# Application of MODBUS Protocol in RADWAG Indicators



*MODBUS* is one of the oldest and at the same time one of the most frequently used communication protocols intended for applications in industrial automation systems. It owes its popularity to its simplicity, versatility and inexpensive implementation. The protocol is based on a master-slave architecture, where a master device (e.g. a computer) communicates with one or more slaves. Communication consists of the master sending a request to all slaves connected to the network. Only one device, the one to which the message is addressed, responds. Communication can only be initiated by the Master device. The Slave device can only send a response to the request.

This manual describes the use of the *MODBUS* protocol by the HY10 weighing indicator. The indicator features two types of the protocol:

- MODBUS RTU enables communication via RS232 serial connector
- MODBUS TCP enables network communication via Ethernet

# Content

1.	IMPLEMENTED FUNCTIONS	4
2.	INPUT VARIABLES	5
3.	OUTPUT VARIABLES	8
4.	SETUP	11
5.	EXAMPLES	16
5.1	Taring	
5.2	Customer Selection	
5.3	Setting MIN Threshold	
5.4	Setting Lot Number	

# **1. IMPLEMENTED FUNCTIONS**

The implemented protocol enables:

- Operation of up to 2 weighing platforms (mass readout, taring, zeroing, determining: tare value, LO, MIN and MAX thresholds of every platform),
- Input status readout,
- Output setting,
- Operator selection,
- Product selection,
- Customer selection,
- Packaging selection,
- Warehouse selection,
- Dosing selection,
- Formulations selection,
- Lot number selection,
- Process stop,
- Process start,
- Saving/Printout,
- Statistics zeroing.

MODBUS communciation is based on 3 functions:

- 03 (0x03) Read Holding Registers output data readout,
- 04 (0x04) Read Input Registers input data readout,
- 16 (0x10) Write Multiple Registers output data record.

# **2. INPUT VARIABLES**

Variable	Address	Length [WORD]	Data type
Platform 1 mass	0	2	float
Platform 1 tare	2	2	float
Platform 1 unit	4	1	word
Platform 1 status	5	1	word
Platform 1 LO threshold	6	2	float
Platform 2 mass	8	2	float
Platform 2 tare	10	2	float
Platform 2 unit	12	1	word
Platform 2 status	13	1	word
Platform 2 LO threshold	14	2	float
Process status (Stop, Start)	32	1	word
Input status	33	1	word
Min	34	2	float
Мах	36	2	float
Lot number	42	2	dword
Operator	44	1	word
Product	45	1	word
Customer	46	1	word
Packaging	47	1	word
Source warehouse	48	1	word
Target warehouse	49	1	word
Formulation/Dosing	50	1	word

**Platform mass** – response: mass value of a given platform in current unit. **Platform tare** – response: tare value of a given platform in adjustment unit **Platform unit** – determines currently displayed mass unit of a given platform.

Unit bits	
0	gram [g]
1	kilogram [kg]
2	carat [ct]
3	pound [lb]
4	ounce [oz]
5	Newton [N]

Example:

Bit No.	B5	B4	B3	B2	B1	B0
Value	0	0	1	0	0	0

The unit of the weighing instrument is pound [lb]

#### **Platform status** – determines status of a given weighing platform.

Status bits	
0	Measurement correct (weighing instrument does not report an error).
1	Measurement stable.
2	Weighing instrument indicates zero.
3	Weighing instrument tared.
4	Weighing instrument in II weighing range.
5	Weighing instrument in III weighing range.
6	Weighing instrument reports NULL error.
7	Weighing instrument reports LH error.
8	Weighing instrument reports FULL error.

Example:

Value	1	0	0	0	0	0	0	0	0
Bit No.	B8	B7	B6	B5	B4	B3	B2	B1	B0

Weighing instrument reports FULL error.

LO threshold - response: LO threshold value in adjustment unit of a given platform.

Process status – determines process status:

Decimal value	Process status	Bit No.		
Decimal value	FIOCESS Status	B1 B0		
0	Process disabled	0	0	
1	Process start	0	1	
2	Process stop	1	0	
3	Process completed	1	1	

**Inputs status** – response: status of set inputs:

Input No.	12	11	10	9	8	7	6	5	4	3	2	1
OFF	0	0	0	0	0	0	0	0	0	0	0	0
ON	1	1	1	1	1	1	1	1	1	1	1	1

Example: Mask of set input 2 and 4: 0000 0000 0000 1010

**MIN** – response: **MIN** threshold value (in the current unit selected for active working mode).

**MAX** – response: **MAX** threshold value (in the current unit selected for active working mode).

**Serial number** – returns the value of a serial number.

**Operator** – returns the value of a logged-in operator code.

**Product** – returns the value of a selected product code.

**Customer** – returns the value of a selected customer code.

**Packaging** – returns the value of a selected packaging code.

**Source warehouse** – returns the code of a selected source warehouse.

**Target warehouse** – returns the code of a selected target warehouse.

**Formulation** – returns the value of a selected formulation code.

# **3. OUTPUT VARIABLES**

Variable	Address	Length [WORD]	Data type
Command	0	1	word
Command with parameter	1	1	word
Platform	2	1	word
Tare	3	2	float
LO threshold	5	2	float
Output state	7	1	word
Min	8	2	float
Мах	10	2	float
Lot number	16	2	dword
Operator	18	1	word
Product	19	1	word
Customer	20	1	word
Packaging	21	1	word
Source warehouse	22	1	word
Target warehouse	23	1	word
Formulation/Dosing	24	1	word

**Basic command** – setting a respective value triggers direct performance of a given task, see the table:

Decimal value	Command
1	Zero the platform
2	Tare the platform
4	Clear statistics
8	Save/Print
16	Start
32	Stop (error)

Example: .0000 0000 0010 0000 - response: process start.

**Complex command** – setting a respective value triggers performance of a given task, see the table:

Decimal value	Command
1	Setting tare value for a given platform
2	Setting LO threshold value for a given platform
3	Setting series number
4	Setting outputs state
5	Operator selection
6	Product selection
7	Packaging selection
8	Setting MIN threshold value
9	Customer selection
10	Source warehouse selection
11	Target warehouse selection
12	Dosing process selection
16	Setting MAX threshold value

# A complex command requires the relevant parameter to be set (addresses 2 to 24 - see <u>output variables table</u>).

**Platform** – complex command parameter: weighing platform number.

**Tare** – complex command parameter: tare value (in an adjustment unit).

**LO threshold** – complex command parameter: LO threshold value (in an adjustment unit).

**Output state** – complex command parameter: status of weighing indicator outputs.

Output No.	12	11	10	9	8	7	6	5	4	3	2	1
OFF	0	0	0	0	0	0	0	0	0	0	0	0
ON	1	1	1	1	1	1	1	1	1	1	1	1

Example:

Mask of active output 2 and 4: 0000 0000 0000 1010

**MIN** – complex command parameter: MIN threshold value (in the unit set for the active working mode).

**MAX** – complex command parameter: MAX threshold value (in the unit set for the active working mode).

**Serial number** – complex command parameter: serial number value.

**Operator** – complex command parameter: code of logged in operator.

**Product** – complex command parameter: code of selected product.

**Customer** – complex command parameter: code of selected customer.

**Packaging** – complex command parameter: code of selected packaging.

**Source warehouse** – complex command parameter: code of selected source warehouse.

**Target warehouse** – complex command parameter: code of selected target warehouse.

**Formulation** – complex command parameter: code of selected formulation.

#### A command or a command with parameter is executed once when its bit setting is detected. If the command with the same bit is to be executed again, zero the bit.

Example:

Command	Address 1	Address 0
Taring	0000 0000	0000 0010
Command bit zeroing	0000 0000	0000 0000
Taring	0000 0000	0000 0010

The presented examples use the *MODBUS TCP* protocol. Communication takes place between the computer (master) and the HY 10 weighing indicator (slave), which is connected to the network via an *Ethernet* cable. *Modbus Poll* was used to simulate the data exchange. It is a program designed primarily to support developers of Modbus slaves or others who want to test and simulate the Modbus protocol. The link below directs you to the manufacturer's website, where you can download the program. You can use the program for free for the first 30 days. After this time, you must purchase a license.

https://www.modbustools.com/

# 4. SETUP

Once the indicator is connected to the Internet, the transmission type must be set. To do this, select *Setup*  $\rightarrow$  *Peripherals*  $\rightarrow$  *Modbus*  $\rightarrow$  *Type* on the indicator screen and change the value to *TCP*.

Ö.	Modbus			5
Mod bus	Туре	Тср	2 Тср	
, 🏠	Address	1		

The TCP port number has a default value of 502.

After correct configuration of the slave device, which is the indicator, move on to the *Modbus Poll* program. Upon start, press *Connect*, as presented below.

හි Modbus Poll - Mbpoll1	- 🗆 X
File Edit Connection Setup Functions Display View Window Help	
🗅 🗃 🖡 Connect F3 05 06 15 16 17 22 23 TC 🗵 🗮 😵 🎗	
Disconnect F4	
Tx = 0: E Auto Connect > 1000ms	
No conn Quick Connect F5	
Name 00000	
3 0	
7 0	
8 0	
9 0	

A window for connection setup is displayed. In this case, we use the TCP interface. In *Connection* menu select *Modbus TCP/IP*. Next, in *IP Address or Node Name* enter IP address of the device that you will connect with and in *Server Port* enter the port number.

Connection			ОК
Modbus TCP/IP	~		Cancel
Serial Settings			cancer
Port komunikacyjny (COM1)	$\sim$	Mode	
9600 Baud 🗸 🗸		• RTU	○ ASCII
8 Data bits 🛛 🗸		Response	Timeout
Even Parity $\sim$		Delay Bet	ween Polls
1 Stop Bit $\sim$	Advanced	20	[ms]
Remote Modbus Server			
IP Address or Node Name			
10.10.2.85			~
Server Port C	onnect Timeout	IPv4	

The IP address can be found in the indicator settings: Setup  $\rightarrow$  Communication  $\rightarrow$  Ethernet

Ø <sub>0</sub>	Ethernet				5
1	DHCP	$\sim$	2 IP address	10.10.2.85	
3	Subnet mask	255.255.0.0	4 Default gateway	10.10.254.254	
5	DNS	8.8.8.8	MAC address	B8 27 EB DB CF 88	

As previously mentioned, the port number is set to 502 by default. To change it, select Setup  $\rightarrow$  Peripherals  $\rightarrow$  Modbus  $\rightarrow$  Tcp in the indicator



Confirm introduced modifications by pressing OK.

Next, move on to program settings. Press Setup  $\rightarrow$  Read/Write Definition.

	1월 Modbu	us Poll - Mbpol	1					_	×
	File Edit	Connection	Setup	Functions	Display	View	Window	Help	
* * * *	🗅 🚅 🖡	3 😂 🗙   t	R	ead/Write De	efinition		F8	TC 🖻 🛃 🤋 🌾	
ľ	Poc Manuel	114	R	ead/Write Or	nce		F6		
	$T_{\rm Y} = 220$	"' ): Frr = (): ID	R	ead/Write Di	sabled	9	Shift+F6		

In the new window, select and enter what is highlighted in the image below. Confirm introduced modifications by pressing *OK*.

	te Definition		
Slave ID:	1		ОК
Function	: 04 Read Input Re	gisters (3x) 🛛 🗸	Cancel
Addres	s mode		
Dec	OHex		
Address:	0 PLC a	address = 30001	
Quantity	: 50		
Scan Rat	e: 1000 [ms]		Apply
Disable			-
Rea	d/Write Disabled		
Disa	able on error		Read/Write Once
View			
Rows	5	0	
01	0 0 20 0 50	○ 100 ● Fit to	Quantity
Hide	e Name Columns	PLC Addres	sses (Base 1)
Add	fress in Cell	Enron/Dani	iel Mode
Reques	st		
Reques	st 01 04 00 00 00 32 7	'1 DF	

A table with the data sent by the HY 10 indicator is displayed in the main menu of the program.

File Edit Connection Setu □ ☞ ■ ● ★ □ ■ Mbpoll1 Tx = 384: Err = 0: ID = 1:	p Functions Display View Window Help 및 ▲   ⊥   05 06 15 16 17 22 23   TC F = 04: SR = 1000ms	2 <b>2 7 7</b>	
D	및 (a)   1.   05 06 15 16 17 22 23   TC F = 04: SR = 1000ms	× • • • • • • • • • • • • • • • • • • •	
Tx = 384: Err = 0: ID = 1:	F = 04: SR = 1000ms		
Tx = 384: Err = 0: ID = 1:	F = 04: SR = 1000ms		
Tx = 384: Err = 0: ID = 1:	F = 04: SR = 1000ms		
Name	00000	^	
0	1000 0000 0000 0000		
	524		
2			
3	0000 0000 0000 0000		
4	0000 0000 0000 0001		
5	0000 0000 0000 0011		
6	0000 0000 0000 0000		
7	0000 0000 0000 0000		
8	0000 0000 0000 0000		
9	1111 1111 1100 0000		
10	0000 0000 0000 0000		
11	0000 0000 0000 0000		
12	0000 0000 0000 0000		
13	0000 0000 0000 0000		
14	0000 0000 0000 0000		
15	0000 0000 0000 0000		
16	0000 0000 0000 0000		
17	1111 1111 1100 0000		
18	0000 0000 0000 0000		
19	0000 0000 0000 0000		
20	0000 0000 0000 0000		
21	0000 0000 0100 0000		
22	0000 0000 0000 0000		
23	0000 0000 0000 0000		
24	0000 0000 0000 0000		
25	1111 1111 1100 0000	~	

The numbers on the left correspond to the addresses in <u>the input variables table</u>. From the above photo you are able to read:

- mass from address 1 (524),
- platform unit from address 4 (g),
- platform status from address 5 (the weighing instrument does not report any error, measurement is stable)

The format in which you want to display the data can be changed in the *Display* tab. In the image above, the data is displayed mainly in binary form. To send a data message to the indicator, select *Functions*  $\rightarrow$  *Write Registers* in the *Modbus Poll* main window or *alt* + *F8* on the keyboard.

훱월 Modbus Poll - Mbpoll1				_	×
File Edit Connection Setup	Functions Display View Win	dow Help			
🗅 🖻 🖶 🎒 🗙 🛅 🖳	05: Write Single Coil	Alt+F5	l 🔚   🖇 💦		
Dec Marine U1	06: Write Single Register	Alt+F6			
	15: Write Coils	Alt+F7			
1x = 30; Eff = 0; ID = 1; F =	16: Write Registers	Alt+F8			
Name (	17: Report Slave ID				
	22: Mask Write Register				
1	23: Read/Write Registers				
2	Test Center	Alt+T			
3	-0				
4	1				
5	3				

#### A window for filling in the data as below is opened.



# 5. EXAMPLES

If you want to send a message to the weighing instrument, refer to <u>the table of output</u> <u>variables</u>. Enter the respective values from the table above in the relevant fields in the program. To send message press *Send*. If the communication was successful, you will receive a message as in the picture below. The following subsections show some examples of communication with the HY 10 indicator.



### 5.1 Taring

To tare the platform use the basic command. In the address field of this command enter the decimal value corresponding to the tare, i.e. 2, and press *Send*.

16: Write Mu	ultiple Registers		>
Slave ID:	1	500 = 2 501 = 0	▲ Send
Address:	500	502 = 0 503 = 0	Cancel
Quantity:	25	504 = 0 505 = 0	Edit
Type:	Signed	> 500 = 0 507 = 0 508 = 0	Open
		509 = 0 510 = 0 511 = 0	Save

If the transmission is successful, the weighing instrument is tared.

#### 5.2 Customer Selection

To select a customer set respective decimal value of the complex command in the address of a command with parameter, in this case 9. Then in <u>the output variables</u> <u>table</u> check the address for the customer, it is 20. Go back to the *Modbus Poll*, find the address field and enter the code assigned to a given customer.

16: Write Mu	Itiple Registers			×
Slave ID: Address: Quantity: Type:	1 500 50 Signed ~	500 = 0 501 = 9 502 = 0 503 = 0 504 = 0 505 = 0 506 = 0 507 = 0 500 = 0	^	Send Cancel Edit Open
16: Write Mu	Itiple Registers			×
Slave ID:	1	518 = 0 519 = 0	^	Send
Address:	500	520 = 136 521 = 0		Cancel
Quantity:	40	522 = 0 523 = 0		Edit
Type:	Signed $\sim$	524 = 0 525 = 0		Open

After completing the above fields, press *Send*. A message is sent to the device to set up a customer with code 136. If there are no errors in transmission you will receive a *Response ok* message and the selected customer will be set. To confirm, check indicator's screen. Of course, a customer with the given code must be in the weighing instrument database.



### 5.3 Setting MIN Threshold

In the presented example, the min value is set to 150 using a binary code. Check the decimal value of the complex command corresponding to the Min threshold setting and change it to binary form. In the <u>output variables table</u> check the address of the Min value. Enter the number in binary form in the appropriate field in the program window. A number can be easily converted to binary using free converters available on the Internet.

16: Write Mu	Itiple Registers		×
Slave ID:	1	500 = 0000 0000 0000 0000 501 = 0000 0000 0000 1000	^ Send
Address:	500	502 = 0000 0000 0000 0000 503 = 0000 0000 0000 0000	Cancel
Quantity:	30	$504 = 0000\ 0000\ 0000\ 0000$ $505 = 0000\ 0000\ 0000\ 0000$	Edit
Type:	Binary	507 = 0000 0000 0000 0000 507 = 0000 0000 0000 0000	Open
		$\frac{509}{510} = \frac{0100}{0000} \frac{0000}{0000} \frac{0000}{0000} \frac{0000}{0000}$	Save

In the picture below, a confirmation of successful communication with the HY 10 indicator is presented.

▲ Weighing		Operator_12	🛱 E2R	15:41:17
Product: Packaging: Lot number: Batch number:	t2	-		<b>198</b> ,
Min:	150		0%	100%
		Taret		

#### 5.4 Setting Lot Number

To set the lot number of weighed product to 102030, follow the next steps. In this example we use the code in a hexadecimal form. In the address field of the complex command, enter the respective decimal value corresponding to the setting of the lot number. Next, in the <u>output variables table</u> find the address being a lot number. Fill in all the fields as presented below.

ave ID: 1	500 = 0x0000	▲ Send
500	$\frac{501 = 0 \times 0003}{502 = 0 \times 0000}$	Cancel
Idress: 500	503 = 0x0000	Cancer
uantity: 30	505 = 0x0000	Edit
Type: Hex	506 = 0x0000 507 = 0x0000	Open
	508 = 0x0000 500 = 0x0000	
	509 = 00000 510 = 00000	Save
	511 = 0x0000 512 = 0x0000	
	513 = 0x0000	
	514 = 00000 515 = 00000	
	516 = 0x8E8E 517 = 0x0001	
	518 = 0x0000	~

As a result of the message, the lot number is set.

Weighing		Operator_12		2021.04.28
Product: Packaging: Lot number: Batch number:	102030	<b>→</b> 0+	0%	<b>0</b> g

