PowerRail 303

Serial Communications Guide
October 2007

1 Programming

Meters fitted with the Modbus option have two additional stages in the front panel programming menu.

Baud Rate

Unique Modbus Address

In programming mode press ◄ until the required parameter is shown.

To change a parameter press kWh ▲ or kW ▼ until the required value is set.

For full information on entering and using programming mode refer to the latest "***Rail303*** Operating Guide".

2 Connection

2.1 Cable Selection

A dedicated, screened twisted pair cable is required to provide basic RS485 connection. A second twisted pair may be used for 0V connection if required. The cable should be chosen to suit the data rate and maximum length to be installed. The EIA RS-485-A standard provides curves that relate cable length to data rate for 24 AWG screened, twisted pair, telephone cable with a shunt capacitance of 50pf/m. For baud rates up to 19,200 the standard suggests a maximum length of 1200m for this type of cable. If other types of cable are to be used it is recommended that the cable supplier is consulted as to the suitability for use with RS485 to 19,200 baud.

2.2 Signal 0V and Cable Shield

A signal 0V termination is provided on each meter. Although RS485 does not strictly require a signal 0V, it is recommended this is connected as shown in the diagram below. This creates a known reference for the isolated RS485 system thereby reducing potential common-mode errors in the meter's RS485 driver circuit.

A cable shield is used to attenuate noise picked up from external sources This should be continuous, and cover as much of the signal pairs as possible. It is recommended that the shield should be connected to ground at the host (PC) only. The cable shield should ***not*** be used as the 0V connection.

2.3 Terminating Resistors

In order to minimise signal errors due to noise over long cable lengths, terminating resistors may be fitted. These match the RS485 device impedance to that of the cable. Two 120Ω resistors, one at the host port terminals and the other at the most remote meter terminals are recommended for this purpose.

2.4 Connection To Meters

The bus wires should be taken to meters at each location for termination, using the meter terminals as a loop in-out connection. 3-Pairs of terminals, internally shorted, are provided for convenience. The use of spurs should be avoided wherever possible.

2.4.1 Basic Connection

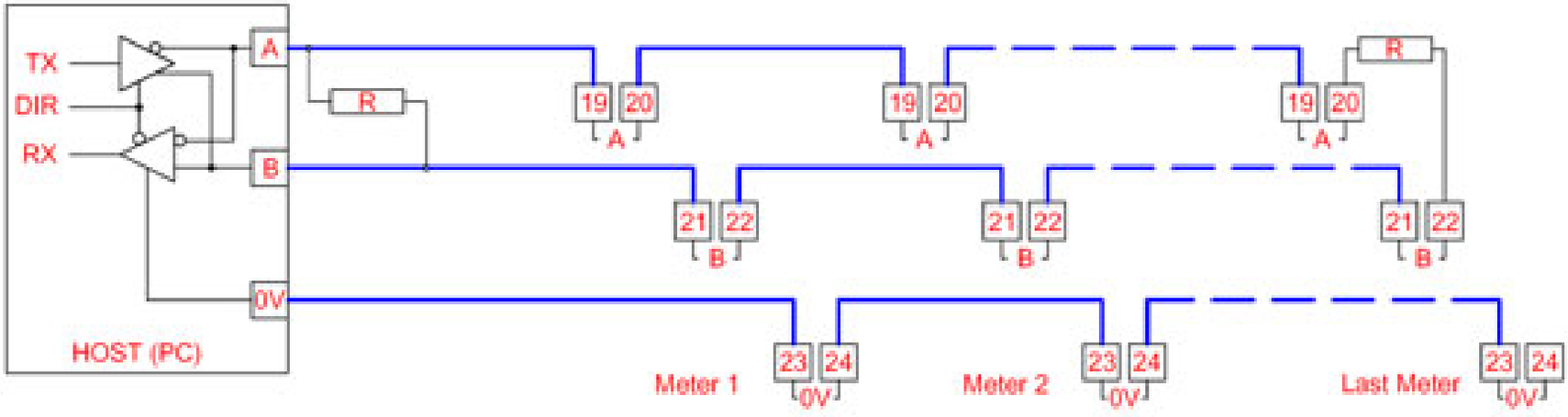

Figure 2-1 Basic RS485 Bus Network

3 Modbus Commands

The ***Rail303*** meter supports the following standard Modbus commands:

Command	*Function*	*Broadcast*
03	Read Multiple Holding Registers	No
04	Read Multiple Input Registers	No
06	Preset a Single Register	Yes
08 (SF=00)	Sub Function 00 only (Loop Back)	No
16	Preset Multiple Registers	Yes

3.1 Exception Responses

If the meter receives a Modbus command, with no errors and a valid address, it will attempt to handle the query and provide an appropriate response. If the meter cannot handle the query a standard Modbus exception response is sent (except broadcast queries). An exception response is characterised by its function byte which has 80H added to that sent in the query. The following exceptions codes are supported:

Code	*Function*
1	Preset data is out of range for parameter
2	Function cannot access requested register address

4 Modbus Data Tables

4.1 Using The Tables

For convenience, meter data is organised in tables of like information with the same format. An entire table may be read with a single Modbus ***command 3*** (Holding Registers). For compatibility with the Modbus standard each register contains a single data ***Word*** (16 bits). Data in the meter is stored as:

Unsigned Integer (U-INT)

16-bit data in the range 0 to 65,535. This is used for parameters such as CT prim as this can never be negative.

Signed Integer (S-INT)

16-bit data in the range –32,767 to +32,767. This is used for parameters such as instantaneous kW, which may have a negative value indicating export power.

Long Integer (LONG)

32-bit data in the range 0 to 4,294,967,295. This is used for parameters such as kWh, which may have large values. Each LONG requires two consecutive Modbus data words. Standard software often handles long integer reads, however, a LONG may be calculated from the individual data words as:

LONG = (65536 x High Word) + Low Word

4.2 Energy Registers

Data Address	Modbus Register	Data	Format	Access
512	40513	eScale High Word	LONG	Read
513	40514	eScale Low Word		Read
514	40515	KWh High Word	LONG	Read/Write
515	40516	KWh Low Word		Read/Write
516	40517	kWh Count High Word[1]	LONG	Read/Write
517	40518	kWh Count Low Word[1]		Read/Write

1. The kWh Count registers, will return 0 on meters that do not have this option fitted.

Energy registers are stored as long integer representations of the number displayed on the meter without decimal point or scaling. For example if the meter displays 123456.78kWh, the Holding Registers 40515-40516 will contain the long integer 12345678. This number may be scaled in Wh or kWh, using eScale as:

$$\mathbf{Wh = Holding\ Reg[40513] \times 10^{(eScale-3)}}$$

$$\mathbf{kWh = Holding\ Reg[40513] \times 10^{(eScale-6)}}$$

The eScale constant is set, along with the kWh register resolution and scaling, by the CT primary and nominal voltage programmed settings. The display scaling and eScale therefore remain constant once a meter is installed and commissioned. A read of eScale High Word always returns zero.

Example:

If the meter displays 1234567.8 kWh then eScale would be 5 and the Holding Register 40513 would contain 12345678.

The host would calculate the scaled energy reading as:

$$12345678 \times 10^{(5-3)} = 12345678 \times 100 = 1{,}234{,}567{,}800 \text{ Wh}$$

or $$12345678 \times 10^{(5-6)} = 12345678 \times 0.1 = 1{,}234{,}567.8 \text{ kWh}$$

The host programmer could take two approaches to interpreting the data from the meter:

- ✓ Enter a fixed scaling factor (x100 for Wh or x0.1 for kWh in above example). This would be set for each meter in the system based on its display after commissioning.
- ✓ Use the transmitted eScale constant, as shown above, to automatically position the decimal point in the interpreted result

4.3 Instantaneous kW

Data Address	Modbus Register	Data	Format	Access
2816	42817	Instantaneous kW	S-INT	Read
2817	42818	pScale	U-INT	Read

Instantaneous kW is stored as a signed integer representation of the number displayed on the meter without decimal point or scaling. For example if the meter displays 123.45 kW, the Holding Register 42817 will contain the signed integer 12345. This number may be scaled in W or kW, using pScale as:

$$\mathbf{W = Holding\ Reg[42817] \times 10^{(pScale-3)}}$$

$$\mathbf{kW = Holding\ Reg[42817] \times 10^{(pScale-6)}}$$

Example:

If the meter displays 123.45 kW the pScale would be 4 and the Holding Register 42817 would contain 12345.

The host would calculate the scaled power reading as:

$$12345 \times 10^{(4-3)} = 12345 \times 10 = 123{,}450\ W$$

or $$12345 \times 10^{(4-6)} = 12345 \times 0.01 = 123.45\ kW$$

4.4 kW Demand

Data Address	Modbus Register	Data	Format	Access
3334	43335	Peak kW Demand	U-INT	Read/Write
3335	43336	Demand Period	U-INT	Read/Write
3336	43337	kW Demand	U-INT	Read

Demand and Peak demand values are scaled using pScale as described above for instantaneous kW.

The demand period is scaled in minutes with a valid data range of 1-60.

4.5 Meter Setup

Data Address	Modbus Register	Data	Format	Access
3584	43585	CT Primary	U-INT	Read/Write
3585	43586	Nominal Volts	U-INT	Read/Write
3586	43587	Pulse Rate	U-INT	Read/Write
3587	43588	Pulse ON Time x10	U-INT	Read/Write
3588	43589	Baud	U-INT	Read/Write
3589	43590	Modbus ID	U-INT	Read/Write
3590	43591	Meter Model	U-INT	Read
3591	43592	Meter Type	U-INT	Read
3592	43593	Meter Version	U-INT	Read

Meter setup values are stored as unsigned integers scaled as follows:

CT Primary 10 to 25,000 Amps

Nominal Volts 10 to 55,000 Volts

Pulse Rate 1-1000 Energy register increments per pulse output.

Pulse Length 1-100 representing pulse lengths 0.1 to 10 seconds.

Baud 4800, 9600 or 19200

Modbus ID 1-247 Unique Modbus meter address

Meter Model ***Rail303*** = 303. Identifies meter type in a network.

Meter Type 1-65535 Identifies meter variant (basic ***Rail303*** = 2)

Meter Version Internal software issue. (e.g. 101=Version1.01)

4.6 Copied Data Table

This table of data provides a copy of all meter readings and settings, available in the above tables, listed together so they can be read with a single Modbus command 3.

In a network of meters this will reduce the time taken to access a large number of meters if, for example, energy and power readings are required simultaneously.

This is a read only table and may not be used with Modbus Preset Register command 6 or 16.

Data is stored in this table in various formats to suit each parameter type. Some work may be required to setup the Modbus host to accept the individual values and scale them accordingly.

Data Address	Modbus Register	Data	Format	Access
7680	47681	KWh High Word	LONG	Read
7681	47682	KWh Low Word		Read
7682	47683	kWh Count High Word	LONG	Read
7683	47684	kWh Count Low Word		Read
7684	47685	Peak kW Demand	U-INT	Read
7685	47686	kW Demand	U-INT	Read
7686	47687	Demand Period	U-INT	Read
7687	47688	Reserved (0)	-	Read
7688	47689	Instantaneous kW	S-INT	Read
7689	47690	eScale	U-INT	Read
7690	47691	pScale	U-INT	Read
7691	47692	CT Primary	U-INT	Read
7692	47693	Nominal Volts	U-INT	Read
7693	47694	Pulse Rate	U-INT	Read
7694	47695	Pulse ON Time x10	U-INT	Read
7695	47696	Baud	U-INT	Read
7696	47697	Modbus ID	U-INT	Read
7697	47698	Meter Model	U-INT	Read
7698	47699	Meter Type	U-INT	Read
7699	47700	Meter Version	U-INT	Read

5 Specification

Modbus	RS485	Half duplex, 2 Wires + 0V
	RX Load:	¼ Unit load per meter (max 128 per bus)
	TX Drive:	32 Unit loads maximum
	Protocol:	Modbus RTU/JBUS, 16-Bit CRC
	Baud:	4800, 9600, 19200 user programmable
	Address:	1-247 user programmable
Isolation	2.5kV (1 minute) RS485 port from all other circuit	
Performance	Reply:	Maximum 250ms
	Rate:	Min 10ms from reply to next request
	Data:	Meter readings & programmable settings Maximum data length 20 Words.
General	Environmental:	Refer to ***Rail303*** specification
	Terminals:	Rising clamp, max wire $4mm^2$

6 Safety

The ***Rail303*** is intended for connection to dangerous voltages giving a risk of electric shock. Refer to the safety/installation instructions in the ***Rail303 Operating Guide*** before connecting the communications.

WARNING

The meter contains no user serviceable parts. Installation and commissioning should only be carried out by qualified personnel