PM290
POWERMETER

Communication Protocols
ASCII & Modbus
Reference Guide

PM290 Communication Protocols

Communication protocol is a method of transferring information between different devices (i.e., the Powermeter and a computer) where the protocol is a repertoire of computer commands and the Powermeter responses.

For example, the computer will command a specific Powermeter to send to the computer all of its measured data. The Powermeter will respond by sending all the data in a specific known order so the computer will recognize it and treat it as data.

This section details the protocols, the computer requests and the Powermeter replies.

The user can choose between two protocols, **ASCII** and **MODBUS**.

NOTE

Table of Contents

BG0321 Rev. A1

1 ASCII PROTOCOL

1.1 Message Format

Field #1	Field #2	Field #3	Field #4	Field #5	Field #6	Field #7

The following is a list of the possible characters and message characteristics appearing in the fields:

Field #1 - Synchronization Character: **One character '!'**, used for starting synchronization.

Field #2 -Message Length: Length of the message including only number of bytes in fields #2, #3, #4 and #5. Contains three characters between **'003'** and **'252'**.

Field #3 -Address: Two characters between **'00'** and **'32'**. Powermeter with address **'00'** answers to requests with any other address.

NOTE For RS-232 this field must ALWAYS be '0'.

NOTE For RS-422/RS-485 (multidrop mode), this field must NEVER be '0'.

Field #4 -Message type: One character representing the type of host request. **Possible requests:**

- **'0' -** Data Request
- **'1' -** Examine Set Point High Boundary
- **'2' -** Change Set Point High Boundary
- **'3' -** DIP Switch Status Request
- **'4' -** Reset all accumulated values to zero
- **'5' -** Request of Printer String
- **'6' -** Examine Set Point Low Boundary
- **'7' -** Change Set Point Low Boundary
- **'8' -** Program Reset
- **'9' -** If internal test is correct return version number

Field #5 -Message Body: Enables use of all **ASCII characters**

Field #6 -Checksum: Checksum is calculated in 2 byte words for fields #2, #3, #4 and #5 to produce one byte checksum in the range **22H (H=Hexadecimal) to 7EH** as follows:

((sum of(each byte - 22H)) modulo 5CH) + 22H.

Field #7 -Trailer: Carriage return and line feed.

NOTE Fields #3 and #4 of replies are always the same as in the request message.

1.2 Data Request

HOST REQUEST
Message Type - '0'
Message Body - none

REPLY
Message Body - String of 171 bytes:

Table 1-1 Reply to Host Request Type '0'

FIELD	OFFSET (BYTES)	LENGTH (BYTES)	DESCRIPTION	CONFIGURATION
1	0	4	Voltage L1	NNN.,
2	4	4	Voltage L2	N.NN, NN.N, .
3	8	4	Voltage L3	NNN
4	12	5	Current L1	
5	17	5	Current L2	NNNN, NN.NN
6	22	5	Current L3	
7	27	6	Power L1	SNNNNN,
8	33	6	Power L2	WNN.NN, WNNN.N
9	39	6	Power L3	WNNNN.
10	45	4	Power Factor L1	
11	49	4	Power Factor L2	T.NN
12	53	4	Power Factor L3	
13	57	6	Total Active Power	SNNNNN, WNN.NN, WNNN.N WNNNN.
14	63	4	System Power Factor	T.NN
15	67	6	Active Energy	NNNNN, NNN.NN, NNNN.N, NNNNN.
16	73	5	Unbalanced Current	NNNN NN.NN
17	78	4	Frequency	NN.N
18	82	6	Reactive Power L1	WNN.NN, SNNNNN,
19	88	6	Reactive Power L2	WNNN.N,
20	94	6	Reactive Power L3	WNNNN.
21	100	6	Apparent Power L1	0NNNNN, NNN.NN, NNNN.N, NNNNN.
22	106	6	Apparent Power L2	
23	112	6	Apparent Power L3	
24	118	6	Reactive Energy	WNNNNN, WNN.NN, WNNN.N, WNNNN.
25	124	6	Total Reactive Power	SNNNNN, WNN.NN, WNNN.N, WNNNN.
26	130	6	Total Apparent Power	0NNNNN, NNN.NN, NNNN.N, NNNNN.

FIELD	OFFSET (BYTES)	LENGTH (BYTES)	DESCRIPTION	CONFIGURATION
27	136	6	Max. Demand	0NNNNN, NNN.NN, NNNN.N, NNNNN.
28	142	6	Accumulated Max. Demand	0NNNNN, NNN.NN, NNNN.N, NNNNN.
29	148	5	Amp. Max. Demand L1	
30	153	5	Amp. Max. Demand L2	0NNNN NN.NN
31	158	5	Amp. Max. Demand L3	
32	163	2	Contact Status (Option B only)	HH
33	165	6	Returned Energy	-0NNNN, -NN.NN -NNN.N -NNNN.

Where:

N- 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

S - 0 or "-"

T - 0, 1, or "-"

W - 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 or "-"

H - 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

NOTE

If a three wire configuration has been chosen the individual phase values for power factor, active power, apparent power and reactive power will appear in the communication protocol as zeros ('0's), because they have no meaning. Only the total three phase system values will be present.

1.3 Examine Set Point High Boundary

HOST REQUEST

Message Type - '1'
Message Body:

Sub field #1	Sub field #2

Sub field #1 - function of programming (length - 1 byte)
See Table 1-2 Sub field 1

Sub field #2 - setpoint serial number (length - 2 bytes)
See Table 1-2 Sub field 2

REPLY

Message Type - '1'
Message Body:

Sub field #1	Sub field #2	Sub field #3	Sub field #4

Sub field #1 - Same as for the HOST REQUEST

Sub field #2 - Same as for the HOST REQUEST

Sub field #3 - Set point delay in 'NN.N' format (length 4 bytes)
Will be '////' when the set point is suppressed

Sub field #4 - Set point limit (length 1 to 9 bytes)

Table 1-2 Setpoints

SETPOINT NAME	**Sub field #1**	**Sub field #2 (Setpoint #)**	**Sub field #4 (Limit)**	**Description**
SETPOINTS FOR RELAYS 1 - 4				
High Voltage	1...4	1	0 to V max	N,NN... NNNNNN
Low Voltage	1...4	2	0 to V max	N,NN... NNNNNN
High Current	1...4	3	0 to I max	N,NN... NNNNN
Max. Demand	1...4	4	0 to P max	N,NN... NNNNNN
Low PF.	1...4	5	0 to 1.00	N.NN
Unbalanced Current	1...4	6	0 to I max	N,NN... NNNNN
+kWH Pulsing	1	7	1 to 200	N,NN, NNN
High Reactive Power	1...4	8	0 to P max	N,NN...NNNNN NN
High Apparent Power	1...4	9	0 to P max	N,NN... NNNNNN
kVARH Pulsing	2	10	1 to 200	N,NN, NNN

SETPOINT NAME	Sub field #1	Sub field #2 (Setpoint #)	Sub field #4 (Limit)	Description
kWH- Pulsing	4	18	1 to 200	N,NN, NNN
SETPOINTS FOR CONFIGURATION				
Wiring Configuration	W	40	0. (3-OP) 1. (4L-n) 2. (3 dir) 3. (4L-L)	N
PT Ratio	U	14	1.0 to 6500.0	N.N ... NNNN.N
CT Primary Current	I	17	1 to 50,000	N ... NNNNN
Max. Demand Period	D	11	1,2,5,10,15,20, 30,60 or 255 for/ext. sync	N ... NNN
Ampere Max. Demand Period	C	12	1 to 1800	N ... NNNN
Buffer Mode	S	41	8 or 32	N or NN
Reset En/Disable	R	42	0 (enable) 1 (disable)	N
Printer Period	P	13	1,2,5,10,15,20, 30,60	N or NN
SETPOINTS FOR ANALOG OUTPUT				
Voltage A	A	21	136	'136'
Voltage B	A	22	136	'136'
Voltage C	A	23	136	'136'
Current A	A	24	136	'136'
Current B	A	25	136	'136'
Current C	A	26	136	'136'
Apparent Power	A	27	136	'136'
Power Factor	A	28	136	'136'
React. Power	A	29	136	'136'
Active Power	A	30	136	'136'
Accumulated Power Demand	A	31	136	'136'
Frequency	A	34	136	'136'
SETPOINTS FOR ANALOG EXPANDER (OPTIONAL)				
Voltage A	E	21	0-14(CHAN.#)	NN
Voltage B	E	22	0-14(CHAN.#)	NN
Voltage C	E	23	0-14(CHAN.#)	NN
Current A	E	24	0-14(CHAN.#)	NN
Current B	E	25	0-14(CHAN.#)	NN
Current C	E	26	0-14(CHAN.#)	NN
Apparent Power	E	27	0-14(CHAN.#)	NN

SETPOINT NAME	Sub field #1	Sub field #2 (Setpoint #)	Sub field #4 (Limit)	Description
Power Factor	E	28	0-14(CHAN.#)	NN
Reactive Power	E	29	0-14(CHAN.#)	NN
Active Power	E	30	0-14(CHAN.#)	NN
Accumulated Maximum Demand	E	31	0-14(CHAN.#)	NN
Frequency	E	34	0-14(CHAN.#)	NN

NOTES

Two analog output set points cannot be assigned at the same time to the same analog channel. Channel 0 is the internal analog output channel and channels 1 to 14 are the Analog Expander channels. The AX-7 Analog Expander has 7 analog channels. Two AX-7 Analog Expanders can be connected together in order to provide 14 analog channels.

Setpoints #7, #10 and #18 are not compatible with all other set points, i.e., if setpoint #7, #10 or #18 is enabled, all other setpoints at the relevant relay will be suppressed automatically.

Setpoints #5 and #14 have a fixed format; i.e., the decimal point position is as shown in the table above. Placing a decimal point into another position is prohibited.

Setpoints #11, #12, #13, #14, #17, #40, #41, #42, #43, #44, #45 and #46 cannot be suppressed.

1.4 Change Setpoint High Boundary

HOST REQUEST

Message Type - '2'
Message Body:

Sub field #1	Sub field #2	Sub field #3	Sub field #4

Sub field #1 - The same as Message Type '1'

Sub field #2 - The same Message Type '1'

Sub field #3 - Set point delay in 'NN.N' format (length 4 bytes).
To suppress this set point, this field should be filled with '////'

Sub field #4 - Set point limit (length 1 to 7 bytes)

REPLY

Message type - '2'
Message Body - the same as in the Host Request

1.5 DIP Switches Status Request

HOST REQUEST

Message type - '3'
Message Body - none

REPLY

Message type - '3'
Message Body:

Sub field #1	Sub field #2	Sub field #3

Sub field #1 - Status of the DIP Switch Block in ASCII (eight ASCII bytes, two bytes per block) where:

'XXXXNNXX'
NN - DIP Switch Block Status
X - Don't care
('1' = on, '0' = off)

Sub field #2 - Status of keypad in ASCII (1 byte); keys are arranged as follows:

Up Key - bit #0
Reset Key - bit #1
Select Key- bit #2
Down Key - bit #3
('1' = key is pressed, '0' = key is not pressed)

Sub field #3 - Status of relays in ASCII (1 byte):

Relay 1 - bit #3
Relay 2 - bit #2
Relay 3 - bit #1
Relay 4 - bit #0

('1' = closed, '0' = open)

1.6 Reset Accumulated Values to Zero

HOST REQUEST

Message type - '4'
Message Body:
'1' - Reset: kWH+, kWH- and kVARH
'2' - Reset: Active Power Maximum Demand and Amp. Max. Demand, Apparent Power Max. Demand

REPLY

Message type - '4'
Message Body:
Same as Host Request

1.7 Send Printer String

HOST REQUEST

Message type - '5'
Message Body - none

REPLY

Message Body - Printer String

1.8 Examine Set Point Low Boundary

HOST REQUEST

Message Type - '6'
Message Body - the same as in the request '1' in section 6.6.3

REPLY

Message Type - '6'
Message Body:

Sub field #1	Sub field #2	Sub field #3	Sub field #4

Sub field #1 - The same as in the HOST REQUEST

Sub field #2 - The same as in the HOST REQUEST

Sub field #3 - Set point delay in 'NNN.' format (length 4 bytes)
Will be '////' when the set point or low boundary is suppressed

Sub field #4 - Set point limit (length 1 to 7 bytes)

1.9 Change Set Point Low Boundary

HOST REQUEST

Message Type - '7'
Message Body:

Sub field #1	Sub field #2	Sub field #3	Sub field #4

Sub field #1 - The same as in the REQUEST TYPE '2'

Sub field #2 - The same as in the REQUEST TYPE '2'

Sub field #3 - Set point delay in 'NNN.' format (length 4 bytes).
To suppress this set point, this field should be filled with '////'

Sub field #4 - Set point limit (length 1 to 7 bytes)

REPLY

Message type - '7'
Message Body - the same as in the HOST REQUEST

1.10 Reset Powermeter

Message Type - '8'
Message Body - none

REPLY - none

1.11 Receive Version Number

HOST REQUEST

Message Type - '9'
Message Body - none

REPLY

Message type - '9'
Message Body:

'XXX' if checksum of ROM is OK. If the checksum is not OK, this field will be '000'.

where:

'XXX' is the version number

1.12 Error Replies

The instrument will send the following error messages in response to incorrect host requests:

Message Body:

'XK'	Powermeter is in definition mode
'XP'	Invalid set point value or set point is not available
'XF'	Invalid message format or checksum
'XM'	Invalid request type

2 MODBUS PROTOCOL

2.1 Introduction

This protocol provides data communication between a PC and multiple Powermeters and is a subset of Modicon's MODBUS protocol. The protocol provides for one master and up to 247 Powermeter slaves on a common line. Although the protocol supports up to 247 slaves, certain device restrictions may limit the number of slaves to less than 247*.

The protocol works in a master-slave mode. Only the master can initiate a transaction. Transactions are either a **query / response** type, when a single Powermeter is addressed, or a **broadcast / no response** type, where all the Powermeters are addressed. A transaction includes a single query and a single response frame or a single broadcast frame. Powermeters communicate in half duplex mode : Powermeter process only one query and do not receive a new query while the pervious response is transmitted.

2.2 Transmission mode

The transmission mode is Remote Terminal Unit (RTU). In the RTU mode, data is sent in 8-bit binary characters. The **8 bit even parity** or **8 bit no parity** should be set in the Powermeter. The RTU transmission mode is defined in Table 6-4.

Table 2-1 RTU Transmission Mode

Field	No. of bits
Start bit	1
Data bits ①	8
Parity (optional)	1
Stop bit	1

① Least significant bit first

2.3 Framing

Frame synchronization is maintained in RTU transmission mode by simulating a synchronization message. The receiving device monitors the elapsed time between reception of characters. If three and one-half character times elapse without a new character or completion of the frame, then the device flushes the frame and assumes that the next byte received will be an address. Frame format is defined below.

The maximum query and response message length is 256 bytes including check characters.

RTU Message Frame Format

T1 T2 T3	Address	Function	Data	Check	T1 T2 T3
	8 bits	8 bits	N * 8 bits	16 bits	

2.3.1 Address Field

The address field contains a user assigned address (1-247) of the Powermeter that is to receive message. Address 0 is used in broadcast mode to transmit to all Powermeters (broadcast mode is available only for functions 06 and 16). In this case all Powermeters receive the message and take action on the request but do not issue a response.

2.3.2 *Function Field*

The function field contains the function code that tells the Powermeter what action to perform.

Function codes used in the protocol are shown below in **Table 2-2**.

Table 2-2 Function Codes Used in PC - Powermeter Protocol

Code (Decimal)	Meaning in MODBUS	Action
20	Read general reference	Obtain data from Powermeter
21	Write general reference	Transmit data to Powermeter
03	Read holding registers	Obtain data from Powermeter
04	Read input registers	Obtain data from Powermeter
16	Preset multiple registers	Transmit data to Powermeter
06	Preset single register	Transmit data to Powermeter
08	Loop back test Code 0- return query data	Communication test

NOTE Broadcast mode is available only for function codes 06 and 16.

2.3.3 *Data Field*

The data field contains information needed by the Powermeter to perform a specific function or it contains data collected by the Powermeter in response to a query.

2.3.4 *Error Check Field*

The error check field contains the result of Cyclical Redundancy Check (CRC). The start of the message is ignored in calculating the CRC.

CRC-16 (Cyclic Redundancy Check) Error Check Sequence

The message (data bits only, disregarding start/stop and optional parity bits) is considered one continuous binary number whose most significant bit (MSB) is transmitted first. The message is pre-multiplied by x^{16} (shifted left 16 bits), then divided by $x^{16} + x^{15} + x^2 + 1$ expressed as a binary number (11000000000000101). The integer quotient digits are ignored and the 16-bit remainder (initialized to all ones at the start to avoid the case of all zeros being an accepted message) is appended to the message (MSB first) as the two CRC check bytes. The resulting message including CRC, when divided by the same polynomial ($x^{16} + x^{15} + x^2 + 1$) at the receiver will give a zero remainder if no errors have occurred. (The receiving unit recalculates the CRC and compares it to the transmitted CRC). All arithmetic is performed modulo two (no carries).

The device used to serialize the data for transmission will send the conventional LSB or right-most bit of each character first. In generating the CRC, the first bit transmitted is defined as the MSB of the dividend. For convenience then, and since there are no carries used in arithmetic, let's assume while computing the CRC that the MSB is on the right. To be consistent, the bit order of the generating polynomial must be reversed. The MSB of the polynomial is dropped since it affects only the quotient and not the remainder. This yields 1010 0000 0000 0001 (Hex A001). Note that this reversal of the bit order will have no affect whatever on the interpretation or bit order of characters external to the CRC calculations.

The step by step procedure to form the CRC-16 check bytes is as follows:

1. Load a 16-bit register with all 1's.
2. Exclusive **OR** the first 8-bit byte with the high order byte of the 16-bit register, putting the result in the 16-bit register.
3. Shift the 16-bit register one bit to the right.

4a. If the bit shifted out to the right (flag) is one, exclusive **OR** the generating polynomial 1010 000 000 0001 with the 16-bit register.

4b. If the bit shifted out to the right is zero; return to step 3.

5. Repeat steps 3 and 4 until 8 shifts have been performed.
6. Exclusive **OR** the next 8-bit byte with the 16-bit register.
7. Repeat step 3 through 6 until all bytes of the message have been exclusive **OR** with the 16-bit register and shifted 8 times.
8. The contents of the 16-bit register are the 2 byte CRC error check and is added to the message most significant bits first.

The start of the message is ignored in calculating the CRC.

2.4 Detailed Command Description

Obtain Data From Powermeter (Function Code 20)

Powermeter Address	Function (20)	Byte Count	Sub Request 1	...	Sub Request N	Error Check
1 byte	1 byte	1 byte	7 bytes	...	7 bytes	2 bytes

Sub Request Format

Reference Type (06)	Table Number	Start Address	Word Count
1 byte	2 bytes	2 bytes	1 byte

Several sub-requests can be included in one message. The maximum number of registers read is dependent upon the maximum message length. The maximum query and response message length is 256 bytes including check characters.

Meaning of message fields:

Byte Count Total number of binary bytes in the message, excluding Powermeter address, function code, byte count, error check fields

Reference type Fixed field, must be 06

Table number Powermeter internal data table number

Starting Address Address of the first word in the table to be read

Word Count Number of words to be read from the table

Response

One or several sub-requests result in one or more sub-responses.

Powermeter Address	Function (20)	Byte Count	Sub-Response	...	Sub-Response	Error check
1 byte	1 byte	1 byte	...	...	...	2 bytes

Sub - Response

Sub-response byte count	Ref Type (06)	Data Word 1	...	Data Word N
1 byte	1 byte	2 bytes	...	2 bytes

The Sub-response byte count contains the number of binary bytes in each sub-response: data length and byte of reference type. Data Word 1 .. N - read data from the table.

The maximum number of query and response message length is 256 bytes.

Write data to parameter (Function Code 21)

Powermeter Address	Function (21)	Byte Count	Sub-Request	...	Sub-Request	Error Check
1 byte	1 byte	1 byte	...	...	...	2 bytes

Sub - Request

Reference Type (06)	Table No.	Start Address	Word Count	Data Word 1	...	Data Word N
1 byte	2 bytes	2 bytes	2 bytes	2 bytes	...	2 bytes

Several sub-requests can be included in one message. The maximum number of registers to be written is dependent upon the maximum message length. The maximum query and response message length is 256 bytes including check characters.

Meaning of message fields:

Byte Count Total number of binary bytes in the message, excluding Powermeter address, function code, byte count, error check fields

Reference Type Fixed field, must be 06

Table Number Powermeter internal data table number

Starting Address Address of the first word in the table to be read

Word Count Number of words to be written to the table

Data Word1 .. N Data to be written to the table

Response

The normal response to write request is retransmission of a write request.

Obtain data from Powermeter (Function Code 03)

Powermeter Address	Function (03)	Table Number	Start Address	Word Count	Error Check
1 byte	1 byte	1 byte	1 byte	2 bytes	2 bytes

Meaning of message fields:

Table Number Powermeter internal data table number

Starting Address Address of the first word in the table to be read

Word Count Number of words to be read from the table

Note The request allows to obtain up to 125 words from the Powermeter.

Response

Powermeter Address	Function (03)	Byte Count	Data Word 1	...	Data Word N	Error Check
1 byte	1 byte	1 byte	2 byte	...	2 byte	2 bytes

The Byte Count field of the response contains the quantity of bytes to be returned.

Obtain data from Powermeter (Function Code 04)

Powermeter Address	Function (04)	Table Number	Start Address	Word Count	Error Check
1 byte	1 byte	1 byte	1 byte	2 bytes	2 byte

Meaning of message fields:

Table Number Powermeter internal data table number

Starting Address Address of the first word in the table to be read

Word Count Number of words to be read from the table

Note The request allows to obtain up to 125 words from Powermeter.

Response

Powermeter Address	Function (04)	Byte Count	Data Word 1	...	Data Word N	Error Check
1 byte	1 byte	1 byte	2 byte	...	2 byte	2 bytes

The Byte Count field of the response contains the quantity of bytes to be returned.

Write Data to Powermeter (Function code 16)

Powermeter Address	Function (16)	Table Number	Start Address	Word Count	Byte Count
1 byte	1 byte	1 byte	1 byte	2 bytes	1 byte

Data Word 1	...	...	...	Data Word N	Error Check
2 bytes	...	...	...	2 bytes	2 bytes

Meaning of message fields:

Table Number Powermeter internal data table number

Starting Address Address of the first word in the table to be read

Word Count Number of words to be written to the table

Byte Count Number of bytes to be written to the table

Response

Powermeter Address	Function (16)	Table Number	Start Address	Word Count	Error Check
1 byte	1 byte	1 byte	1 byte	1 word	2 bytes

Note This request allows to write up to 125 words to the Powermeter.

Preset Single Register (Function code 06)

Powermeter Address	Function (06)	Table Number	Start Address	Data value HO	Data value LO	Error check
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	2 bytes

Meaning of message fields:

Table number Powermeter internal data table number;

Starting Address Address of the first word in the table to be read

Data Value Data to be written to the table (HO - high order byte, LO - low order byte).

Response

The normal response to write request is retransmission of a write request.

Loop Back Communication Test (Function Code 08)

Powermeter Address	Function (08)	Diagnostic Code (0)	Data	Error Check
1 byte	1 byte	2 bytes	2 bytes	2 bytes

The purpose of the Loop back test is to check the communication system between a specified Powermeter and the PC.

Meaning of message fields:

Diagnostic Code Designate action to be taken in Loop back test. The protocol supports only Diagnostic Code = 0 - return query data.

Data Query data. The data passed in this field will be returned to the master through the Powermeter. The entire message returned should be identical to the message transmitted by the master, field-per-field.

Response

Powermeter Address	Function (08)	Dianostic. Code (0)	Data	Error Check
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Exception Responses

The slave sends an exception response when errors are detected in the received message. To indicate that the response is a notification of an error, the high order bit of the function code is set to 1. The format of the exception response is:

Powermeter Address	Function high order bit is set to 1	Exception Code	Error Check
1 byte	1 byte	1 byte	2 bytes

Exception Response Codes defined in MODBUS:

01 Illegal function

02 Illegal data address (table number or start address is not valid)

03 Illegal data value

06 Busy, rejected message; the message was received without error, but the Powermeter is programming from keypad mode (only for requests dealing with tables 6 through 11).

2.5 Powermeter Internal Data Tables

2.5.1 Data conversion

There are 11 methods of data conversion in the MODBUS PLC. To define data conversion it is necessary to define **HI Scale**, **LO Scale** and **Conversion**. Any range between 0.01 and 99,999.00 can be entered in the HI and LO scales. Conversion is carried out by one of the following methods:

NONE The data will be presented exactly as retrieved by the communication program from the Powermeter.

Linear The raw input data X must be in the range 0 - 4095. Conversion:

Y = X / 4095 * (HI - LO) + LO

When a value is written to the Powermeter, the conversion is carried out in reverse to produce the written value:

Y = 4095 * (X - LO) / (HI - LO)

LIN1 (Linear) The raw input data X must be in the range 0 - 1023. Conversion:

Y = X / 1023 * (HI - LO) + LO

When a value is written to the Powermeter, the conversion is carried out in reverse to produce the written value:

Y = 1023 * (X - LO) / (HI - LO)

LIN2 (Linear) The raw input data X must be in the range 0 - 999. Conversion:

Y = X / 999 * (HI - LO) + LO

When a value is written to the Powermeter, the conversion is carried out in reverse to produce the written value:

Y = 999 * (X - LO) / (HI - LO)

LIN3 (Linear) The raw input data X must be in the range 0 - 9999. Conversion:

Y = X / 9999 * (HI - LO) + LO

When a value is written to the Powermeter, the conversion is carried out in reverse to produce the written value:

Y = 9999 * (X - LO) / (HI - LO)

2.5.2 Measured Data Table

Powermeter Internal Table #1

No	Parameter	Add-ress	Bytes	Data Conversion Method	HI Scale	LO Scale
1	Voltage A	0	2	LIN3	Vmax	0
2	Voltage B	1	2	LIN3	Vmax	0
3	Voltage C	2	2	LIN3	Vmax	0
4	Current A	3	2	LIN3	Imax	0
5	Current B	4	2	LIN3	Imax	0
6	Current C	5	2	LIN3	Imax	0
7	Power A	6	2	LIN3	Pmax	-Pmax
8	Power B	7	2	LIN3	Pmax	-Pmax
9	Power C	8	2	LIN3	Pmax	-Pmax
10	Reactive Power A	9	2	LIN3	Pmax	-Pmax
11	Reactive Power B	10	2	LIN3	Pmax	-Pmax
12	Reactive Power C	11	2	LIN3	Pmax	-Pmax
13	Apparent Power A	12	2	LIN3	Pmax	-Pmax
14	Apparent Power B	13	2	LIN3	Pmax	-Pmax
15	Apparent Power C	14	2	LIN3	Pmax	-Pmax
16	Power factor A	15	2	LIN3	1.00	-1.00
17	Power factor B	16	2	LIN3	1.00	-1.00
18	Power factor C	17	2	LIN3	1.00	-1.00
19	Average Power factor	18	2	LIN3	1.00	-1.00
20	Total Active Power	19	2	LIN3	Pmax	-Pmax
21	Total Reactive Power	20	2	LIN3	Pmax	-Pmax
22	Total Apparent Power	21	2	LIN3	Pmax	-Pmax
23	Unbalanced Current	22	2	LIN3	Imax	0
24	Frequency	23	2	LIN3	65.00	45.00
25	Maximum Demand	24	2	LIN3	Pmax	-Pmax
26	Accumulated Maximum Demand	25	2	LIN3	Pmax	-Pmax
27	Maximum Apparent Demand	26	2	LIN3	Pmax	-Pmax
28	Accumulated Apparent Demand	27	2	LIN3	Pmax	-Pmax
29	Ampere Maximum Demand A	28	2	LIN3	Imax	0

No	Parameter	Add-ress	Bytes	Data Conversion Method	HI Scale	LO Scale
30	Ampere Maximum Demand B	29	2	LIN3	Imax	0
31	Ampere Maximum Demand C	30	2	LIN3	Imax	0
32	Consumption KWH	31	2	NONE	9999	0
33	Consumption 10*MWH	32	2	NONE	9999	0
34	Returned Energy KWH	33	2	NONE	9999	0
35	Returned Energy MWH	34	2	NONE	9999	0
36	+Reactive Energy kVARH	35	2	NONE	9999	0
37	+Reactive Energy 10*MVARH	36	2	NONE	9999	0
38	-Reactive Energy kVARH	37	2	NONE	9999	0
39	-Reactive Energy 10*MVARH	38	2	NONE	9999	0

Where:

Vmax = 660V if PT Ratio = 1.0 and Vmax = 144 * PT Ratio if PT Ratio is not 1.0

Imax = 1.2 * CT primary current

Pmax = Imax * Vmax * 3 if wiring configuration is 4L-n

Pmax = Imax * Vmax * 2 if wiring configuration is not 4L-n

NOTE

An attempt to write any values to one or more addresses from 24 to 30 causes reset of all demands: Maximum Demand, Accumulated Maximum Demand, Maximum Apparent Demand, Accumulated Apparent Maximum Demand, Ampere Maximum Demand A, Ampere Maximum Demand B, Ampere Maximum Demand C.

The record of 0 to the addresses 31 or 32 will reset Consumption; the record of 0 to the addresses 33 or 34 will reset Returned Energy; the record of 0 to the addresses 35, 36, 37 or 38 will reset Reactive Energy.

2.5.3 *Setpoint Tables*

Table of Available Setpoints

The following table contains bit flags of available setpoints for the relay.

Bit meaning :

1 Set point exists
0 Set point does not exist

Powermeter Internal Table #2

No.	Setpoints	Address	Number of bytes
1	Relay 1	0	2
2	Relay 2	1	2
3	Relay 3	2	2
4	Relay 4	3	2
5	Analog Output	4	2
6	Pulsing	5	2
7	Configuration	6	2

Format of Available Setpoints for Internal Table #2

No.	Setpoint	Bit Number	Range
1-4	High Voltage	1	0 or 1
1-4	Low Voltage	2	0 or 1
1-4	High Current	3	0 or 1
1-4	High Unbalanced Current	4	0 or 1
1-4	Max Demand	5	0 or 1
1-4	High Reactive Power	6	0 or 1
1-4	High Apparent Power	7	0 or 1
1-4	Low PF.	8	0 or 1
1-4	Reserved	9	0 or 1
1-4	Reserved	10	0 or 1
5	Pulsing kWH	1	0 or 1
5	Pulsing -kWH	2	0 or 1
5	Pulsing kVARH	3	0 or 1
5	Reserved	4	0 or 1
6	Voltage - A	1	0 or 1
6	Voltage - B	2	0 or 1
6	Voltage - C	3	0 or 1
6	Current - A	4	0 or 1
6	Current - B	5	0 or 1
6	Current - C	6	0 or 1

No.	Setpoint	Bit Number	Range
6	Reserved	7	0 or 1
6	Reserved	8	0 or 1
6	Active Power	9	0 or 1
6	Reactive Power	10	0 or 1
6	Apparent Power	11	0 or 1
6	Accumulated Maximum Demand	12	0 or 1
6	Accumulated Apparent Maximum Demand	13	0 or 1
6	Power Factor	14	0 or 1
6	Frequency	15	0 or 1
7	Wiring Configuration	1	0 or 1
7	PT Ratio	2	0 or 1
7	CT Primary Current	3	0 or 1
7	Maximum Demand Period	4	0 or 1
7	Ampere Maximum Demand Period	5	0 or 1
7	Buffer Size	6	0 or 1
7	Reset Enable/Disable	7	0 or 1
7	Reserved	8	0 or 1

Relay Setpoint Tables

Setpoints for Relay 1 - Table Number 3

Setpoints for Relay 2 - Table Number 4

Setpoints for Relay 3 - Table Number 5

Setpoints for Relay 4 - Table Number 6

Powermeter Internal Tables 3 to 6

	Setpoint	Data type	Add-ress	No. of Bytes	Data Conversion Type	HI Scale	LO Scale
1	High Voltage	High Bound	0	2	LIN3	Vmax	0
		High Delay	1	2	None	999 or ①	0
		Low Bound	2	2	Line3	Vmax	0
		Low Delay	3	2	None	999 or ①	0
2	Low Voltage	High Bound	4	2	LIN3	Vmax	0
		High Delay	5	2	None	999 or ①	0
		Low Bound	6	2	Line3	Vmax	0
		Low Delay	7	2	None	999 or ①	0
3	High Current	High Bound	8	2	LIN3	Imax	0
		High Delay	9	2	None	999 or ①	0
		Low Bound	10	2	Line3	Imax	0
		Low Delay	11	2	None	999 or ①	0

	Setpoint	Data type	Add-ress	No. of Bytes	Data Conversion Type	HI Scale	LO Scale
4	High Unbalanced Current	High Bound	12	2	LIN3	Imax	0
		High Delay	13	2	None	999 or ①	0
		Low Bound	14	2	Line3	Imax	0
		Low Delay	15	2	None	999 or ①	0
5	Maximum Demand	High Bound	16	2	LIN3	Pmax	-Pmax
		High Delay	17	2	None	999 or ①	0
		Low Bound	18	2	Line3	Pmax	-Pmax
		Low Delay	19	2	None	999 or ①	0
6	High Reactive Power	High Bound	20	2	LIN3	Pmax	-Pmax
		High Delay	21	2	None	999 or ①	0
		Low Bound	22	2	Line3	Pmax	-Pmax
		Low Delay	23	2	None	999 or ①	0
7	High Apparent Power	High Bound	24	2	LIN3	Pmax	-Pmax
		High Delay	25	2	None	999 or ①	0
		Low Bound	26	2	Line3	Pmax	-Pmax
		Low Delay	27	2	None	999 or ①	0
8	Low Power Factor	High Bound	28	2	LIN3	Pmax	-1.00
		High Delay	29	2	None	999 or ①	0
		Low Bound	30	2	Line3	Pmax	-1.00
		Low Delay	31	2	None	999 or ①	0

① 65535 to suppress

NOTE

Although LO Scale in some setpoints are negative the boundaries must be positive.
A **High Delay** value of 999 corresponds to a delay of 99.9 seconds.
A **Low Delay** value of 999 corresponds to a delay of 999 seconds.
The setpoint will be suppressed while the **High Delay** is suppressed.

Pulsing Setpoints

Powermeter Internal Table #7

No	SETPOINT	ADDRESS	NO OF BYTES	RANGE
1	Pulsing kWH	0	2	1 to 200 or ①
2	Pulsing -kWH	1	2	1 to 200 or ①
3	Pulsing kVARH	2	2	1 to 200 or ①

① 65535 to suppress pulsing

Analog Output Setpoint Table

Powermeter Internal Table #8

No	Setpoint	Address	No. of bytes	Range
1	Voltage - A	0	2	0 to 14 or ①
2	Voltage - B	1	2	0 to 14 or ①
3	Voltage - C	2	2	0 to 14 or ①
4	Current - A	3	2	0 to 14 or ①
5	Current - B	4	2	0 to 14 or ①
6	Current - C	5	2	0 to 14 or ①
7	Reserved	6	2	
8	Reserved	7	2	
9	Active Power	8	2	0 to 14 or ①
10	Reactive Power	9	2	0 to 14 or ①
11	Apparent Power	10	2	0 to 14 or ①
12	Accumulated Maximum Demand	11	2	0 to 14 or ①
13	Accumulated Apparent Maximum Demand	12	2	0 to 14 or ①
14	Power Factor	13	2	0 to 14 or ①
15	Frequency	14	2	0 to 14 or ①

① 65535 to suppress

2.5.4 System Configuration Setpoint

Powermeter Internal Table #9

No	Setpoint	Addr	No. of bytes	Range
1	Wiring Configuration	0	2	0 = 3-wire direct connection 1 = 4-wire line to neutral 2 = 3-wire open delta 3 = 4-wire line to line
2	PT Ratio ①	1	2	1 to 65000
3	CT Primary Current	2	2	1 to 50000
4	Maximum Demand Period	3	2	1,2,5,10,20,30,60 or 255=External synchronization
5	Ampere Maximum Demand Period	4	2	1 to 1800
6	Buffer Size	5	2	8 or 32 ('nor' or 'UnSt')
7	Reset Mode	6	2	0 Enable 1 Disable

① For PT ratio multiply desired value by ten (10).

2.5.5 Powermeter Status Table

Powermeter Internal Table #10

No	Parameter	Address	No. of Bytes	Range
1	State Flags	0	2	0 - 255
2	Keypad Status	1	2	0 - 15
3	Relay Status	2	2	0 - 15
4	DIP Switch 1 and 2	3	2	0 to 65535
5	Dry contacts status	4	2	0 to 255
6	Version Number	5	2	0 to 65000

Normal state of **State Flags** is 0. Writing 65535 to **State Flags** will cause the Powermeter to restart.

Status of the front panel keypad keys:

Bit No.	Key
0	⇧ (Up Arrow)
1	RESET
2	SELECT
3	⇩ (Down Arrow)

Status of the relays:

Bit No.	Relay No.
0	4
1	3
2	2
3	1

('1' = closed, '0' = open)