PM290HD
POWERMETER &
HARMONIC ANALYZER

Communication Protocols
ASCII & Modbus

Reference Guide

PM290HD 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 manual details the protocols, the computer requests and the Powermeter replies.

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

NOTE

Every effort has been made to ensure that the material herein is complete and accurate. However, the manufacturer is not responsible for any mistakes in printing or faulty instructions contained in this book. Notification of any errors or misprints will be received with appreciation.

For further information regarding a particular installation, operation or maintenance of equipment, contact the manufacturer or your local representative or distributor.

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BG0322 Rev. A1

1 ASCII PROTOCOL

All messages conform to the following protocol, designed to consist only of printable characters.

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 following 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 **'006'** 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-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 Common Setpoint Value or Relay Setpoint ON Limit**
'2' - **Change Common Setpoint Value or Relay Setpoint ON Limit**
'3' - **DIP Switch Status Request**
'4' - **Reset all accumulated values to zero**
'5' - **Request of Printer String**
'6' - **Examine Relay Setpoint OFF Limit**
'7' - **Change Setpoint OFF Limit**
'8' - **Program Reset**
'9' - **Get version number**
'H' - **Get Harmonic evaluation parameters**
'W'- **Lock Waveform / Get Waveform Points**
'S' - **Get Real Time Clock**
'T' - **Set Real Time Clock**

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: Two characters **CR** (ASCII 13) and **LF** (ASCII 10) .

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 201 bytes:

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

FIELD	OFFSET (BYTES)	LENGTH (BYTES)	DESCRIPTION	CONFIGURATION
1	0	4	Voltage L1	NNNN, NN.N, NNN.
2	4	4	Voltage L2	
3	8	4	Voltage L2	
4	12	5	Current L1	NNNNN, NN.NN
5	17	5	Current L2	
6	22	5	Current L3	
7	27	6	Power L1	SNNNNN, WNN.NN, WNNN.N, WNNNN.
8	33	6	Power L2	
9	39	6	Power L3	
10	45	4	Power Factor L1	T.NN
11	49	4	Power Factor L2	
12	53	4	Power Factor L3	
13	57	6	Total Active Power	SNNNNN, WNN.NN, WNNN.N, WNNNN.
14	63	4	Total Power Factor	T.NN
15	67	6	Active Energy	0NNNNN, NNN.NN, NNNN.N, NNNNN.
16	73	5	Unbalanced Current	NNNNN NN.NN
17	78	4	Frequency	NN.N
18	82	6	Reactive Power L1	WNN.NN, SNNNNN, WNNN.N, WNNNN.
19	88	6	Reactive Power L2	
20	94	6	Reactive Power L3	
21	100	6	Apparent Power L1	0NNNNN,
22	106	6	Apparent Power L2	NNN.NN, NNNN.N, NNNNN.
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.
27	136	6	Active Power Maximum Demand	0NNNNN, NNN.NN, NNNN.N, NNNNN.

FIELD	OFFSET (BYTES)	LENGTH (BYTES)	DESCRIPTION	CONFIGURATION
28	142	6	Accumulated Active Power Maximum Demand	0NNNNN, NNN.NN, NNNN.N, NNNNN.
29	148	5	Ampere Maximum Demand L1	0NNNN NN.NN
30	153	5	Ampere Maximum Demand L2	0NNNN NN.NN
31	158	5	Ampere Maximum Demand L3	0NNNN NN.NN
32	163	2	Contact Status for 290H/B Only	HH
33	165	6	Returned Energy	-0NNNN, -NN.NN -NNN.N -NNNN.
34	171	6	Apparent Power Maximum Demand	0NNNNN, NNN.NN, NNNN.N, NNNNN.
35	177	4	%THD of Voltage phase L1 or L12	NN.N
36	181	4	%THD of Voltage phase L2 or L23	NN.N
37	185	4	%THD of Voltage phase L3	NN.N
38	189	4	%THD of Current phase L1	NN.N
39	193	4	%THD of Current phase L2	NN.N
40	197	4	%THD of Current phase L3	NN.N

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 Common Setpoint or Relay Setpoint ON Limit

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 - Setpoint delay in 'NN.N' format (length 4 bytes); will be '////' when the setpoint is suppressed

Sub field #4 - Setpoint 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 ... NNNNNN
Low Voltage	1...4	2	0 to V max	N ... NNNNNN
High Current	1...4	3	0 to I max	N ... NNNNN
High Accumulated Active Power Maximum Demand	1...4	4	0 to P max	N ... NNNNNN
Low Power Factor	1...4	5	0 to 1.00	N.NN
Unbalanced Current	1...4	6	0 to I max	N ... NNNNN
High Reactive Power	1...4	8	0 to P max	N ... NNNNNN
High THD	1...4	16	0 to 100	N ... NNN
High Apparent Power	1...4	9	0 to P max	N ... NNNNNN
+kWH Pulsing	1	7	1 to 200	N ... NNN
kVARH Pulsing	2	10	1 to 200	N ... NNN
kWH- Pulsing	4	18	1 to 200	N ... NNN

SETPOINT NAME	Sub field #1	Sub Field #2 (Setpoint #)	Sub Field #4 (Limit)	Description
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
Power Maximum Demand Period	D	11	1,2,5,10,15, 20, 30,60 or 255 for/ext. sync	N ... NNN
Ampere Maximum Demand Period	C	12	1 to 1800	N ... NNNN
Buffer Mode	S	41	8 or 32	N, NN
Reset Enable/ Disable	R	42	0 (enable) 1 (disable)	N
Printer Period	P	13	1,2,5,10,15, 20, 30,60	N, NN
SETPOINTS FOR ANALOG OUTPUT				
Voltage L1	A	21	136	NNN
Voltage L2	A	22	136	NNN
Voltage L3	A	23	136	NNN
Current L1	A	24	136	NNN
Current L2	A	25	136	NNN
Current L3	A	26	136	NNN
Apparent Power	A	27	136	NNN
Power Factor	A	28	136	NNN
Reactive Power	A	29	136	NNN
Active Power	A	30	136	NNN
Accumulated Active Power Demand	A	31	136	NNN
Frequency	A	34	136	NNN
SETPOINTS FOR ANALOG EXPANDER (OPTIONAL)				
Voltage L1	E	21	0-14(CHAN.#)	NN
Voltage L2	E	22	0-14(CHAN.#)	NN
Voltage L3	E	23	0-14(CHAN.#)	NN
Current L1	E	24	0-14(CHAN.#)	NN
Current L2	E	25	0-14(CHAN.#)	NN
Current L3	E	26	0-14(CHAN.#)	NN
Apparent Power	E	27	0-14(CHAN.#)	NN
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 Active Power Maximum Demand	E	31	0-14(CHAN.#)	NN
Frequency	E	34	0-14(CHAN.#)	NN

NOTES

1. Two analog output setpoints 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 provides 7 analog channels. Two AX-7 Analog Expanders can be connected together in order to provide 14 analog channels.
2. Setpoints #7, #10 and #18 are not compatible with all other setpoints; i.e., if setpoint #7, #10 or #18 is enabled, all other setpoints at the relevant relay will be suppressed automatically.
3. 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.
4. Setpoints #11, #12, #13, #14, #17, #40, #41 and #42 cannot be suppressed.

1.4 Change Common Setpoint or Relay Setpoint ON Limit

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 - Setpoint delay in 'NN.N' format (length 4 bytes).
To suppress this setpoint, this field should be filled with '////'
Sub field #4 - Setpoint 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): **'XXXXNXXX'**
where **X** - Don't care
N - DIP Switch Block Status in ASCII hexadecimal.
Bits meaning: '1' = on, '0' = off.

Sub field #2 - Status of keypad in ASCII hexadecimal (1 byte); keys are arranged as follows:
Up Key - bit #0
Reset Key - bit #1
Select Key - bit #2
Down Key - bit #3
Bits meaning: '1' = key is pressed, '0' = key is not pressed.

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

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

Bits meaning: '0' = closed, '1' = 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, Ampere Maximum Demand, Apparent Power Maximum 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 Relay Setpoint OFF Limit

HOST REQUEST
Message Type - '**6**'
Message Body - the same as in the request '1' in Section 1.3.

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 - Relay setpoint OFF delay in 'NNN.' format (length 4 bytes)
Will be '////' when the setpoint or OFF Limit is suppressed
Sub field #4 - Relay setpoint OFF limit (length 1 to 7 bytes)

1.9 Change Relay Setpoint OFF Limit

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 - Relay setpoint OFF delay in 'NNN.' format (length 4 bytes).
To suppress this setpoint, this field should be filled with '////'
Sub field #4 - Relay setpoint OFF limit (length 1 to 7 bytes)

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

1.10 Reset Powermeter

HOST REQUEST
Message Type - '**8**'
Message Body - none

REPLY - none

1.11 Get Version Number

HOST REQUEST
Message Type - '**9**'
Message Body - none

REPLY
Message type - '**9**'
Message Body: 'XXX' where **'XXX'** is the version number.

1.12 Get Harmonic Evaluation Parameters

HOST REQUEST
Message Type - '**H**'
Message Body -

Sub field #1

Sub field #1 - channel number (length - 1 byte):
'1' - Voltage phase L1 or L12
'2' - Voltage phase L2 or L23
'3' - Voltage phase L3
'4' - Current phase L1
'5' - Current phase L2
'6' - Current phase L3

REPLY
Message Body - String of 170 bytes:

Table 1-3 Reply to Host Request Type 'H'

FIELD	OFFSET (BYTES)	LENGTH (BYTES)	DESCRIPTION	CONFIGU-RATION
1	0	5	Corresponding RMS value (voltage or current)	NNNNN, NNN.N
2	5	5	Fundamental Frequency	NN.NN
3	10	5	%THD	NNN.N
4	15	5	Reference magnitude of 1st harmonic (100.0%)	NNN.N

FIELD	OFFSET (BYTES)	LENGTH (BYTES)	DESCRIPTION	CONFIGU-RATION
5	20	5	Magnitude of 2nd harmonic	NN.NN, NNN.N
6	25	5	Magnitude of 3rd harmonic	NN.NN, NNN.N
7	30	5	Magnitude of 4th harmonic	NN.NN, NNN.N
8	35	5	Magnitude of 5th harmonic	NN.NN, NNN.N
9	40	5	Magnitude of 6th harmonic	NN.NN, NNN.N
10	45	5	Magnitude of 7th harmonic	NN.NN, NNN.N
11	50	5	Magnitude of 8th harmonic	NN.NN, NNN.N
12	55	5	Magnitude of 9th harmonic	NN.NN, NNN.N
13	60	5	Magnitude of 10th harmonic	NN.NN, NNN.N
14	65	5	Magnitude of 11th harmonic	NN.NN, NNN.N
15	70	5	Magnitude of 12th harmonic	NN.NN, NNN.N
16	75	5	Magnitude of 13th harmonic	NN.NN, NNN.N
17	80	5	Magnitude of 14th harmonic	NN.NN, NNN.N
18	85	5	Magnitude of 15th harmonic	NN.NN, NNN.N
19	90	5	Magnitude of 16th harmonic	NN.NN, NNN.N
20	95	5	Magnitude of 17th harmonic	NN.NN, NNN.N
21	100	5	Magnitude of 18th harmonic	NN.NN, NNN.N
22	105	5	Magnitude of 19th harmonic	NN.NN, NNN.N
23	110	5	Magnitude of 20th harmonic	NN.NN, NNN.N
24	115	5	Magnitude of 21st harmonic	NN.NN, NNN.N
25	120	5	Magnitude of 22nd harmonic	NN.NN, NNN.N
26	125	5	Magnitude of 23rd harmonic	NN.NN, NNN.N
27	134	4	Magnitude of 24th harmonic	NN.NN, NNN.N
28	135	5	Magnitude of 25th harmonic	NN.NN, NNN.N
29	140	5	Magnitude of 26th harmonic	NN.NN, NNN.N
30	145	5	Magnitude of 27th harmonic	NN.NN, NNN.N

FIELD	**OFFSET (BYTES)**	**LENGTH (BYTES)**	**DESCRIPTION**	**CONFIGU-RATION**
31	150	5	Magnitude of 28th harmonic	NN.NN, NNN.N
32	155	5	Magnitude of 29th harmonic	NN.NN, NNN.N
33	160	5	Magnitude of 30th harmonic	NN.NN, NNN.N
34	165	5	Magnitude of 31st harmonic	NN.NN, NNN.N

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

1.13 Lock Waveform / Get Waveform Points

HOST REQUEST
Message Type - 'W'
Message Body -

Sub field #1	Sub field #2

Sub field #1 - channel number (length - 1 byte):
'1' - Voltage phase L1 or L12
'2' - Voltage phase L2 or L23
'3' - Voltage phase L3
'4' - Current phase L1
'5' - Current phase L2
'6' - Current phase L3

Sub field #2 - function number (length - 1 byte):
'0' - Lock waveform and get waveform capture parameters;
'1' ... '8' - Get N-th waveform half cycle's points (N = 1 ... 8).

REPLY to function 0:
Message Body - String of 29 bytes:

Table 1-4 Reply to Host Request 'W0'

FIELD	OFFSET (BYTES)	LENGTH (BYTES)	DESCRIPTION	CONFIGU-RATION
1	0	2	Capture code	NN
2	2	2	Second	NN
3	4	2	Minute	NN
4	6	2	Hour	NN
5	8	2	Day	NN
6	10	2	Month	NN
7	12	2	Year	NN
8	14	5	Corresponding RMS value (voltage or current)	NNNNN, NNN.N
9	19	5	Fundamental Frequency	NN.NN
10	24	5	%THD	NNN.N

REPLY to functions 1 ... 8:

Message Body - String of 192 bytes:

Table 1-5 Reply to Host Requests 'W1' ... 'W8'

FIELD	OFFSET (BYTES)	LENGTH (BYTES)	DESCRIPTION	CONFIGURATION
1	0	3	Waveform half cycle's point 1	NNN
2	2	3	Waveform half cycle's point 2	NNN
...	...	...	...	...
64	61	3	Waveform half cycle's point 64	NNN

NOTES

1. To get waveform, you should first lock the corresponding waveform by using the function '0'. Then, you may get 8 half cycles of the corresponding waveform.
2. Every waveform point is represented by three hexadecimal digits in ASCII format. Waveform point range is from 0 to 1023.

1.14 Get Real Time Clock Request

HOST REQUEST
Message Type - '**S**'
Message Body - none

REPLY
Message Body - String of 12 bytes:

Table 1-6 Reply to Host Request Type 'S'

FIELD	OFFSET (BYTES)	LENGTH (BYTES)	DESCRIPTION	CONFIGURATION
1	0	2	Second	NN
2	2	2	Minute	NN
3	4	2	Hour	NN
4	6	2	Day	NN
5	8	2	Month	NN
6	10	2	Year	NN

1.15 Set Real Time Clock

HOST REQUEST
Message Type - '**T**'
Message Body - string of 6 sub fields:

Table 1-7 Message Body of Host Request Type 'T'

SUB FIELD	OFFSET (BYTES)	LENGTH (BYTES)	DESCRIPTION	CONFIGURATION
1	0	2	Second	NN
2	2	2	Minute	NN
3	4	2	Hour	NN
4	6	2	Day	NN
5	8	2	Month	NN
6	10	2	Year	NN

REPLY
Message Body - the same as in the host request.

1.16 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 setpoint value or setpoint is not available

'XM' Invalid request type

NOTE When check error or framing error is detected, the Powermeter will not act on or respond to the master's request.

2 MODBUS PROTOCOL

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: the Powermeter processes only one query and does not receive a new query while the previous response is being transmitted.

2.1 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.

2.2 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	

2.2.1 Address Field

The address field contains a user assigned address (1-247) of the Powermeter that is to receive a 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.

2.2.2 Function Field

The function field contains a function code that tells the Powermeter what action to perform. Function codes used in the protocol are shown in **Table 2-1**.

Table 2-1 Function Codes Used in PC - Powermeter Protocol

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

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

2.2.3 *Data Field*

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

2.2.4 *Error Check Field*

The error check field contains the result of the 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 the 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.

2.3 Detailed Command Description

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 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 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 byte

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 the 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 byte

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

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.

LOOPBACK 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 communications 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)	Diagnostic . Code (0)	Data	Error Check
1 byte	1 byte	2 bytes	2 bytes	2 bytes

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 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

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 byte

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

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 byte

Sub Request Format

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

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 POWERMETER (Function Code 21)

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

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.

EXCEPTION RESPONSES

The Powermeter 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. Format of exception response:

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

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 #3 to #9).

NOTE

When the character framing, parity, or redundancy check detect a communication error, processing of the master's request stops. The Powermeter will not act on or respond to the message.

2.4 Powermeter Internal Data Tables

2.4.1 Data Conversion

There are 11 methods of data conversion in the MODBUS protocol. In the Powermeter's subset of MODBUS communication protocol, data conversion is accomplished in the master computer by one of the following methods:

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

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 Power Meter, the conversion is carried out in reverse to produce the written value:
Y = 9999 * (X - LO) / (HI - LO)

To define data conversion it is necessary to define **HI Scale**, **LO Scale** and **Conversion Method** Any range between 0.01 and 99,999.00 can be entered in the HI and LO scales.

2.4.2 Measured Data Table

Table 2-2 Powermeter Internal Table #1

No.	Parameter	Add-ress	Bytes	Data Conversion	Units	HI Scale	LO Scale
1	Voltage L1	0	2	LIN3	V	Vmax	0
2	Voltage L2	1	2	LIN3	V	Vmax	0
3	Voltage L3	2	2	LIN3	V	Vmax	0
4	Current L1	3	2	LIN3	A	Imax	0
5	Current L2	4	2	LIN3	A	Imax	0
6	Current L3	5	2	LIN3	A	Imax	0
7	Power L1	6	2	LIN3	W	Pmax	-Pmax
8	Power L2	7	2	LIN3	W	Pmax	-Pmax
9	Power L3	8	2	LIN3	W	Pmax	-Pmax
10	Reactive Power L1	9	2	LIN3	VAR	Pmax	-Pmax
11	Reactive Power L2	10	2	LIN3	VAR	Pmax	-Pmax
12	Reactive Power L3	11	2	LIN3	VAR	Pmax	-Pmax
13	Apparent Power L1	12	2	LIN3	VA	Pmax	-Pmax
14	Apparent Power L2	13	2	LIN3	VA	Pmax	-Pmax
15	Apparent Power L3	14	2	LIN3	VA	Pmax	-Pmax
16	Power factor L1	15	2	LIN3		1.00	-1.00
17	Power factor L2	16	2	LIN3		1.00	-1.00
18	Power factor L3	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	W	Pmax	-Pmax
21	Total Reactive Power	20	2	LIN3	VAR	Pmax	-Pmax
22	Total Apparent Power	21	2	LIN3	VA	Pmax	-Pmax
23	Unbalanced Current	22	2	LIN3	A	Imax	0
24	Frequency	23	2	LIN3	Hz	65.00	45.00
25	Maximum Demand	24	2	LIN3	W	Pmax	-Pmax
26	Accumulated Maximum Demand	25	2	LIN3	W	Pmax	-Pmax
27	Maximum Apparent Demand	26	2	LIN3	VA	Pmax	-Pmax
28	Accumulated Apparent Demand	27	2	LIN3	VA	Pmax	-Pmax
29	Ampere Maximum Demand L1	28	2	LIN3	A	Imax	0
30	Ampere Maximum Demand L2	29	2	LIN3	A	Imax	0
31	Ampere Maximum Demand L3	30	2	LIN3	A	Imax	0
32	Consumption	31	2	NONE	kWH	9999	0
33	Consumption	32	2	NONE	10*MWH	9999	0
34	Returned Energy	33	2	NONE	kWH	9999	0
35	Returned Energy	34	2	NONE	10*MWH	9999	0
36	+Reactive Energy	35	2	NONE	kVARH	9999	0
37	+Reactive Energy	36	2	NONE	10* MVARH	9999	0
38	-Reactive Energy	37	2	NONE	kVARH	9999	0
39	-Reactive Energy	38	2	NONE	10* MVARH	9999	0
40	%THD Voltage phase L1 or L12	39	2	LIN3	%	100.0	0
41	%THD Voltage phase L2 or L23	40	2	LIN3	%	100.0	0
42	%THD Voltage phase L3	41	2	LIN3	%	100.0	0
43	%THD Current phase L1	42	2	LIN3	%	100.0	0

No.	Parameter	Add-ress	Bytes	Data Conversion	Units	HI Scale	LO Scale
44	%THD Current phase L2	43	2	LIN3	%	100.0	0
45	%THD Current phase L3	44	2	LIN3	%	100.0	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

NOTES

1. An attempt to write any values to one or more addresses 24 to 30 causes reset of all demands: Maximum Demand, Accumulated Maximum Demand, Maximum Apparent Demand, Accumulated Apparent Maximum Demand, Ampere Maximum Demand L1, Ampere Maximum Demand L2, Ampere Maximum Demand L3.
2. 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.

2.4.3 Setpoint Tables

Table of Available Setpoints
The table contains bit flags of available setpoints for relay.
Bit meaning:
- **1** Setpoint exists
- **0** Setpoint does not exist

Table 2-3 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	Pulsing	4	2
6	Analog Output	5	2
7	Configuration	6	2

Table 2-4 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	High Accumulated Active Power Maximum 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 Power Factor	8	0 or 1
1-4	High THD	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

No	Setpoint	Bit Number	Range
5	Pulsing kVARH	3	0 or 1
5	Reserved	4	0 or 1
6	Voltage - L1	1	0 or 1
6	Voltage - L2	2	0 or 1
6	Voltage - L3	3	0 or 1
6	Current - L1	4	0 or 1
6	Current - L2	5	0 or 1
6	Current - L3	6	0 or 1
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 Active Power Maximum Demand	12	0 or 1
6	Reserved	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	Power 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

Table 2-5 Powermeter Internal Tables 3 to 6

	Setpoint	Data type	Add-ress	No. of Bytes	Data Conversion	HI Scale	LO Scale
1	High Voltage	ON Limit	0	2	LIN3	Vmax	0
		ON Delay	1	2	None	999 or ①	0
		OFF Limit	2	2	LIN3	Vmax	0
		OFF Delay	3	2	None	999 or ①	0
2	Low Voltage	ON Limit	4	2	LIN3	Vmax	0
		ON Delay	5	2	None	999 or ①	0
		OFF Limit	6	2	LIN3	Vmax	0
		OFF Delay	7	2	None	999 or ①	0
3	High Current	ON Limit	8	2	LIN3	Imax	0
		ON Delay	9	2	None	999 or ①	0
		OFF Limit	10	2	LIN3	Imax	0
		OFF Delay	11	2	None	999 or ①	0
4	High Unbalanced Current	ON Limit	12	2	LIN3	Imax	0
		ON Delay	13	2	None	999 or ①	0
		OFF Limit	14	2	LIN3	Imax	0

	Setpoint	Data type	Add-ress	No. of Bytes	Data Conversion	HI Scale	LO Scale
		OFF Delay	15	2	None	999 or ①	0
5	High Accum-ulated Power Maximum Demand	ON Limit	16	2	LIN3	Pmax	-Pmax
		ON Delay	17	2	None	999 or ①	0
		OFF Limit	18	2	LIN3	Pmax	-Pmax
		OFF Delay	19	2	None	999 or ①	0
6	High Reactive Power	ON Limit	20	2	LIN3	Pmax	-Pmax
		ON Delay	21	2	None	999 or ①	0
		OFF Limit	22	2	LIN3	Pmax	-Pmax
		OFF Delay	23	2	None	999 or ①	0
7	High Apparent Power	ON Limit	24	2	LIN3	Pmax	-Pmax
		ON Delay	25	2	None	999 or ①	0
		OFF Limit	26	2	LIN3	Pmax	-Pmax
		OFF Delay	27	2	None	999 or ①	0
8	Low Power Factor	ON Limit	28	2	LIN3	1.00	-1.00
		ON Delay	29	2	None	999 or ①	0
		OFF Limit	30	2	LIN3	1.00	-1.00
		OFF Delay	31	2	None	999 or ①	0
9	High THD	ON Limit	32	2	LIN3	100	0
		ON Delay	33	2	None	999 or ①	0
		OFF Limit	34	2	LIN3	100	0
		OFF Delay	35	2	None	999 or ①	0

① 65535 to suppress

NOTES

1. Although LO Scale in some setpoints is negative the boundaries must be positive.
2. In **ON Delay,** value 999 corresponds to delay 99.9 seconds.
3. In **Low Delay,** value 999 corresponds to delay 999 seconds.
4. The Setpoint will be suppressed while **ON Delay** is suppressed.
5. If any Pulsing Setpoint is assigned to relay, an attempt to assign another setpoint to the relay will result in exception response until pulsing is suppressed.

Pulsing Relay Setpoints

Table 2-6 Powermeter Internal Table #7

No	SET-POINT	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

Table 2-7 Powermeter Internal Table #8

No	Setpoint	Address	No. of bytes	Range
1	Voltage - L1	0	2	0 to 14 or ①
2	Voltage - L2	1	2	0 to 14 or ①
3	Voltage - L3	2	2	0 to 14 or ①
4	Current - L1	3	2	0 to 14 or ①
5	Current - L2	4	2	0 to 14 or ①
6	Current - L3	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 Active Power Maximum Demand	11	2	0 to 14 or ①
13	Reserved	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

2.4.4 System Configuration Setpoint

Table 2-8 Powermeter Internal Table #9

No	Setpoint	Add-ress	No. of bytes	Range
1	Wiring Configuration	0	2	0 = 3-wire open delta 1 = 4-wire line to neutral 2 = 3-wire direct connection 3 = 4-wire line to line
2	PT Ratio ①	1	2	10 to 65000
3	CT Primary Current	2	2	1 to 50000
4	Power 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 Disable 1 Enable

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

2.4.5 Powermeter Status Table

Table 2-9 Powermeter Internal Table #10

No	Parameter	Address	No. of Bytes	Significant bits	Range (hexadecimal)
1	State Flags	0	2	0-15	0000-FFFF
2	Keypad Status	1	2	0-3	00F0-00FF
3	Relay Status	2	2	4-7	000F-00FF
4	DIP Switch	3	2	4-7	0000-00F0
5	Dry contacts status	4	2	0-7	0000-00FF
6	Version Number	5	2	0-15	0000-FFFF

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

The status of the front panel keypad keys:

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

Bit meaning: '1' = key is pressed; '0' = key is released.

Status of the relays:

Bit No.	Relay No.
4	4
5	3
6	2
7	1

Bit meaning: '0' = closed, '1' = open.

2.4.6 Harmonic Evaluation Tables

Parameters for Voltage L1 or L12 channel - Table Number 11
Parameters for Voltage L2 or L23 channel - Table Number 12
Parameters for Voltage L3 channel - Table Number 13
Parameters for Current L1 channel - Table Number 14
Parameters for Current L2 channel - Table Number 15
Parameters for Current L3 channel - Table Number 16

Note that all the Harmonic Evaluation Registers are read only. An attempt to write a value to any register will result in an exception response.

Table 2-10 Powermeter Internal Tables #11 to #16

No	Parameter	Address	Bytes	Data Conversion	HI Scale	LO Scale
1	Voltage or current on the corresponding phase (V or A, RMS)	0	2	LIN3	Vmax or Imax	0
2	Fundamental frequency (Hz)	1	2	LIN3	100.0	0
3	%THD	2	2	LIN3	100.0	0
4	Reference magnitude of 1st harmonic (100.00%)	3	2	LIN3	100.0	0
5	Magnitude of 2nd harmonic	4	2	LIN3	100.0	0
6	Magnitude of 3rd harmonic	5	2	LIN3	100.0	0
7	Magnitude of 4th harmonic	6	2	LIN3	100.0	0
8	Magnitude of 5th harmonic	7	2	LIN3	100.0	0
9	Magnitude of 6th harmonic	8	2	LIN3	100.0	0
10	Magnitude of 7th harmonic	9	2	LIN3	100.0	0
11	Magnitude of 8th harmonic	10	2	LIN3	100.0	0
12	Magnitude of 9th harmonic	11	2	LIN3	100.0	0
13	Magnitude of 10th harmonic	12	2	LIN3	100.0	0
14	Magnitude of 11th harmonic	13	2	LIN3	100.0	0
15	Magnitude of 12th harmonic	14	2	LIN3	100.0	0
16	Magnitude of 13th harmonic	15	2	LIN3	100.0	0
17	Magnitude of 14th harmonic	16	2	LIN3	100.0	0

No	Parameter	Add-ress	Bytes	Data Conversion	HI Scale	LO Scale
18	Magnitude of 15th harmonic	17	2	LIN3	100.0	0
19	Magnitude of 16th harmonic	18	2	LIN3	100.0	0
20	Magnitude of 17th harmonic	19	2	LIN3	100.0	0
21	Magnitude of 18th harmonic	20	2	LIN3	100.0	0
22	Magnitude of 19th harmonic	21	2	LIN3	100.0	0
23	Magnitude of 20th harmonic	22	2	LIN3	100.0	0
24	Magnitude of 21st harmonic	23	2	LIN3	100.0	0
25	Magnitude of 22nd harmonic	24	2	LIN3	100.0	0
26	Magnitude of 23rd harmonic	25	2	LIN3	100.0	0
27	Magnitude of 24th harmonic	26	2	LIN3	100.0	0
28	Magnitude of 25th harmonic	27	2	LIN3	100.0	0
29	Magnitude of 26th harmonic	28	2	LIN3	100.0	0
30	Magnitude of 27th harmonic	29	2	LIN3	100.0	0
31	Magnitude of 28th harmonic	30	2	LIN3	100.0	0
32	Magnitude of 29th harmonic	31	2	LIN3	100.0	0
33	Magnitude of 30th harmonic	32	2	LIN3	100.0	0
34	Magnitude of 31st harmonic	33	2	LIN3	100.0	0

2.4.7 Real Time Clock Table

Table 2-11 Powermeter Internal Table #17

No	Parameter	Addr	Bytes	Data Conversion Method	HI Scale	LO Scale
1	Seconds	0	2	NONE	59	0
2	Minutes	1	2	NONE	59	0
3	Hour	2	2	NONE	23	0
4	Day of month	3	2	NONE	31	1
5	Month	4	2	NONE	12	1
6	Year	5	2	NONE	99	0

NOTE
All Real Time Clock registers are both read and write. Writing the corresponding value to any register will set the respective value in the instrument's Real Time Clock.

2.4.8 Waveform tables

Waveform capture parameter tables:

Parameters for Voltage L1 or L12 channel - Table Number 18
Parameters for Voltage L2 or L23 channel - Table Number 19
Parameters for Voltage L3 channel - Table Number 20
Parameters for Current L1 channel - Table Number 21
Parameters for Current L2 channel - Table Number 22
Parameters for Current L3 channel - Table Number 23

Waveform points tables :

points 1 ... 256 - Table Number 25
points 257 ... 512 - Table Number 26

Note that all the tables are read only. An attempt to write a value to any register will result in an exception response.

To get the waveform, you should first read capture parameters from one of tables #18 to #23. This will lock the corresponding waveform in the instrument's communication buffer. Then, you may read the waveform points from tables #24 and #25. Note than you may not read more than 125 registers by one request.

Table 2-12 Powermeter Internal Tables #18 to #23

No	Parameter	Add-ress	Bytes	Data Conversion Method	HI Scale	LO Scale
1	Capture code	0	2	NONE	0	0
2	Second	1	2	NONE	59	0
3	Minute	2	2	NONE	59	0
4	Hour	3	2	NONE	23	0
5	Day of month	4	2	NONE	31	1
6	Month	5	2	NONE	12	1
7	Year	6	2	NONE	99	0
8	Voltage or Current on the corresponding phase (V or A, RMS)	7	2	LIN3	Vmax or Imax	0
9	Fundamental frequency (Hz)	8	2	LIN3	100.0	0
10	%THD	9	2	LIN3	100.0	0

Table 2-13 Powermeter Internal Table #24

No	Parameter	Add-ress	Bytes	Data Conversion Method	HI Scale	LO Scale
1	Waveform point 1	0	2	NONE	1023	0
2	Waveform point 2	1	2	NONE	1023	0
...	...	...	...	...	...	...
256	Waveform point 256	255	2	NONE	1023	0

Table 2-14 Powermeter Internal Table #25

No	Parameter	Add-ress	Bytes	Data Conversion Method	HI Scale	LO Scale
1	Waveform point 257	0	2	NONE	1023	0
2	Waveform point 258	1	2	NONE	1023	0
...	...	...	...	...	...	...
256	Waveform point 512	255	2	NONE	1023	0

3 Notes for Communication Programmers

When programming serial communication, you must take into account the response time of your instrument.

To let the master PC switch a communication port, it is guarantied that Powermeter's minimum response time will not be less than 1,75 character time depending on the baud rate used.

The maximum response time depends on the communication protocol you apply. If you do not use the AX-7 analog expander option, then in the ASCII mode, the Powermeter's response time will not exceed 80 ms plus 1.75 character time. In the MODBUS mode, you need to add to this value additional 1.75 character time.

When using the AX-7 Analog Expander option, the communication link works in full duplex mode, and is shared between the master PC and AX-7. This means that master's request is received when AX-7 communication is in progress and will wait till it is completed. From this point, the response time will be increased by the time required for analog message transmission via communication link and by the time that is used by the AX-7 to switch the link.

The communication link switching time is about 15 ms plus 1.75 character time. The transmission of the analog output message for one AX-7's channel takes 9 character time, and for all 14 analog channels - it will take 126 character time, in accordance with the baud rate. In the worst case, you need to add to the instrument's own response time the full AX-7's message transmission time, plus double communication link switching time.