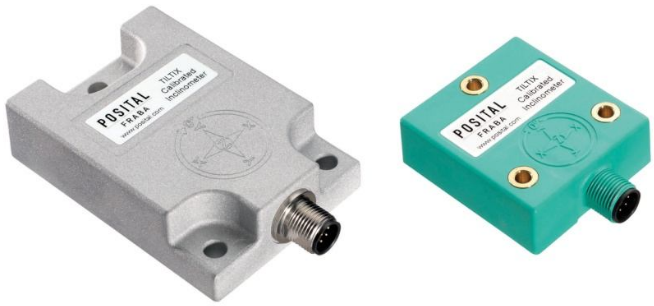
TILTIX INCLINOMETER
WITH MODBUS RTU INTERFACE



User Manual

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TILTIX INCLINOMETER
WITH MODBUS RTU INTERFACE

1 General Safety Advice

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 the ACS inclinometer with a Modbus RTU interface with illustrations from a Schneider TWIDO® PLC.

2.2 Version Management

- Updated On: 20190529
- Document Name: Manual_ACS_Modbus RTU_General.pdf

2.3 Imprint

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2.4 Copyright

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.

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2.6 Document History

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Created	2014/08/29
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Reviewers	DPR/ANA
Versions	First Release – 20140829

3 Introduction

This manual explains how to install and configure the ACS gravity referenced inclinometers with a Modbus RTU interface, suitable for industrial, military and heavy duty applications.

3.1 TILTIX Inclinometers

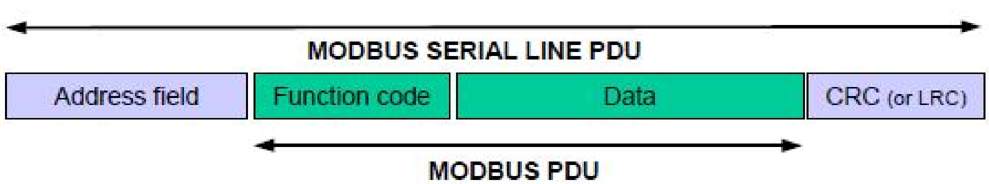
TILTIX inclinometers sense and measure the angle of tilt (inclination/slope/elevation) of an object with respect to the force of gravity. The basic principle behind this ACS inclinometer is a Micro-Electro-Mechanical Systems (MEMS) sensor cell that is embedded to a fully molded ASIC. The angle is measured with the relative change in electrical capacitance in the MEMS cell.

The ACS series of inclinometers, both industrial and heavy-duty lines, are available in two variants. First, a single axis measurement variant with a range of 360° and the other variant, a dual axis measurement capable ACS model with a range of ±80°.

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. 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 [1] defines a simple Protocol Data Unit (PDU) independent of the underlying communication layers: The mapping of MODBUS protocol on a specific bus or network introduces some additional fields on the Protocol Data Unit. The client that initiates a MODBUS transaction builds the MODBUS PDU, and then adds fields in order to build the appropriate communication PDU.
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.

3.3 ACS Modbus RTU

The ACS Modbus RTU inclinometer corresponds to the Modbus RTU standards. It is available in industrial and heavy-duty housings, and two measurement axes variants. The single axis measurement variant with a range of 360° and a dual axis measurement capable ACS model with a range of ±80°. In addition to high resolution, accuracy and protection class of IP69K, it has built-in active linearization and temperature compensation. This makes ACS suitable for rugged environments and versatile applications in industrial, heavy duty and solar applications.

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

3.4 Typical Applications of ACS

- Solar Tracking
- Cranes and Construction Machinery
- Medical Systems
- Elevated Platforms
- Mobile Lifts and Fire Engines
- Automated Guided Vehicles (AGV)
- Automatic Assembling Machinery
- Boring and Drilling Applications
- Levelling and Flattening

4 Installation

4.1 Accessories

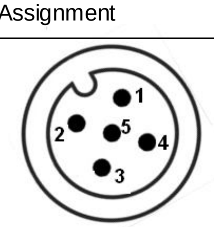
Article No	Article	Description
ACS360/080	Inclinometer	ACS series of Inclinometers (Industrial / Heavy-Duty)
Download	User Manual[1)]	Installation and Configuration User Manual (English)
10001978	Connector	Female M12, 5pin A-coded Connector, w/ 2m PUR Shielded Cable
10012182	Connector	Female M12, 5pin A-coded Connector, w/ 5m PUR Shielded Cable
10005631	Termination Res	External terminal resistors for higher baud rate transmissions

1) The latest documentation can also be downloaded from our website.

4.2 Pin Assignment

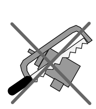
The inclinometer is connected via a 5-pin round M12 connector. (Standard M12, Male side at sensor, Female at connector counterpart or connection cable).

Signal	5 pin round connector	Pin Assignment
N.C.	1	
+ Vs Supply Voltage	2	
0 V Supply Voltage	3	
RS-485 A +	4	
RS-485 B -	5	

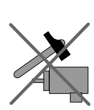


4.3 Installation Precautions

Warning: Do not remove or mount while the inclinometer is under power!



Avert any modifications to the housing!



Avoid mechanical load!

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 ACS Inclinometers over long period of time.

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

4.4 Mounting Instructions

ACS is a pre-calibrated device which can be put into immediate operation, upon simple and easy installation with a three point mount. The mounting surface must be plane and free of dust and grease. We recommend hex-head screws with M4 or UNC bolts #6 (ACS Industrial) and M6 or UNC bolts ¼ (ACS Heavy-Duty) for the best possible and secure mounting.Use all three screws for mounting but restrict the tightening torque in the range of 1.5 – 2.5 Nm for the screws. The M12 connectors are to be perfectly aligned and screwed till the end with a tightening torque in the range of 0.4 – 0.6 Nm. Use all three screws for mounting and also note to use the same tightening torque for all the screws.

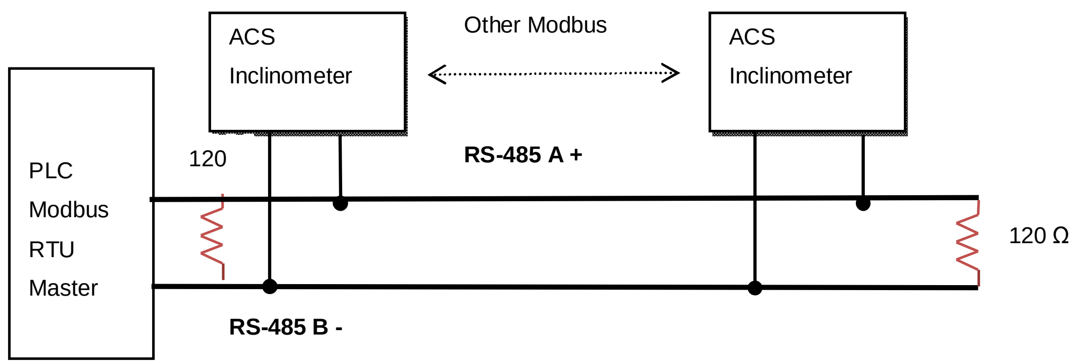
Prior to installation, please check for all connection and mounting instructions to be complied with. Please do also observe the general rules and regulations on low voltage technical devices.

4.5 Termination

If the inclinometer is connected at the end or beginning of the bus or is used at transmission baud rates ≥ 50kBaud a termination resistor of 120 Ohm must be used in order to prevent reflection of information back into the bus. ACS sensors have built-in termination resistors that can be activated or deactivated by setting correct register accordingly. (Section 5.4)

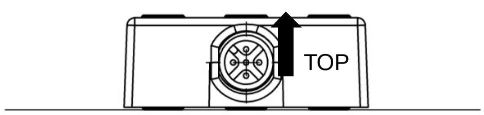
The bus wires can be routed in parallel or twisted, with or without shielding in accordance with the electromagnetic compatibility requirements. A single line structure minimizes reflection.

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

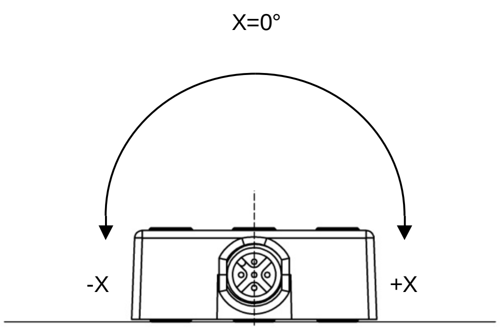


4.6 Measurement Axes

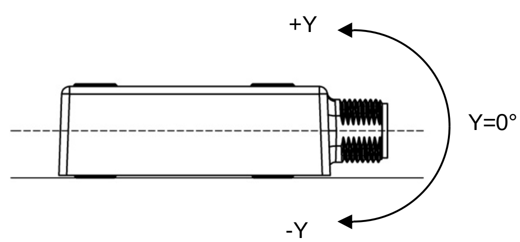
ACS 80 – Dual Axis Inclinometer



X=Y=0°
mid Angle Position
(With Factory Settings)

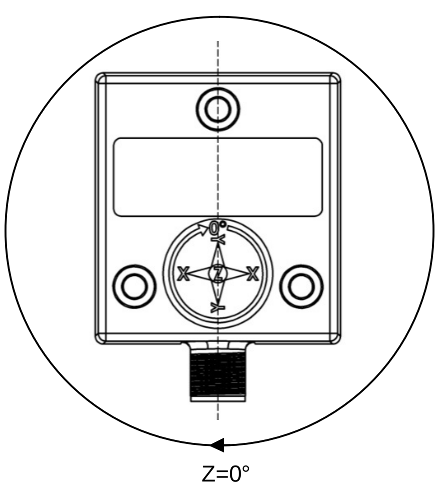


X-Axis Inclination



Y-Axis Inclination

ACS360 – Single Axis Inclinometer



Initial Starting Point (Factory Settings)

5 TILTIX Modbus- RTU

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

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

5.1 Communication Settings for Setup

Description	Value
Baud Rate	19200
Device Address	7Fh (127d)
Parity / Stop Bits	Even / 1 Stop Bit
Data Format	8 bit Binary

5.2 Function Codes supported by ACS

Function codes are used to access the various registers. The Codes supported by ACS 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

Register Name	Register Offset in hex	Access (Function Code)	Data type	Description and Values	Default
Current Position Value Higher Register (x/ 1-Axis)	0x0000	RO (0x03h)	16 bits signed	You read this value as current position value	-
Current Position Value Lower Register (x/1 - Axis)	0x0001	RO (0x03h)	16 bits signed	You read this value as current position value	-
Current Position Value Higher Register (y - Axis)	0x0002	RO (0x03h)	16 bits signed	You read this value as current position value	-
Current Position Value Lower Register (y - Axis)	0x0003	RO (0x03h)	16 bits signed	You read this value as current position value	-
Preset Value Higher Register (x/ 1-Axis)	0x0004	R/W (0x03h/ 0x10h)	16 bits signed	You can write a 0 or current value here to make the current value your preset point	-
Preset Value Lower Register (x/ 1-Axis)	0x0005	R/W (0x03h/ 0x10h)	16 bits signed	You can write a 0 or current value here to make the current value your preset point	-
Preset Value Higher Register (y -Axis)	0x0006	R/W (0x03h/ 0x10h)	16 bits signed	You can write a 0 or current value here to make the current value your preset point	-
Preset Value Lower Register (y -Axis)	0x0007	R/W (0x03h/ 0x10h)	16 bits signed	You can write a 0 or current value here to make the current value your preset point	-
Resolution	0x0008	R/W (0x03h/ 0x10h)	16 bits	Resolution of Position Value Values 0= 0.001 , 1: 0.01, 2:0.1, 3:1	1h

Measurement Direction	0x0009	R/W (0x03h/ 0x10h)	16 bits	Using this you can invert the counting direction Both axis CW: 0: X / 1- axis CCW: 1 Y axis CCW: 2 Both Axis CCW: 3	0h
Offset Value Higher Register (x-Axis)	0x000A	RO (0x03h)	16 bits signed	Read the offset value = Physical position - set position	-
Offset Value Lower Register (x-Axis)	0x000B	RO (0x03h)	16 bits signed	Read the offset value = Physical position - set position	-
Offset Value Higher Register (y -Axis)	0x000C	RO (0x03h)	16 bits signed	Read the offset value = Physical position - set position	-
Offset Value Lower Register (y -Axis)	0x000D	RO (0x03h)	16 bits signed	Read the offset value = Physical position - set position	-
Moving Average Filter Length	0x000E	R/W (0x03h/ 0x10h)	16 bits	The Moving Average Filter length accepts only 2n values. E.g. 4, 8, 16, 32, 64, 128, 256. If the input number isn't a 2n number, the next lower 2n number will be taken	40h (64d)

EXAMPLE WRITE: Preset value for x – and y –axis

Request (Command)		Response	
Name	Value	Name	Value
Device Address	7Fh	Device Address	7Fh
Function Code	10h	Function Code	10h
Starting Register Address	0004h	Starting Register Address	0004h
Number of Register	0004h	Number of Register	0004h
Number of Bytes	0008h	CRC	xxxxh
Data to be Written reg 1	0000h		
Data to be Written reg 2	0500h		
Data to be Written reg 3	0000h		
Data to be Written reg 4	0000h		
CRC	xxxxh		

EXAMPLE READ – Position value for 2 –axis inclinometer

Request (Command)		Response	
Name	Value	Name	Value
Device Address	7Fh	Device Address	7Fh
Function Code	03h	Function Code	03h
Starting Register Address	0000h	Byte Count	8h
Number of Register	0004h	Register 0 Value	0004h
CRC	xxxxh	Register 1 Value	1234h
		Register 2 Value	0005h
		Register 3 Value	1234h
		CRC	xxxxh

5.4 Manufacture Specific Registers and Function Codes

User defined Function Code 44h / 45h is for less commonly used, off-line functions such as setting serial port parameters and changing the device address. Some Modbus hosts cannot support this Function code, but the frames can still be sent using a serial terminal program on a PC that can send binary data on the serial port. Changes to the serial port parameters and device address are stored in flash memory so these settings are retained when power is off. A soft power cycle (Command 0xaa) or a manual power cycle is needed to activate the new values

Register Name	Command in hex	Access (Function Code)	Data type	Comments	Default
Baud Rate	0x20	Read (0x45h) / Write(0x44h)	8 bits	Baud Rate values (0 = 2400 ; 1 =4800 ; 2 = 9600; 3 = 19200; 4 = 38400; 5 = 57600; 6 = 115200)	3 =19200
Parity	0x21	Read (0x45h) / Write(0x44h)	8 bits	0: no parity , 1: odd parity , 2: even parity	2 = even
Device Address	0x22	Read (0x45h) / Write(0x44h)	8 bits	Used to set the device address; Valid range from 1 to 247	7fh (127d)
Activate Terminating Resistor	0x23	Read (0x45h) / Write(0x44h)	8 bits	Used to set the internal terminating resistor of 120 ohms 0 – inactive, 1 active	0 = inactive

Read device H/W version	0x30	Read (0x45h)	8 bits	H/W version read as a BCD value (egg: 01 means 01)	-
Read device S/W version	0x31	Read (0x45h)	16 bits	S/W version read as a BCD value (e.g.: 0110 means 1.10)	-
Restore to Factory Setting	0x55	Write(0x44h)	8 bits	No data (command length smaller)	-
Software Power cycle	0xAA	Write(0x44h)	8 bits	No data (command length smaller)	-

EXAMPLE WRITE– Set Device Address

Request (Command)		Response	
Name	Value	Name	Value
Device Address	7Fh	Device Address	7Fh
Function Code	44h	Function Code	44h
Command	22h	Command	22h
Number of Bytes	01h	Number of Bytes	01h
New Address	05h	CRC	Xxxxh
CRC	xxxxh		

EXAMPLE READ– Read Baud Rate

Request (Command)		Response	
Name	Value	Name	Value
Device Address	7fh	Device Address	7fh
Function Code	45h	Function Code	45h
Command	20h	Command	20h
Number of Bytes	01h	Number of Bytes	01h
CRC	xxxxh	Response	03h
		CRC	Xxxxh

EXAMPLE Write – Software power cycle

Request (Command)		Response	
Name	Value	Name	Value
Device Address	7fh	Device Address	7fh
Function Code	44h	Function Code	44h
Command	AAh	Command	AAh
Number of Bytes	00h	CRC	Xxxxh
CRC	xxxxh		

5.5 Device Identity

This function code is used to get information regarding the device identity like manufacturers name, software and hardware versions, product name and serial number. We support the basic type of Object ID. We shall include the serial number as part of the product code

Name	Object ID	Access	Data type	Value	Size in Characters
Vendor Name	0x00	Read	8 bits (Ascii)	"POSITAL"	7
Product Code (Includes Serial Number)	0x01	Read	8 bits (Ascii)	"ACS360 M1" or "ACS180 M1" & " S#00123456"	9 + 11
Major Minor Rev	0x02	Read	8 bits (Ascii)	"SW01.00 HW01"	12

EXAMPLE:

Request (Command)		Response	
Name	Value	Name	Value
Device Address	7Fh	Device Address	7Fh
Function Code	2Bh	Function Code	2Bh
MEI Type	0Eh	MEI Type	0Eh
Read Dev id Code	01h	Read Dev id Code	01h
Object ID	00h	Conformity Level	01h
CRC	xxxxh	More Follows	00h
		Next Object ID	00h
		Number of Objects	03h
		Object ID	00h
		Object Length	07h
		Object Value	POSITAL
		Object ID	01h
		Object Length	14h
		Object Value	ACS360 M1 S#12345678
		Object ID	02h
		Object Length	0Ch
		Object Value	SW01.00 HW01

6 Working with Schneider PLC

6.1 Hardware Tested With

Base controller – Schneider TWIDO – TWDLMDA20DTK

Operator Display - Schneider TWIDO - TWDXCPODM

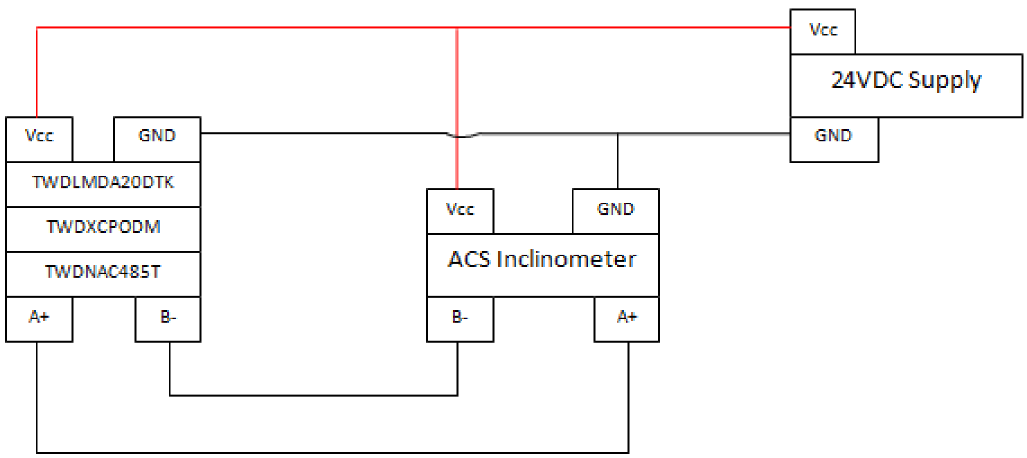
RS485 Interface Serial Adapter – Schneider TWIDO - TWDNAC485T

6.2 Connection scheme

An ACS360, single axis inclinometer was connected to a TWIDO programmable logic controller with a Modbus RTU communication interface.

The step-by-step connection procedure and the working of the inclinometer are illustrated in the following sections. Please note that, the programming in other control systems may vary individually. Please have this section as a reference for ACS's working with programmable logic controllers.

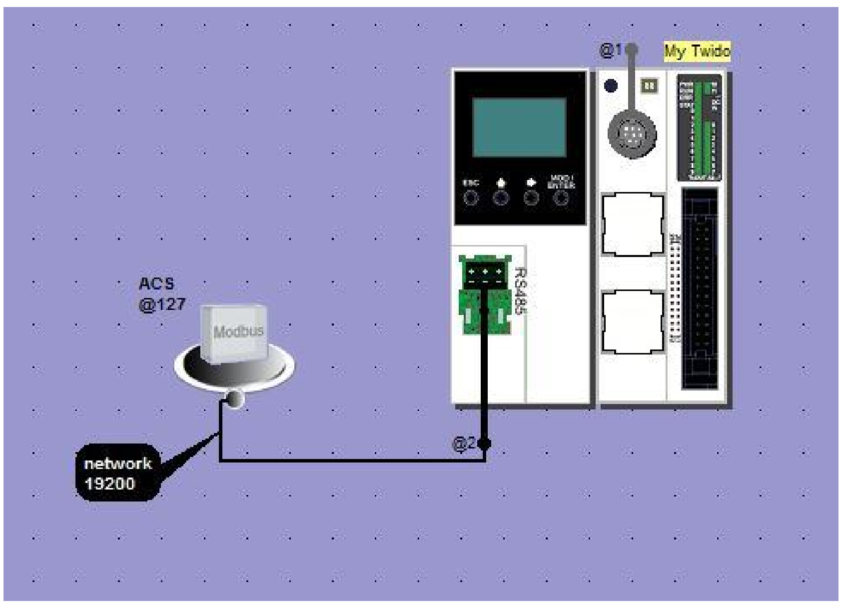
A dual axis ACS080 was also connected to at a later stage to get values from the same.



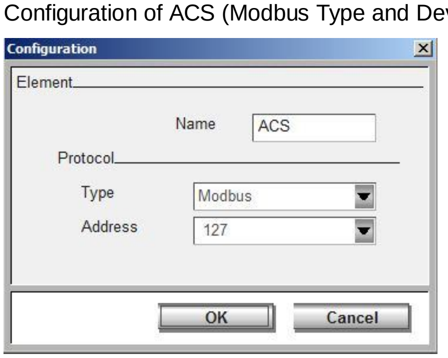
6.3 Software Configuration

To configure the controller to use RS485 serial connection, to send and receive characters using the Modbus protocol:

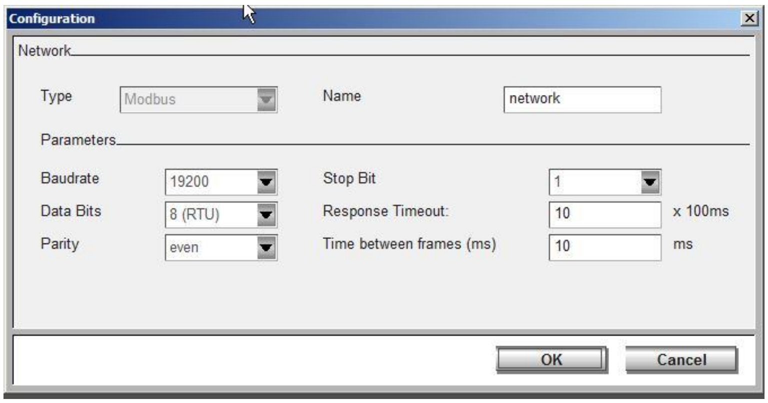
- Define the controller, expansion module, communication module and DUT
- Make the connections between the devices
- Configure the ports and communication network



Configuration of ACS (Modbus Type and Device Address)



Configuration of network (All network parameters)



Configure RS485 Serial Port

Modbus Master

Modbus master mode allows the controller to send a Modbus query to a slave, and to wait for the response. The Modbus Master mode is only supported via the EXCHx instruction. Moreover, the word table associated with the EXCHx instruction is composed of the control, transmission and reception tables.

The EXCHx instruction allows the Twido controller to send and/or receive information to/from Modbus devices. The user defines a table of words (%MWi:L) containing control information and the data to be sent and/or received (up to 250 bytes in transmission and/or reception). The format for the word table is described later. A message exchange is performed using the EXCHx instruction:

Syntax: [EXCHx %MWi:L]
where: x = port number (1 or 2)
L = number of words in the control words, transmission and reception tables

	Most significant byte	Least significant byte
Control table	Command	Length (Transmission/Reception)
	Reception offset	Transmission offset
Transmission table	Transmitted Byte 1	Transmitted Byte 2
	...	...
	...	Transmitted Byte n
	Transmitted Byte n+1	
Reception table	Received Byte 1	Received Byte 2
	...	...
	...	Received Byte p
	Received Byte p+1	

Command : 01 for all RX and TX functions

Length (Transmission/ Reception): The total number of bytes in the transmission table

Transmission Table : Command Transmission sequence to the sensor

Reception Table : Response from the sensor

EXAMPLE PROGRAM:

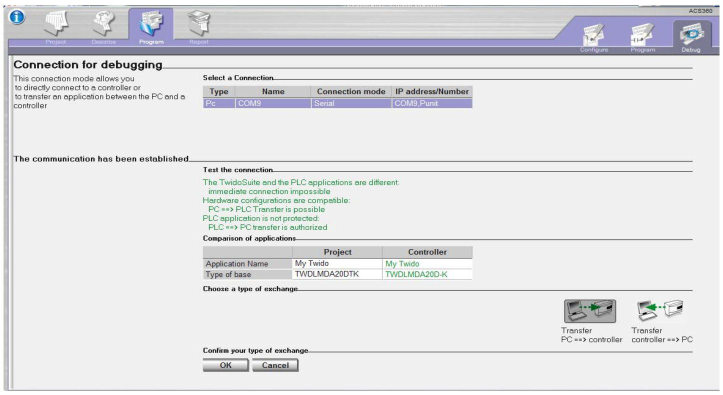
```
LD    1
[ %MW0 := 16#0106 ]
[ %MW1 := 16#0000 ]
[ %MW2 := 16#7F03 ]
[ %MW3 := 16#0000 ]
[ %MW4 := 16#000A ]

LD    1
AND   %MSG2.D
[ EXCH2 %MW0:16 ]

LD    %MSG2.E
ST    %Q0.0
```

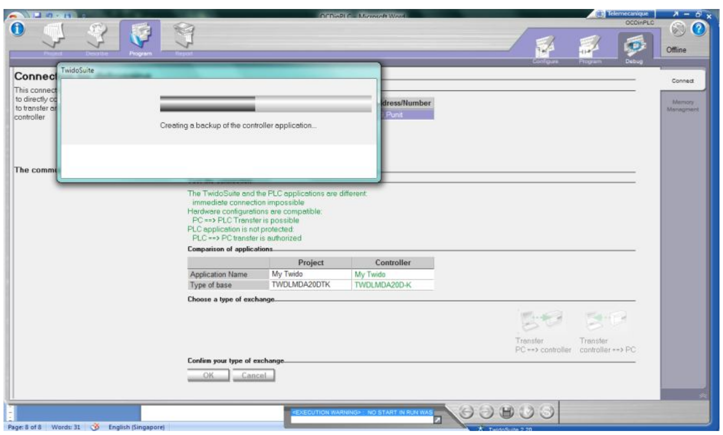
Write the control table, transmission table

Write the EXCHx function

Debugging

(Transfer program to controller and establish communication for debugging)





Manage Animation Table

Create a list of memory words you would like to read out from the controller to check the status of the sensor reply.

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0106	0000	Hexadecimal
2	☑	%MW1		0000	0000	Hexadecimal
3	☑	%MW2		7F03	[illegible]	[illegible]nal
4	☑	%MW3		0000	[illegible]	[illegible]exadecimal
5	☑	%MW4		000A	0000	Hexadecimal
6	☑	%MW5		7F03	0000	Hexadecimal
7	☑	%MW6		1400	0000	Hexadecimal
8	☑	%MW7		0009	0000	Hexadecimal
9	☑	%MW8		D600	0000	Hexadecimal
10	☑	%MW9		0006	0000	Hexadecimal
11	☑	%MW10		5600	[illegible]	[illegible]
12	☑	%MW11		0000	0000	Hexadecimal
13	☑	%MW12		0000	0000	Hexadecimal
14	☑	%MW13		0000	0000	Hexadecimal
15	☑	%MW14		0000	0000	Hexadecimal
16	☑	%MW15		0100	0000	Hexadecimal

Control and transmission program to sensor (rows 1–5)

Response to program from sensor (rows 7–16)

Explanation

Memory Word	Most Significant Byte	Least Significant Byte	
MW0	01h – Standard for TX/RX Control	06h – Total bytes in TX Table	Control Table
MW1	00h – Reception Offset	00h – Reception Offset	
MW2	7Fh – Device Address	03h – Modbus Function Code (Read registors)	Transmission Table
MW3	0000h – Starting Registor Address		
MW4	000Ah – Number of Registors to read		
MW5	7Fh– Response Device Address	03h – Modbus Function Code	Reception Table
MW6	14h – Number of bytes transmitted after response	00h – First byte transmitted from sensor…..	

6.4 Testing of ACS Modbus Functions

6.4.1 Single Axis

Read All Basic Data

Control and transmission (rows 1–4)
Response from sensor (rows 5–18)

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0106	0000	Hexadecimal
2	☑	%MW1		0300	0000	Hexadecimal
3	☑	%MW2		[illegible]	[illegible]	Hexadecimal
4	☑	%MW3		0000	0000	Hexadecimal
5	☑	%MW4		000E	0000	Hexadecimal
6	☑	%MW5		7F03	0000	Hexadecimal
7	☑	%MW6		001C	0000	Hexadecimal
8	☑	%MW7		0000	0000	Hexadecimal
9	☑	%MW8		8C90	0000	Hexadecimal
10	☑	%MW9		[illegible]	[illegible]	Hexadecimal
11	☑	%MW10		[illegible]	[illegible]	Hexadecimal
12	☑	%MW11		0000	0000	Hexadecimal
13	☑	%MW12		0000	0000	Hexadecimal
14	☑	%MW13		0000	0000	Hexadecimal
15	☑	%MW14		0000	0000	Hexadecimal
16	☑	%MW15		0001	0000	Hexadecimal
17	☑	%MW16		0000	0000	Hexadecimal
18	☑	%MW17		FFFF	0000	Hexadecimal
19	☑	%MW18		DCF1	9F9F	Hexadecimal
20	☑	%MW19		0000	0000	Hexadecimal
21	☑	%MW20		0000	0000	Hexadecimal
22	☑	%MW21		0040	0000	Hexadecimal

MW5	7F03	7F- Device Address / 03 – Function Code
MW6	001C	1C – Number of bytes transmitted
MW7	0000 (Register offset 0000h)	X Position Value – 000021FAh = 35984d = 359.84°
MW8	8C90 (Register offset 0001h)	
MW9	0000 (Register offset 0002h)	Y Position Value – N.A
MW10	0000 (Register offset 0003h)	
MW11	0000 (Register offset 0004h)	X Position Preset - 0°
MW12	0000 (Register offset 0005h)	
MW13	0000 (Register offset 0006h)	Y Position Preset – N.A
MW14	0000 (Register offset 0007h)	
MW15	0001 (Register offset 0008h)	Resolution = 1 = 0.01°
MW16	0000 (Register offset 0009h)	Measurement Direction = 0 = Clockwise
MW17	FFFF(Register offset 000Ah)	Offset X = FFFFDCF1h = -8975d = -89.75°
MW18	DCF1 (Register offset 000Bh)	
MW19	0000 (Register offset 000Ch)	Offset Y = N.A / 0°
MW20	0000 (Register offset 000Dh)	
MW21	0040 (Register offset 000Eh)	Filter Length = 40h = 64d

Read position value

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		0002	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0004	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		2693	0000	Hexadecimal

Position Value: (00002693)h = (9875)d -> (9875 x 0.01°) = 98.75°

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		0002	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0004	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		4981	0000	Hexadecimal

Position Value: (00004981)h = (18817)d -> (18817 x 0.01°) = 188.17°

Preset Functionality

Read position before preset

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		0002	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0004	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		4641	0000	Hexadecimal

Position Value: (00004641)h = (17985)d -> (17985 x 0.01°) = 179.85°

Preset the current position with a user defined position of (2222h = 87.38°)

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0110	0000	Hexadecimal
2		☑	%MW1		0007	0000	Hexadecimal
3		☑	%MW2		7F10	0000	Hexadecimal
4		☑	%MW3		0004	0000	Hexadecimal
5		☑	%MW4		0004	0000	Hexadecimal
6		☑	%MW5		0008	0000	Hexadecimal
7		☑	%MW6		0000	0000	Hexadecimal
8		☑	%MW7		2222	0000	Hexadecimal
9		☑	%MW8		0000	0000	Hexadecimal
10		☑	%MW9		0000	0000	Hexadecimal
11		☑	%MW10		7F10	0000	Hexadecimal
12		☑	%MW11		0004	0000	Hexadecimal
13		☑	%MW12		0004	0000	Hexadecimal

(Note: It is not mandatory to write the Preset registers of Y Axis for Single axis inclinometers)

Read position again

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW3		0000	0000	Hexadecimal
4		☑	%MW4		0004	0000	Hexadecimal
5		☑	%MW5		7F03	0000	Hexadecimal
6		☑	%MW6		0008	0000	Hexadecimal
7		☑	%MW7		0000	0000	Hexadecimal
8		☑	%MW8		2221	0000	Hexadecimal

Position Value: (00002221)h = (8737)d -> (8737 x 0.01°) = 87.37°

Preset the current position to reference origin (0°)

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0110	0000	Hexadecimal
2		☑	%MW1		0007	0000	Hexadecimal
3		☑	%MW2		7F10	0000	Hexadecimal
4		☑	%MW3		0004	0000	Hexadecimal
5		☑	%MW4		0004	0000	Hexadecimal
6		☑	%MW5		0008	0000	Hexadecimal
7		☑	%MW6		0000	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		0000	0000	Hexadecimal
10		☑	%MW9		0000	0000	Hexadecimal
11		☑	%MW10		7F10	0000	Hexadecimal
12		☑	%MW11		0004	0000	Hexadecimal
13		☑	%MW12		0004	0000	Hexadecimal

Read position value again

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		0004	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0008	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		002F	0000	Hexadecimal

Position Value: (0000002F)h = (47)d -> (47 x 0.01°) = 0.47°

Output Resolution

Read resolution register

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0008	0000	Hexadecimal
5		☑	%MW4		0001	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0002	0000	Hexadecimal
8		☑	%MW7		0001	0000	Hexadecimal

Output Resolution: 0001h = 0.01° (Default Factory Setting)

Read position with current resolution (0.01°)

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW3		0000	0000	Hexadecimal
4		☑	%MW4		0004	0000	Hexadecimal
5		☑	%MW5		7F03	0000	Hexadecimal
6		☑	%MW6		0008	0000	Hexadecimal
7		☑	%MW7		0000	0000	Hexadecimal
8		☑	%MW8		4642	0000	Hexadecimal

Position Value: (00004642)h = (17986)d -> (17986 x 0.01°) = 179.86°

Write new output resolution to 0002h=0.1°

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		010A	0000	Hexadecimal
2		☑	%MW1		0007	0000	Hexadecimal
3		☑	%MW2		7F10	0000	Hexadecimal
4		☑	%MW3		0008	0000	Hexadecimal
5		☑	%MW4		0001	0000	Hexadecimal
6		☑	%MW5		0002	0000	Hexadecimal
7		☑	%MW6		0002	0000	Hexadecimal
8		☑	%MW7		7F10	0000	Hexadecimal
9		☑	%MW8		0008	0000	Hexadecimal
10		☑	%MW9		0001	0000	Hexadecimal

Read position value after change in resolution (0.1°)

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		0004	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0008	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		070A	0000	Hexadecimal

Position Value: (0000070A)h = (17986)d -> (1802 x 0.1°) = 180.2°

Measurement Direction

Read measurement direction (Default is 0000h = Clockwise measurement)

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0009	0000	Hexadecimal
5		☑	%MW4		0001	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0002	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal

Read position

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		0004	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0008	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		22C3	0000	Hexadecimal

Position Value: (000022C3)h = (8899)d -> (8899 x 0.01°) = 88.99°

Change measurement direction (to 1 = Counter Clockwise measurement X Axis)

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		010A	0000	Hexadecimal
2		☑	%MW1		0007	0000	Hexadecimal
3		☑	%MW2		7F10	0000	Hexadecimal
4		☑	%MW3		0009	0000	Hexadecimal
5		☑	%MW4		0001	0000	Hexadecimal
6		☑	%MW5		0002	0000	Hexadecimal
7		☑	%MW6		0001	0000	Hexadecimal
8		☑	%MW7		7F10	0000	Hexadecimal
9		☑	%MW8		0009	0000	Hexadecimal
10		☑	%MW9		0001	0000	Hexadecimal

Read measurement direction after change

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0009	0000	Hexadecimal
5		☑	%MW4		0001	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0002	0000	Hexadecimal
8		☑	%MW7		0001	0000	Hexadecimal

Read position

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		000E	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		001C	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		69DA	0000	Hexadecimal

Position Value: (000069DA)h = (27098)d -> (27098 x 0.01°) = 270.98°

Filter Value

Read filter value (default 64 = 40h)

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		000E	0000	Hexadecimal
5		☑	%MW4		0001	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0002	0000	Hexadecimal
8		☑	%MW7		0040	0000	Hexadecimal

Change filter value to 128

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		010A	0000	Hexadecimal
2		☑	%MW1		0007	0000	Hexadecimal
3		☑	%MW2		7F10	0000	Hexadecimal
4		☑	%MW3		000E	0000	Hexadecimal
5		☑	%MW4		0001	0000	Hexadecimal
6		☑	%MW5		0002	0000	Hexadecimal
7		☑	%MW6		0080	0000	Hexadecimal
8		☑	%MW7		7F10	0000	Hexadecimal
9		☑	%MW8		000E	0000	Hexadecimal
10		☑	%MW9		0001	0000	Hexadecimal

Read new filter value (check)

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		000E	0000	Hexadecimal
5		☑	%MW4		0001	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0002	0000	Hexadecimal
8		☑	%MW7		0080	0000	Hexadecimal

Offset Registers

Offset value = Physical position - set position

To check the working

First read position

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		0004	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		0008	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		4677	0000	Hexadecimal

Position = 4677h = 180.39°

Then preset to zero

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0110	0000	Hexadecimal
2	☑	%MW1		0007	0000	Hexadecimal
3	☑	%MW2		7F10	0000	Hexadecimal
4	☑	%MW3		0004	0000	Hexadecimal
5	☑	%MW4		0004	0000	Hexadecimal
6	☑	%MW5		0008	0000	Hexadecimal
7	☑	%MW6		0000	0000	Hexadecimal
8	☑	%MW7		0000	0000	Hexadecimal
9	☑	%MW8		0000	0000	Hexadecimal
10	☑	%MW9		0000	0000	Hexadecimal
11	☑	%MW10		7F10	0000	Hexadecimal
12	☑	%MW11		0004	0000	Hexadecimal
13	☑	%MW12		0004	0000	Hexadecimal

Read position again

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0106	0000	Hexadecimal
2	☑	%MW1		0300	0000	Hexadecimal
3	☑	%MW2		7F03	0000	Hexadecimal
4	☑	%MW3		0000	0000	Hexadecimal
5	☑	%MW4		0004	0000	Hexadecimal
6	☑	%MW5		7F03	0000	Hexadecimal
7	☑	%MW6		0008	0000	Hexadecimal
8	☑	%MW7		0000	0000	Hexadecimal
9	☑	%MW8		0006	0000	Hexadecimal

New position value = 0006h = 0.06degree

Read offset values

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0106	0000	Hexadecimal
2	☑	%MW1		0300	0000	Hexadecimal
3	☑	%MW2		7F03	0000	Hexadecimal
4	☑	%MW3		000A	0000	Hexadecimal
5	☑	%MW4		0004	0000	Hexadecimal
6	☑	%MW5		7F03	0000	Hexadecimal
7	☑	%MW6		0008	0000	Hexadecimal
8	☑	%MW7		FFFF	0000	Hexadecimal
9	☑	%MW8		BA05	0000	Hexadecimal
10	☑	%MW9		0000	0000	Hexadecimal
11	☑	%MW10		0000	0000	Hexadecimal

Offset value = (FFFFBA05h)signed = -179.15 degrees

Theoretical Calculation:

Offset value = (Physical position - set position) = (0.06° - 180.39°) = -180.33°

Baud rate

Read with reply (default 3- 19200 Bd)

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0104	0000	Hexadecimal
2		☑	%MW1		0500	0000	Hexadecimal
3		☑	%MW2		7F45	0000	Hexadecimal
4		☑	%MW3		2001	0000	Hexadecimal
5		☑	%MW4		7F45	0000	Hexadecimal
6		☑	%MW5		2001	0000	Hexadecimal
7		☑	%MW6		0003	0000	Hexadecimal

Change baud rate to 02 – 9600 Bd

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0005	0000	Hexadecimal
3		☑	%MW2		7F44	0000	Hexadecimal
4		☑	%MW3		2001	0000	Hexadecimal
5		☑	%MW4		0002	0000	Hexadecimal
6		☑	%MW5		7F44	0000	Hexadecimal
7		☑	%MW6		2001	0000	Hexadecimal

NOTE: A power cycle is required for the changes to take place. Also ensure the network configuration of PLC is also changed before continuing.

Check new baud rate

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0104	0000	Hexadecimal
2		☑	%MW1		0500	0000	Hexadecimal
3		☑	%MW2		7F45	0000	Hexadecimal
4		☑	%MW3		2001	0000	Hexadecimal
5		☑	%MW4		7F45	0000	Hexadecimal
6		☑	%MW5		2001	0000	Hexadecimal
7		☑	%MW6		0002	0000	Hexadecimal

Parity

Read parity value (default - even parity)

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0104	0000	Hexadecimal
2	☑	%MW1		0500	0000	Hexadecimal
3	☑	%MW2		7F45	0000	Hexadecimal
4	☑	%MW3		2101	0000	Hexadecimal
5	☑	%MW4		7F45	0000	Hexadecimal
6	☑	%MW5		2101	0000	Hexadecimal
7	☑	%MW6		0002	0000	Hexadecimal

Change to odd parity

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0106	0000	Hexadecimal
2	☑	%MW1		0005	0000	Hexadecimal
3	☑	%MW2		7F44	0000	Hexadecimal
4	☑	%MW3		2101	0000	Hexadecimal
5	☑	%MW4		0001	0000	Hexadecimal
6	☑	%MW5		7F44	0000	Hexadecimal
7	☑	%MW6		2101	0000	Hexadecimal

NOTE: A power cycle is required for the changes to take place. Also ensure the network configuration of PLC is also changed before continuing.

Read parity value (Now reads odd parity)

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0104	0000	Hexadecimal
2	☑	%MW1		0500	0000	Hexadecimal
3	☑	%MW2		7F45	0000	Hexadecimal
4	☑	%MW3		2101	0000	Hexadecimal
5	☑	%MW4		7F45	0000	Hexadecimal
6	☑	%MW5		2101	0000	Hexadecimal
7	☑	%MW6		0001	0000	Hexadecimal

Device address

Procedure to change device address (Default 7F)

Read device address

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0104	0000	Hexadecimal
2		☑	%MW1		0500	0000	Hexadecimal
3		☑	%MW2		7F45	0000	Hexadecimal
4		☑	%MW3		2201	0000	Hexadecimal
5		☑	%MW4		7F45	0000	Hexadecimal
6		☑	%MW5		2201	0000	Hexadecimal
7		☑	%MW6		007F	0000	Hexadecimal

Change device address to 05h

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0005	0000	Hexadecimal
3		☑	%MW2		7F44	0000	Hexadecimal
4		☑	%MW3		2201	0000	Hexadecimal
5		☑	%MW4		0005	0000	Hexadecimal
6		☑	%MW5		7F44	0000	Hexadecimal
7		☑	%MW6		2201	0000	Hexadecimal

NOTE: A power cycle is required for the changes to take place. Also ensure the network configuration of PLC is also changed before continuing

Establish communication and read position value with new device address

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		0503	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		0004	0000	Hexadecimal
6		☑	%MW5		0503	0000	Hexadecimal
7		☑	%MW6		0008	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		2F35	0000	Hexadecimal

Hardware version

Hardware version value read is 9

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0104	0000	Hexadecimal
2		☑	%MW1		0500	0000	Hexadecimal
3		☑	%MW2		7F45	0000	Hexadecimal
4		☑	%MW3		3001	0000	Hexadecimal
5		☑	%MW4		7F45	0000	Hexadecimal
6		☑	%MW5		3001	0000	Hexadecimal
7		☑	%MW6		0009	0000	Hexadecimal

Software version

Software version value read is 1.00

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0104	0000	Hexadecimal
2		☑	%MW1		0500	0000	Hexadecimal
3		☑	%MW2		7F45	0000	Hexadecimal
4		☑	%MW3		3102	0000	Hexadecimal
5		☑	%MW4		7F45	0000	Hexadecimal
6		☑	%MW5		3102	0000	Hexadecimal
7		☑	%MW6		1	0	Decimal

Termination Resistor

Default value is 0 (i.e termination resistor is OFF)

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0104	0000	Hexadecimal
2		☑	%MW1		0500	0000	Hexadecimal
3		☑	%MW2		7F45	0000	Hexadecimal
4		☑	%MW3		2301	0000	Hexadecimal
5		☑	%MW4		7F45	0000	Hexadecimal
6		☑	%MW5		2301	0000	Hexadecimal
7		☑	%MW6		0	0	Decimal

Software power cycle

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0104	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F44	0000	Hexadecimal
4		☑	%MW3		AA01	0000	Hexadecimal
5		☑	%MW4		7FC4	0000	Hexadecimal
6		☑	%MW5		0003	0000	Hexadecimal

Restore to Factory Settings

First read all data

		Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		000E	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		001C	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		267A	0000	Hexadecimal
10		☑	%MW9		0000	0000	Hexadecimal
11		☑	%MW10		0000	0000	Hexadecimal
12		☑	%MW11		0000	0000	Hexadecimal
13		☑	%MW12		2222	0000	Hexadecimal
14		☑	%MW13		0000	0000	Hexadecimal
15		☑	%MW14		0000	0000	Hexadecimal
16		☑	%MW15		0001	0000	Hexadecimal
17		☑	%MW16		0000	0000	Hexadecimal
18		☑	%MW17		0000	0000	Hexadecimal
19		☑	%MW18		03A6	9F9F	Hexadecimal
20		☑	%MW19		0000	0000	Hexadecimal
21		☑	%MW20		0000	0000	Hexadecimal
22		☑	%MW21		0040	0000	Hexadecimal

Then factory reset

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0104	0000	Hexadecimal
2		☑	%MW1		0000	0000	Hexadecimal
3		☑	%MW2		7F44	0000	Hexadecimal
4		☑	%MW3		5500	0000	Hexadecimal
5		☑	%MW4		7F44	0000	Hexadecimal
6		☑	%MW5		5500	0000	Hexadecimal

Read all data again

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		000E	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		001C	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		22D3	0000	Hexadecimal
10		☑	%MW9		0000	0000	Hexadecimal
11		☑	%MW10		0000	0000	Hexadecimal
12		☑	%MW11		0000	0000	Hexadecimal
13		☑	%MW12		0000	0000	Hexadecimal
14		☑	%MW13		0000	0000	Hexadecimal
15		☑	%MW14		0000	0000	Hexadecimal
16		☑	%MW15		0001	0000	Hexadecimal
17		☑	%MW16		0000	0000	Hexadecimal
18		☑	%MW17		0000	0000	Hexadecimal
19		☑	%MW18		0000	9F9F	Hexadecimal
20		☑	%MW19		0000	0000	Hexadecimal
21		☑	%MW20		0000	0000	Hexadecimal
22		☑	%MW21		0040	0000	Hexadecimal

Preset, Offset values are all set to default factory settings

Device Identity

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0001	0000	Hexadecimal
3		☑	%MW2		007F	0000	Hexadecimal
4		☑	%MW3		2B0E	0000	Hexadecimal
5		☑	%MW4		0100	0000	Hexadecimal
6		☑	%MW5		7F2B	0000	Hexadecimal
7		☑	%MW6		0E01	0000	Hexadecimal
8		☑	%MW7		0100	0000	Hexadecimal
9		☑	%MW8		0003	0000	Hexadecimal
10		☑	%MW9		0007	0000	Hexadecimal
11		☑	%MW10		PO		ASCII (8 bits)
12		☑	%MW11		SI		ASCII (8 bits)
13		☑	%MW12		TA		ASCII (8 bits)
14		☑	%MW13		L		ASCII (8 bits)
15		☑	%MW14		A		ASCII (8 bits)
16		☑	%MW15		CS		ASCII (8 bits)
17		☑	%MW16		36		ASCII (8 bits)
18		☑	%MW17		0		ASCII (8 bits)
19		☑	%MW18		M1		ASCII (8 bits)
20		☑	%MW19		S		ASCII (8 bits)
21		☑	%MW20		#		ASCII (8 bits)
22		☑	%MW21		00		ASCII (8 bits)
23		☑	%MW22		71		ASCII (8 bits)
24		☑	%MW23		93		ASCII (8 bits)
25		☑	%MW24		71		ASCII (8 bits)
26		☑	%MW25				ASCII (8 bits)
27		☑	%MW26		SW		ASCII (8 bits)
28		☑	%MW27		01		ASCII (8 bits)
29		☑	%MW28		.0		ASCII (8 bits)
30		☑	%MW29		2		ASCII (8 bits)
31		☑	%MW30		HW		ASCII (8 bits)
32		☑	%MW31		09		ASCII (8 bits)

POSITAL
ACS 360 M1
S#00719371
SW 01.00 HW 09

6.4.2 Dual Axis

Read All Basic Data

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	[illegible]	decimal
5		☑	%MW4		000E	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		001C	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		0017	0000	Hexadecimal
10		☑	%MW9		0000	0000	Hexadecimal
11		☑	%MW10		0B4E	0000	Hexadecimal
12		☑	%MW11		0000	0000	Hexadecimal
13		☑	%MW12		0000	0000	Hexadecimal
14		☑	%MW13		0000	[illegible]	exadecimal
15		☑	%MW14		0000	0000	Hexadecimal
16		☑	%MW15		0001	0000	Hexadecimal
17		☑	%MW16		0000	0000	Hexadecimal
18		☑	%MW17		0000	0000	Hexadecimal
19		☑	%MW18		0000	9F9F	Hexadecimal
20		☑	%MW19		0000	0000	Hexadecimal
21		☑	%MW20		0000	0000	Hexadecimal
22		☑	%MW21		0040	0000	Hexadecimal

Control and transmission (rows 1–5)

Response from sensor (rows 6–22)

MW5	7F03	7F- Device Address / 03 – Function Code
MW6	001C	1C – Number of bytes transmitted
MW7	0000 (Register offset 0000h)	X Position Value – 00000017h = 23d = 0.23°
MW8	0017 (Register offset 0001h)	
MW9	0000 (Register offset 0002h)	Y Position Value – 00000B4Eh = 2894d = 28.94°
MW10	0B4E (Register offset 0003h)	
MW11	0000 (Register offset 0004h)	X Position Preset - 0°
MW12	0000 (Register offset 0005h)	
MW13	0000 (Register offset 0006h)	Y Position Preset – 0°
MW14	0000 (Register offset 0007h)	
MW15	0001 (Register offset 0008h)	Resolution = 1 = 0.01°
MW16	0000 (Register offset 0009h)	Measurement Direction = 0 = Clockwise
MW17	0000(Register offset 000Ah)	Offset X = 0°
MW18	0000(Register offset 000Bh)	
MW19	0000 (Register offset 000Ch)	Offset Y = 0°
MW20	0000 (Register offset 000Dh)	
MW21	0040 (Register offset 000Eh)	Filter Length = 40h = 64d

Preset Functionality

First read all data

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		000E	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		001C	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		0586	0000	Hexadecimal
10		☑	%MW9		FFFF	0000	Hexadecimal
11		☑	%MW10		FFB4	0000	Hexadecimal
12		☑	%MW11		0000	0000	Hexadecimal
13		☑	%MW12		0000	0000	Hexadecimal
14		☑	%MW13		0000	0000	Hexadecimal
15		☑	%MW14		0000	0000	Hexadecimal
16		☑	%MW15		0001	0000	Hexadecimal
17		☑	%MW16		0000	0000	Hexadecimal
18		☑	%MW17		0000	0000	Hexadecimal
19		☑	%MW18		0000	9F9F	Hexadecimal
20		☑	%MW19		0000	0000	Hexadecimal
21		☑	%MW20		0000	0000	Hexadecimal
22		☑	%MW21		0040	0000	Hexadecimal

Position

X Axis – (00000586)h = (1414)d -> 14.14°

Y Axis – (FFFFFFB4)h = (-76)d -> -0.76°

Preset to X=0.85°; Y=0.85°;

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0110	0000	Hexadecimal
2	☑	%MW1		0007	0000	Hexadecimal
3	☑	%MW2		7F10	0000	Hexadecimal
4	☑	%MW3		0004	0000	Hexadecimal
5	☑	%MW4		0004	0000	Hexadecimal
6	☑	%MW5		0008	0000	Hexadecimal
7	☑	%MW6		0000	0000	Hexadecimal
8	☑	%MW7		0055	0000	Hexadecimal
9	☑	%MW8		0000	0000	Hexadecimal
10	☑	%MW9		0055	0000	Hexadecimal
11	☑	%MW10		7F10	0000	Hexadecimal
12	☑	%MW11		0004	0000	Hexadecimal
13	☑	%MW12		0004	0000	Hexadecimal

Read all data again

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0106	0000	Hexadecimal
2	☑	%MW1		0300	0000	Hexadecimal
3	☑	%MW2		7F03	0000	Hexadecimal
4	☑	%MW3		0000	0000	Hexadecimal
5	☑	%MW4		000E	0000	Hexadecimal
6	☑	%MW5		7F03	0000	Hexadecimal
7	☑	%MW6		001C	0000	Hexadecimal
8	☑	%MW7		0000	0000	Hexadecimal
9	☑	%MW8		003E	New position after preset	decimal
10	☑	%MW9		0000	0000	Hexadecimal
11	☑	%MW10		0054	0000	Hexadecimal
12	☑	%MW11		0000	0000	Hexadecimal
13	☑	%MW12		0055	0000	Hexadecimal
14	☑	%MW13		0000	Preset values updated	exadecimal
15	☑	%MW14		0055	0000	Hexadecimal
16	☑	%MW15		0001	0000	Hexadecimal
17	☑	%MW16		0000	0000	Hexadecimal
18	☑	%MW17		FFFF	0000	Hexadecimal
19	☑	%MW18		FBAE	9F9F	Hexadecimal
20	☑	%MW19		0000	Offset calculated	Hexadecimal
21	☑	%MW20		00A2	0000	Hexadecimal
22	☑	%MW21		0040	0000	Hexadecimal

New Position: X= 0000003Eh -> 0.62° / Y= 54h -> 0.84°

Preset Values: X = 00000055h -> 0.85° / Y = 00000055h -> 0.85°

Offset Values: X = FFFFFBAEh -> -11.06°/ Y = 000000A2h -> 1.62°

Measurement Direction

Default Measurement direction = 0 = Both Axis Counter clockwise

Read Position

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0106	0000	Hexadecimal
2	☑	%MW1		0300	0000	Hexadecimal
3	☑	%MW2		7F03	0000	Hexadecimal
4	☑	%MW3		0000	0000	Hexadecimal
5	☑	%MW4		0004	0000	Hexadecimal
6	☑	%MW5		7F03	0000	Hexadecimal
7	☑	%MW6		0008	0000	Hexadecimal
8	☑	%MW7		0000	0000	Hexadecimal
9	☑	%MW8		0318	0000	Hexadecimal
10	☑	%MW9		FFFF	0000	Hexadecimal
11	☑	%MW10		FBEC	0000	Hexadecimal

Position: X = 7.92° / Y = -10.44°

Change measurement direction to 1 = X Axis Counter clockwise

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		010A	0000	Hexadecimal
2	☑	%MW1		0007	0000	Hexadecimal
3	☑	%MW2		7F10	0000	Hexadecimal
4	☑	%MW3		0009	0000	Hexadecimal
5	☑	%MW4		0001	0000	Hexadecimal
6	☑	%MW5		0002	0000	Hexadecimal
7	☑	%MW6		0001	0000	Hexadecimal
8	☑	%MW7		7F10	0000	Hexadecimal
9	☑	%MW8		0009	0000	Hexadecimal
10	☑	%MW9		0001	0000	Hexadecimal

Read Position

	Us	Address	Symbol	Current	Retained	Format
1	☑	%MW0		0106	0000	Hexadecimal
2	☑	%MW1		0300	0000	Hexadecimal
3	☑	%MW2		7F03	0000	Hexadecimal
4	☑	%MW3		0000	0000	Hexadecimal
5	☑	%MW4		000E	0000	Hexadecimal
6	☑	%MW5		7F03	0000	Hexadecimal
7	☑	%MW6		001C	0000	Hexadecimal
8	☑	%MW7		FFFF	0000	Hexadecimal
9	☑	%MW8		F441	0000	Hexadecimal
10	☑	%MW9		FFFF	0000	Hexadecimal
11	☑	%MW10		FBF3	0000	Hexadecimal

Position X = -30.07° / Y=-10.37°

Change measurement direction to 2 = Y Axis counter clockwise and read position

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		000E	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		001C	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		0319	0000	Hexadecimal
10		☑	%MW9		0000	0000	Hexadecimal
11		☑	%MW10		0551	0000	Hexadecimal

Position: X = 7.93° / Y = 13.61°

Change measurement direction to 3 = Both Axis counter clockwise and read position

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		000E	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		001C	0000	Hexadecimal
8		☑	%MW7		FFFF	0000	Hexadecimal
9		☑	%MW8		F443	0000	Hexadecimal
10		☑	%MW9		0000	0000	Hexadecimal
11		☑	%MW10		0550	0000	Hexadecimal

Position: X =-30.02° / Y= 13.60°

Summary

Register Value	X Position	Y Position
0	Clockwise: 7.92°	Clockwise: -10.44°
1	Counter Clockwise: -30.07°	Clockwise: -10.37°
2	Clockwise: 7.93°	Counter Clockwise: 13.61°
3	Counter Clockwise: -30.02°	Counter Clockwise: 13.60°

Restore Factory Settings

Read all data before factory reset

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		000E	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		001C	0000	Hexadecimal
8		☑	%MW7		FFFF	0000	Hexadecimal
9		☑	%MW8		F442	0000	Hexadecimal
10		☑	%MW9		0000	0000	Hexadecimal
11		☑	%MW10		0551	0000	Hexadecimal
12		☑	%MW11		0000	0000	Hexadecimal
13		☑	%MW12		0055	0000	Hexadecimal
14		☑	%MW13		0000	0000	Hexadecimal
15		☑	%MW14		0055	0000	Hexadecimal
16		☑	%MW15		0001	0000	Hexadecimal
17		☑	%MW16		0003	0000	Hexadecimal
18		☑	%MW17		FFFF	0000	Hexadecimal
19		☑	%MW18		FBAE	9F9F	Hexadecimal
20		☑	%MW19		0000	0000	Hexadecimal
21		☑	%MW20		00A2	0000	Hexadecimal
22		☑	%MW21		0040	0000	Hexadecimal

Perform factory reset

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0104	0000	Hexadecimal
2		☑	%MW1		0000	0000	Hexadecimal
3		☑	%MW2		7F44	0000	Hexadecimal
4		☑	%MW3		5500	0000	Hexadecimal
5		☑	%MW4		7F44	0000	Hexadecimal
6		☑	%MW5		5500	0000	Hexadecimal

Read all data again

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0300	0000	Hexadecimal
3		☑	%MW2		7F03	0000	Hexadecimal
4		☑	%MW3		0000	0000	Hexadecimal
5		☑	%MW4		000E	0000	Hexadecimal
6		☑	%MW5		7F03	0000	Hexadecimal
7		☑	%MW6		001C	0000	Hexadecimal
8		☑	%MW7		0000	0000	Hexadecimal
9		☑	%MW8		06D4	0000	Hexadecimal
10		☑	%MW9		FFFF	0000	Hexadecimal
11		☑	%MW10		FB79	0000	Hexadecimal
12		☑	%MW11		0000	0000	Hexadecimal
13		☑	%MW12		0000	0000	Hexadecimal
14		☑	%MW13		0000	0000	Hexadecimal
15		☑	%MW14		0000	0000	Hexadecimal
16		☑	%MW15		0001	0000	Hexadecimal
17		☑	%MW16		0000	0000	Hexadecimal
18		☑	%MW17		0000	0000	Hexadecimal
19		☑	%MW18		0000	9F9F	Hexadecimal
20		☑	%MW19		0000	0000	Hexadecimal
21		☑	%MW20		0000	0000	Hexadecimal
22		☑	%MW21		0040	0000	Hexadecimal

Device Identity

	⚠	Us	Address	Symbol	Current	Retained	Format
1		☑	%MW0		0106	0000	Hexadecimal
2		☑	%MW1		0001	0000	Hexadecimal
3		☑	%MW2		007F	0000	Hexadecimal
4		☑	%MW3		2B0E	0000	Hexadecimal
5		☑	%MW4		0100	0000	Hexadecimal
6		☑	%MW5		7F2B	0000	Hexadecimal
7		☑	%MW6		0E01	0000	Hexadecimal
8		☑	%MW7		0100	0000	Hexadecimal
9		☑	%MW8		0003	0000	Hexadecimal
10		☑	%MW9		0007	0000	Hexadecimal
11		☑	%MW10		PO		ASCII (8 bits)
12		☑	%MW11		SI		ASCII (8 bits)
13		☑	%MW12		TA		ASCII (8 bits)
14		☑	%MW13		L		ASCII (8 bits)
15		☑	%MW14		A		ASCII (8 bits)
16		☑	%MW15		CS		ASCII (8 bits)
17		☑	%MW16		08		ASCII (8 bits)
18		☑	%MW17		0		
19		☑	%MW18		M1		CII (8 bits)
20		☑	%MW19		S		ASCII (8 bits)
21		☑	%MW20		#		ASCII (8 bits)
22		☑	%MW21		00		ASCII (8 bits)
23		☑	%MW22		72		ASCII (8 bits)
24		☑	%MW23		02		ASCII (8 bits)
25		☑	%MW24		39		ASCII (8 bits)
26		☑	%MW25				ASCII (8 bits)
27		☑	%MW26		SW		ASCII (8 bits)
28		☑	%MW27		01		ASCII (8 bits)
29		☑	%MW28		.0		ASCII (8 bits)
30		☑	%MW29		2		ASCII (8 bits)
31		☑	%MW30		HW		ASCII (8 bits)
32		☑	%MW31		09		ASCII (8 bits)

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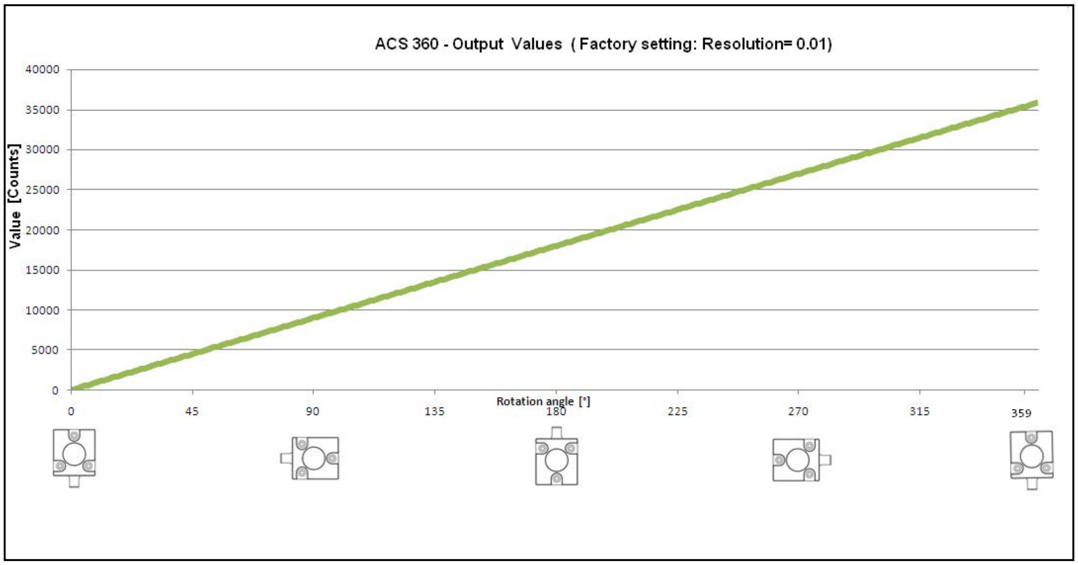
ACS080 M1 S#00720239
SW 01.01 HW 09

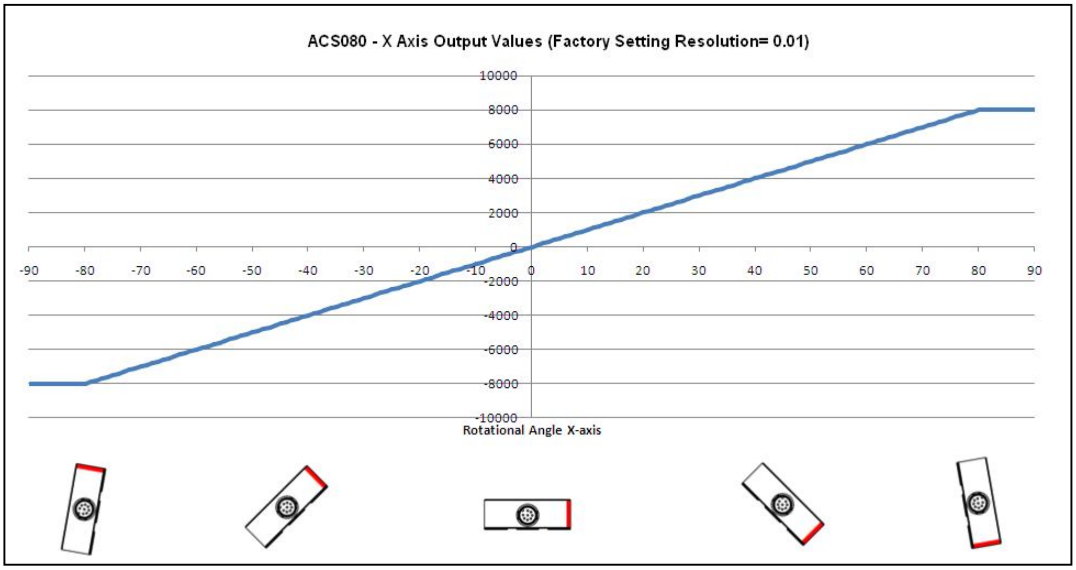
Appendix

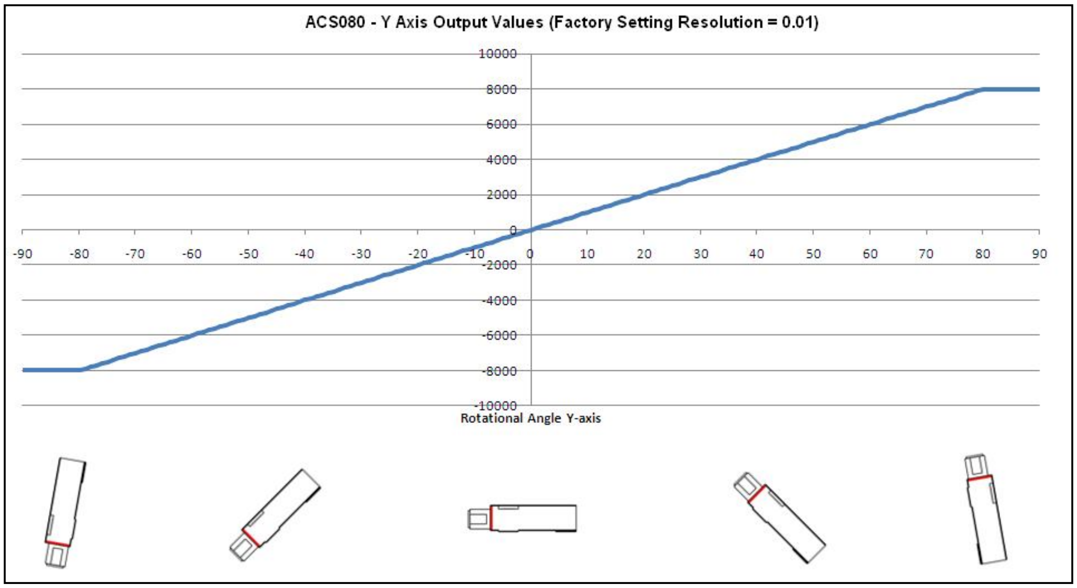
Appendix A: Output Graphs

ACS 360: Modbus RTU Output Values



ACS 080 : Modbus RTU Output Values





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

POSITAL
FRABA

TILTIX INCLINOMETER
WITH MODBUS RTU INTERFACE

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