POSITAL
FRABA

ABSOLUTE ROTARY ENCODER
WITH MODBUS RTU INTERFACE

Modbus

User Manual

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1 4

1.1 Important Information 4

2 About this manual 5

2.1 Background 5

2.2 Version Management 5

2.3 Imprint 5

2.4 Copyright 5

2.5 User Annotation 5

2.6 Document History 5

3 Introduction 6

3.1 Measuring systems 6

3.2 Modbus RTU Interface 6

3.3 UCD Modbus RTU 7

3.4 Typical Applications of UCD Encoder with Modbus RTU Interface 7

4 Installation 8

4.1 Pin Assignment 8

4.2 Installation Precautions 8

4.3 Instructions for mechanical installation and electrical connection of the rotary encoder 10

4.4 Termination 10

4.5 LED Definition 11

5 UCD Modbus RTU 12

5.1 Communication Settings for Setup 12

5.2 Function Codes supported by UCD Modbus RTU absolute encoder 12

5.3 Device Specific Registers 13

Read Holding Register Mapping 13

6 Working with Modbus Poll 16

6.1 Connection Setup 16

6.2 Write Registers 18
7 Glossary 26
8 Check Out Some of the Other POSITAL Products 27
Disclaimer 28

1

1.1 Important Information

Read these instructions carefully and have a look at the equipment to become familiar with the device before trying to install, operate, or maintain it.

The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention towards information that clarifies/simplifies a procedure.

Please Note: Electrical equipment should be serviced only by qualified personnel. No responsibility is assumed by POSITAL for any consequences arising out of the use of this material. This document is not intended as an instruction manual for untrained personnel.

The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

2 About this manual

2.1 Background

This user manual explains how to install and configure Posital's absolute encoder with a Modbus RTU interface with illustrations from a Modbus Poll program.

2.2 Version Management

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2.3 Imprint

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2.4 Copyright

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2.5 User Annotation

All readers are highly welcome to send us feedback and comments about this document. Depending on your region you can reach us by e-mail at the following e-mail addresses.

- America info@posital.com
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- Europe info@posital.eu

2.6 Document History

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3 Introduction

This manual explains how to install and configure the absolute rotary encoder with Modbus RTU interface applicable for both military and industrial applications with Modbus RTU interface.

3.1 Measuring systems

Magnetic rotary encoder determines positions using the Hall effect sensor technology developed for the automotive mass market. A permanent magnet fixed to the shaft generates a magnetic field that is sampled by the Hall sensor, which translates the measured value into a unique absolute position value.

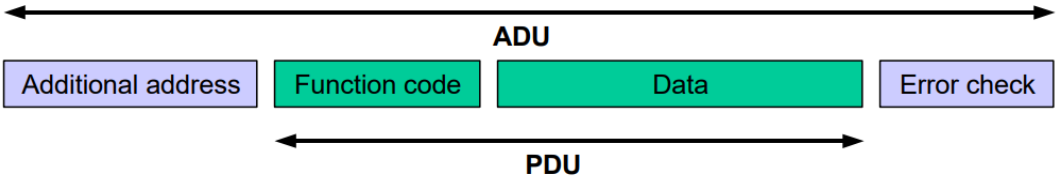
To register revolutions even when no voltage is applied, energy from the turning of the shaft must suffice for proper operation. An innovative, patented technology makes this feasible even at low rotational speeds and through long standstill periods – a Wiegand wire ensures that the magnetic field can only follow the turning of the shaft in discrete steps. A coil wound on the Wiegand wire receives only brief, strong voltage spikes, which prompt the reliable recognition of each revolution.

Typical Applications:
- Packing Machines
- Solar
- Windmills
- Medical Equipment

3.2 Modbus RTU Interface

Modbus RTU is an open, serial (RS-232 or RS-485) protocol derived from the Master/Slave architecture. It is a widely accepted protocol due to its ease of use and reliability. Modbus RTU messages are a simple 16-bit structure with a CRC (Cyclic-Redundant Checksum). The simplicity of these messages is to ensure reliability. Due to this simplicity, the basic 16-bit Modbus RTU register structure can be used to pack in floating point, tables, ASCII text, queues, and other unrelated data.

The Modbus application protocol defines a simple Protocol Data Unit (PDU) independent of the underlying communication layers. The mapping of Modbus protocol on a specific bus or network can introduces some additional fields on the Protocol Data Unit (ADU). The client that initiates a Modbus transaction builds the Modbus PDU and then adds fields in order to build the appropriate communication PDU.
The basic structure of a Modbus frame is: Address field, Function code, Data, CRC (or LRC)



On Modbus Serial Line, the Address field only contains the slave address. The valid slave nodes addresses are in the range of 0 – 247 decimal. The individual slave devices are assigned addresses in the range of 1 – 247. A master addresses a slave by placing the slave address in the address field of the message. When the slave returns its response, it places its own address in the response address field to let the master know which slave is responding.

Further information is available at:
http://www.modbus.org/

3.3 UCD Modbus RTU

Features of the Encoder:

Limit switch
Device identification via LED's
Different speed filter – Moving Average
Configurable resolution

Various software tools for configuration and parameter-setting are available from different suppliers.

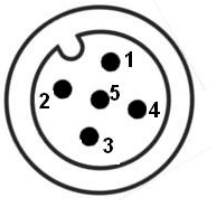
3.4 Typical Applications of UCD Encoder with Modbus RTU Interface

- Solar Tracking
- Cranes and Construction Machinery
- Packing Machines
- Defence
- Automated Guided Vehicles (AGV)
- Automatic Assembling Machinery
- Boring and Drilling Applications

4 Installation

4.1 Pin Assignment

The encoder is connected via a 5-pin round M12 connector. (Standard M12, Male side at sensor, Female at connector counterpart or connection cable).

Signal	5 pin round connector	Wire color	Pin Assignment
Power Supply	2	Red	
GND	3	Yellow	
RS-485 A +	4	White	
RS-485 B -	5	Brown	
Not Connected	1	Blue	
Not Connected		Green	
Not Connected		Gray	
Not Connected		Pink	

4.2 Installation Precautions

	Do not remove or mount the connectors while the power supply is on!
	Avoid mechanical load!
	Do not adapt the housing additionally!

	Do not stand on the encoder!
	Do not adapt the driving shaft additionally!

Prior to installation, please check for all connections and mounting instructions to be complied with. Please also observe the general rules and regulations on operating low voltage technical devices, for safety and sustainability of UCD Encoders over long period of time.

Please read the installation leaflet for detailed instructions and precautions during mounting and installation.

4.3 Instructions for mechanical installation and electrical connection of the rotary encoder

The following points should be observed:

- Do not drop the angular encoder or subject it to excessive vibration. The encoder is a precision device.
- Do not open the angular encoder housing. If the device is opened and closed again, it can be damaged and dirt may enter the unit.
- The angular encoder shaft must be connected to the shaft to be measured through a suitable coupling (full shaft version). This coupling is used to dampen vibrations and imbalance on the encoder shaft and to avoid inadmissible high forces. Suitable couplings are available from Posital.
- Although Posital absolute encoders are rugged, when used in tough ambient conditions, they should be protected against damage using suitable protective measures. The encoder should not be used as handles or steps.
- Only qualified personnel may commission and operate these devices. These are personnel who are authorized to commission, ground and tag devices, systems and circuits according to the current state of safety technology.
- It is not permissible to make any electrical changes to the encoder.
- Route the connecting cable to the angular encoder at a considerable distance or completely separated from power cables with their associated noise. Completely shielded cables must be used for reliable data transfer and good grounding must be provided. Cabling, establishing and interrupting electrical connections may only be carried-out when the equipment is in a no-voltage condition. Short-circuits, voltage spikes etc. can result in erroneous functions and uncontrolled statuses which can even include severe personnel injury and material damage.
- The encoder should have got a large-area connection to PE (only for UCD-M100B). If the flange don't have a good electrical connection to the machine – i.e. if there was used a plastic mounting device – then use i.e. a 30cm long and 2cm wide copper tape to get the PE connection.

Before powering-up the system, check all of the electrical connections. Connections, which are not correct, can cause the system to function incorrectly. Fault connections can result in severe personnel injury and material damage.

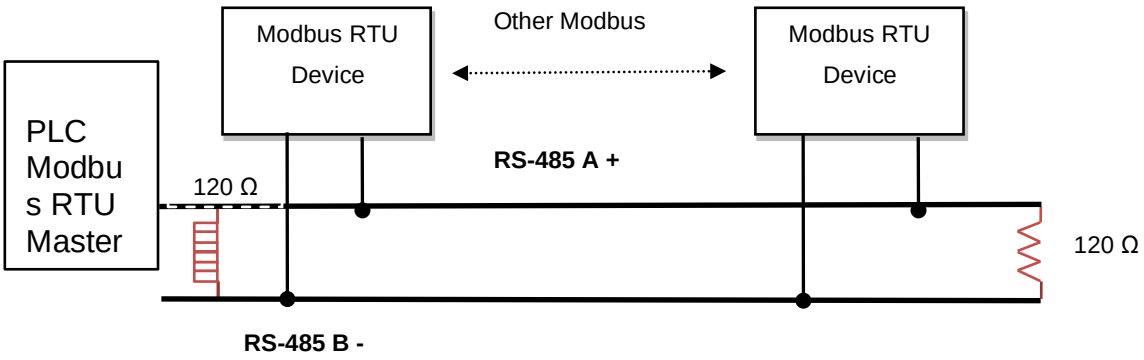
4.4 Termination

If the Modbus device is connected at the end or beginning of the bus a termination resistor of 120 Ohm must be used in order to prevent reflection of information back into the bus. UCD absolute encoders have built-in termination resistors that can be activated or deactivated by setting correct register accordingly. Be aware, that the termination resistor is only activated, when the encoder is powered, because the microcontroller is internally

needed to switch on the resistor. Please refer to the Chapter 5 to learn more about the registers.

The bus wires can be routed in parallel or twisted, with or without shielding in accordance with the electromagnetic compatibility requirements. A single line structure minimizes reflection.

The following diagram shows the components for the physical layer of a two-wire Modbus connection.



4.5 LED Definition

Status LED Green / Red LED	Meaning
Off	No power supply
Green on	Device status: Device powered
Yellow on	Communication: Switched on during frame reception or sending
Red on	Error: Internal fault

5 UCD Modbus RTU

This chapter succeeds the hardware configuration as in real time. This is a very flexible device and hence all the parameters are programmable via Modbus master. This enables remote configuration.

This chapter is divided into two major parts - one describing the methodology for putting this device into operation and the other for programming of it.

5.1 Communication Settings for Setup

Description	Value
Baud Rate	19200
Device Address	7Fh (127d)
Parity / Stop Bits	No / 1 Stop Bit
Data Format	8 Bit binary

5.2 Function Codes supported by UCD Modbus RTU absolute encoder

Function codes are used to access the various registers. The Codes supported by the encoder are as follows:

Function	Type	Hex Value	Error Code (Exception Codes)
Read Holding Register	Public	0x03h	0x83h (01/02/03/04)
Write Multiple Register	Public	0x10h	0x90h (01/02/03/04)
Write (Manufacturer Specific)	User Defined	0x44h	0xC4h (01/02/03/04)
Read (Manufacturer Specific)	User Defined	0x45h	0xC5h (01/02/03/04)
Read Device ID	Diagnostic	0x2B / 0x0E)	0xAB (01/02/03/04)

5.3 Device Specific Registers

Read Holding Register Mapping

Reads the binary contents of holding registers (4XXXX references) in the encoder slave
Broadcast is not supported

Write Holding Register Mapping

Description
Write values into a sequence of holding registers (4XXXX references). When broadcast, the function presets the same
register references in all attached encoder slaves.

Note
The function will override the Encoder memory protect state.
The programmed values will remain valid in the registers during the complete power-cycle and some functions will achieve immediately.
All green tagged values need a power off/on cycle before they are valid and as of now the encoder works with the new register contents. The green tagged values will achieve immediately after a valid Update command (Preset, Count Direction)
The register values will remain and are stored in a nonvolatile memory, independent from being not programmed in the controller's logic.

Register	Data name	Order	Access	Data type	Value	Default
40002	Position	MSB	RO	32bit_h	Position Value Bit 17-32	
40003	Position	LSB	RO	32bit_l	Position Value Bit 1–16	
40004	Actual Reverse State	MSB	RO	8bit	Actual State CW = 0, CCW = 1	0
40005	Term Rest State	MSB	RO	8bit	Termination on = 1, off = 0	1
40006	Speed	MSB	RO	32bit_h	Speed Value Bit 17-32	
40007	Speed	LSB	RO	32bit_l	Speed Value Bit 1–16	
40008	Limit switch state		RO	8bit		
40013	Physical ST Resolution		RO	32bit_h		0
40014	Physical ST Resolution		RO	32bit_l		8192
40015	Physical MT Resolution		RO	32bit_h		0
40016	Physical MT Resolution		RO	32bit_l		4096
40017	Scaling Enabled		RW	8bit		
40018	ST resolution	MSB	RW	32bit_h	steps	0x2000
40019	ST resolution	LSB	RW	32bit_l	steps	
40020	Tot Resolution	MSB	RW	32bit_h	steps	0x2000000

40021	Tot Resolution	LSB	RW	32bit_l	steps	
40022	Preset	MSB	RW	32bit_h		0
40023	Preset	LSB	RW	32bit_l		0
40024	Offset	MSB	RO	32bit_h		
40025	Offset	LSB	RO	32bit_l		
40026	Count direction		RW	8bit		0
40027	Speed mode		RW	8bit	0=disable, 1=rpm, 2=degree/sec, 3=steps/s, 4=rad/sec, 5=hertz.	0
40028	Speed filter		RW	8bit	Moving average: param range 0..2	0
40029	Limt Swicth Enable			8bit		0
40030	Limit switch Low	MSB	RW	32bit_h		0
40031	Limit switch Low	LSB	RW	32bit_l		0
40032	Limit switch High	MSB	RW	32bit_h		0
40033	Limit switch High	LSB	RW	32bit_l		0
40034	Limit switch Delay		RW	16bit		0
40035	Error Reg		RW	16bit		
40036	Device Reset		RW			
40037	Store Parameters		RW	8bit		
40038	Auto Store		RW	8bit		
40039	Restore All Parameters		RW	8bit		
40040	Restore Application Parameters		RW	8bit		
40041	Auto Test		RW	8bit		
40042	Software Version		RO	16bit		
40043	Serial Number		RO	32bit_h		
40044	Serial Number		RO	32bit_l		
40050	Life Cycle Counter		RO	32bit_h		
40051	Life Cycle Counter		RO	32bit_l		
40052	Roll Counter		RO	16bit		

40257	Baudrate	MSB	RW	8bit	Baudrate 0=1200, 1=2400, 2=4800, 3=9600, 4=14400, 5=19200, 6=38400, 7=56000, 8=57600, 9=115200, 10=128000, 11=256000	5
40258	Number Data	MSB	RW	8bit	Number of Data 2=8 Bit	2
40259	Parity	MSB	RW	8bit	Parity 0=No, 1=Odd, 2=Even	0
40260	Stopbits	MSB	RW	8bit	Stopbits 1=1 Stop, 2=2 Stop	1
40261	Comm Update	MSB	RW		Communication Update 1=execute	0
40262	Node Address	MSB	RW	8bit	Node-ID 1…247 (1..0xF7)	127
40263	Node Update	MSB	RW		Node-ID Update 1=execute	0
40264	Auto baud enable			8bit		
40265	Auto baud timeout			32bit_h		
40266	Restore Bus Parameters					
40269	Termination	MSB	RW	8bit	Termination off=0, on=1	0
40270	Term Update	MSB	RW		Termination Update 1 = execute	0

6 Working with Modbus Poll

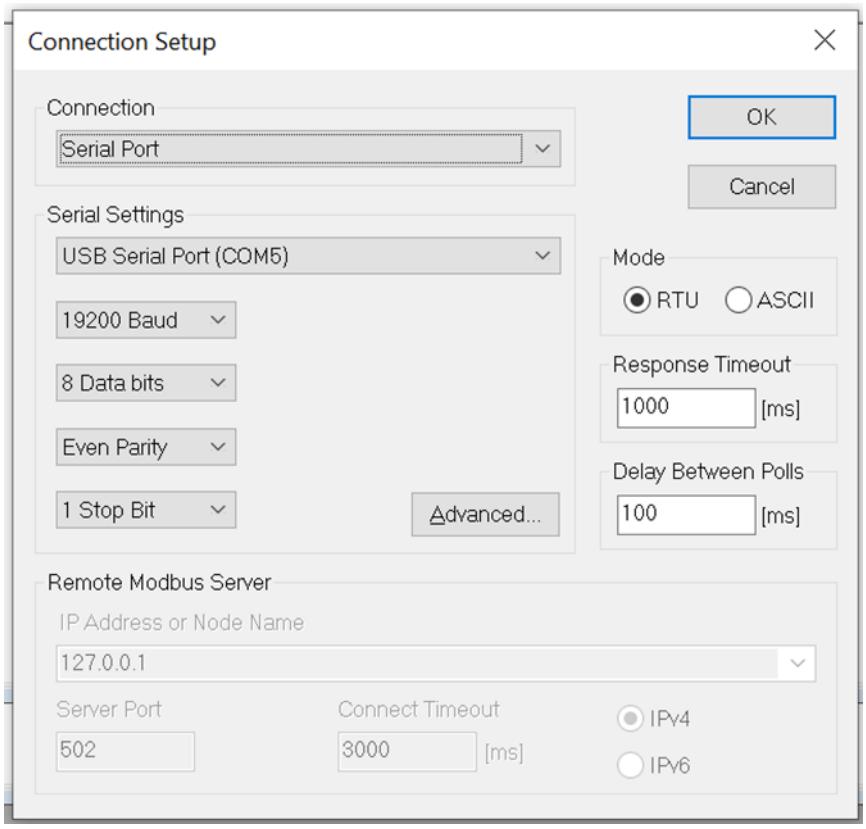
6.1 Connection Setup

PC-Software – Modbus Poll

Modbus Poll

Step 1 – Connection Setup

Press F3 for Connection Setup

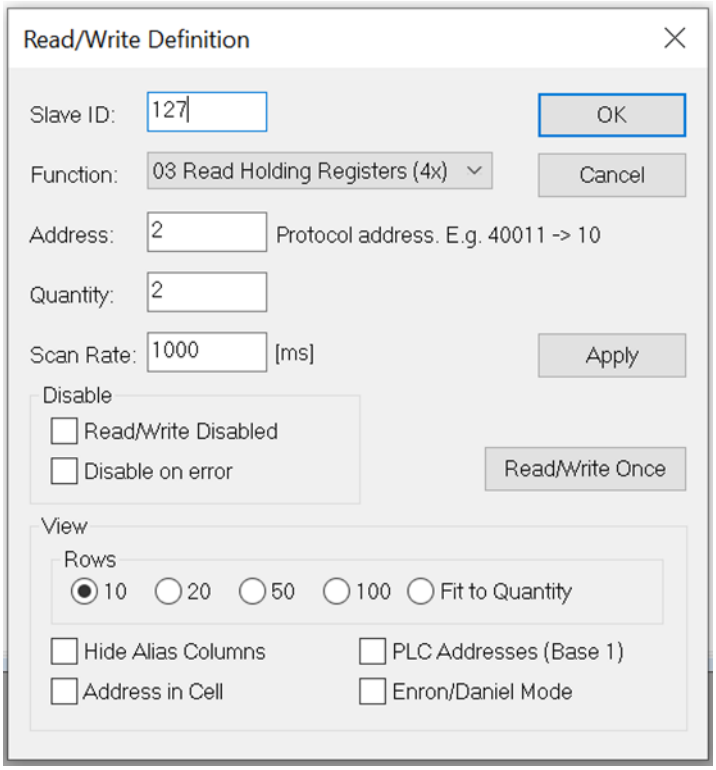


Set the data to factory default values of the encoder.

Select your RS485 to USB device

Step 2: Read/Write definition

Press F3 for Read/Write definition



Enter the Slave ID and register you want to write / read and press “OK”.

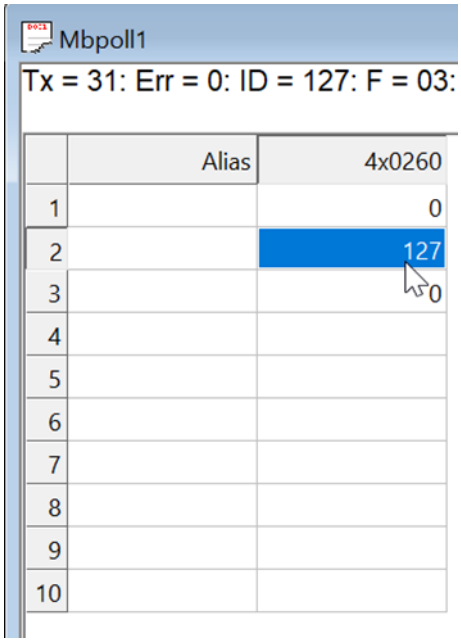
Done! Now you’re connected to the encoder and can read out the position value.

6.2 Write Registers

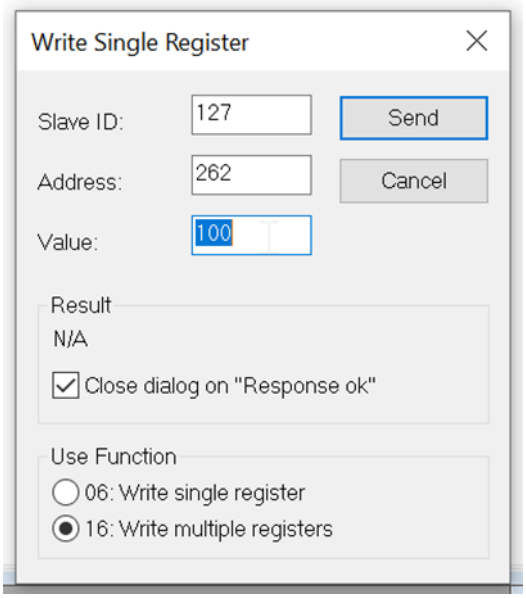
The registers can be written by double-clicking or Command Alt + F8.

6.2.2 Node ID: 40262

Doubleclick on Register 40262:



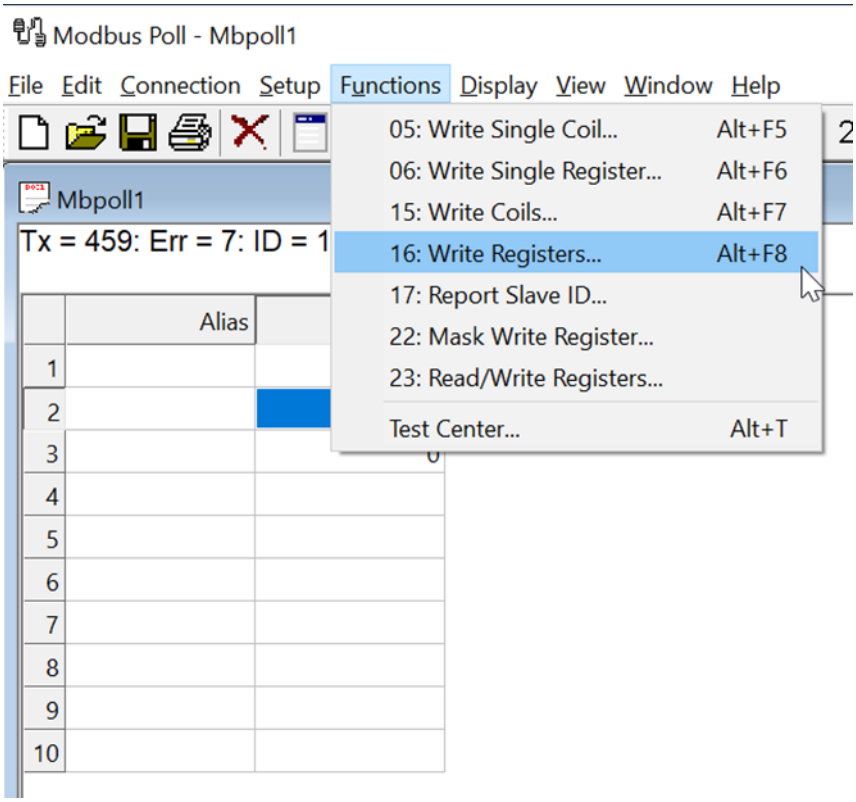
Insert the new Node ID and click on “Send”:



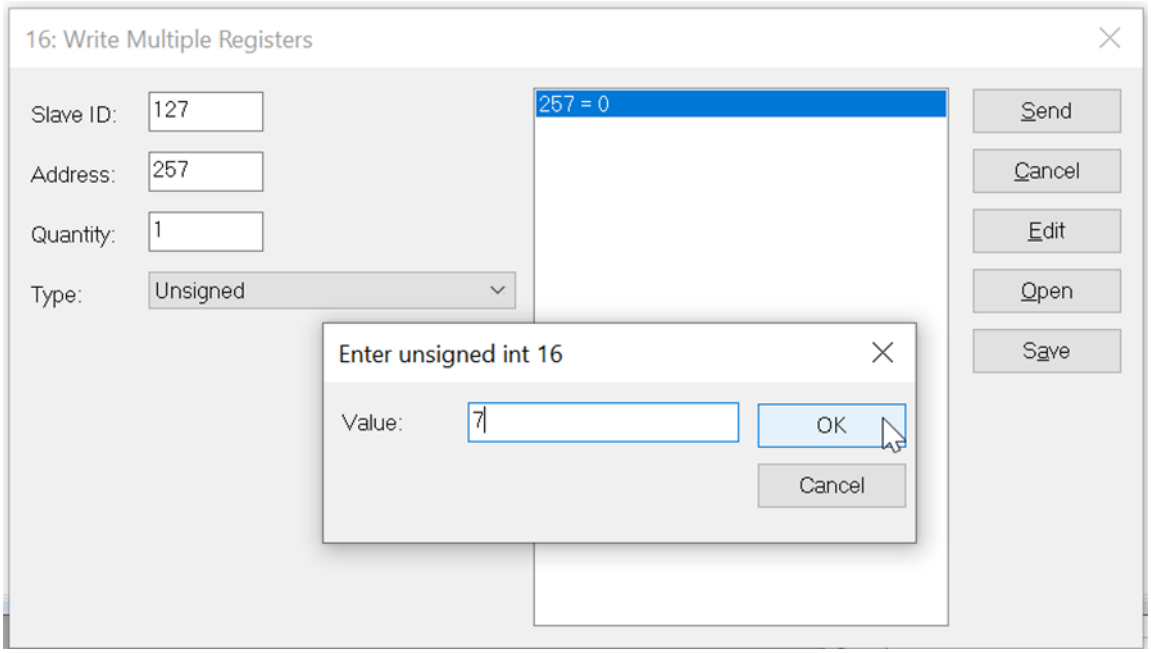
Restart the device and reconnect with the new Node ID.

6.2.3 Baudrate 40257:

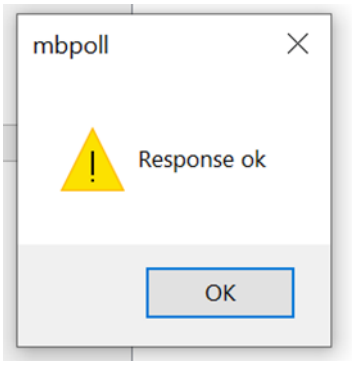
Open function 16: Write Multiple Registers by clicking Alt + F8



Enter the new baud rate (e.g. 7 for 56000 Baud)



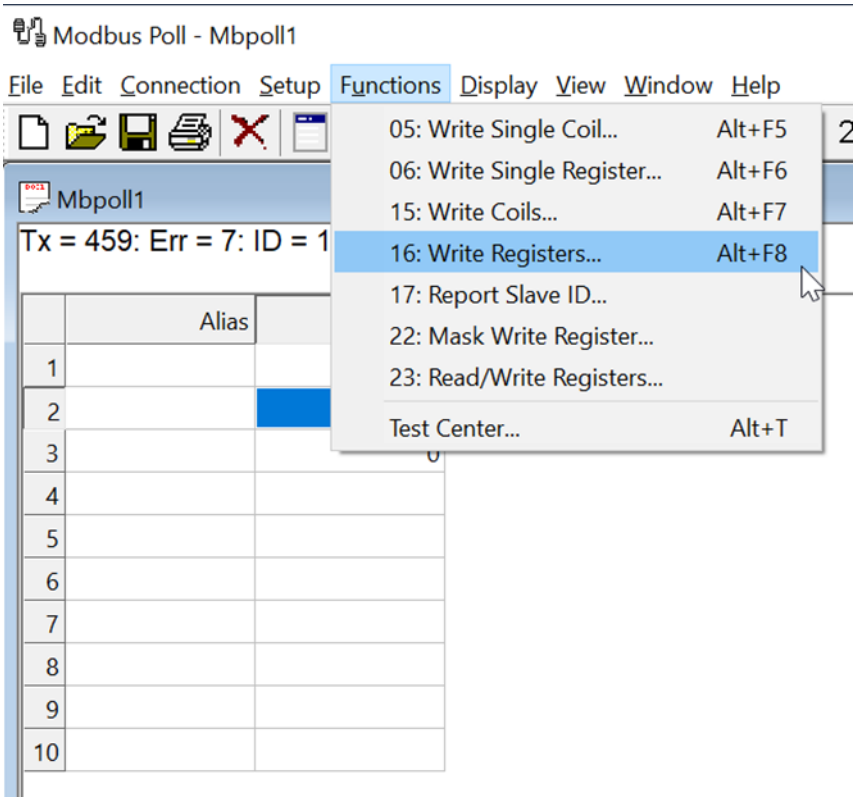
Click OK -> Send



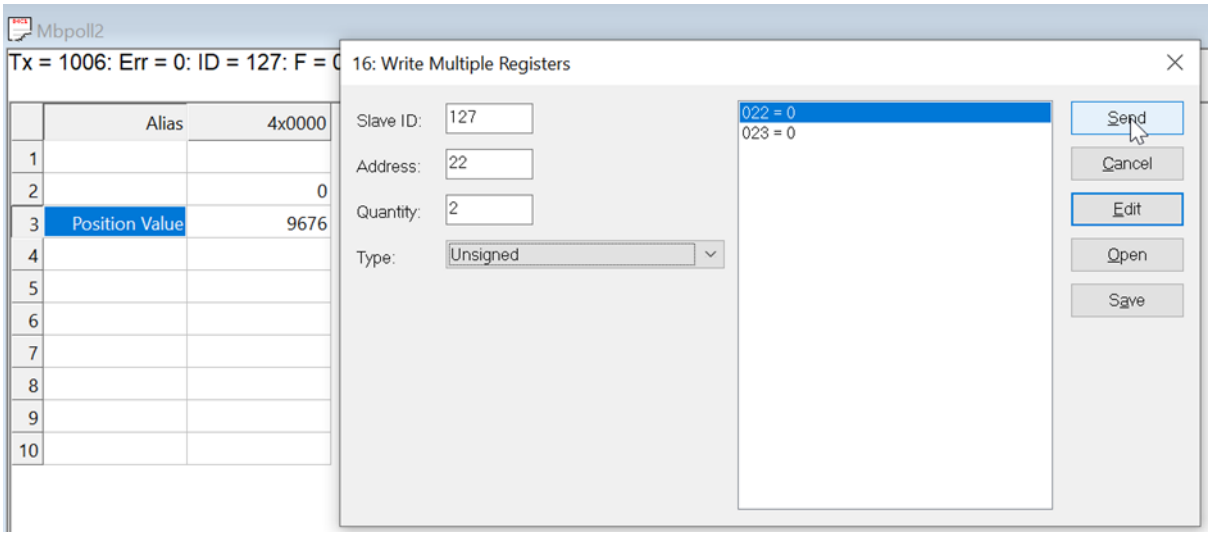
Restart the device and connect with a new baud rate.

6.2.4. Preset 40022 & 40023

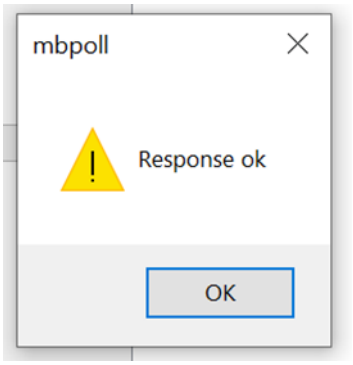
Open function 16: Write Multiple Registers by clicking Alt + F8


Modbus Poll - Mbpoll1
File Edit Connection Setup Functions Display View Window Help
Mbpoll1
Tx = 459: Err = 7: ID = 1
Alias
05: Write Single Coil... Alt+F5
06: Write Single Register... Alt+F6
15: Write Coils... Alt+F7
16: Write Registers... Alt+F8
17: Report Slave ID...
22: Mask Write Register...
23: Read/Write Registers...
Test Center... Alt+T

Set your preset value (e.g. to 0 at a position value of 9676)



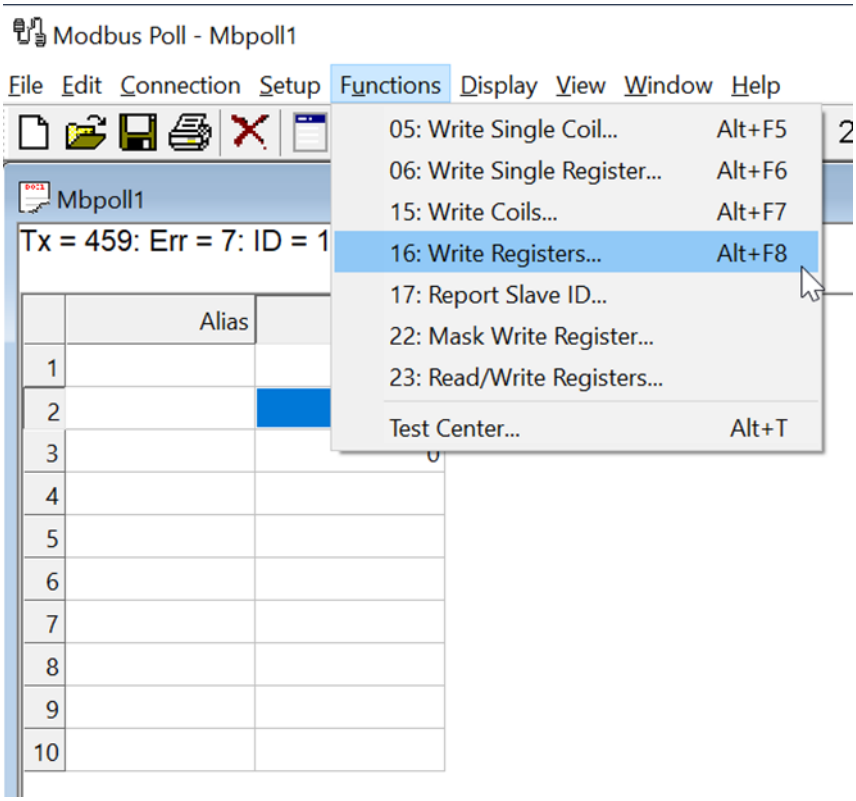
Click OK -> Send



Restart the device

6.2.5. Resolution

Open function 16: Write Multiple Registers by clicking Alt + F8

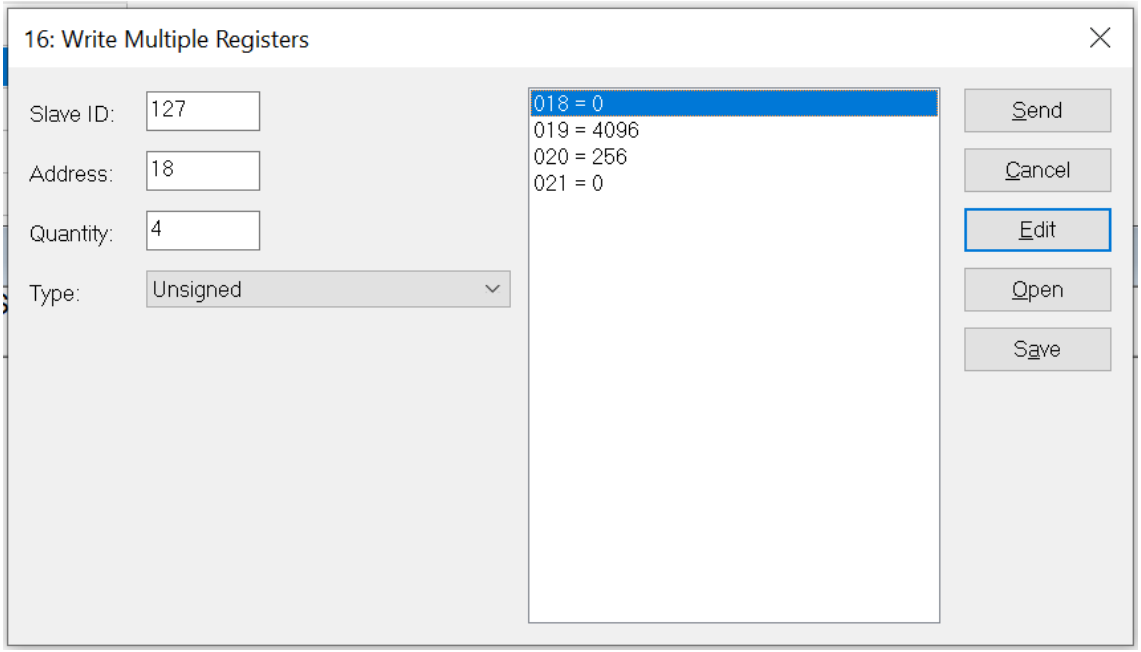


Set the resolution to your desired value (Attention! Maximum resolution is 15-bit multi turn and 16-bit single turn. This resolution is delivered as default).

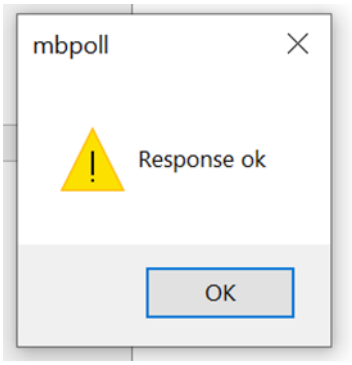
To set a new resolution, you must calculate it. For 12-bit multi turn and 12-bit single turn, it results in:

Register 40020 = 256 Dec / 100 Hex for Multiturn

Register 40019 = 4096 Dec / 1000 Hex for Singleturn



Click OK -> Send



Restart the device

7 Glossary

A	
Address	Number, assigned to each node, irrespective of whether it is a master or slave. The inclinometer address (non-volatile) is configured in the base with rotary switches.
APV	Absolute Position Value.
B	
Baud rate	Transmission speed formulated in number of bits per second. Bus node Device that can send and/or receive or amplify data by means of the bus.
Bus	Topology of a communication network, where all nodes are reached by passive links. This allows transmission in both directions.
Byte	8-bit unit of data = 1 byte.
C	
Modbus RTU	Application layer of an industrial network based on.
CCW	Counter-clockwise
CW	Clockwise
F	
Function Code	
L	
Line terminator	Resistor terminating the main segments of the bus.
P	
PV	Preset Value: Configuration value
R	
RO	Read Only: Parameter that is only accessible in read mode.
R/W	Read/Write: Parameter that can be accessed in read or write mode.
W	
WO	Write Only: Parameter that is only accessible in write mode.

Useful Links

Modbus over serial document from Modbus.org:

*www.**modbus**.org/docs/**Modbus_over_serial**_line_V1.pdf*

8 Check Out Some of the Other POSITAL Products

Fast EtherCAT Rotary Encoder

POSITAL's new optical encoders with EtherCAT provide high-speed data for positioning and speed control – they ensure extremely short cycle times of up to 62 µs. Thanks to their distributed clock function, they allow users to synchronize axes with a deviation of <1 µs. The EtherCAT encoders support cable redundancy, thus minimizing breakdown times in case of cable breaks: if special PLCs with two network cards are used, a maximum of one cycle is lost.

More Information

IXARC Rotary Encoders – Designed for Challenging Environments

POSITAL is excited to introduce the new IXARC high performance magnetic encoder in a heavy duty version. With an IP68/IP69K rating, high shock and vibration resistance and high load bearing shafts, these encoders are built to last in the most abusive environments.

More Information

TILTIX Inclinometers

Accurate measurement of the degree of tilt or inclination from a horizontal position is very important for many motion control systems or to ensure safety. Inclination sensors offer an easy and efficient way of monitoring spatial orientation without the need for mechanical linkages – a real advantage for design engineers.

More Information

Disclaimer

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