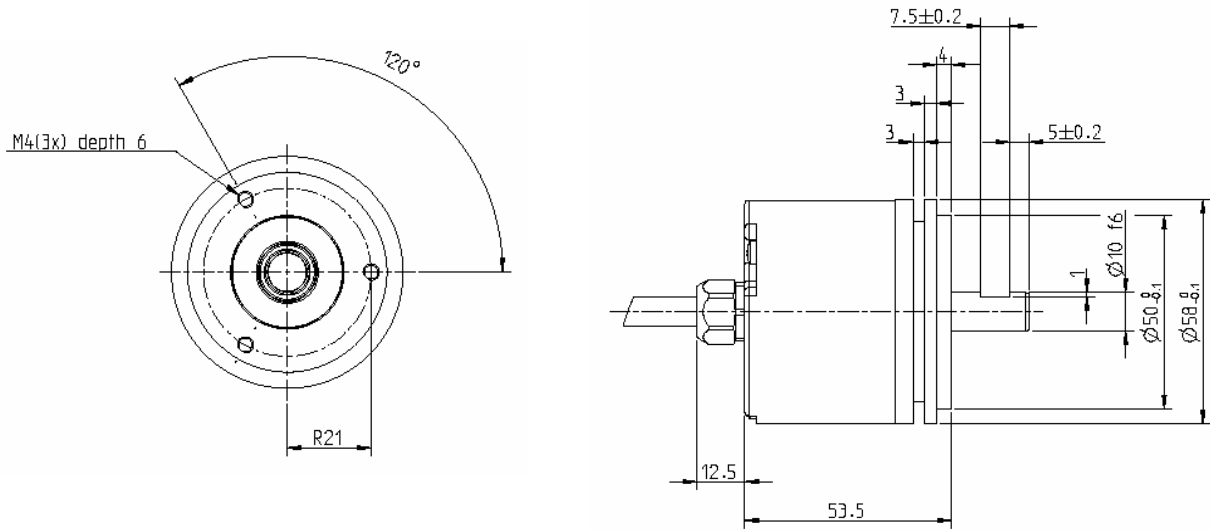
#### 3.4.1 Electrical data

1 Default baud rate is 500kbit/s

Note: Baud rate and CAN identifier could be ordered with pre-selected values from Leine & Linde or programmed via the CAN Open interface.

Power supply	9-36 Vdc
Polarity protected	Yes
Output interface	CAN Open
Short circuit protected	Yes
Interface	CAN specifications 2.0 part A and B
Application layer	Safe Encoder
Baud rate <sup>1</sup>	5 kbit/s - 1 Mbit/s
CAN identifier	3 bit hardware adjustable
Address input <sup>2</sup>	Active low
Code type	Binary
Programmable functions	Resolution, Preset
	Direction, Baud rate
	Node ID
Current consumption	50mA @ 24Vdc
Max curent consumption	100mA

### 3.4.2 Mechanical data



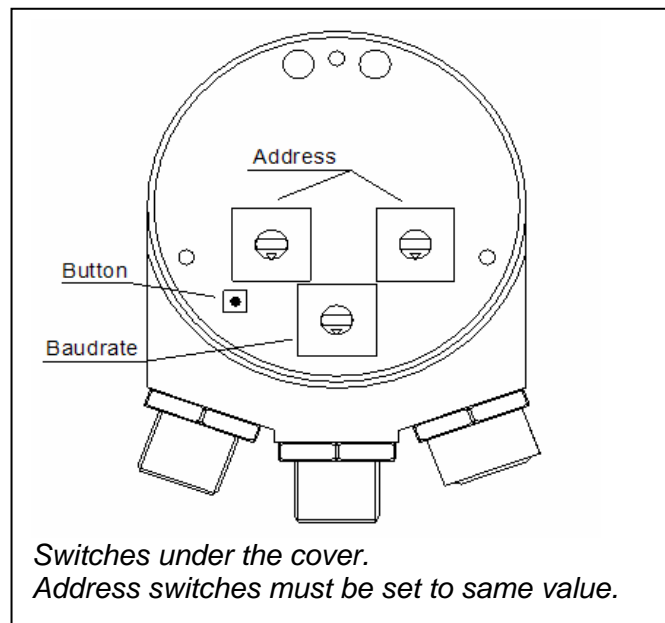
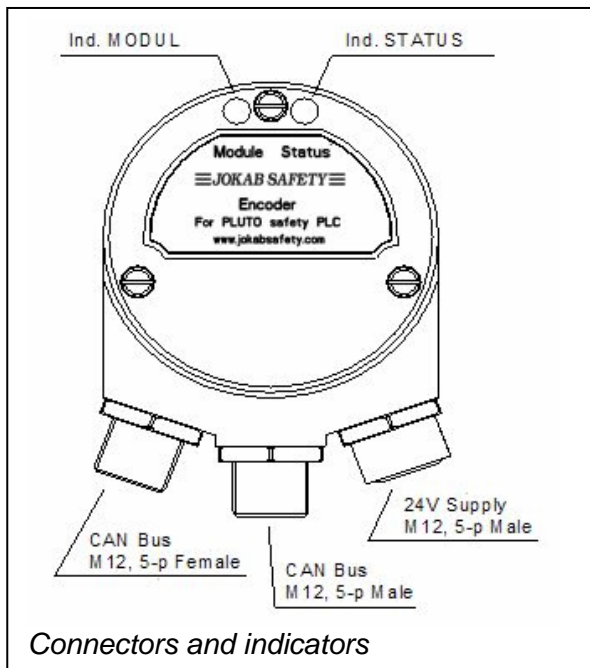
#### Shaft option

Shaft type	Ø 10 with face
Axial shaft load	50 N
Radial shaft load	60 N
Mech. permissible speed	6000 rpm (12 000)
Shaft material	Stainless steel
Moment of inertia	$2,0 \times 10^{-6} \text{ kgm}^2$

#### Flange option

Flange type	63, Synchro
Outer diameter	Ø58 mm
Mounting holes	3 x M4
Flange material	Aluminium
Surface treatment	Anodized

## 4 Multiturn encoder RSA 698



### 4.1 Connectors

Power supply 24 VDC	Pin
+24 Volt	1
-	2
0 Volt	3
-	4

CAN Bus	Pin
CAN Shield	1
CAN V+	2
CAN GND	3
CAN High	4
CAN Low	5

### 4.2 Indicators

**STATUS:** Follows the CANopen standard.

Green	OK
Flashing red/green	Fault Example: Wrong baudrate Baudrate conflict
Flashing green/short red	No contact with bus

**MODULE:** Indicates sensor status.

Green	OK
Flashing red	Fault Example: Address switches set to different values Baudrate switch set to 9. Sensor fault

### 4.3 Address setting

The address is set by the two rotary switches under the cover. The two address switches shall be set to the same value.

Address	Switch 1, 2
1	1, 1
2	2, 2
3	3, 3
4	4, 4
5	5, 5
6	6, 6
7	7, 7
8	8, 8
9	9, 9

### 4.4 Baudrate

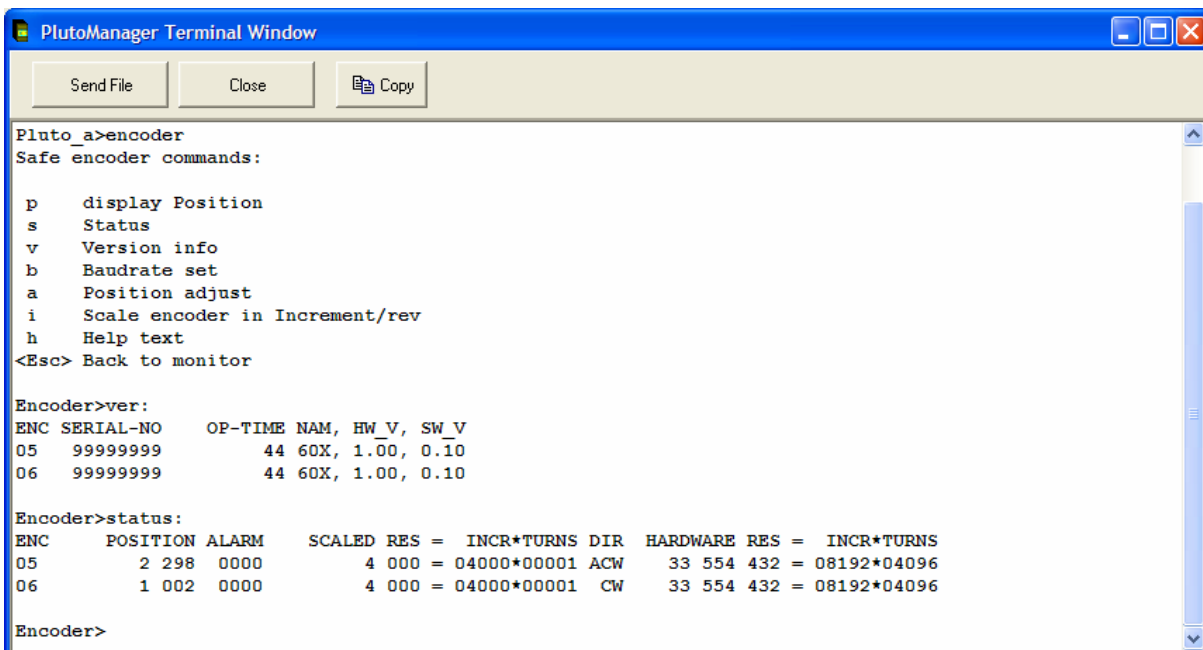
The baudrate is set by the switch under the cover.

Baud rate	Baudrate switch
10 Kbit	0
20 Kbit	1
50 Kbit	2
125 Kbit	3
250 Kbit	4
500 Kbit	5
800 Kbit	6
1000 Kbit	7
400 Kbit	8
Error	9

### 4.5 Software settings

Via Terminal window in Pluto Manager it is possible to scale, set actual position and get information.

- Connect the computer to Pluto and start Pluto Manager. Start the terminal window.
- Start by typing `encoder` and `v` and `s` to see if the encoders are present on the bus:



In this case encoder 5 and 6 are present on the bus.

The "v" command (version) shows serial number, version of hardware and software and operating time.

The status command "s" gives scaled and hardware resolution, position. Here the encoders are configured to emulate singleturn encoders (scaled res turns=1) with 4000 increments/rev.

The encoders must be scaled so that the total range is with 0 to 31999.

### 4.5.1 Scaling

The encoder is rescaled by the command “i”.

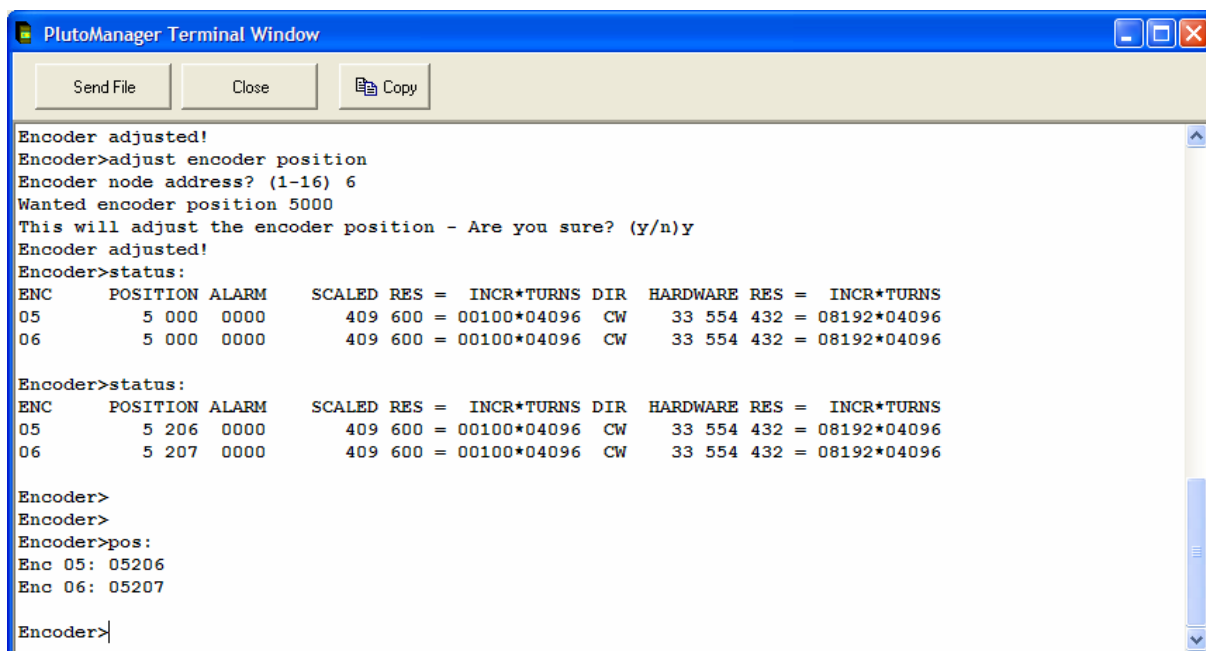
In below example the encoder is set to 100 increments/rev in multiturn mode. This means we can have up to 320 turns within the total range. Rotation direction is clockwise:

```
Encoder>increment/rev scaling
Encoder node address? (1-16) 5
Wanted increments/rev? 100
Direction: ClockWise/AntiClockWise? (a/c)c
Singleturn/Multiturn? (s/m)m
This will rescale the encoder - Are you sure? (y/n)y
Encoder rescaled!
Total resolution=      409 600 (ClockWise direction)
Encoder>increment/rev scaling
Encoder node address? (1-16) 6
Wanted increments/rev? 100
Direction: ClockWise/AntiClockWise? (a/c)c
Singleturn/Multiturn? (s/m)m
This will rescale the encoder - Are you sure? (y/n)y
Encoder rescaled!
Total resolution=      409 600 (ClockWise direction)
Encoder>status:
ENC    POSITION ALARM    SCALED RES = INCR*TURNS DIR  HARDWARE RES = INCR*TURNS
05     322 044 0000    409 600 = 00100*04096 CW   33 554 432 = 08192*04096
06     370 768 0000    409 600 = 00100*04096 CW   33 554 432 = 08192*04096
Encoder>
```

By typing “s” after the rescaling we can see that the total range is 409600, but since Pluto only has 16-bit arithmetic only the part between 0 and 31999 is usable.

### 4.5.2 Position adjustment

In below example the actual encoder position is adjusted to 5000.



By typing “s” after the rescaling we can see that the position is changed to 5000. If the encoder is turned and “s” is typed again we can see that the position is changed.

It is also possible to type “p” (position) to get the actual position. If position is displayed by the status command but not for the “p” command, probably the position is outside range 0-31999.

## 4.6 Technical data

Type designation: RSA 698  
 Article number, Jokab: 20-070-37

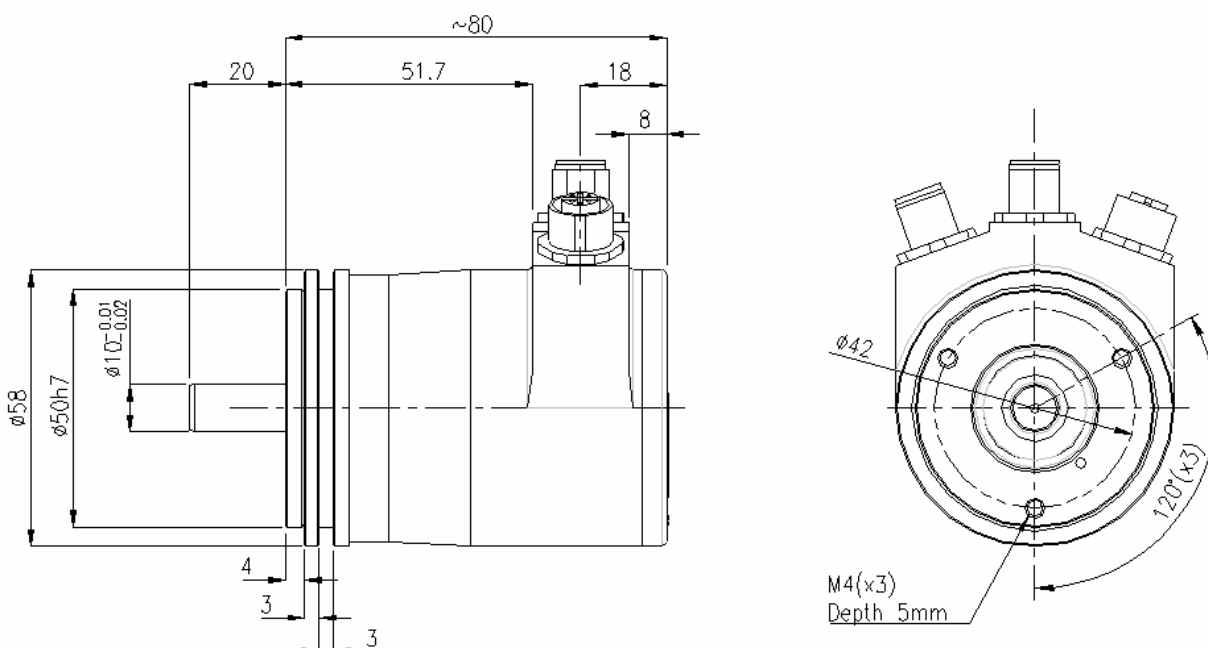


Encoder data	
Type	RSA 608
Operating temperature	-40°C ... +70°C
Storage temperature	-30°C ... +70°C
Ingress protection class	IP-67 according to IEC 60529
At shaft inlet	IP-66 according to IEC 60529
Vibration (55 to 2000Hz)	< 100 m/s <sup>2</sup> according to IEC 60068-2-6
Shock (6ms)	< 2000 m/s <sup>2</sup> according to IEC 60068-2-27
Cover material	Aluminium
Cover surface treatment	Anodized
Weight	Approx. 400g
Accuracy and resolution	
Total Resolution	25 Bit
Single turn resolution	13 Bit, 8192 positions per revolution
Multiturn resolution	12 Bit, 4096 absolute number of revolutions
Accuracy	± 1 LSB

Shaft type	Ø 10 round
Axial shaft load	50 N
Radial shaft load	60 N
Mech. permissible speed	6000 rpm
Shaft material	Stainless steel
Moment of inertia	2,0 x 10 <sup>-8</sup> kgm <sup>2</sup>

Flange type	63, Synchro
Outer diameter	ø58 mm
Mounting holes	3 x M4
Flange material	Aluminium
Surface treatment	Trumbled

### 4.6.1 Mechanical drawing



## 5 PLC Software - Description of function blocks

The safety blocks for reading encoders are located in file “encoder01.fps”.

### 5.1 SafeEncoder

Function block for singleturn encoders generating safe position and speed value out of two absolute encoders.

----- Function -----

The function block reads and evaluates two absolute encoders. The average of the two encoders is calculated and set to the output 'Position'.

The output 'Speed' is also an average value given in increments/10ms.

It is also monitored that the two encoder values do not deviate more than the value set by the input 'MaxDiff'.

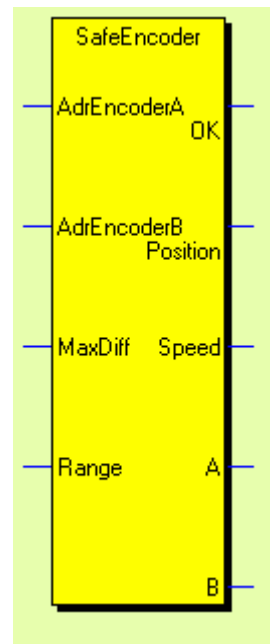
If something is wrong the output 'OK' is set '0'. In some application the values 'Position' and 'Speed' must be used together with the 'OK' output.

----- Description of in- and outputs -----

- AdrEncoderA: Encoder A node address
- AdrEncoderB: Encoder B node address
- MaxDiff: Max allowed deviation between the encoders (max 2% of Range)
- Range: Number of increments per revolution
- OK: Set when encoders are working OK and the position values are within the margin set by 'MaxDiff'
- Position: Position value
- Speed: Speed value as increments/10ms
- A: Encoder A position. Must not be used in PLC program!
- B: Encoder B position. Must not be used in PLC program!

NOTE! Position values from single encoders are only available for adjustment purposes and must NOT be used for safety.

NOTE! When error occurs 'Position' = -1, 'Speed' = -32768 and the OK output will be reset.



## 5.2 SafeEncoderMult

Function block for multiturn encoders generating safe position and speed value out of two absolute encoders.

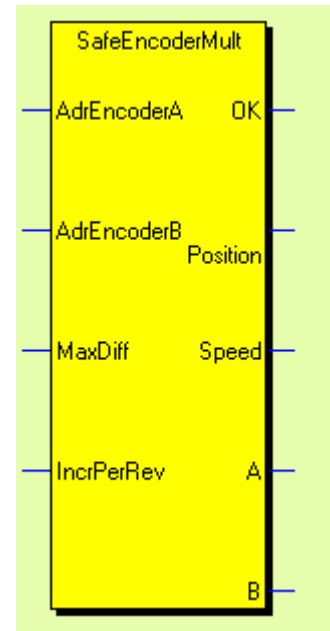
Operating system must be of version 2.4.4 or higher.

----- Function -----

The function block reads and evaluates two absolute multiturn encoders. The average of the two encoders is calculated and set to the output 'Position'. The output 'Speed' is also an average value given in increments/10ms. It is also monitored so the two encoder values do not deviate more than the value set by the input 'MaxDiff'. If something is wrong the output 'OK' is set '0'. In some application the values 'Position' and 'Speed' must be used together with the 'OK' output.

----- Description of in- and outputs -----

- AdrEncoderA: Encoder A node address
- AdrEncoderB: Encoder B node address
- MaxDiff: Max allowed deviation between the encoders (max 2% of IncrPerRev)
- IncrPerRev: Number of increments per revolution
- OK: Set when encoders are working OK and the position values are within the margin set by 'MaxDiff'
- Position: Position value
- Speed: Speed value as increments/10ms
- A: Encoder A position. Must not be used in PLC program!
- B: Encoder B position. Must not be used in PLC program!



NOTE! Position values from single encoders are only available for adjustment purposes and must NOT be used for safety.

NOTE! When error occurs 'Position' = -1, 'Speed' = -32768 and the OK output will be reset.

## 5.3 EncoderCam

Function block for electronic cam limit switch.

----- Function -----

The output Q is set when the value in the input register PosReg is within the limits MinPos and MaxPos. The input value is normally Generated by the function block SafeEncoder.

NOTE! It is possible to specify a cam which passes through the zero position of an encoder. Position<0 is forbidden. Example: If MinPos=3000 and MaxPos=200, Q is set when the position is greater than 2999 or less than 201.

----- Description of in- and outputs -----

- PosReg: Register where the position is stored
- MinPos: Min allowed value
- MaxPos: Max allowed value

