Rail310
Serial Communications
Revision 2

1 Safety

This instruction sheet gives details of the operation of the ***Rail310V Optional Modbus interface***. Labels on each meter give details of equipment ratings for safe operation. Take time to examine all labels before commencing installation. Safety symbols on the meter have specific meanings as:

Caution Risk of Danger
Refer to Instructions

Danger
Risk of Electric Shock

Safety may be impaired if the instructions are not followed or the meter is used in a manner not specified by the manufacturer.

Contains no user serviceable parts. Field wiring and commissioning should only be carried out by qualified personnel, in compliance with applicable national regulations.

e.g. National Electrical Code (NEC) for US; Canadian Electrical Code for Canada

For further Information contact the manufacturer:
Address: Northern Design (Electronics) Ltd: 228 Bolton Road, Bradford, West Yorkshire, BD3 0QW. (UK)
Web: http://www.ndmeter.co.uk
Email: sales@ndmeter.co.uk

NOTE:

The ***Rail310*** is intended for connection to dangerous voltages giving a risk of electric shock. Refer to the safety/installation instructions in the ***Rail310 Installation Guide*** before connecting the communications.

2 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 I ◀ until the required parameter is shown.

To change a parameter press P ▲ or E ▼ until the required value is set.

For full information on entering and using programming mode refer to the latest "***Rail310*** Installation Guide".

3 Connection

3.1 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.

3.2 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.

3.3 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.

3.4 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. The use of spurs should be avoided wherever possible.

3.4.1 Basic Connection

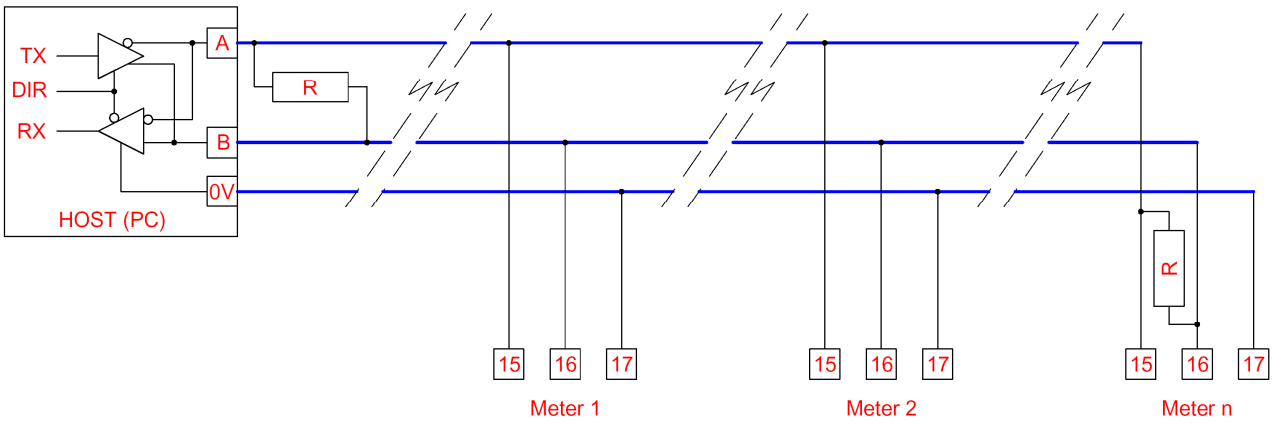

Figure 3-1 Basic RS485 Bus Network

4 Modbus Commands

The ***Rail310*** 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

4.1 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

5 Modbus Data

5.1 Data Addresses

Data Address	Modbus Register	Data	Scaling	Access
7680	47681	Meter 1KWh High Word	Ke	Read/Write
7681	47682	Meter 1 KWh Low Word		
7682	47683	Meter 2KWh High Word	Ke	
7683	47684	Meter 2 KWh Low Word		
7684	47685	Meter 3KWh High Word	Ke	
7685	47686	Meter 3 KWh Low Word		
7686	47687	Total KWh High Word	Ke	Read Only
7687	47688	Total KWh Low Word		
7688	47689	Energy Scale Ke	-	
7689	47690	Meter 1 kW	Kp	
7690	47691	Meter 2 kW		
7691	47692	Meter 3 kW		
7692	47693	Total kW		
7693	47694	Power Scale Kp	-	
7694	47695	Meter 1 Amps	Ki	
7695	47696	Meter 2 Amps		
7696	47697	Meter 3 Amps		
7697	47698	Average Amps		
7698	47699	Amps Scale Ki	-	
7699	47700	Meter 1 Volts	Kv	
7700	47701	Meter 2 Volts		
7701	47702	Meter 3 Volts		
7702	47703	Average Volts		
7703	47704	Phase Volts Scale Kv	-	
7704	47705	Meter 1 PF	1000 = 1.000	
7705	47706	Meter 2 PF		
7706	47707	Meter 3 PF		
7707	47708	Total PF		
7708	47709	Meter 1 kvar	Kp	
7709	47710	Meter 2 kvar		
7710	47711	Meter 3 kvar		
7711	47712	Total kvar		

5.2 Scaling Energy Values

Energy registers are stored as 32-bit Long Integers because the range of possible values 0-99,999,999) is too large to be expressed with a single, 16 bit, Modbus register.

Each 32 bit LONG number requires two consecutive Modbus data registers (eg 47681 and 47682) for storage.

If possible a Modbus master should be selected that has built in handling for unsigned 32 bit LONG integers.

If only 16-bit registers are available, a LONG may be calculated from the individual data words as:

$$\textbf{LONG} = (65536 \times \textbf{High Word}) + \textbf{Low Word}$$

5.2.1 Energy Scaling

Energy registers are copies of the value displayed on the LCD without decimal point or scaling. For example if Meter 1 displays 123456.78 kWh, Holding Registers 47681-47682 will contain a long integer 12345678. This may be scaled in Wh or kWh, using Ke as:

$$\textbf{Wh} = \textbf{Holding Reg}[47682] \times 10^{(Ke-3)}$$

$$\textbf{kWh} = \textbf{Holding Reg}[47682] \times 10^{(Ke-6)}$$

The Ke constant is set, along with the kWh register resolution and scaling, by the CT and PT programmed settings. The display scaling and Ke therefore remain constant once a meter is installed and commissioned.

Energy Scaling Example:

If the meter displays 1234567.8 kWh then Ke would be 5 and the Holding Registers 47681-47682 would contain 12345678.

The Master would calculate the scaled energy reading as:

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

or $12345678 \times 10^{(5-6)} = 12345678 \times 0.1 = 1,234,567.8$ 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 Ke constant, as shown above, to automatically position the decimal point in the interpreted result.

5.2.2 Instantaneous Register Scaling

Instantaneous readings are provided as signed integer values with no decimal point or legend (e.g. kW or MW). Scaling factors are provided to enable conversion of the raw data to real numbers in basic unit form (amps, volts or watts). These scaling factors are constant values calculated as a function of CT and PT Primary programming.

To convert raw data to real numbers:

$$R = I \times 10^{(K-3)}$$

Where:

I = Modbus register value
K = Relevant Scaling Factor (Kp=kW, Ki=Amps, Kv=Volts)
R = Real number result

Example:

If the meter is programmed with CT Primary=50Amps and PT Primary=415V:
LCD values would be scaled as: 50.00A, 240.0V and 12.00kW.
Scaling factors would be: ***Ki***=1, ***Kv***=2, ***Kp***=4.
Integer Values would be transmitted as: 5000, 2400 and 1200
Amps would be calculated as $5000 \times 10^{(1-3)} = 5000/100 = 50.00$A
Phase Volts would be calculated as $2400 \times 10^{(2-3)} = 2400/10 = 240.0$V
Power would be calculated as $1200 \times 10^{(4-3)} = 1200 \times 10 = 12000$W

5.3 Meter Setup

Data Address	Modbus Register	Data	Scaling	Access
3584	43585	CT Primary	5 - 25,000 Amps	Read/Write
3585	43586	Nominal Volts	10 - 55,000 Volts	
3586	43587	Pulse Rate	1-1000 Counts/Pulse	
3587	43588	Pulse ON Time	1 = 100ms, 2=200ms etc	
3588	43589	Baud	96 = 9600baud etc	
3589	43590	Modbus ID	0 – 247	
3590	43591	Meter Model	Rail310 = 310	Read Only
3591	43592	Meter Type	Model = 1 - 3	
3592	43593	Firmware Version	Eg. 0x14 = 1.04	
3593	43594	Security Code (PIN)	0 - 9999	Read/Write

Note: All values in this table are unsigned Integers with read/write access except 43591-43593 which are read only

Note: If a value greater than zero is set for the security code then the user must enter this code before access to the programming menu is allowed using the front panel keys.

6 Specification

Aux Mains	Internally supplied from ***Rail310*** Auxiliary
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	3.5kV (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 Rail***310*** specification Terminals: Rising clamp, max wire 4mm^2

E. & O. E.