Interface specification

EMU Professional Modbus RTU/ASCII

Version	Date of release	Editor	Description
V0.0	17. Juli 2012	Daniel Koller	First release

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1 Purpose

Specification of the communication with the EMU Professional energy meter as a Modbus-Slave (server) over the Modbus RTU / ASCII Serial Line protocol.

2 Resourcen

- Modbus over Serial Line Implemention Guide V1.02: http://www.modbus.org
- Modbus Application Protocol Specification V1.1b: http://www.modbus.org

3 Modbus Basics

The MODBUS Serial Line protocol is a Master-Slaves protocol. Only one master (at the same time) is connected to the bus, and one or several slaves nodes are also connected to the same serial bus.
A MODBUS communication is always initiated by the master. The slave nodes will never transmit data without receiving a request from the master node. The slave nodes will never communicate with each other. The master node initiates only one MODBUS transaction at the same time.

The master node issues a MODBUS request to the slave nodes in two modes :

- In **unicast mode**, the master addresses an individual slave. After receiving and processing the request, the slave returns a message (a 'reply') to the master .
  In that mode, a MODBUS transaction consists of 2 messages : a request from the master, and a reply from the slave. Each slave must have an unique address (from 1 to 247) so that it can be addressed independently from other nodes.
- In **broadcast mode**, the master can send a request to all slaves.
  No response is returned to broadcast requests sent by the master. The broadcast requests are necessarily writing commands. All devices must accept the broadcast for writing function. The address 0 is reserved to identify a broadcast exchange.

Modbus Serial Line Frame :

Field 1	Field 2	Field 3	Field 4
Address	Function-Code	Data	CRC / LRC

- Address : Slave address 1..247 or 0 for a broadcast
- Function-Code : The function code indicates to the slave what kind of action to perform.
- Data : Master: register address; Slave: the register contents
- CRC / LRC : The redundancy check

The Function codes and the data is defined in the “Modbus Application Protocol Specification”.

Two different serial transmission modes are defined : The RTU mode and the ASCII mode. The transmission mode (and serial port parameters) must be the same for all devices on a MODBUS Serial Line.

4 Modbus RTU

When devices communicate on a MODBUS serial line using the RTU (Remote Terminal Unit) mode, each 8–bit byte in a message contains two 4–bit hexadecimal characters. The main advantage of this mode is that its greater character density allows better data throughput than ASCII mode for the same baud rate.

The format (11 bits) for each byte in RTU mode is :

Coding System**:** 8–bit binary
Bits per Byte**:** 1 start bit
8 data bits, least significant bit sent first
1 bit for parity completion; Odd, Even and None (2.Stopbit in case of None)
1 stop bit
Baudrate: 9600, 19200, 38400, 57600 or 115200
Timing**:** Max. intercharacter delay 2,5 Char.
Frame:

Start	Address	Function	Data	CR-Check	End
Idle time (min. 3.5 Char.)	1 Byte	1 Byte	0..252 Byte	2 Byte	Idle time (min. 3.5 Char.)

5 Modbus ASCII

When devices are setup to communicate on a MODBUS serial line using ASCII (American Standard Code for Information Interchange) mode, each 8–bit byte in a message is sent as two ASCII characters. This mode is used when the physical communication link or the capabilities of the device does not allow the conformance with RTU mode requirements regarding timers management.

Example : The byte 0X5B is encoded as two characters : 0x35 and 0x42 (0x35 ="5", and 0x42 ="B" in ASCII).

The format (10 bits) for each byte in ASCII mode is :

Coding System: Hexadecimal, ASCII characters 0–9, A–F
One hexadecimal character contains 4-bits of data within each ASCII character of the message
Bits per Byte: 1 start bit
7 data bits, least significant bit sent first
1 bit for parity completion; Odd, Even and None (2.Stopbit in case of None)
1 stop bit
Baudrate: 9600, 19200, 38400, 57600 or 115200
Timing: Max. intercharacter delay 1000ms
Frame:

Start	Address	Function	Data	LR-Check	End
1 Char. (:)	2 Char.	2 Char.	0..2*252 Char.	2 Char.	2 Char. (CR+LF)

6 Modbus interface

The EMU Professional is an energy meter with an optionally installed Modbus RTU/ASCII Interface, including an 2 wire RS485 Modbus connector. The Modbus Interface supports the Modbus implementation class REGULAR.
The Modbus configuration (Slave address, baudrate, mode and parity) is handled by the meter's menu.

The Modbus interface module reads out all data of the meter in an interval of 1 second. That means a Modbus Request responds immediately with meter data not older than 1 second.

Meter data is transmitted as integer. Typically, a measured value is distributed among several registers. (active energy register e.g. requires 4).
The data are "big endian" transferred, that means the most significant byte is transmitted first.
Example: In the first place the value 0x1234 is transferred 0x12 0x34 and the second place.

The maximum length of a Modbus RTU message is 256 bytes (252 byte payload) and of a ASCII message is 513 bytes (2*252 character payload). If you want to read all measurement values of the counter, the registers must be divided into several messages.

6.1 Implemented Functions

The Modbus interface supports following function codes :

- Read Holding Registers (Code 03) : read out the meter data, see 6.2
- Diagnostics (Code 08) : as defined in "Modbus Application Protocol Specification"
- ReadDeviceID (Code 43 / 14) : device specific data supporting following Objects:

Object ID	Name	Value
0	VendorName	"EMU AG"
1	ProductCode	"EMU Professional"
2	Revision	"V0.0"

6.2 Read Holding Registers

With the Modbus function "Read Holding Registers" one or more registers of the meter can be read out. 2 bytes per register are sent. (High byte first)

Request

Size (Byte)	Value (Hex)	Description
1	03	Function code
2	10 00	Starting address of the register (e.g. 0x1000)
2	00 02	Quantity of registers (words). (e.g. 2 for 4 Bytes)

Response

Size (Byte)	Value (Hex)	Description
1	03	Function code
1	xx	2*N Byte count (size of the following registers)
N	2*N	Register data

6.3 Register addressing

The register starting address in the Modbus protocol defines the meters first register to address. For historical reasons, the starting address of the register starts at 1, but the start address in Modbus starts with 0.

This means that in the telegram as a starting Modbus register address is the address minus 1.

Example:

Momentary system time (4200) will be send as Modbus start address 4199.

6.4 System parameter registers

System Parameter Modbus RTU/ASCII Interface

Register (Hex)	Name	Size (Byte)	Description
4108	Software Version	2	Software Version of the Modbus interface firmware

System Parameter Meter

Register (Hex)	Name	Size (Byte)	Description
4109	Meter Serial number	4	Serial number of the meter
4111	Software Version and Checksum	4	Software Version and Checksum of the meters firmware

6.5 Data registers

The following table provides an overview of all measurement values and the register:

Register	Name	Size (Byte)	Unit
4200	Momentary System time	4	Unix time stamp
4202	Active-Energy Total Import	8	Wh
4206	Active-Energy Import Phase L1 Tariff 1	8	Wh
4210	Active-Energy Import Phase L2 Tariff 1	8	Wh
4214	Active-Energy Import Phase L3 Tariff 1	8	Wh
4218	Active-Energy Import Total Tariff 1	8	Wh
4222	Active-Energy Import Phase L1 Tariff 2	8	Wh
4226	Active-Energy Import Phase L2 Tariff 2	8	Wh
4230	Active-Energy Import Phase L3 Tariff 2	8	Wh
4234	Active-Energy Import Total Tariff 2	8	Wh
4238	Active-Energy Import Phase L1 Tariff 3	8	Wh
4242	Active-Energy Import Phase L2 Tariff 3	8	Wh
4246	Active-Energy Import Phase L3 Tariff 3	8	Wh
4250	Active-Energy Import Total Tariff 3	8	Wh
4254	Active-Energy Import Phase L1 Tariff 4	8	Wh
4258	Active-Energy Import Phase L2 Tariff 4	8	Wh
4262	Active-Energy Import Phase L3 Tariff 4	8	Wh
4266	Active-Energy Import Total Tariff 4	8	Wh
4270	Active-Energy Total Export	8	Wh
4274	Active-Energy Export Phase L1 Tariff 1	8	Wh
4278	Active-Energy Export Phase L2 Tariff 1	8	Wh
4282	Active-Energy Export Phase L3 Tariff 1	8	Wh
4286	Active-Energy Export Total Tariff 1	8	Wh
4290	Active-Energy Export Phase L1 Tariff 2	8	Wh
4294	Active-Energy Export Phase L2 Tariff 2	8	Wh
4298	Active-Energy Export Phase L3 Tariff 2	8	Wh
4302	Active-Energy Export Total Tariff 2	8	Wh
4306	Active-Energy Export Phase L1 Tariff 3	8	Wh
4310	Active-Energy Export Phase L2 Tariff 3	8	Wh
4314	Active-Energy Export Phase L3 Tariff 3	8	Wh
4318	Active-Energy Export Total Tariff 3	8	Wh
4322	Active-Energy Export Phase L1 Tariff 4	8	Wh
4326	Active-Energy Export Phase L2 Tariff 4	8	Wh
4330	Active-Energy Export Phase L3 Tariff 4	8	Wh
4334	Active-Energy Export Total Tariff 4	8	Wh
4338	Reactive-Energy Total Inductive	8	varh
4342	Reactive-Energy Inductive Phase L1 Tariff 1	8	varh
4346	Reactive-Energy Inductive Phase L2 Tariff 1	8	varh

4350	Reactive-Energy Inductive Phase L3 Tariff 1	8	varh
4354	Reactive-Energy Inductive Total Tariff 1	8	varh
4358	Reactive-Energy Inductive Phase L1 Tariff 2	8	varh
4362	Reactive-Energy Inductive Phase L2 Tariff 2	8	varh
4366	Reactive-Energy Inductive Phase L3 Tariff 2	8	varh
4370	Reactive-Energy Inductive Total Tariff 2	8	varh
4374	Reactive-Energy Inductive Phase L1 Tariff 3	8	varh
4378	Reactive-Energy Inductive Phase L2 Tariff 3	8	varh
4382	Reactive-Energy Inductive Phase L3 Tariff 3	8	varh
4386	Reactive-Energy Inductive Total Tariff 3	8	varh
4390	Reactive -Energy Inductive Phase L1 Tariff 4	8	varh
4394	Reactive-Energy Inductive Phase L2 Tariff 4	8	varh
4398	Reactive-Energy Inductive Phase L3 Tariff 4	8	varh
4402	Reactive-Energy Inductive Total Tariff 4	8	varh
4406	Reactive-Energy Total Capacitive	8	varh
4410	Reactive-Energy Capacitive Phase L1 Tariff 1	8	varh
4414	Reactive-Energy Capacitive Phase L2 Tariff 1	8	varh
4418	Reactive-Energy Capacitive Phase L3 Tariff 1	8	varh
4422	Reactive-Energy Capacitive Total Tariff 1	8	varh
4426	Reactive-Energy Capacitive Phase L1 Tariff 2	8	varh
4430	Reactive-Energy Capacitive Phase L2 Tariff 2	8	varh
4434	Reactive-Energy Capacitive Phase L3 Tariff 2	8	varh
4438	Reactive-Energy Capacitive Total Tariff 2	8	varh
4442	Reactive-Energy Capacitive Phase L1 Tariff 3	8	varh
4446	Reactive-Energy Capacitive Phase L2 Tariff 3	8	varh
4450	Reactive-Energy Capacitive Phase L3 Tariff 3	8	varh
4454	Reactive-Energy Capacitive Total Tariff 3	8	varh
4458	Reactive-Energy Capacitive Phase L1 Tariff 4	8	varh
4462	Reactive-Energy Capacitive Phase L2 Tariff 4	8	varh
4466	Reactive-Energy Capacitive Phase L3 Tariff 4	8	varh
4470	Reactive-Energy Capacitive Total Tariff 4	8	varh
4474	Momentary Active-Power Phase L1	4	W
4476	Momentary Active-Power Phase L2	4	W
4478	Momentary Active-Power Phase L3	4	W
4480	Momentary Active-Power Total	4	W
4482	Momentary Reactive-Power Phase L1	4	var
4484	Momentary Reactive-Power Phase L2	4	var
4486	Momentary Reactive-Power Phase L3	4	var
4488	Momentary Reactive-Power Total	4	var
4490	Momentary Apparent-Power Phase L1	4	VA
4492	Momentary Apparent-Power Phase L2	4	VA
4494	Momentary Apparent-Power Phase L3	4	VA
4496	Momentary Apparent-Power Total	4	VA
4498	Max. Active-Power Tariff 1 (15min)	4	W
4500	Max. Active-Power Tariff 2 (15min)	4	W
4502	Max. Active-Power Tariff 3 (15min)	4	W

4504	Max. Active-Power Tariff 4 (15min)	4	W
4506	Max. Active-Power Total (15min)	4	W
4508	Max. Active-Power Phase L1	4	W
4510	Max. Active-Power Phase L2	4	W
4512	Max. Active-Power Phase L3	4	W
4514	Max. Active-Power Phase L1 Date / Time	4	Unix time stamp
4516	Max. Active-Power Phase L2 Date / Time	4	Unix time stamp
4518	Max. Active-Power Phase L3 Date / Time	4	Unix time stamp
4520	Momentary voltage Phase L1	2	V/10
4521	Momentary voltage Phase L2	2	V/10
4522	Momentary voltage Phase L3	2	V/10
4523	Momentary voltage Phase L1 – L2	2	V/10
4524	Momentary voltage Phase L2 – L3	2	V/10
4525	Momentary voltage Phase L3 – L1	2	V/10
4526	Min. voltage Phase L1	2	V/10
4527	Min. voltage Phase L2	2	V/10
4528	Min. voltage Phase L3	2	V/10
4529	Min. voltage Phase L1 Date / Time	4	Unix time stamp
4531	Min. voltage Phase L2 Date / Time	4	Unix time stamp
4533	Min. voltage Phase L2 Date / Time	4	Unix time stamp
4535	Max. voltage Phase L1	2	V/10
4536	Max. voltage Phase L2	2	V/10
4537	Max. voltage Phase L3	2	V/10
4538	Max. voltage Phase L1 Date / Time	4	Unix time stamp
4540	Max. voltage Phase L2 Date / Time	4	Unix time stamp
4542	Max. voltage Phase L3 Date / Time	4	Unix time stamp
4544	Aktueller Strom Phase L1	4	mA
4546	Aktueller Strom Phase L2	4	mA
4548	Aktueller Strom Phase L3	4	mA
4550	Aktueller Strom Total	4	mA
4552	Min. current Phase L1	4	mA
4554	Min. current Phase L2	4	mA
4556	Min. current Phase L3	4	mA
4558	Min. current Phase L1 Date / Time	4	Unix time stamp
4560	Min. current Phase L2 Date / Time	4	Unix time stamp
4562	Min. current Phase L3 Date / Time	4	Unix time stamp
4564	Max. current Phase L1	4	mA
4566	Max. current Phase L2	4	mA
4568	Max. current Phase L3	4	mA
4570	Max. current Phase L1 Date / Time	4	Unix time stamp
4572	Max. current Phase L2 Date / Time	4	Unix time stamp
4574	Max. current Phase L3 Date / Time	4	Unix time stamp
4576	Momentary form factor Phase L1 (cos phi)	2	Cos/100
4577	Momentary form factor Phase L2 (cos phi)	2	Cos/100
4578	Momentary form factor Phase L3 (cos phi)	2	Cos/100
4579	Momentary line frequency	2	Hz/10

4580	Power down counter	2	-
4581	Trafo ratio	2	-
4582	Momentary valid tarif	2	-

6.6 Data types

All measured values are transmitted as integers. The size of the integers depends on the length of the Reading:

Length measurement (bytes)	Data type
2	int16
4	int32
8	int64

If a measured value does not exist on the meter. The smallest possible value will be transmitted (eg. int32:-2'147'483'648).

6.7 Error Codes

If during the processing of the Modbus message frame, an error occurs, a standardized error code is returned.

A distinction is made between the following error codes:

Errorcode	Name	Description
1	Illegal function supported.	This Modbus function is not supported
2	Illegal data address	Invalid register address
3	Illegal data value	Parameter out of range
4	Slave device failure	Interface to meter communication error

6.8 Example Readout of Active-Energy Tariff 1 Import

Request

Size (Byte)	Value (Hex)	Description
1	03	Function (Read Holding Registers)
2	10 67	Register Address (4200)
2	00 04	Register count (4 Registers -> 8 Byte Data)

Response

Size (Byte)	Value (Hex)	Description
1	03	Function (Read Holding Registers)
1	08	Byte count
8	00 00 00 12 34 56 78 90	Data (in this example the value: 0x0000001234567890 = 78'187'493'520 Wh)