SYSTEM 290HD POWERMETER

PM290HD

ABB SPA-bus Communications Protocol

USER'S GUIDE

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1 GENERAL

This document specifies a subset of the ABB SPA-bus serial communications protocol used to transfer data between a master station and the *PM290HD*. The document provides the complete information necessary to develop a third-party communications software capable to communicate with the *Series 290HD* Powermeters.

Table 1-1 lists communications parameters that should be set up in the instrument in the SPA-bus communications mode. For information on how to configure setup parameters via the front panel, refer to your *PM290HD User's Guide*.

Additional information concerning communications operation, configuring the communications parameters and communications connections is found in the *PM290HD User's Guide*.

IMPORTANT

◆ The voltage parameters throughout the protocol can represent line-to-neutral or line-to-line voltages depending on the wiring mode selected in the Powermeter. When a 4L-N wiring mode is selected, they will be line-to-neutral voltages, and when another mode is selected, they will be line-to-line voltages. In all grounded connections using either 4L-N or 4L-L wiring mode, voltage harmonics and captured waveforms will represent line-to-neutral voltages. In a 3-wire direct connection, voltage harmonics and captured waveforms will represent line-to-neutral voltages that arise on the Powermeter's input transformers. In a 3-wire open delta connection, voltage harmonics and captured waveforms will comprise L12 and L23 line-to-line voltages.

◆ In 3-wire connection schemes, the individual phase values for power factor, active power, apparent power and reactive power will be zeros, because they have no meaning. The only total three-phase power values can be used.

Table 1-1 SPA-bus communications parameters

Label	*Parameter Name*	*Range/ options*	*Description*
br.	Baud rate and data format	*7E/9600*	7 bit, even parity, 9600 bps
		7E/4800	7 bit, even parity, 4800 bps
		7E/2400	7 bit, even parity, 2400 bps
		7E/1200	7 bit, even parity, 1200 bps
		7E/600	7 bit, even parity, 600 bps
		7E/300	7 bit, even parity, 300 bps
		7E/110	7 bit, even parity, 110 bps
Add.	Address	*1 to 255*	Communication address
H.Sh.	Handshaking ①	*SOFt*	Software flow control (XON/XOFF protocol). The DTR/RTS signal permanently asserted
		rtS/SOFt	Software flow control (XON/XOFF protocol). The DTR/RTS signal asserted during transmission
		HArd	Hardware flow control (CTS protocol). The DTR/RTS signal permanently asserted
		rtS/HArd	Hardware flow control (CTS protocol). The DTR/RTS signal asserted during transmission
CoP.	Communications protocol and interface	*SPA/232*	SPA-bus protocol/RS-232
		SPA/422	SPA-bus protocol/RS-422
		SPA/485	SPA-bus protocol/RS-485

① In the SPA-bus mode, software handshaking is not applicable. Choose software handshaking to disable flow control.

The DTR/RTS control line operates independently of the flow control protocol. With the RTS option selected, the PM290HD asserts the DTR/RTS line high at least 5 ms before the response message is sent out, and holds it asserted throughout the transmission. If the RTS option is not selected, the DTR/RTS line is permanently asserted high. Note that the DTR/RTS signal has an RS-232 bipolar logic level.

2 PM290HD/SPA-BUS FRAMING

2.1 Message Frames

Mode of Transmission

All messages within the SPA-bus communications protocol are designed to consist only of printable characters. The maximum message length is 255 characters.

The mode of transmission is 7 data bit with even parity check bit.

Message format

The master message frame has the following format:

>nTeXm/m:dddd/dddd/dddd:CCcr

where

>nTeXm/m		***= master header:***
	>	= master start synchronization character
	n	= slave number (address)
	T	= message type code
	e	= channel number (e=0 or can be omitted)
	X	= data type
	m	= data number
	m/m	= first/last data numbers for multiple data
dddd/...		= data part (optional)
CC		= checksum
cr		= master stop synchronization character (carriage return 0Dh)
:		= header and data part delimiter

The slave message frame has the following format:

lf<nT:dddd/dddd/dddd:CCcrlf

where

lf<*nT*		***= slave header:***
	lf<	= slave start synchronization characters (lf = line feed 0Ah)
	n	= slave (number) address
	T	= message type code
dddd/...		= data part (optional)
CC		= checksum
crlf		= slave stop characters (carriage return 0Dh and line feed 0Ah)
:		= header and data part delimiter

Synchronization Characters

The master messages are started with a single character “>“ (ASCII 62) and ended with a single character “cr” (ASCII 13).

The slave message starts with two characters “lf<“ (ASCII 10, ASCII 60) and ends with two characters “crlf” (ASCII 13, ASCII 10).

Slave Number

The slave number is given in decimal format as 1...255. It may contain from one to three digits (no nonsignificant leading zeros).

The slave number of 900 is used as the broadcast address. *The only data category for which the broadcast mode is supported by the PM290HD is the ‘D’ category - the date and time update. The instrument takes an action on this request, but will not respond to the message.*

Message Type

A single-letter code is used for designating the message type as follows:

Master messages

R = read
W = write

Slave messages

D = data
A = acknowledgment (ACK)
N = negative acknowledgment (NAK)

Channel Number

The channel number can be given in decimal format as 0 or omitted. *All the data in the PM290HD is available in channel 0.*

Data Category

A single-letter character is used to designate the logical data type as follows:

I = input data
O = output data
S = setting values
V = internal variables
C = slave status
F = slave identification
D = date and time

Data Number

The data number is given in decimal format as 1...999999. A string of several contiguous data items can be addressed by issuing the first and last item numbers separated by a slash character.

The data number field can be omitted. In this event, the request is assumed to address all contiguous data of the data category.

Data Part

The data part includes slave data items separated by a slash character "/". The last data is followed by character ":".

Data items can have numerical or character (text) format. Data items represented in numerical format are given in ASCII decimal or hexadecimal notation.

In decimal notation, a data item can contain a decimal point. Positive numbers are given without a sign, and negative numbers are preceded by a "-" character. No leading or trailing zeros are allowed.

In the *PM290HD/SPA-BUS* data map (see *Chapter 3*), the data format is designated by a "D" for decimal data (when a data item can contain a decimal point, a "D" character is followed by a dot and a one-digit letter showing the number of allowable decimal places after a point), by an "H" - for hexadecimal data, and by a "C" - for character data.

Redundancy Check

The message checksum is an 8-bit binary number represented and transmitted as two ASCII hexadecimal characters (0-9, A-F). The checksum is produced by XORing the message bytes. Excluded from the checksum are the checksum field itself and characters "cr" and "lf".

In the PM290HD messages, the checksum will be always present, while the master can omit the checksum by replacing it with two letters "XX".

At the received end, the checksum is calculated and compared to the sent checksum. W*hen the redundancy check error is detected, the PM290HD will not act on or respond to the message.*

2.2 Interchange Protocols

The communications works on a master-slave basis. The master initiates the communications by sending a message to the bus. The slave, which recognize its own slave number, responds by sending an appropriate reply message.

The *PM290HD* supports the only SPA-bus slave protocol. It can respond to the master requests, but does not transmit information on its own initiative.

The communications protocols are basically divided into two categories:

- data read from the slave
- data write to slave

Data write can use one of the two alternative procedures:

- direct data write to slave
- broadcast data write to all slaves using the broadcast address of 900

The following paragraphs specify the interchange protocols for each category.

Data Read from Slave

Master Slave

R ------------> 1. Master sends a read message

<------------ D 2a. Slave replies with a data message
<------------ N 2b. Slave replies with a negative acknowledgment

Direct Data Write to Slave

Master Slave

W ------------> 1. Master sends data to slave

<------------ A 2a. Slave acknowledges data
<------------ N 2b. Slave replies with a negative acknowledgment

Broadcast Data Write to Slaves

Master Slave

W ------------> 1. Master sends data to all slaves

No acknowledgment is sent by the slaves

2.3 Master Messages

Message Type R (Read)

The message has the following format:

>nReXm/m:CCcr

where

>	= master start synchronization character
n	= slave number (address)
R	= read message type (literally)
e	= channel number (e=0 or can be omitted)
X	= data type
m	= data number
m/m	= first/last data numbers for multiple data read
CC	= checksum
cr	= master stop synchronization character
:	= header delimiter

Message Type W (Write)

The message has the following format:

>nWeXm/m:*dddd/.../dddd:*CCcr

where

> = master start synchronization character
n = slave number (address)
W = write message type (literally)
e = channel number (e=0 or can be omitted)
X = data type
m = data number
m/m = first/last data numbers for multiple data read
dddd/.../dddd = data part
CC = checksum
cr = master stop synchronization character
: = header and data part delimiter

2.4 Slave Messages

Message Type D (Data)

The message has the following format:

lf<nD:*dddd/.../dddd:*CCcrlf

where

lf< = slave start synchronization characters
n = slave number (address)
D = data message type (literally)
dddd/.../dddd = data part
CC = checksum
crlf = slave stop characters
: = header and data part delimiter

Message Type A (ACK)

The message has the following format:

lf<nA:CCcrlf

where

lf< = slave start synchronization characters
n = slave number (address)
A = ACK message type (literally)
CC = checksum

crlf = slave stop characters
: = header delimiter

Message Type N (NAK)

The message has the following format:

lf<nN:d:CCcrlf

where
lf< = slave start synchronization characters
n = slave number (address)
N = NAK message type (literally)
d = error code (see below)
CC = checksum
crlf = slave stop characters
: = header delimiter

The error codes in the NAK message are as follows:

1 = slave is busy: the instrument is being programmed via the front panel (only for requests accessing setup registers)
3 = too more data requested: the requested data cannot be transmitted in a single message
5 = syntax error: incorrect or unrecognized message type, data type, channel number or data item number; error in data part of the message
6 = slave does not contain all data requested: data is not available
7 = addressed data is impossible to read or write (illegal operation):
- when read, the error is reported if the addressed data item is for write only
- when written, the error is reported if the addressed data item is nonexistent or requires a shared resource (such as a relay output) that is permanently locked by another data setting
8 = data in write message is not validated: illegal data format or value

NOTE

When the character framing, parity, or redundancy check error is detected, processing of the master's request stops. The instrument will not act on or respond to the message.

3 PM290HD/SPA-BUS DATA MAP

This chapter specifies the *PM290HD* registers in terms of the SPA-bus data identification convention.

Table 3-1 Input data parameters

Data parameter	*Data ID*	*Direc-tion*	*For-mat*	*Unit*	*Value range ①*
Voltage L1/L12	I1	R	D	V	0 to Vmax
Voltage L2/L23	I2	R	D	V	0 to Vmax
Voltage L3/L31	I3	R	D	V	0 to Vmax
Current L1	I4	R	D	A	0 to Imax
Current L2	I5	R	D	A	0 to Imax
Current L3	I6	R	D	A	0 to Imax
kW L1	I7	R	D	kW	-Pmax to Pmax
kW L2	I8	R	D	kW	-Pmax to Pmax
kW L3	I9	R	D	kW	-Pmax to Pmax
kvar L1	I10	R	D	kvar	-Pmax to Pmax
kvar L2	I11	R	D	kvar	-Pmax to Pmax
kvar L3	I12	R	D	kvar	-Pmax to Pmax
kVA L1	I13	R	D	kVA	-Pmax to Pmax
kVA L2	I14	R	D	kVA	-Pmax to Pmax
kVA L3	I15	R	D	kVA	-Pmax to Pmax
Power factor L1	I16	R	D.2		-0.99 to 1
Power factor L2	I17	R	D.2		-0.99 to 1
Power factor L3	I18	R	D.2		-0.99 to 1
Total power factor	I19	R	D.2		-0.99 to 1
Total kW	I20	R	D	kW	-Pmax to Pmax
Total kvar	I21	R	D	kvar	-Pmax to Pmax
Total kVA	I22	R	D	kVA	-Pmax to Pmax
Unbalanced current (Ground leakage ②)	I23	R	D	A (mA)	0 to Imax (0 to Iaux max)
Frequency	I24	R	D.1	Hz	45 to 65
Maximum kW demand	I25	R	D	kW	0 to Pmax
Accumulated kW demand	I26	R	D	kW	0 to Pmax
Maximum kVA demand	I27	R	D	kVA	0 to Pmax
Accumulated kVA demand	I28	R	D	kVA	0 to Pmax

Table 3-1 Input data parameters (continued)

Data parameter	*Data ID*	*Direc-tion*	*For-mat*	*Unit*	*Value range* ①
Maximum ampere demand L1	I29	R	D	A	0 to Imax
Maximum ampere demand L2	I30	R	D	A	0 to Imax
Maximum ampere demand L3	I31	R	D	A	0 to Imax
kWh import ý	I32	R	D	kWh	0 to 99999999
kWh export	I33	R	D	kWh	0 to -9999999
kvarh net	I34	R	D	kvarh	-9999999 to 99999999
Voltage THD L1/L12	I35	R	D.1	%	0 to 100
Voltage THD L2/L23	I36	R	D.1	%	0 to 100
Voltage THD L3	I37	R	D.1	%	0 to 100
Current THD L1	I38	R	D.1	%	0 to 100
Current THD L2	I39	R	D.1	%	0 to 100
Current THD L3	I40	R	D.1	%	0 to 100
Status inputs	I101	R	H		00 to FF (see Table 3.2)

① The parameters' limits are as follows:

Vmax (660 V input option) = 660 [V] @ PT Ratio = 1.0
Vmax (660 V input option) = 144 ∗ PT Ratio [V] @ PT ratio > 1.0
Vmax (120 V input option) = 144 ∗ PT Ratio [V]
Imax = 1.2 ∗ CT primary current [A] @ current overrange = 20%
Imax = 2 ∗ CT primary current [A] @ current overrange = 100%
Iaux max = 1.2 ∗ Auxiliary CT primary current [mA]
Pmax = (Imax ∗ Vmax ∗ 3)/1000 [kW] @ wiring mode 4L-N
Pmax = (Imax ∗ Vmax ∗ 2)/1000 [kW] @ wiring mode 4L-L, 3-OP, or 3DIR

② For instruments with the ‘L’ option

All electrical parameters are averaged values over the specified number of the real-time measurements (see the *averaging buffer size* in *Table 3-5*).

Table 3-2 Status inputs

Bit number	*Description*
0	Status input #1
1	Status input #2
2	Status input #3
3	Status input #4
4	Status input #5
5	Status input #6
6	Status input #7
7	Status input #8

Bit meaning: 0 = contact open, 1 = contact closed

Table 3-3 Output data parameters

Data parameter	*Data ID*	*Direc-tion*	*Format*	*Value range*
Relay status	O101	R	H	00 to 0F (see Table 3.4)

Table 3-4 Relay status

Bit number	*Description*
0	Relay #1 status
1	Relay #2 status
2	Relay #3 status
3	Relay #4 status
4-15	Not used (permanently set to 0)

Bit meaning: 0 = relay released, 1 = relay operated

Table 3-5 Basic setup parameters

Parameter	*Data ID*	*Direc-tion*	*For-mat*	*Value range*
Wiring mode	S1	R/W	D	0 = 3OP, 1 = 4L-N, 2 = 3DIR, 3 = 4L-L
PT ratio	S2	R/W	D.1	1 to 6500
CT primary current	S3	R/W	D	1 to 50000 A
Power demand period	S4	R/W	D	1,2,5,10,15,20,30,60 min, 255 = external synchronization
Ampere demand period	S5	R/W	D	0 to 1800 s 0 = measuring peak currents
Averaging buffer size	S6	R/W	D	8, 32 entries
Reset enable/disable	S7	R/W	D	0 = disable, 1 = enable
Auxiliary CT primary current (‘L’ option)	S8	R/W	D	1 to 50000 mA

Table 3-6 Instrument control parameters

Parameter	*Data ID*	*Direc-tion*	*For-mat*	*Value range*
Communication address	V200	R	D	1 to 255
Data transfer rate	V201	R	D	110 to 9600
Software version number	V205	R	C	800 to 899
Instrument options 1	V206	R	H	0000 to FFFF (see Table 3-7)
Instrument options 2	V207	R	H	0000 to FFFF (see Table 3-7)
Energy reset register	V260	W	D	0=reset accumulated energies
Maximum demand reset register	V261	W	D	0=reset maximum demands
Instrument reset register	V300	W	D	0=reset the instrument (remote restart)
Fault counters (see Table 3-8)	V600-V611	R/W	D	When read: 0 to 255 When written: 0=reset counters
Slave identification data	F	R	C	PM290HD
Status data register	C	R/W	D	When read: 0=normal status 1=module has been reset When written: 0=reset status data

Table 3-7 Instrument options

Options register	*Bit number*	*Description*
Options 1	0	120V option
	1-3	Reserved
	4	100% current overrange option
	5	Reserved
	6	Analog output 0/4-20 mA option
	7-8	Reserved
	9	Relays option
	10	Digital inputs option
	11	4-th (ground leakage) current option
	12-15	Reserved
Options 2	0-2	Number of relays - 1
	3-6	Number of digital inputs - 1
	7-15	Reserved

Table 3-8 Fault counters

Data ID	*Counter contents*
V600	External resets
V601	Reserved
V602	RAM errors
V603	Watchdog timer resets
V604	Sampling failures
V605	Out of control traps
V606	Reserved
V607	Timing failures
V608	Power up
V609-V611	Reserved

All fault counters are cleared together by writing zero to either counter location.

Table 3-9 Relays setpoints parameters

Relay No	*Relay setpoint*	*Setpoint parameter*	*Data ID*	*Direction*	*Format*	*Value range ①*
1	High voltage	Operate limit	S100	R/W	D	0 to Vmax
		Operate delay	S101	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S102	R/W	D	0 to Vmax
		Release delay	S103	R/W	D	0 to 999 s, 65535 ②
	Low voltage	Operate limit	S104	R/W	D	0 to Vmax
		Operate delay	S105	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S106	R/W	D	0 to Vmax
		Release delay	S107	R/W	D	0 to 999 s, 65535 ②
	High current	Operate limit	S108	R/W	D	0 to Imax
		Operate delay	S109	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S110	R/W	D	0 to Imax
		Release delay	S111	R/W	D	0 to 999 s, 65535 ②
	High unbalanced current	Operate limit	S112	R/W	D	0 to Imax
		Operate delay	S113	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S114	R/W	D	0 to Imax
		Release delay	S115	R/W	D	0 to 999 s, 65535 ②
	High accumulated kW demand	Operate limit	S116	R/W	D	0 to Pmax
		Operate delay	S117	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S118	R/W	D	0 to Pmax
		Release delay	S119	R/W	D	0 to 999 s, 65535 ②
	High kvar (positive)	Operate limit	S120	R/W	D	0 to Pmax
		Operate delay	S121	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S122	R/W	D	0 to Pmax
		Release delay	S123	R/W	D	0 to 999 s, 65535 ②
	High kVA	Operate limit	S124	R/W	D	0 to Pmax
		Operate delay	S125	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S126	R/W	D	0 to Pmax
		Release delay	S127	R/W	D	0 to 999 s, 65535 ②
	Low power factor (lag)	Operate limit	S128	R/W	D.2	0 to 1
		Operate delay	S129	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S130	R/W	D.2	0 to 1
		Release delay	S131	R/W	D	0 to 999 s, 65535 ②
	High THD	Operate limit	S132	R/W	D	0 to 100
		Operate delay	S133	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S134	R/W	D	0 to 100
		Release delay	S135	R/W	D	0 to 999 s, 65535 ②

Table 3-9 Relays setpoints parameters (continued)

Relay No	*Relay setpoint*	*Setpoint parameter*	*Data ID*	*Direction*	*Format*	*Value range* ①
2	High voltage	Operate limit	S164	R/W	D	0 to Vmax
		Operate delay	S165	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S166	R/W	D	0 to Vmax
		Release delay	S167	R/W	D	0 to 999 s, 65535 ②
	Low voltage	Operate limit	S168	R/W	D	0 to Vmax
		Operate delay	S169	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S170	R/W	D	0 to Vmax
		Release delay	S171	R/W	D	0 to 999 s, 65535 ②
	High current	Operate limit	S172	R/W	D	0 to Imax
		Operate delay	S173	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S174	R/W	D	0 to Imax
		Release delay	S175	R/W	D	0 to 999 s, 65535 ②
	High unbalanced current	Operate limit	S176	R/W	D	0 to Imax
		Operate delay	S177	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S178	R/W	D	0 to Imax
		Release delay	S179	R/W	D	0 to 999 s, 65535 ②
	High accumulated kW demand	Operate limit	S180	R/W	D	0 to Pmax
		Operate delay	S181	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S182	R/W	D	0 to Pmax
		Release delay	S183	R/W	D	0 to 999 s, 65535 ②
	High kvar (positive)	Operate limit	S184	R/W	D	0 to Pmax
		Operate delay	S185	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S186	R/W	D	0 to Pmax
		Release delay	S187	R/W	D	0 to 999 s, 65535 ②
	High kVA	Operate limit	S188	R/W	D	0 to Pmax
		Operate delay	S189	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S190	R/W	D	0 to Pmax
		Release delay	S191	R/W	D	0 to 999 s, 65535 ②
	Low power factor (lag)	Operate limit	S192	R/W	D.2	0 to 1
		Operate delay	S193	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S194	R/W	D.2	0 to 1
		Release delay	S195	R/W	D	0 to 999 s, 65535 ②
	High THD	Operate limit	S196	R/W	D	0 to 100
		Operate delay	S197	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S198	R/W	D	0 to 100
		Release delay	S199	R/W	D	0 to 999 s, 65535 ②

Table 3-9 Relays setpoints parameters (continued)

Relay No	*Relay setpoint*	*Setpoint parameter*	*Data ID*	*Direc-tion*	*For-mat*	*Value range* ①
3	High voltage	Operate limit	S228	R/W	D	0 to Vmax
		Operate delay	S229	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S230	R/W	D	0 to Vmax
		Release delay	S231	R/W	D	0 to 999 s, 65535 ②
	Low voltage	Operate limit	S232	R/W	D	0 to Vmax
		Operate delay	S233	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S234	R/W	D	0 to Vmax
		Release delay	S235	R/W	D	0 to 999 s, 65535 ②
	High current	Operate limit	S236	R/W	D	0 to Imax
		Operate delay	S237	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S238	R/W	D	0 to Imax
		Release delay	S239	R/W	D	0 to 999 s, 65535 ②
	High unbalanced current	Operate limit	S240	R/W	D	0 to Imax
		Operate delay	S241	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S242	R/W	D	0 to Imax
		Release delay	S243	R/W	D	0 to 999 s, 65535 ②
	High accumulated kW demand	Operate limit	S244	R/W	D	0 to Pmax
		Operate delay	S245	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S246	R/W	D	0 to Pmax
		Release delay	S247	R/W	D	0 to 999 s, 65535 ②
	High kvar (positive)	Operate limit	S248	R/W	D	0 to Pmax
		Operate delay	S249	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S250	R/W	D	0 to Pmax
		Release delay	S251	R/W	D	0 to 999 s, 65535 ②
	High kVA	Operate limit	S252	R/W	D	0 to Pmax
		Operate delay	S253	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S254	R/W	D	0 to Pmax
		Release delay	S255	R/W	D	0 to 999 s, 65535 ②
	Low power factor (lag)	Operate limit	S256	R/W	D.2	0 to 1
		Operate delay	S257	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S258	R/W	D.2	0 to 1
		Release delay	S259	R/W	D	0 to 999 s, 65535 ②
	High THD	Operate limit	S260	R/W	D	0 to 100
		Operate delay	S261	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S262	R/W	D	0 to 100
		Release delay	S263	R/W	D	0 to 999 s, 65535 ②

Table 3-9 Relays setpoints parameters (continued)

Relay No	*Relay setpoint*	*Setpoint parameter*	*Data ID*	*Direc-tion*	*For-mat*	*Value range ①*
4	High voltage	Operate limit	S292	R/W	D	0 to Vmax
		Operate delay	S293	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S294	R/W	D	0 to Vmax
		Release delay	S295	R/W	D	0 to 999 s, 65535 ②
	Low voltage	Operate limit	S296	R/W	D	0 to Vmax
		Operate delay	S297	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S298	R/W	D	0 to Vmax
		Release delay	S299	R/W	D	0 to 999 s, 65535 ②
	High current	Operate limit	S300	R/W	D	0 to Imax
		Operate delay	S301	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S302	R/W	D	0 to Imax
		Release delay	S303	R/W	D	0 to 999 s, 65535 ②
	High unbalanced current	Operate limit	S304	R/W	D	0 to Imax
		Operate delay	S305	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S306	R/W	D	0 to Imax
		Release delay	S307	R/W	D	0 to 999 s, 65535 ②
	High accumulated kW demand	Operate limit	S308	R/W	D	0 to Pmax
		Operate delay	S309	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S310	R/W	D	0 to Pmax
		Release delay	S311	R/W	D	0 to 999 s, 65535 ②
	High kvar (positive)	Operate limit	S312	R/W	D	0 to Pmax
		Operate delay	S313	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S314	R/W	D	0 to Pmax
		Release delay	S315	R/W	D	0 to 999 s, 65535 ②
	High kVA	Operate limit	S316	R/W	D	0 to Pmax
		Operate delay	S317	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S318	R/W	D	0 to Pmax
		Release delay	S319	R/W	D	0 to 999 s, 65535 ②
	Low power factor (lag)	Operate limit	S320	R/W	D.2	0 to 1
		Operate delay	S321	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S322	R/W	D.2	0 to 1
		Release delay	S323	R/W	D	0 to 999 s, 65535 ②
	High THD	Operate limit	S324	R/W	D	0 to 100
		Operate delay	S325	R/W	D.1	0 to 99.9 s, 65535 ②
		Release limit	S326	R/W	D	0 to 100
		Release delay	S327	R/W	D	0 to 999 s, 65535 ②

① For the parameters' limits, see note ① to Table 3-1

② 65535 = setpoint is disabled. To disable a setpoint, write 65535 into the operate delay register

NOTES

1. If a relay has been allocated to output energy pulses, an attempt to re-allocate it for a setpoint will result in a negative acknowledgment with the error code 7.

2. The operate delay should be setup before you change the release delay for a setpoint. While the operate delay shows the setpoint is disabled, the release delay will not change. No error will be reported.

Table 3-10 Pulsing relays registers

Relay No	*Pulsing parameter*	*Data ID*	*Direc-tion*	*For-mat*	*Value range*
1	kWh import	S356	R/W	D	1 to 200 kWh, 65535=disabled ①
4	kWh export	S357	R/W	D	1 to 200 kvarh, 65535=disabled ①
2	kvarh total	S358	R/W	D	1 to 200 kWh, 65535=disabled ①

① 65535 = pulsing is disabled. To disable a pulsing relay, write 65535.

NOTE

Allocating a relay for pulsing will unconditionally disable all setpoints associated with this relay.

Table 3-11 Analog output allocation parameters

Analog output parameter	*Data ID*	*Direction*	*Format*	*Value range*
Voltage L1/L12	S380	R/W	D	0 to 14, 65535=disabled ①
Voltage L2/L23	S381	R/W	D	0 to 14, 65535=disabled ①
Voltage L3/L31	S382	R/W	D	0 to 14, 65535=disabled ①
Current L1	S383	R/W	D	0 to 14, 65535=disabled ①
Current L2	S384	R/W	D	0 to 14, 65535=disabled ①
Current L3	S385	R/W	D	0 to 14, 65535=disabled ①
Reserved ②	S386			
Reserved ②	S387			
kW	S388	R/W	D	0 to 14, 65535=disabled ①
kvar	S389	R/W	D	0 to 14, 65535=disabled ①
kVA	S390	R/W	D	0 to 14, 65535=disabled ①
Accumulated kW demand	S391	R/W	D	0 to 14, 65535=disabled ①
Reserved ②	S392			
Power factor	S393	R/W	D	0 to 14, 65535=disabled ①
Frequency	S394	R/W	D	0 to 14, 65535=disabled ①

① 0 = the parameter is allocated to the internal analog output, 1-14 = the parameter is allocated to the analog expander AX-7 analog channel (channels 1 to 7 correspond to the first analog expander, and channels 8 to 14 correspond to the second one).

65535 = output is disabled. To disable an analog output parameter, write 65535, except of the reserved locations.

② Addressing of a reserved item will result in a negative acknowledgment with the error code 6 when read, and 7 when written.

Table 3-12 Real-time clock parameters

Parameter	*Data ID*	*Direction*	*Format*	*Value range*
Date and time	D	R/W	C	yy-mo-dd hh.mm;ss.sss yy=year (00 to 99) mo=month (01 to 12) dd=day of month (01 to 31) hh=hours (00 to 23) mm=minutes (00 to 59) ss=seconds (00 to 59) sss=milliseconds (will be always read as 000)

Table 3-13 Phase harmonics parameters

Channel	*Parameter*	*Data ID*	*Direction*	*Format*	*Unit*	*Value range*
Voltage L1/L12	Phase voltage (RMS) ①	I200	R	D	V	0 to Vmax (see note ① to Table 3-1)
	Fundamental frequency	I201	R	D.2	Hz	45 to 65
	THD	I202	R	D.1	%	0 to 100
	Harmonic H01 (reference)	I203	R	D	%	100
	Harmonic H02	I204	R	D.2	%	0 to 100
	Harmonic H03	I205	R	D.2	%	0 to 100
	. . .	. . .				
	Harmonic H31	I233	R	D.2	%	0 to 100
Voltage L2/L21	Phase voltage (RMS) ①	I250	R	D	V	0 to Vmax (see note ① to Table 3-1)
	Fundamental frequency	I251	R	D.2	Hz	45 to 65
	THD	I252	R	D.1	%	0 to 100
	Harmonic H01 (reference)	I253	R	D	%	100
	Harmonic H02	I254	R	D.2	%	0 to 100
	Harmonic H03	I255	R	D.2	%	0 to 100
	. . .	. . .				
	Harmonic H31	I283	R	D.2	%	0 to 100
Voltage L3	Phase voltage (RMS)	I300	R	D	V	0 to Vmax (see note ① to Table 3-1)
	Fundamental frequency	I301	R	D.2	Hz	45 to 65
	THD	I302	R	D.1	%	0 to 100
	Harmonic H01 (reference)	I303	R	D	%	100
	Harmonic H02	I304	R	D.2	%	0 to 100
	Harmonic H03	I305	R	D.2	%	0 to 100
	. . .	. . .				
	Harmonic H31	I333	R	D.2	%	0 to 100

Table 3-13 Phase harmonics parameters (continued)

Channel	*Parameter*	*Data ID*	*Direction*	*Format*	*Unit*	*Value range*
Current L1	Phase current (RMS)	I350	R	D	A	0 to Imax (see note ① to Table 3-1)
	Fundamental frequency	I351	R	D.2	Hz	45 to 65
	THD	I352	R	D.1	%	0 to 100
	Harmonic H01 (reference)	I353	R	D	%	100
	Harmonic H02	I354	R	D.2	%	0 to 100
	Harmonic H03	I355	R	D.2	%	0 to 100
	. . .	. . .				
	Harmonic H31	I383	R	D.2	%	0 to 100
Current L2	Phase current (RMS)	I400	R	D	A	0 to Imax (see note ① to Table 3-1)
	Fundamental frequency	I401	R	D.2	Hz	45 to 65
	THD	I402	R	D.1	%	0 to 100
	Harmonic H01 (reference)	I403	R	D	%	100
	Harmonic H02	I404	R	D.2	%	0 to 100
	Harmonic H03	I405	R	D.2	%	0 to 100
	. . .	. . .				
	Harmonic H31	I433	R	D.2	%	0 to 100
Current L3	Phase current (RMS)	I450	R	D	A	0 to Imax (see note ① to Table 3-1)
	Fundamental frequency	I451	R	D.2	Hz	45 to 65
	THD	I452	R	D.1	%	0 to 100
	Harmonic H01 (reference)	I453	R	D	%	100
	Harmonic H02	I454	R	D.2	%	0 to 100
	Harmonic H03	I455	R	D.2	%	0 to 100
	. . .	. . .				
	Harmonic H31	I483	R	D.2	%	0 to 100

① Phase voltage will be line-to-line voltage in a 3-wire open delta connection, and line-to-neutral voltage in other configurations.

Table 3-14 Real-time waveform capture header parameters

Channel	*Parameter*	*Data ID*	*Direction*	*Format*	*Unit*	*Value range*
Voltage L1/L12	Capture code	I500	R	D		0=real-time waveform
	Date and time	I501	R	C		yy-mo-dd hh.mm;ss.sss (see Table 3-12)
	Phase voltage (RMS) ①	I502	R	D	V	0 to Vmax (see note ① to Table 3-1)
	Fundamental frequency	I503	R	D.2	Hz	45 to 65
	THD	I504	R	D.1	%	0 to 100
Voltage L2/L23	Capture code	I510	R	D		0=real-time waveform
	Date and time	I511	R	C		yy-mo-dd hh.mm;ss.sss (see Table 3-12)
	Phase voltage (RMS) ①	I512	R	D	V	0 to Vmax (see note ① to Table 3-1)
	Fundamental frequency	I513	R	D.2	Hz	45 to 65 Hz
	THD	I514	R	D.1	%	0 to 100
Voltage L3	Capture code	I520	R	D		0=real-time waveform
	Date and time	I521	R	C		yy-mo-dd hh.mm;ss.sss (see Table 3-12)
	Phase voltage (RMS)	I522	R	D	V	0 to Vmax (see note ① to Table 3-1)
	Fundamental frequency	I523	R	D.2	Hz	45 to 65
	THD	I524	R	D.1	%	0 to 100
Current L1	Capture code	I530	R	D		0=real-time waveform
	Date and time	I531	R	C		yy-mo-dd hh.mm;ss.sss (see Table 3-12)
	Phase current (RMS)	I532	R	D	V	0 to Imax (see note ① to Table 3-1)
	Fundamental frequency	I533	R	D.2	Hz	45 to 65
	THD	I534	R	D.1	%	0 to 100

Table 3-14 Real-time waveform capture header parameters (continued)

Channel	Parameter	Data ID	Direction	Format	Unit	Value range
Current L2	Capture code	I540	R	D		0=real-time waveform
	Date and time	I541	R	C		yy-mo-dd hh.mm;ss.sss (see Table 3-12)
	Phase current (RMS)	I542	R	D	V	0 to Imax (see note ① to Table 3-1)
	Fundamental frequency	I543	R	D.2	Hz	45 to 65
	THD	I544	R	D.1	%	0 to 100
Current L3	Capture code	I550	R	D		0=real-time waveform
	Date and time	I551	R	C		yy-mo-dd hh.mm;ss.sss (see Table 3-12)
	Phase current (RMS)	I552	R	D	V	0 to Imax (see note ① to Table 3-1)
	Fundamental frequency	I553	R	D.2	Hz	45 to 65
	THD	I554	R	D.1	%	0 to 100

① Phase voltage will be line-to-line voltage in a 3-wire open delta connection, and line-to-neutral voltage in other configurations.

Table 3-15 Real-time waveform samples

Parameter	Data ID	Direction	Format	Value range
Waveform point #1	I600	R	D	0-1023
Waveform point #2	I601	R	D	0-1023
Waveform point #3	I602	R	D	0-1023
. . .	. . .			
Waveform point #512	I1111	R	D	0-1023

NOTE

Waveform registers allow the user to obtain the real-time waveforms (4 cycles x 128 samples per cycle) sampled by the Powermeter.

Each waveform consists of 512 samples. A waveform record contains six waveforms: 2 inputs (voltage and current) x 3 phases. Both the voltage and current waveforms on any phase are always sampled and recorded simultaneously.

To access the real-time waveforms, a particular order of requests is needed. The waveform data is transmitted to a master via the special large scale communications buffer. Before reading the waveform samples, the waveform record containing two waveforms for the selected phase should be locked in the communications buffer. It is made by reading the corresponding header record for the voltage input (see Table 3-14). Before accessing the current waveform samples, the current waveform header record must be accessed to prepare waveform for reading. The capture code register should be always read first.

Once waveform is locked in the communications buffer, the user can read the waveform samples by accessing the samples' registers (see Table 3-15). Data in the communications buffer doesn't change until a header record for the voltage channel is accessed.

Each waveform sample is represented by a value in the range of 0 to 1023. A value of 0 corresponds to the highest negative amplitude of the measured signal, and a value of 1023 corresponds to the highest positive amplitude.

4 PM290HD RESPONSE TIME

To allow the master to switch the communications link, it is guaranteed that the PM290HD minimum response time will not be less than 3.5 character time (depending on the baud rate) and not less than 5 ms.

Response Time to Read Message

The response time can be estimated using the following formulas:

Typical time ≈ 3.5 character time + 2 ms + 1.5 ms × (number of parameters)
Maximum time ≈ 3.5 character time + 25 ms + 3 ms × (number of parameters)

The following table shows the actual response time measured at 9600 bps:

Number of parameters	Typical response time, ms	Maximum response time, ms
1	7	30
5	13	50
10	21	68
20	38	87
30	51	124
40	67	147

Response Time to Write Message

The response time can be estimated using the following formulas:

Typical time ≈ 3.5 character time + 4 ms + 3 ms × (number of parameters)
Maximum time ≈ 3.5 character time + 25 ms + 8 ms × (number of parameters)

The following table shows the actual response time measured at 9600 bps:

Number of parameters	Typical response time, ms	Maximum response time, ms
1	10	37
2	14	45
4	20	61

NOTE These evaluations do not take into consideration the message transfer time and the use of the analog expander AX-7. When using the AX-7, add to the estimated maximum response time 15 ms + 3.5 character time + 9 character time × (number of active analog channels).