Inbuilt Modbus Protocol

Technical description

Revision 1.1

1. Revisions History

Revision 1.0 original version

Revision 1.1 We introduced some corrections to the document (several errors in the protocol descriptions, without any real modification to the protocol itself).

2. Preface

2.1. Overview

The present guide describes the RTU Modbus Protocol when implemented inside the Energy Meters, Power Meters and LED Network Analyzers. In these meters, ASCII Protocol is not supported

The physical layer is standard RS-485.
The link parameters are: xxx, N, 8, 1 (xxx is baudrate, N menas No parity, 8 means 8 bits per byte, 1 means 1 stop bit).

Modbus address and Modbus Baud-rate are configurable by means of keyboard/display interface and by means of Modbus protocol itself.

The Modbus address can be selected in the range 1…247.
The Modbus Baud rate is selectable among one of the following: 1200, 2400, 4800, 9600, and 19200. Some recent Power and Energy Meters accept also a baud rate of 38400 baud.

Refer to the product instruction manual for Modbus Address and Modbus Baud Rate modification by means of display/keyboard.

When you order an product with inbuilt Modbus, you can choose between Big Endian format and Little Endian format.

In the following table you can see the products with inbuilt Modbus, including their available baud rates:

Energy Meter	1phase	80A	NA	1200...38400 baud
Energy Meter	1phase	80A	NA	1200...38400 baud
Energy Meter	1phase	125A	NA	1200...38400 baud
Energy Meter	1phase	125A	**DRM-125-1P-MOD**	1200...38400 baud
Energy Meter	3phase	../1A	NA	1200...38400 baud
Energy Meter	3phase	../1A	NA	1200...38400 baud
Energy Meter	3phase	../5A	NA	1200...38400 baud
Energy Meter	3phase	../5A	**DRB-5-3P-MOD**	1200...38400 baud
Energy Meter	3phase	80A	NA	1200...19200 baud
Energy Meter	3phase	80A	**DRB-80-3P-MOD**	1200...19200 baud
Network Analyzer	3phase	../5A	NA	1200...19200 baud
Network Analyzer	3phase	80A	NA	1200...19200 baud
Power Meter	3phase	../5A	NA	1200...38400 baud
Power Meter	3phase	63A	NA	1200...38400 baud

Note:
In the rest of this document, we will use the term “counter” to indicate a generic Energy Meter, Network Analyzer or Power Meter.

2.2. Default settings

These are the factory default settings:

- Protocol: Modbus RTU (fixed)
- Modbus Address: 001
- Baud rate: 19200 bit/s
- Parity: None (fixed)
- Stop bits: 1 (fixed)

3. Modbus commands

The protocol supports only two type of commands, one for reading the register values, one for writing the configuration registers. The reading is only possible for a block of registers (the command for a single register reading is not supported).

3.1. Read holding registers (function code 03)

This function code is used to read the contents of a contiguous block of holding registers in a remote device. The Request frame specifies the starting register address and the number of registers.
The register data in the response message are packed as two bytes per register, with the binary contents left justified within each byte.
In case of Little Endian format, the first byte contains the low order bits and the second contains the high order bits;
In case of Big Endian format, the first byte contains the high order bits and the second contains the low order bits.

In many cases, a value is stored in more than one register (more than one word of 16 bits). For example, the active energy is represented using 4 registers (4 words or 8 bytes). Please refer to the chapter “Internal registers” for details.

Warning!
Because of the limited size of a Modbus frame, not all the internal registers can be sent on a single reading request. This means that a complete snapshot can only be acquired performing more (three) read holding registers calls with different starting address.
Example:
poll nr. 1 start 4099 nr. of registers 100
poll nr. 2 start 4197 nr. of registers 100
poll nr. 3 start 4297 nr. of registers 10 (16 in some models)

3.1.1. Frame layout

ADR	03	STh	STl	NRh	NRl	CRCh	CRCl

ADR	Modbus Address
03	Read holding register function code (fixed)
STh	Starting address register (high order bits)
STl	Starting address register (low order bits)
NRh	Number of registers (high order bits)
NRl	Number of registers (low order bits)
CRCh	Modbus Checksum (high order bits)
CRCl	Modbus Checksum (low order bits)

3.2. Write single register (function code 06)

This function code is used to write a single holding register in a remote device. The Request specifies the address of the register to be written. The normal response is an echo of the request, returned after the register contents have been written.

3.2.1. Frame layout

ADR	06	RAh	RAl	RVh	RVl	CRCh	CRCl

ADR	Modbus Address
06	Write single register function code (fixed)
RAh	Register address (high order bits)
RAl	Register address (low order bits)
RVh	Register value (high order bits)
RVl	Register value (low order bits)
CRCh	Modbus Checksum (high order bits)
CRCl	Modbus Checksum (low order bits)

4. Internal registers

This is the complete list of the internal registers.

Register Address	Designation	counter types DRB-5-3P-MOD DRB-80-3P-MOD	NA NA	DRM-125-1P-MOD	Notes
4099	Device type	x	x	x	General read-only registers
4100	Firmware version	x	x	x	
4101	Range overflow alarm	x	x	x	
4102	Running tariff	x	x	x	
4104	PID (Product Identification) bytes 1 and 2	x	x	x	
4105	PID – bytes 3 and 4	x	x	x	
4106	PID – bytes 5 and 6	x	x	x	
4107	PID – bytes 7 and 8	x	x	x	
4108	PID – bytes 9 and 10	x	x	x	
4109	PID – bytes 11 and 12	x	x	x	
4110	PID – bytes 13 and 14	x	x	x	
4111	Read-only not used register.	x	x	x	always=0x0000
4112	Speed	x	x	x	writable parameter
4113	Read-only not used register.	x	x	x	always=0x0000
4114	Read-only not used register.	x	x	x	always=0x0000
4115	Modbus address	x	x	x	writable parameter
4116	Read-only not used register.	x	x	x	always=0x0000
4117	Value format	x	x	x	writable parameter
4118	Reset energy counters command	x	x	x	writable command
4119	Active Energy 1st phase T1, imp (kWh)	x	x	x	Readable values (Energies and other istantaneous measurements)
4123	Active Energy 2nd phase T1, imp (kWh)	x	x		
4127	Active Energy 3rd phase T1, imp (kWh)	x	x		
4131	Active Energy Σ T1, imp (kWh)	x	x		
4135	Active Energy 1st phase T2, imp (kWh)	x	x	x	
4139	Active Energy 2nd phase T2, imp (kWh)	x	x		
4143	Active Energy 3rd phase T2, imp (kWh)	x	x		
4147	Active Energy Σ T2, imp (kWh)	x	x		
4151	Active Power 1st phase (kW)	x	x	x	
4153	Active Power 2nd phase (kW)	x	x		
4155	Active Power 3rd phase (kW)	x	x		
4157	Active Power Σ (kW)	x	x		
4161	Active Energy 1st phase T1, exp (kWh)	x	x	x	
4165	Active Energy 2nd phase T1, exp (kWh)	x	x		
4169	Active Energy 3rd phase T1, exp (kWh)	x	x		
4173	Active Energy Σ T1, exp (kWh)	x	x		
4177	Active Energy 1st phase T2, exp (kWh)	x	x	x	
4181	Active Energy 2nd phase T2, exp (kWh)	x	x		
4185	Active Energy 3rd phase T2, exp (kWh)	x	x		
4189	Active Energy Σ T2, exp (kWh)	x	x		
4193	Reactive Energy 1st phase T1, imp (kvarh)	x	x	x	
4197	Reactive Energy 2nd phase T1, imp (kvarh)	x	x		
4201	Reactive Energy 3rd phase T1, imp (kvarh)	x	x		
4205	Reactive Energy Σ T1, imp (kvarh)	x	x		
4209	Reactive Energy 1st phase T2, imp (kvarh)	x	x	x	
4213	Reactive Energy 2nd phase T2, imp (kvarh)	x	x		
4217	Reactive Energy 3rd phase T2, imp (kvarh)	x	x		
4221	Reactive Energy Σ T2, imp (kvarh)	x	x		
4225	Reactive Energy 1st phase T1, exp (kvarh)	x	x	x	

4229	Reactive Energy 2nd phase T1, exp (kvarh)	x	x	
4233	Reactive Energy 3rd phase T1, exp (kvarh)	x	x	
4237	Reactive Energy Σ T1, exp (kvarh)	x	x	
4241	Reactive Energy 1st phase T2, exp (kvarh)	x	x	x
4245	Reactive Energy 2nd phase T2, exp (kvarh)	x	x	
4249	Reactive Energy 3rd phase T2, exp (kvarh)	x	x	
4253	Reactive Energy Σ T2, exp (kvarh)	x	x	
4257	Reactive Power 1st phase (kvar)	x	x	x
4259	Reactive Power 2nd phase (kvar)	x	x	
4261	Reactive Power 3rd phase (kvar)	x	x	
4263	Reactive Power Σ (kvar)	x	x	
4267	L1-N voltage (V)	x	x	x
4269	L2-N voltage (V)	x	x	
4271	L3-N voltage (V)	x	x	
4273	L1-L2 voltage (V)	x	x	
4275	L2-L3 voltage (V)	x	x	
4277	L3-L1 voltage (V)	x	x	
4279	phase1 current (A)	x	x	x
4281	phase2 current (A)	x	x	
4283	phase3 current (A)	x	x	
4285	apparent power phase1 (kVA)	x	x	x
4287	apparent power phase2 (kVA)	x	x	
4289	apparent power phase3 (kVA)	x	x	
4291	apparent power Σ (kVA)	x	x	
4295	power factor cos φ phase1	x	x	x
4297	power factor cos φ phase2	x	x	
4299	power factor cos φ phase3	x	x	
4301	power factor cos φ Σ	x	x	
4303	frequency (Hz)	x	x	x
4305	Total Harmonic Distortion in % (V L1)		x	
4307	Total Harmonic Distortion in % (V L2)		x	
4309	Total Harmonic Distortion in % (V L3)		x	
4311	Total Harmonic Distortion in % (I L1)		x	
4313	Total Harmonic Distortion in % (I L2)		x	
4315	Total Harmonic Distortion in % (I L3)		x	

4.1. General read-only registers

These registers store general read-only information.

Register	Designation	Description
4099	Device type	Code that identifies the type of device 1 Three phase counter 3 Single phase counter
4100	Firmware revision	Firmware revision of the counter
4101	Range overflow alarm	The register is set by the counter if it has the detected a value over the voltage or the current nominal threshold. The lowest order byte of the register is bit-coded as follows: n.u.|n.u.|OFV3|OFI3|OFV2|OFI2|OFV1|OFI1 Where: OFV Voltage overflow (on phase 1, 2 and 3) OFI Current overflow (on phase 1, 2 and 3) n.u. Not Used
4102-03	Running tariff	0 Tariff 1 is currently in use 1 Tariff 2 is currently in use
4104-10	PID	Part number identification string (a maximum of 14 bytes)

4.2. Writable parameters and command

Three registers are used for the Modbus configuration. One register (4118) is dedicated to reset the energy registers internal to the counter (**assuming that it is not MID certified**)

Register	Designation	Description	
4112	Speed	One of the following: 1200, 2400, 4800, 9600, 19200, 38400	
4115	Modbus address	From 1 to 247	
4117	Value format	0	Numeric values are coded as floating point 32 bit
		1	Numeric values are coded as integers (see par. 4.4)
4118	Reset energy counters command.	1	Reset active energy registers
	The command is accepted by not	2	Reset reactive energy registers
	MID certified counters	3	Reset all the registers

4.3. Readable values (energies and other measurements)

These registers holds the electrical values generated by the counter. The number of available readable values depends on the counter type.

Register	Designation	Counter types			Length
address		**DRB-5-3P-MOD DRB-80-3P-MOD**	NA NA	**DRM-125-1P-MOD**	(bytes)
4119	Active Energy 1st phase T1, imp (kWh)	x	x	x	8
4123	Active Energy 2nd phase T1, imp (kWh)	x	x		8
4127	Active Energy 3rd phase T1, imp (kWh)	x	x		8
4131	Active Energy Σ T1, imp (kWh)	x	x		8
4135	Active Energy 1st phase T2, imp (kWh)	x	x	x	8
4139	Active Energy 2nd phase T2, imp (kWh)	x	x		8
4143	Active Energy 3rd phase T2, imp (kWh)	x	x		8
4147	Active Energy Σ T2, imp (kWh)	x	x		8
4151	Active Power 1st phase (kW)	x	x	x	4
4153	Active Power 2nd phase (kW)	x	x		4
4155	Active Power 3rd phase (kW)	x	x		4
4157	Active Power Σ (kW)	x	x		8
4161	Active Energy 1st phase T1, exp (kWh)	x	x	x	8
4165	Active Energy 2nd phase T1, exp (kWh)	x	x		8
4169	Active Energy 3rd phase T1, exp (kWh)	x	x		8
4173	Active Energy Σ T1, exp (kWh)	x	x		8
4177	Active Energy 1st phase T2, exp (kWh)	x	x	x	8
4181	Active Energy 2nd phase T2, exp (kWh)	x	x		8
4185	Active Energy 3rd phase T2, exp (kWh)	x	x		8
4189	Active Energy Σ T2, exp (kWh)	x	x		8
4193	Reactive Energy 1st phase T1, imp (kvarh)	x	x	x	8
4197	Reactive Energy 2nd phase T1, imp (kvarh)	x	x		8
4201	Reactive Energy 3rd phase T1, imp (kvarh)	x	x		8
4205	Reactive Energy Σ T1, imp (kvarh)	x	x		8
4209	Reactive Energy 1st phase T2, imp (kvarh)	x	x	x	8
4213	Reactive Energy 2nd phase T2, imp (kvarh)	x	x		8
4217	Reactive Energy 3rd phase T2, imp (kvarh)	x	x		8
4221	Reactive Energy Σ T2, imp (kvarh)	x	x		8
4225	Reactive Energy 1st phase T1, exp (kvarh)	x	x	x	8
4229	Reactive Energy 2nd phase T1, exp (kvarh)	x	x		8
4233	Reactive Energy 3rd phase T1, exp (kvarh)	x	x		8
4237	Reactive Energy Σ T1, exp (kvarh)	x	x		8
4241	Reactive Energy 1st phase T2, exp (kvarh)	x	x	x	8
4245	Reactive Energy 2nd phase T2, exp (kvarh)	x	x		8
4249	Reactive Energy 3rd phase T2, exp (kvarh)	x	x		8
4253	Reactive Energy Σ T2, exp (kvarh)	x	x		8
4257	Reactive Power 1st phase (kvar)	x	x	x	4
4259	Reactive Power 2nd phase (kvar)	x	x		4

4261	Reactive Power 3rd phase (kvar)	x	x		4
4263	Reactive Power Σ (kvar)	x	x		8
4267	L1-N voltage (V)	x	x	x	4
4269	L2-N voltage (V)	x	x		4
4271	L3-N voltage (V)	x	x		4
4273	L1-L2 voltage (V)	x	x		4
4275	L2-L3 voltage (V)	x	x		4
4277	L3-L1 voltage (V)	x	x		4
4279	phase1 current (A)	x	x	x	4
4281	phase2 current (A)	x	x		4
4283	phase3 current (A)	x	x		4
4285	apparent power phase1 (kVA)	x	x	x	4
4287	apparent power phase2 (kVA)	x	x		4
4289	apparent power phase3 (kVA)	x	x		4
4291	apparent power total (kVA)	x	x		8
4295	power factor cos phi phase1	x	x	x	4
4297	power factor cos phi phase2	x	x		4
4299	power factor cos phi phase3	x	x		4
4301	power factor cos phi total	x	x		4
4303	frequency (Hz)	x	x	x	4
4305	THD % (V L1)		x		4
4307	THD % (V L1)		x		4
4309	THD % (V L1)		x		4
4311	THD % (V L1)		x		4
4313	THD % (V L1)		x		4
4315	THD % (V L1)		x		4

Notes
T1/T2 indicates the running Tariff (1 or 2)
The symbol **Σ** indicates a total amount value (for example: the Reactive Power Σ (kvar) value is the total Reactive Power on the three phases. It is of course significant in a three phase counter only.
imp/exp (imported/exported) indicates whether the energy is generated (exported) or consumed (imported).
Length in bytes of the measured value. Note that, since a Modbus register is 2 bytes long, several values use more registers (4 bytes: 2 registers; 8 bytes: 4 registers).

Tip!
Remember that, if you select a Floating point format (register 4117 set = 0), all the values are coded as 32 bit floating point values. (IEEE ANSI 754)
When you buy an counter with inbuilt Modbus, you can choose between Big Endian format and Little Endian format (BE/LE).
BE – the floating point values are transmitted in *big-endian* format
LE – the floating point values are transmitted in *little-endian* format

If you want to switch to an integer representation, you have write 1 into the value of the configuration register 4117 (see the paragraph 4.3).

4.4.1. Values stored as Integer values

While the notation using floating point 32 bit values is unambiguous, when you switch to the integer notation something must be explained in order to allow the correct interpretation of original value.

4 bytes long values

The integer value stored in these registers (2) must be divided by a factor of 10000 to rebuild the original value.
Example: Active Power 1st phase
Integer value: 122447
Original value: 122447/10000=12,2447 (kW)

8 bytes long values

The rebuilding of the original value is slightly more complicated.
The value stored in the first 4 bytes must be multiplied by a factor of 10^9 (1000000000).
Then it must be added to the value stored in the following 4 bytes.
Finally, the result must be divided by 10000.
Example: Active Power total
Integer value (most significat 4 bytes): 12344

Integer value (less significant 4 bytes): 765532
Original value: (12344*1000000000+765532)/10000=1234400076,5532 (kW)

5. References

For any further information concerning the Modbus protocol implementation, you can consult the following documents and references:

Modbus application protocol specifications V 1.1b, at http://www.modbus-IDA.org

Modbus over serial line – Specification and implementation guide V. 1.02, at http://www.modbus.org

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