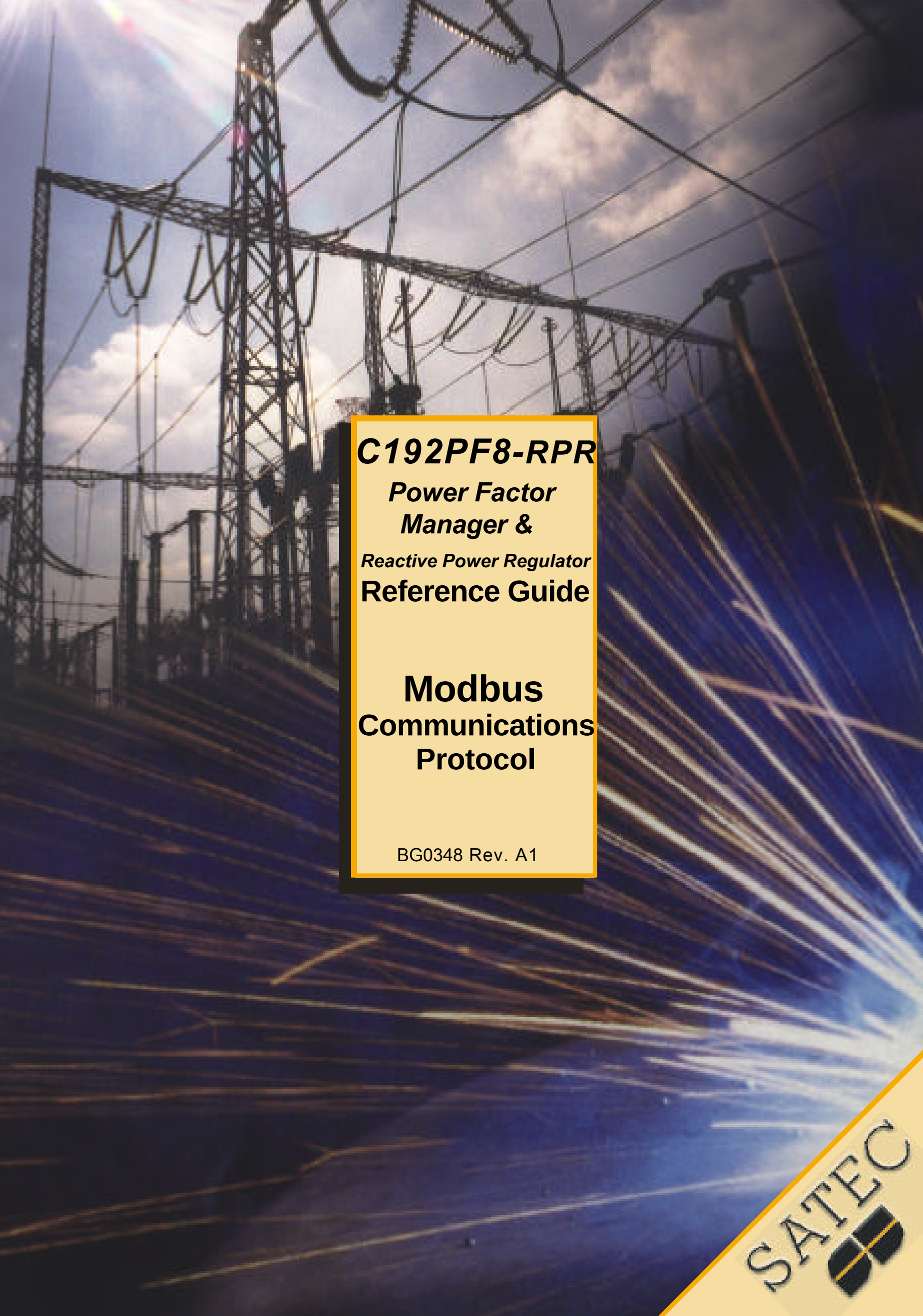


C192PF8-RPR

Power Factor Manager &

Reactive Power Regulator

Reference Guide

Modbus Communications Protocol

BG0348 Rev. A1

SATEC

C192PF8-RPR
POWER FACTOR MANAGER AND REACTIVE POWER REGULATOR

COMMUNICATIONS

Modbus Communications Protocol

REFERENCE GUIDE

BG0348 Rev. A1

Table of Contents

1 GENERAL

This document specifies a subset of the Modbus serial communications protocol used to transfer data between a master computer station and the C192PF8-RPR. The document provides the complete information necessary to develop third-party communications software capable of communication with the Series C192PF8-RPR Powermeters. Additional information concerning communications operation, configuring the communications parameters, and communications connections is found in "C192PF8-RPR Power Factor Manager and Reactive Power Regulator, Installation and Operation Manual".

IMPORTANT

1. In 3-wire connection schemes, the unbalanced current and phase readings for power factor, active power, and reactive power will be zeros, because they have no meaning. Only the total three-phase power values can be used.
2. In the 4LN3, 3LN3 and 4LL3 wiring modes, harmonic voltages will be line-to-neutral voltages; in other modes, they will be line-to-line voltages, and voltage THD will not account for multiples of the third harmonic. In the 3OP2 and 3OP3 wiring modes, voltage THD will be given only for phases L12 and L23.
3. Most of the advanced features are configured using multiple setup parameters that can be accessed in some contiguous registers. When writing the setup registers, it is recommended to write all the registers at once using a single request, or to clear (zero) the setup before writing into separate registers.

2 MODBUS FRAMING

2.1 Transmission Mode

The protocol uses the Modbus Remote Terminal Unit (RTU) transmission mode. In RTU mode, data is sent in 8-bit binary characters. The 8 bit even parity or 8 bit no parity data format must be selected when configuring the instrument communications. The data format is shown in the following table.

Table 2-1 RTU Data Format

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

① Least significant bit first

2.2 The RTU Frame Format

Frame synchronization is maintained in RTU transmission mode by simulating a synchronization message. The receiving device monitors the elapsed time between receptions 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. The 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	CRC Check	T1 T2 T3
	8 bits	8 bits	N * 8 bits	16 bits	

2.3 Address Field

The address field contains a user assigned address (1-247) of the instrument that is to receive a message. Address 0 is used in broadcast mode to transmit to all instruments (broadcast mode is available only for functions 06 and 16). In this case all instruments receive the message and take action on the request, but do not issue a response. In the C192PF8-RPR, the broadcast mode is supported only for register addresses 287-294 and 301-302 (reset energies and maximum demands), 3404-3415 (reset/clear registers), and 4352-4358 (real-time clock registers).

2.4 Function Field

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

Table 2-2 Modbus Function Codes

Code (decimal)	Meaning in Modbus	Action
03	Read holding registers	Read multiple registers
04	Read input registers	Read multiple registers
06	Preset single register	Write single register
16	Preset multiple registers	Write multiple registers
08	Loop-back test	Communications test

NOTE Broadcast mode available only for functions code 06 and 16.

2.5 Data Field

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

IMPORTANT Fields composed of two bytes are sent in the order high byte first, low byte second.

2.6 Error Check Field

The error check field contains the Cyclical Redundancy Check (CRC) word. The start of the message is ignored in calculating the CRC. The CRC-16 error check sequence is implemented as described in the following paragraphs.

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), and 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, and since there are no carries used in the 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 effect 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 low 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 ORed with the 16-bit register and shifted 8 times.
8. When the 16-bit CRC is transmitted in the message, the low order byte will be transmitted first, followed by the high order byte.

For detailed information about CRC calculation, refer to the Modbus Protocol Reference Guide.

3 MODBUS MESSAGE FORMATS

3.1 Function 03 - Read Multiple Registers

This command allows the user to obtain contents of up to 125 contiguous registers from a single data table.

Request

Instrument Address	Function (03)	Starting Address	Word Count	Error Check
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Starting Address Address of the first register to be read
Word Count The number of contiguous words to be read

Response

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

The byte count field contains quantity of bytes to be returned.

3.2 Function 04 - Read Multiple Registers

This command allows the user to obtain contents of up to 125 contiguous registers from a single data table. It can be used instead of function 03.

Request

Instrument Address	Function (04)	Starting Address	Word Count	Error Check
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Starting Address Address of the first register to be read
Word Count The number of contiguous words to be read

Response

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

The byte count field contains quantity of bytes to be returned.

3.3 Function 06 - Write Single Register

This command allows the user to write the contents of a data register in any data table where a register can be written.

Request

Instrument Address	Function (06)	Starting Address	Data Word	Error check
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Starting Address Address of the register to be written
Data Value Data to be written to the register

Response
The normal response is the retransmission of the write request.

3.4 Function 16 - Write Multiple Registers

This request allows the user to write the contents of multiple contiguous registers to a single data table where registers can be written.

Request

Instrument Address	Function (16)	Starting Address	Word Count	Byte Count
1 byte	1 byte	2 bytes	2 bytes	1 byte

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

Starting Address Address of the first register to be written
Word Count The number of contiguous words to be written
Byte Count The number of bytes to be written

Response

Instrument Address	Function (16)	Starting Address	Word Count	Error Check
1 byte	1 byte	2 bytes	1 word	2 bytes

3.5 Function 08 - Loop-back Communications Test

The purpose of this request is to check the communications link between the specified instrument and PC.

Request

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

Diagnostic Code Designates 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 instrument. The entire message returned will be identical to the message transmitted by the master, field-per-field.

Response

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

The normal response is the re-transmission of a test message.

3.6 Exception Responses

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

Exception Response

Instrument Address	Function (high order bit is set to 1)	Exception Code	Error Check
1 byte	1 byte	1 byte	2 byte

Exception response codes:

01 - Illegal function
02 - Illegal data address
03 - Illegal data value
06 - Busy, rejected message. The message was received without errors, but the instrument is being programmed from the keypad (only for requests accessing setup registers).

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

4 PROTOCOL IMPLEMENTATION

4.1 Modbus Register Addresses

The C192PF8-RPR Modbus registers are referred to by using addresses in the range of 0 to 65535. From within the Modbus applications, the C192PF8-RPR Modbus registers can be accessed by simulating holding registers of the Modicon 584, 884 or 984 Programmable Controller, using a 5-digit “4XXXX” or 6-digit “4XXXXX” addressing scheme. To map the C192PF8-RPR register address to the range of the Modbus holding registers, add a value of 40001 to the C192PF8-RPR register address. When a register address exceeds 9999, use a 6-digit addressing scheme by adding 400001 to the C192PF8-RPR register address.

4.2 Data Formats

The C192PF8-RPR uses three data formats to pass data between a master application and the instrument: a 16-bit integer format, a 32-bit modulo 10000 format, and a 32-bit long integer format.

4.2.1 16-bit Integer Format

A 16-bit data is transmitted in a single 16-bit Modbus register as unsigned (UINT16) or signed (INT16) integer (whole) numbers without conversion or using pre-scaling to accommodate large-scale and fractional numbers to a 16-bit register format. Scaling can be made using either the LIN3 linear conversion, or decimal pre-scaling to pass fractional numbers in integer format.

Non-scaled data

The data will be presented exactly as retrieved by the communications program from the instrument. The value range for unsigned data is 0 to 65535; for signed data the range is -32768 to 32767.

LIN3 (Linear) Scaling

This conversion maps the raw data received by the communications program in the range of 0-9999 onto the user-defined LO scale/HI scale range. The conversion is carried out according to the formula:

$$Engineering\_Units\_Value = \frac{Raw\_Data \times (HI - LO)}{9999} + LO$$

where:

Engineering_Units_Value	-	the true value in engineering units
Raw_Data	-	the raw input data in the range of 0 - 9999
LO, HI	-	the data low and high scales in engineering units

When data conversion is necessary, the HI and LO scales, and data conversion method are indicated for the corresponding registers.

CONVERSION EXAMPLES

1. Voltage readings

a) Assume device settings (690V input, direct wiring): PT ratio = 1.

Voltage engineering scales (see Note 1 to Table 5-1):

HI = Vmax = 828.0 × PT ratio = 828.0 × 1 = 828.0V
LO = 0V

If the raw data reading is 1449 then the voltage reading in engineering units will be as follows:

Volts reading = 1449 × (828.0 - 0)/9999 + 0 = 120.0V

b) Assume device settings (wiring via PT): PT ratio = 14,400V : 120V = 120.

Voltage engineering scales:

HI = Vmax = 144.0 × PT ratio = 144 × 120 = 17,280V
LO = 0V

If the raw data reading is 8314 then the voltage reading in engineering units will be as follows:

Volts reading = 8314 × (17,280 - 0)/9999 + 0 = 14,368V

2. Current readings

Assume device settings: CT primary current = 200A; current input overload = 120% (6A).

Current engineering scales:

HI = Imax = CT primary current × 1.2 = 200.00 × 1.2 = 240.00A
LO = 0A

If the raw data reading is 250 then the current reading in engineering units will be as follows:

Amps reading = 250 × (240.00 - 0)/9999 + 0 = 6.00A

3. Power readings

a) Assume device settings (690V input, direct wiring): wiring configuration 4LN3; PT = 1; CT primary current = 200A.

Active Power engineering scales:

HI = Pmax = Vmax × Imax × 3 = 828.0 × (200.00 × 1.2) × 3 = 596,160W = 596.160kW
LO = -Pmax = -596.160kW

If the raw data reading is 5500 then the power reading in engineering units will be as follows:

Watts reading = 5500 × (596.160 - (-596.160))/9999 + (-596.160) = 59.682kW

If the raw data reading is 500 then the power reading in engineering units will be as follows:

Watts reading = 500 × (596.160 - (-596.160))/9999 + (-596.160) = -536.538kW

b) Assume device settings (wiring via PT): wiring configuration 4LL3; PT = 120; CT primary current = 200A.

Active Power engineering scales:

HI = Pmax = Vmax × Imax × 2 = (144 × 120) × (200.00 × 1.2) × 2/1000 = 8294kW
LO = -Pmax = -8294kW

If the raw data reading is 5500 then the power reading in engineering units will be as follows:

Watts reading = 5500 × (8294 - (-8294))/9999 + (-8294) = 830kW

If the raw data reading is 500 then the power reading in engineering units will be as follows:

Watts reading = 500 × (8294 - (-8294))/9999 + (-8294) = -7465kW

4. Power Factor readings

Power factor engineering scales:

HI = 1.000.
LO = -1.000.

If the raw data reading is 8900 then the power factor in engineering units will be as follows:

Power factor reading = 8900 × (1.000 - (-1.000))/9999 + (-1.000) = 0.78

Decimal Scaling

Decimal pre-scaling is used to accommodate fractional numbers to an integer register format. Fractional numbers pre-multiplied by 10 in power N, where N is the number of digits in the fractional part. For example, the frequency reading of 50.01 Hz is transmitted as 5001, having been pre-multiplied by 100. Whenever a data register contains a fractional number, the register measurement unit is given with a multiplier ×0.1, ×0.01 or ×0.001, showing an actual register resolution (the weight of the least significant decimal digit). To get an actual fractional number with specified precision, scale the register value with the given multiplier. To write a fractional number into the register, divide the number by the given multiplier.

4.2.2 32-bit Modulo 10000 Format

The short energy registers 287-294, and 301-302 are transmitted in two contiguous 16-bit registers in modulo 10000 format. The first (low order) register contains the value mod 10000, and the second (high order) register contains the value/10000. To get the true energy reading, the high order register value should be multiplied by 10,000 and added to the low order register.

4.2.3 32-bit Long Integer Format

In a 32-bit long integer format, data is transmitted in two adjacent 16-bit Modbus registers as unsigned (UINT32) or signed (INT32) long integer (whole) numbers. The first register contains the low-order word (lower 16 bits) and the second register contains the high order word (higher 16 bits) of the 32-bit long number. The low-order word always starts at an even Modbus address. The value range for unsigned data is 0 to 4,294,967,295; for signed data the range is -2,147,483,648 to 2,147,483,647.

A 32-bit data can be transmitted without conversion as is, or by using decimal pre-scaling to transform fractional numbers to an integer format as described above (see Decimal Scaling in Section 4.2.1).

4.3 User Assignable Registers

The C192PF8-RPR contains the 120 user assignable registers in the address range of 0 to 119 (see Table 4-1), any of which you can map to either register address accessible in the instrument. Registers that reside in different locations may be accessed by a single request by re-mapping them to adjacent addresses in the user assignable registers area.

The actual addresses of the assignable registers which are accessed via addresses 0 to 119 are specified in the user assignable register map (see Table 4-2). This map occupies addresses from 120 to 239, where map register 120 should contain the actual address of the register accessed via assignable register 0, register 121 should contain the actual address of the register accessed via assignable register 1, and so on. Note that the assignable register addresses and the map register addresses may not be re-mapped.

To build your own register map, write to map registers (120 to 239) the actual addresses you want to read from or write to via the assignable area (0 to 119). Note that long word registers should always be aligned at even addresses. For example, if you want to read registers 7136 (real-time voltage of phase A, word) and 7576/7577 (kWh import, long word) via registers 0-2, then do the following:

- write 7576 to register 120
- write 7577 to register 121
- write 7136 to register 122

Reading from registers 0-2 will return the kWh reading in registers 0 (low word) and 1 (high word), and the voltage reading in register 2.

Table 4-1 User Assignable Registers

Register contents	Address	Type	Direction	Range
User definable data 0	0	INT16	①	①
User definable data 1	1	INT16	①	①
User definable data 2	2	INT16	①	①
…	…	…	…	…
User definable data 119	119	INT16	①	①

① - depends on the mapped register

Table 4-2 User Assignable Register Map

Register contents	Address	Type	Direction	Range
Register address for user data 0	120	UINT16	R/W	240 to 9999
Register address for user data 1	121	UINT16	R/W	240 to 9999
Register address for user data 2	122	UINT16	R/W	240 to 9999
…	…	…	…	…
Register address for user data 119	239	UINT16	R/W	240 to 9999

5 POWERMETER REGISTERS DESCRIPTION

5.1 Basic Data Registers

Table 5-1 Basic Data Registers

Parameter	Register	Type	R/W	Unit ②	Scale ①		Con-version
					Low	High	
Voltage L1/L12 ⑥	256	UINT16	R	0.1V/1V	0	Vmax	LIN3
Voltage L2/L23 ⑥	257	UINT16	R	0.1V/1V	0	Vmax	LIN3
Voltage L3/L31 ⑥	258	UINT16	R	0.1V/1V	0	Vmax	LIN3
Current L1	259	UINT16	R	0.01A	0	Imax	LIN3
Current L2	260	UINT16	R	0.01A	0	Imax	LIN3
Current L3	261	UINT16	R	0.01A	0	Imax	LIN3
kW L1	262	UINT16	R	0.001kW/1kW	-Pmax	Pmax	LIN3
kW L2	263	UINT16	R	0.001kW/1kW	-Pmax	Pmax	LIN3
kW L3	264	UINT16	R	0.001kW/1kW	-Pmax	Pmax	LIN3
kvar L1	265	UINT16	R	0.001kvar/1kvar	-Pmax	Pmax	LIN3
kvar L2	266	UINT16	R	0.001kvar/1kvar	-Pmax	Pmax	LIN3
kvar L3	267	UINT16	R	0.001kvar/1kvar	-Pmax	Pmax	LIN3
kVA L1	268	UINT16	R	0.001kVA/1kVA	-Pmax	Pmax	LIN3
kVA L2	269	UINT16	R	0.001kVA/1kVA	-Pmax	Pmax	LIN3
kVA L3	270	UINT16	R	0.001kVA/1kVA	-Pmax	Pmax	LIN3
Power factor L1	271	UINT16	R	0.001	-1.000	1.000	LIN3
Power factor L2	272	UINT16	R	0.001	-1.000	1.000	LIN3
Power factor L3	273	UINT16	R	0.001	-1.000	1.000	LIN3
Total power factor	274	UINT16	R	0.001	-1.000	1.000	LIN3
Total kW	275	UINT16	R	0.001kW/1kW	-Pmax	Pmax	LIN3
Total kvar	276	UINT16	R	0.001kvar/1kvar	-Pmax	Pmax	LIN3
Total kVA	277	UINT16	R	0.001kVA/1kVA	-Pmax	Pmax	LIN3
Neutral current	278	UINT16	R	0.01A	0	Imax	LIN3
Frequency	279	UINT16	R	0.01Hz	45.00	65.00	LIN3
Max. sliding window kW demand ⑤	280	UINT16	R/W	0.001kW/1kW	-Pmax	Pmax	LIN3
Accumulated kW demand	281	UINT16	R/W	0.001kW/1kW	-Pmax	Pmax	LIN3
Max. sliding window kVA demand ⑤	282	UINT16	R/W	0.001kVA/1kVA	-Pmax	Pmax	LIN3
Accumulated kVA demand	283	UINT16	R/W	0.001kVA/1kVA	-Pmax	Pmax	LIN3
Max. ampere demand L1	284	UINT16	R/W	0.01A	0	Imax	LIN3
Max. ampere demand L2	285	UINT16	R/W	0.01A	0	Imax	LIN3
Max. ampere demand L3	286	UINT16	R/W	0.01A	0	Imax	LIN3
kWh import (low)	287	UINT16	R/W	1kWh	0	9999	NONE
kWh import (high)	288	UINT16	R/W	10,000 kWh	0	9999	NONE
kWh export (low)	289	UINT16	R/W	1kWh	0	9999	NONE
kWh export (high)	290	UINT16	R/W	10,000 kWh	0	9999	NONE
+kvarh net (low) ③	291	UINT16	R/W	1kvarh	0	9999	NONE
+kvarh net (high) ③	292	UINT16	R/W	10,000 kvarh	0	9999	NONE
-kvarh net (low) ④	293	UINT16	R/W	1kvarh	0	9999	NONE
-kvarh net (high) ④	294	UINT16	R/W	10,000 kvarh	0	999	NONE
Voltage THD L1/L12	295	UINT16	R	0.1%	0	999.9	LIN3
Voltage THD L2/L23	296	UINT16	R	0.1%	0	999.9	LIN3
Voltage THD L3/L31	297	UINT16	R	0.1%	0	999.9	LIN3
Current THD L1	298	UINT16	R	0.1%	0	999.9	LIN3
Current THD L2	299	UINT16	R	0.1%	0	999.9	LIN3
Current THD L3	300	UINT16	R	0.1%	0	999.9	LIN3
kVAh (low)	301	UINT16	R/W	1kVAh	0	9999	NONE
kVAh (high)	302	UINT16	R/W	10,000 kVAh	0	9999	NONE
Present sliding window kW demand ⑤	303	UINT16	R	0.001kW/1kW	-Pmax	Pmax	LIN3
Present sliding window kVA demand ⑤	304	UINT16	R	0.001kVA/1kVA	-Pmax	Pmax	LIN3
PF at maximum kVA siding window demand	305	UINT16	R	0.001	-1.000	1.000	LIN3
Current TDD L1	306	UINT16	R	0.1%	0	100.0	LIN3
Current TDD L2	307	UINT16	R	0.1%	0	100.0	LIN3
Current TDD L3	308	UINT16	R	0.1%	0	100.0	LIN3

① The parameter limits are as follows:

Imax (20% over-range) = 1.2 × CT primary current [A]

Direct wiring (PT Ratio = 1):

Vmax (690 V input option) = 828.0 V
Vmax (120 V input option) = 144.0 V
Pmax = (Imax × Vmax × 3) [kW x 0.001] if wiring mode is 4LN3 or 3LN3
Pmax = (Imax × Vmax × 2) [kW x 0.001] if wiring mode is 4LL3, 3OP2, 3DIR2, 3OP3, 3LL3 or 2LL1

Wiring via PTs (PT Ratio > 1):

Vmax (690 V input option) = 144 × PT Ratio [V]
Vmax (120 V input option) = 144 × PT Ratio [V]
Pmax = (Imax × Vmax × 3)/1000 [MW x 0.001] if wiring mode is 4LN3 or 3LN3
Pmax = (Imax × Vmax × 2)/1000 [MW x 0.001] if wiring mode is 4LL3, 3OP2, 3DIR2, 3OP3, 3LL3 or 2LL1

② When using direct wiring (PT Ratio = 1), voltages are transmitted in 0.1 V units, currents in 0.01 A units, and powers in 0.001 kW/kvar/kVA units. For wiring via PT (PT Ratio > 1), voltages are transmitted in 1V units, currents in 0.01 A units, and powers in 0.001 MW/Mvar/MVA units.

③ Positive readings of kvarh net

④ Negative readings of kvarh net

⑤ To get block interval demand readings, specify the number of demand periods equal to 1 (see Table 5-2)

⑥ When the 4LN3 or 3LN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.

NOTE Writing a zero to one of registers 280-286 causes reset of all maximum demands. Writing a zero to one of registers 287-294 and 301-302 causes reset of all accumulated energies.

5.2 Basic Setup

Table 5-2 Basic Setup Registers

Parameter	Register	Type	R/W	Range
Wiring mode ①	2304	UINT16	R/W	0 = 3OP2, 1 = 4LN3, 2 = 3DIR2, 3 = 4LL3, 4 = 3OP3, 5 = 3LN3, 6 = 3LL3, 7 = 2LL1
PT ratio	2305	UINT16	R/W	10 to 65000 × 0.1
CT primary current	2306	UINT16	R/W	1 to 6500 A
Power demand period	2307	UINT16	R/W	1,2,5,10,15,20,30,60 min, 255 = external synchronization ②
Volt/ampere demand period	2308	UINT16	R/W	0 to 1800 sec
Averaging buffer size	2309	UINT16	R/W	8, 16, 32
Reset enable/disable	2310	UINT16	R/W	0 = disable, 1 = enable
Reserved	2311	UINT16	R	Read as 65535
The number of demand periods	2312	UINT16	R/W	1 to 15
Reserved	2313	UINT16	R	Read as 65535
Reserved	2314	UINT16	R	Read as 65535
Nominal frequency	2315	UINT16	R/W	50, 60 Hz
Maximum demand load current	2316	UINT16	R/W	0 to 6500 A (0 = CT primary current)

① The wiring mode options are as follows:

3OP2 - 3-wire open delta using 2 CTs (2 element)
4LN3 - 4-wire WYE using 3 PTs (3 element), line-to-neutral voltage readings
3DIR2 - 3-wire direct connection using 2 CTs (2 element)
4LL3 - 4-wire WYE using 3 PTs (3 element), line-to-line voltage readings
3OP3 - 3-wire open delta using 3 CTs (2 1/2 element)
3LN3 - 4-wire WYE using 2 PTs (2 1/2 element), line-to-neutral voltage readings
3LL3 - 4-wire WYE using 2 PTs (2 1/2 element), line-to-line voltage readings
2LL1 - 2-wire line-to-line connection using 1 PT (1 element)

② Synchronization of power demand interval can be made through a digital input or via communications using the Synchronize power demand interval command (see Table 5-5).

NOTE

WIRING MODE, PT RATIO and CT PRIMARY CURRENT are protected from being changed while the PFC is running. Writing to these locations will result in a negative response with the exception code 01 (illegal operation).

5.3 User Selectable Options Setup

Table 5-3 User Selectable Options Registers

Parameter	Register	Type	R/W	Range
Power calculation mode	2376	UINT16	R/W	0 = using reactive power, 1 = using non-active power
Energy roll value ①	2377	UINT16	R/W	0 = 1×10^4 1 = 1×10^5 2 = 1×10^6 3 = 1×10^7 4 = 1×10^8
Phase energy calculation mode	2378	UINT16	R/W	0 = disable, 1 = enable

① For short energy registers (see Table 5-1), the maximum roll value will be 1×10^8 for positive readings and 1×10^7 for negative readings.

5.4 Communications Setup

Table 5-4 Communications Setup Registers

Parameter	Register	Type	R/W	Range
Reserved	2344	UINT16	R	Read as 65535
Reserved	2345	UINT16	R	Read as 65535
Address	2346	UINT16	R/W	1 to 247
Baud rate	2347	UINT16	R/W	0 = 110 bps 1 = 300 bps 2 = 600 bps 3 = 1200 bps 4 = 2400 bps 5 = 4800 bps 6 = 9600 bps 7 = 19200 bps
Data format	2348	UINT16	R/W	1 = 8 bits/no parity 2 = 8 bits/even parity

When changing the instrument address, baud rate or data format, the new communications parameters will take effect 100 ms after the instrument responds to the master's request.

5.5 Reset/Synchronization Registers

Table 5-5 Reset/Synchronization Registers

Register function	Register	Type	R/W	Reset value
Clear total energy registers	3404	UINT16	W	0
Clear total maximum demand registers	3405	UINT16	W	0 = all maximum demands 1 = power demands 2 = volt/ampere demands
Reserved	3406- 3407	UINT16 UINT16		
Clear event/time counters	3408	UINT16	W	0 = all counters 1-4 = counter #1 - #4
Clear Min/Max log	3409	UINT16	W	0
Reserved	3410-3419	UINT16		
Synchronize power demand interval ①	3420	UINT16	W	0
Clear PFC relay operation counters	3421	UINT16	W	0 = all PFC operation counters 1-8 = counter #1 - #8

① 1) If the power demand period is set to External Synchronization (see Table 5-2), writing a zero to this location will simulate an external synchronization pulse denoting the start of the next demand interval. The synchronization requests should not follow in intervals of less than 30 seconds, or the request will be rejected. This function is not permitted if the external synchronization is implemented by hardware, i.e., the digital input is configured as an external synchronization pulse input.

2) If the power demand period is specified in minutes, writing a zero to this location provides synchronization of the instrument's internal timer with the time of reception of the master's request. If the time expired from the beginning

of the current demand interval is more than 30 seconds, the new demand interval starts immediately, otherwise synchronization is delayed until the next demand interval.

5.6 Instrument Status

Table 5-6 Instrument Status Registers

Parameter	Register	Type	R/W	Range
Instrument reset register ①	2560	UINT16	R/W	0 (when read) 65535 (when written) = reset the instrument
Reserved	2561	UINT16	R	Read as 0
Relay status	2562	UINT16	R	see Table 5-7
Reserved	2563	UINT16	R	Read as 0
Status inputs	2564	UINT16	R	see Table 5-11
Firmware version number	2565	UINT16	R	0-65535
Instrument options 1	2566	UINT16	R	see Table 5-8
Instrument options 2	2567	UINT16	R	see Table 5-8

① Writing a value of 65535 into register 2560 will cause the instrument to perform a warm restart.

Table 5-7 Relay Status

Bit number	Description
0	Relay #8 status
1	Relay #7 status
2	Relay #6 status
3	Relay #5 status
4	Relay #4 status
5	Relay #3 status
6	Relay #2 status
7	Relay #1 status
8-15	Not used (permanently set to 0)

Bit meaning: 0 = relay is energized, 1 = relay is not energized

Table 5-8 Instrument Options

Options register	Bit	Description
Options1	0	120V option
	1	690V option
	2-5	Reserved
	6	Analog output 0/4-20 mA
	7-8	Reserved
	9	Relays option
	10	Digital input option
	11-15	Reserved
Options 2	0-2	Number of relays - 1
	3-6	Number of digital inputs - 1
	7-15	Reserved

5.7 Extended Status

Table 5-9 Extended Status Registers

Register description	Register	Type	R/W	Value range
Relay status	3452	UINT16	R	see Table 5-10
Reserved	3453	UINT16	R	Read as 0
Status inputs	3454	UINT16	R	see Table 5-11
Setpoints status	3455	UINT16	R	see Table 5-12
Log status	3456	UINT16	R	see Table 5-13
Reserved	3457-3473	UINT16	R	Read as 0
Setpoint alarm status	3474	UINT16	R/W	see Table 5-14
Self-check diagnostics	3475	UINT16	R/W	see Table 5-15
Reserved	3476-3485	UINT16	R	Read as 0

Register description	Register	Type	R/W	Value range
PFC operating mode	3486	UINT16	R	0 = OFF 1 = AUTO 1 (self adapting mode) 2 = AUTO 2 (optimizing mode) 3 = Manual 4 = Shut Down
PFC status	3487	UINT16	R	see Table 5-16

Table 5-10 Relay Status

Bit	Description
0	Relay #1 status
1	Relay #2 status
2	Relay #3 status
3	Relay #4 status
4	Relay #5 status
5	Relay #6 status
6	Relay #7 status
7	Relay #8 status
8-15	Not used (permanently set to 0)

Bit meaning: 0 = relay is not energized, 1 = relay is energized

Table 5-11 Status Inputs

Bit	Description
0	Status input
1-15	Not used (permanently set to 0)

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

Table 5-12 Setpoints Status

Bit	Description
0	Setpoint # 1 status
1	Setpoint # 2 status
2	Setpoint # 3 status
3	Setpoint # 4 status
4	Setpoint # 5 status
5	Setpoint # 6 status
6	Setpoint # 7 status
7	Setpoint # 8 status
8	Setpoint # 9 status
9	Setpoint # 10 status
10	Setpoint # 11 status
11	Setpoint # 12 status
12	Setpoint # 13 status
13	Setpoint # 14 status
14	Setpoint # 15 status
15	Setpoint # 16 status

Bit meaning: 0 = setpoint is released, 1 = setpoint is operated

Table 5-13 Log Status

Bit	Description
0	Reserved
1	New Min/Max Log
2-15	Not used (permanently set to 0)

Bit meaning: 0 = no new logs, 1 = new log recorded (the new log flag is reset when the user reads the first log record after the flag has been set)

Table 5-14 Setpoint Alarm Status

Bit	Description
0	Alarm #1
1	Alarm #2
2	Alarm #3
3	Alarm #4
4	Alarm #5
5	Alarm #6
6	Alarm #7
7	Alarm #8
8	Alarm #9
9	Alarm #10
10	Alarm #11
11	Alarm #12
12	Alarm #13
13	Alarm #14
14	Alarm #15
15	Alarm #16

Bit meaning: 1 = setpoint has been operated

The setpoint alarm register stores the status of the operated setpoints by setting the appropriate bits to 1. The alarm status bits can be reset all together by writing zero to the setpoint alarm register. It is possible to reset each alarm status bit separately by writing back the contents of the alarm register with a corresponding alarm bit set to 0.

Table 5-15 Self-check Diagnostics

Bit	Description
0	Reserved
1	Reserved
2	RAM error
3	Watchdog timer reset
4	Sampling failure
5	Hardware exception
6	Reserved
7	Software exception
8	Loss of power (power up)
9	External reset (warm restart)
10	Configuration corrupted
11-15	Reserved

The self-check diagnostics register indicates possible problems with the instrument hardware or setup configuration. The hardware problems are indicated by the appropriate bits, which are set whenever the instrument fails self-test diagnostics, or in the event of loss of power. The setup configuration problems are indicated by the dedicated bit, which is set when either configuration register is corrupted. In this event, the instrument will use the default configuration. The configuration corrupt bit may also be set as a result of the legal changes in the setup configuration since the instrument might implicitly change or clear other setups if they are affected by the changes made.

Hardware fault bits can be reset by writing zero to the self-check diagnostics register. The configuration corrupt status bit is also reset automatically when you change setup either via the front panel or through communications.

Table 5-16 PFC Status

Code	Status	Meaning
0	Ready	A switching program is complete
1	Alarm	Operations are stopped by an alarm setpoint
2	Busy	Waiting for a switching delay
3	Low power	Insufficient reactive power to trigger PFC
4	Excessive inductive load (automatic mode)	Non-compensated inductive load
5	Excessive capacitive load (automatic mode)	Non-compensated capacitive load
6	Full (manual mode)	All capacitor banks are switched in
7	Idle (manual mode)	All capacitor banks are switched off
8	OFF	The PFC is switched off

5.8 Extended Data Registers

The following table lists all registers containing the data measured by the instrument. Notice that these registers are arranged into groups, which are not located at adjacent addresses. You can re-map these registers into adjacent addresses to access multiple data from different data groups by using a single request. Refer to Section 2.9 for information on the user assignable registers.

Along with the register address, the table shows for each data item its point identifier (ID). This is a one word containing a data group ID in the high byte and the parameter offset in a group in the low byte. Point IDs are used to specify input or output parameters whenever a data parameter specification is needed, for example, when selecting analog output parameters or reading Min/Max log records.

Table 5-17 Extended Data Registers

Parameter	UINT16		INT32	Point ID	R/W	Unit②	Range/Scale①	
	Reg.	Conv.					Low	High
None								
None	6656		11776-11777	0	R		0	0
Status inputs								
Status inputs (see Table 5-11)	6896		12544-12545	0x0600	R		0	3
Relays								
Relay status (see Table 5-10)	6976		12800-12801	0x0800	R		0	3
Event/time counters								
Counter #1	7056 7057		13056-13057	0x0A00	R/W		0	99999
Counter #2	7058 7059		13058-13059	0x0A01	R/W		0	99999
Counter #3	7060 7061		13060-13061	0x0A02	R/W		0	99999
Counter #4	7062 7063		13062-13063	0x0A03	R/W		0	99999
PFC relay operation (switching cycles) counters								
Relay operation counter #1	7064 7065		13064-13065	0x0A03	R/W		0	99999
Relay operation counter #2	7066 7067		13066-13067	0x0A04	R/W		0	99999
Relay operation counter #3	7068 7069		13068-13069	0x0A05	R/W		0	99999
Relay operation counter #4	7070 7071		13070-13071	0x0A06	R/W		0	99999
Relay operation counter #5	7072 7073		13072-13073	0x0A07	R/W		0	99999
Relay operation counter #6	7074 7075		13074-13075	0x0A08	R/W		0	99999
Relay operation counter #7	7076 7077		13076-13077	0x0A09	R/W		0	99999
Relay operation counter #8	7078 7079		13078-13079	0x0A0A	R/W		0	99999
Real-time values per phase								
Voltage L1/L12 ⑥	7136	LIN3	13312-13313	0x0C00	R	0.1V/1V	0	Vmax
Voltage L2/L23 ⑥	7137	LIN3	13314-13315	0x0C01	R	0.1V/1V	0	Vmax
Voltage L3/L31 ⑥	7138	LIN3	13316-13317	0x0C02	R	0.1V/1V	0	Vmax
Current L1	7139	LIN3	13318-13319	0x0C03	R	0.01A	0	Imax
Current L2	7140	LIN3	13320-13321	0x0C04	R	0.01A	0	Imax
Current L3	7141	LIN3	13322-13323	0x0C05	R	0.01A	0	Imax
kW L1	7142	LIN3	13324-13325	0x0C06	R	0.001kW/1kW	-Pmax	Pmax
kW L2	7143	LIN3	13326-13327	0x0C07	R	0.001kW/1kW	-Pmax	Pmax
kW L3	7144	LIN3	13328-13329	0x0C08	R	0.001kW/1kW	-Pmax	Pmax
kvar L1	7145	LIN3	13330-13331	0x0C09	R	0.001kvar/1kvar	-Pmax	Pmax
kvar L2	7146	LIN3	13332-13333	0x0C0A	R	0.001kvar/1kvar	-Pmax	Pmax
kvar L3	7147	LIN3	13334-13335	0x0C0B	R	0.001kvar/1kvar	-Pmax	Pmax
kVA L1	7148	LIN3	13336-13337	0x0C0C	R	0.001kVA/1kVA	0	Pmax
kVA L2	7149	LIN3	13338-13339	0x0C0D	R	0.001kVA/1kVA	0	Pmax
kVA L3	7150	LIN3	13340-13341	0x0C0E	R	0.001kVA/1kVA	0	Pmax

Parameter	UINT16		INT32	Point	R/W	Unit②	Range/Scale①	
	Reg.	Conv.		ID			Low	High
Power factor L1	7151	LIN3	13342-13343	0x0C0F	R	0.001	-1.000	1.000
Power factor L2	7152	LIN3	13344-13345	0x0C10	R	0.001	-1.000	1.000
Power factor L3	7153	LIN3	13346-13347	0x0C11	R	0.001	-1.000	1.000
Voltage THD L1/L12	7154	LIN3	13348-13349	0x0C12	R	0.1%	0	999.9
Voltage THD L2/L23	7155	LIN3	13350-13351	0x0C13	R	0.1%	0	999.9
Voltage THD L3/L31	7156	LIN3	13352-13353	0x0C14	R	0.1%	0	999.9
Current THD L1	7157	LIN3	13354-13355	0x0C15	R	0.1%	0	999.9
Current THD L2	7158	LIN3	13356-13357	0x0C16	R	0.1%	0	999.9
Current THD L3	7159	LIN3	13358-13359	0x0C17	R	0.1%	0	999.9
K-Factor L1	7160	LIN3	13360-13361	0x0C18	R	0.1	1.0	999.9
K-Factor L2	7161	LIN3	13362-13363	0x0C19	R	0.1	1.0	999.9
K-Factor L3	7162	LIN3	13364-13365	0x0C1A	R	0.1	1.0	999.9
Current TDD L1	7163	LIN3	13366-13367	0x0C1B	R	0.1%	0	100.0
Current TDD L2	7164	LIN3	13368-13369	0x0C1C	R	0.1%	0	100.0
Current TDD L3	7165	LIN3	13370-13371	0x0C1D	R	0.1%	0	100.0
Voltage L12	7166	LIN3	13372-13373	0x0C1E	R	0.1V/1V	0	Vmax
Voltage L23	7167	LIN3	13374-13375	0x0C1F	R	0.1V/1V	0	Vmax
Voltage L31	7168	LIN3	13376-13377	0x0C20	R	0.1V/1V	0	Vmax
Real-time total values								
Total kW	7256	LIN3	13696-13697	0x0F00	R	0.001kW/1kW	-Pmax	Pmax
Total kvar	7257	LIN3	13698-13699	0x0F01	R	0.001kvar/1kvar	-Pmax	Pmax
Total kVA	7258	LIN3	13700-13701	0x0F02	R	0.001kVA/1kVA	0	Pmax
Total PF	7259	LIN3	13702-13703	0x0F03	R	0.001	-1.000	1.000
Total PF lag	7260	LIN3	13704-13705	0x0F04	R	0.001	-1.000	1.000
Total PF lead	7261	LIN3	13706-13707	0x0F05	R	0.001	-1.000	1.000
Total kW import	7262	LIN3	13708-13709	0x0F06	R	0.001kW/1kW	0	Pmax
Total kW export	7263	LIN3	13710-13711	0x0F07	R	0.001kW/1kW	0	Pmax
Total kvar import	7264	LIN3	13712-13713	0x0F08	R	0.001kvar/1kvar	0	Pmax
Total kvar export	7265	LIN3	13714-13715	0x0F09	R	0.001kvar/1kvar	0	Pmax
Real-time auxiliary values								
Reserved	7296		13824-13825	0x1000	R		0	0
Neutral current	7297	LIN3	13826-13827	0x1001	R	0.01A	0	Imax
Frequency ③	7298	LIN3	13828-13829	0x1002	R	0.01Hz	0	100.00
Voltage unbalance	7299	LIN3	13830-13831	0x1003	R	1%	0	300
Current unbalance	7300	LIN3	13832-13833	0x1004	R	1%	0	300
Average values per phase								
Voltage L1/L12 ⑥	7336	LIN3	13952-13953	0x1100	R	0.1V/1V	0	Vmax
Voltage L2/L23 ⑥	7337	LIN3	13954-13955	0x1101	R	0.1V/1V	0	Vmax
Voltage L3/L31 ⑥	7338	LIN3	13956-13957	0x1102	R	0.1V/1V	0	Vmax
Current L1	7339	LIN3	13958-13959	0x1103	R	0.01A	0	Imax
Current L2	7340	LIN3	13960-13961	0x1104	R	0.01A	0	Imax
Current L3	7341	LIN3	13962-13963	0x1105	R	0.01A	0	Imax
kW L1	7342	LIN3	13964-13965	0x1106	R	0.001kW/1kW	-Pmax	Pmax
kW L2	7343	LIN3	13966-13967	0x1107	R	0.001kW/1kW	-Pmax	Pmax
kW L3	7344	LIN3	13968-13969	0x1108	R	0.001kW/1kW	-Pmax	Pmax
kvar L1	7345	LIN3	13970-13971	0x1109	R	0.001kvar/1kvar	-Pmax	Pmax
kvar L2	7346	LIN3	13972-13973	0x110A	R	0.001kvar/1kvar	-Pmax	Pmax
kvar L3	7347	LIN3	13974-13975	0x110B	R	0.001kvar/1kvar	-Pmax	Pmax
kVA L1	7348	LIN3	13976-13977	0x110C	R	0.001kVA/1kVA	0	Pmax
kVA L2	7349	LIN3	13978-13979	0x110D	R	0.001kVA/1kVA	0	Pmax
kVA L3	7350	LIN3	13980-13981	0x110E	R	0.001kVA/1kVA	0	Pmax
Power factor L1	7351	LIN3	13982-13983	0x110F	R	0.001	-1.000	1.000
Power factor L2	7352	LIN3	13984-13985	0x1110	R	0.001	-1.000	1.000
Power factor L3	7353	LIN3	13986-13987	0x1111	R	0.001	-1.000	1.000
Voltage THD L1/L12	7354	LIN3	13988-13989	0x1112	R	0.1%	0	999.9
Voltage THD L2/L23	7355	LIN3	13990-13991	0x1113	R	0.1%	0	999.9
Voltage THD L3/L31	7356	LIN3	13992-13993	0x1114	R	0.1%	0	999.9
Current THD L1	7357	LIN3	13994-13995	0x1115	R	0.1%	0	999.9
Current THD L2	7358	LIN3	13996-13997	0x1116	R	0.1%	0	999.9
Current THD L3	7359	LIN3	13998-13999	0x1117	R	0.1%	0	999.9
K-Factor L1	7360	LIN3	14000-14001	0x1118	R	0.1	1.0	999.9
K-Factor L2	7361	LIN3	14002-14003	0x1119	R	0.1	1.0	999.9
K-Factor L3	7362	LIN3	14004-14005	0x111A	R	0.1	1.0	999.9
Current TDD L1	7363	LIN3	14006-14007	0x111B	R	0.1%	0	100.0
Current TDD L2	7364	LIN3	14008-14009	0x111C	R	0.1%	0	100.0

Parameter	UINT16		INT32	Point	R/W	Unit②	Range/Scale①	
	Reg.	Conv.		ID			Low	High
Current TDD L3	7365	LIN3	14010-14011	0x111D	R	0.1%	0	100.0
Voltage L12	7366	LIN3	14012-14013	0x111E	R	0.1V/1V	0	Vmax
Voltage L23	7367	LIN3	14014-14015	0x111F	R	0.1V/1V	0	Vmax
Voltage L31	7368	LIN3	14016-14017	0x1120	R	0.1V/1V	0	Vmax
Average total values								
Total kW	7456	LIN3	14336-14337	0x1400	R	0.001kW/1kW	-Pmax	Pmax
Total kvar	7457	LIN3	14338-14339	0x1401	R	0.001kvar/1kvar	-Pmax	Pmax
Total kVA	7458	LIN3	14340-14341	0x1402	R	0.001kVA/1kVA	0	Pmax
Total PF	7459	LIN3	14342-14343	0x1403	R	0.001	-1.000	1.000
Total PF lag	7460	LIN3	14344-14345	0x1404	R	0.001	-1.000	1.000
Total PF lead	7461	LIN3	14346-14347	0x1405	R	0.001	-1.000	1.000
Total kW import	7462	LIN3	14348-14349	0x1406	R	0.001kW/1kW	0	Pmax
Total kW export	7463	LIN3	14350-14351	0x1407	R	0.001kW/1kW	0	Pmax
Total kvar import	7464	LIN3	14352-14353	0x1408	R	0.001kvar/1kvar	0	Pmax
Total kvar export	7465	LIN3	14354-14355	0x1409	R	0.001kvar/1kvar	0	Pmax
Average auxiliary values								
Reserved	7496		14464-14465	0x1500	R		0	0
Neutral current	7497	LIN3	14466-14467	0x1501	R	0.01A	0	Imax
Frequency ③	7498	LIN3	14468-14469	0x1502	R	0.01Hz	0	100.00
Voltage unbalance	7499	LIN3	14470-14471	0x1503	R	1%	0	300
Current unbalance	7500	LIN3	14472-14473	0x1504	R	1%	0	300
Present demands								
Volt demand L1/L12 ⑥	7536	LIN3	14592-14593	0x1600	R	0.1V/1V	0	Vmax
Volt demand L2/L23 ⑥	7537	LIN3	14594-14595	0x1601	R	0.1V/1V	0	Vmax
Volt demand L3/L31 ⑥	7538	LIN3	14596-14597	0x1602	R	0.1V/1V	0	Vmax
Ampere demand L1	7539	LIN3	14598-14599	0x1603	R	0.01A	0	Imax
Ampere demand L2	7540	LIN3	14600-14601	0x1604	R	0.01A	0	Imax
Ampere demand L3	7541	LIN3	14602-14603	0x1605	R	0.01A	0	Imax
Block kW demand	7542	LIN3	14604-14605	0x1606	R	0.001kW/1kW	0	Pmax
Reserved	7543		14606-14607	0x1607	R		0	0
Block kVA demand	7544	LIN3	14608-14609	0x1608	R	0.001kVA/1kVA	0	Pmax
Sliding window kW demand	7545	LIN3	14610-14611	0x1609	R	0.001kW/1kW	0	Pmax
Reserved	7546		14612-14613	0x160A	R		0	0
Sliding window kVA demand	7547	LIN3	14614-14615	0x160B	R	0.001kVA/1kVA	0	Pmax
Reserved	7548		14616-14617	0x160C	R		0	0
Reserved	7549		14618-14619	0x160D	R		0	0
Reserved	7550		14620-14621	0x160E	R		0	0
Accumulated kW demand (import)	7551	LIN3	14622-14623	0x160F	R	0.001kW/1kW	0	Pmax
Reserved	7552		14624-14625	0x1610	R		0	0
Accumulated kVA demand	7553	LIN3	14626-14627	0x1611	R	0.001kVA/1kVA	0	Pmax
Predicted sliding window kW demand (import)	7554	LIN3	14628-14629	0x1612	R	0.001kW/1kW	0	Pmax
Reserved	7555		14630-14631	0x1613	R		0	0
Predicted sliding window kVA demand	7556	LIN3	14632-14633	0x1614	R	0.001kVA/1kVA	0	Pmax
PF at maximum kVA sliding window demand	7557	LIN3	14634-14635	0x1615	R	0.001	-1.000	1.000
Total energies								
kWh import	7576 7577		14720-14721	0x1700	R	kWh	0	10^8-1
kWh export ⑤	7578 7579		14722-14723	0x1701	R	kWh	0	10^8-1
Reserved	7580 7581		14724-14725	0x1702	R		0	0
Reserved	7582 7583		14726-14727	0x1703	R		0	0
kvarh import	7584 7585		14728-14729	0x1704	R	kvarh	0	10^8-1
kvarh export ⑤	7586 7587		14730-14731	0x1705	R	kvarh	0	10^8-1
Reserved	7588 7589		14732-14733	0x1706	R		0	0
Reserved	7590 7591		14734-14735	0x1707	R		0	0

Parameter	UINT16		INT32	Point ID	R/W	Unit②	Range/Scale①	
	Reg.	Conv.					Low	High
kVAh total	7592 7593		14736-14737	0x1708	R	kVAh	0	10^8-1
Phase energies								
kWh import L1	7616 7617		14848-14849	0x1800	R	kWh	0	10^8-1
kWh import L2	7618 7619		14850-14851	0x1801	R	kWh	0	10^8-1
kWh import L3	7620 7621		14852-14853	0x1802	R	kWh	0	10^8-1
kvarh import L1	7622 7623		14854-14855	0x1803	R	kvarh	0	10^8-1
kvarh import L2	7624 7625		14856-14857	0x1804	R	kvarh	0	10^8-1
kvarh import L3	7626 7627		14858-14859	0x1805	R	kvarh	0	10^8-1
kVAh total L1	7628 7629		14860-14861	0x1806	R	kVAh	0	10^8-1
kVAh total L2	7630 7631		14862-14863	0x1807	R	kVAh	0	10^8-1
kVAh total L3	7632 7633		14864-14865	0x1808	R	kVAh	0	10^8-1
Fundamental's (H01) real-time values per phase								
Voltage L1/L12 ⑦	8296	LIN3	17024-17025	0x2900	R	0.1V/1V	0	Vmax
Voltage L2/L23 ⑦	8297	LIN3	17026-17027	0x2901	R	0.1V/1V	0	Vmax
Voltage L3/L31 ⑦	8298	LIN3	17028-17029	0x2902	R	0.1V/1V	0	Vmax
Current L1	8299	LIN3	17030-17031	0x2903	R	0.01A	0	Imax
Current L2	8300	LIN3	17032-17033	0x2904	R	0.01A	0	Imax
Current L3	8301	LIN3	17034-17035	0x2905	R	0.01A	0	Imax
kW L1	8302	LIN3	17036-17037	0x2906	R	0.001kW/1kW	-Pmax	Pmax
kW L2	8303	LIN3	17038-17039	0x2907	R	0.001kW/1kW	-Pmax	Pmax
kW L3	8304	LIN3	17040-17041	0x2908	R	0.001kW/1kW	-Pmax	Pmax
kvar L1	8305	LIN3	17042-17043	0x2909	R	0.001kvar/1kvar	-Pmax	Pmax
kvar L2	8306	LIN3	17044-17045	0x290A	R	0.001kvar/1kvar	-Pmax	Pmax
kvar L3	8307	LIN3	17046-17047	0x290B	R	0.001kvar/1kvar	-Pmax	Pmax
kVA L1	8308	LIN3	17048-17049	0x290C	R	0.001kVA/1kVA	0	Pmax
kVA L2	8309	LIN3	17050-17051	0x290D	R	0.001kVA/1kVA	0	Pmax
kVA L3	8310	LIN3	17052-17053	0x290E	R	0.001kVA/1kVA	0	Pmax
Power factor L1	8311	LIN3	17054-17055	0x290F	R	0.001	-1.000	1.000
Power factor L2	8312	LIN3	17056-17055	0x2910	R	0.001	-1.000	1.000
Power factor L3	8313	LIN3	17058-17059	0x2911	R	0.001	-1.000	1.000
Fundamental's (H01) real-time total values								
Total kW	8336	LIN3	17152-17153	0x2A00	R	0.001kW/1kW	-Pmax	Pmax
Total kvar	8337	LIN3	17154-17155	0x2A01	R	0.001kvar/1kvar	-Pmax	Pmax
Total kVA	8338	LIN3	17156-17157	0x2A02	R	0.001kVA/1kVA	0	Pmax
Total PF	8339	LIN3	17158-17159	0x2A03	R	0.001	-1.000	1.000
Minimum real-time values per phase (M)								
Voltage L1/L12 ⑥	8416	LIN3	17408-17409	0x2C00	R	0.1V/1V	0	Vmax
Voltage L2/L23 ⑥	8417	LIN3	17410-17411	0x2C01	R	0.1V/1V	0	Vmax
Voltage L3/L31 ⑥	8418	LIN3	17412-17413	0x2C02	R	0.1V/1V	0	Vmax
Current L1	8419	LIN3	17414-17415	0x2C03	R	0.01A	0	Imax
Current L2	8420	LIN3	17416-17417	0x2C04	R	0.01A	0	Imax
Current L3	8421	LIN3	17418-17419	0x2C05	R	0.01A	0	Imax
Minimum real-time total values (M)								
Total kW	8456	LIN3	17536-17537	0x2D00	R	0.001kW/1kW	-Pmax	Pmax
Total kvar	8457	LIN3	17538-17539	0x2D01	R	0.001kvar/1kvar	-Pmax	Pmax
Total kVA	8458	LIN3	17540-17541	0x2D02	R	0.001kVA/1kVA	0	Pmax
Total PF ④	8459	LIN3	17542-17543	0x2D03	R	0.001	0	1.000
Minimum real-time auxiliary values (M)								
Reserved	8496		17664-17665	0x2E00	R		0	0
Neutral current	8497	LIN3	17666-17667	0x2E01	R	0.01A	0	Imax
Frequency ③	8498	LIN3	17668-17669	0x2E02	R	0.01Hz	0	100.00
Maximum real-time values per phase (M)								
Voltage L1/L12 ⑥	8736	LIN3	18432-18433	0x3400	R	0.1V/1V	0	Vmax
Voltage L2/L23 ⑥	8737	LIN3	18434-18435	0x3401	R	0.1V/1V	0	Vmax

Parameter	UINT16		INT32	Point ID	R/W	Unit②	Range/Scale①	
	Reg.	Conv.					Low	High
Voltage L3/L31 ⑥	8738	LIN3	18436-18437	0x3402	R	0.1V/1V	0	Vmax
Current L1	8739	LIN3	18438-18439	0x3403	R	0.01A	0	Imax
Current L2	8740	LIN3	18440-18441	0x3404	R	0.01A	0	Imax
Current L3	8741	LIN3	18442-18443	0x3405	R	0.01A	0	Imax
Maximum real-time total values (M)								
Total kW	8776	LIN3	18560-18561	0x3500	R	0.001kW/1kW	-Pmax	Pmax
Total kvar	8777	LIN3	18562-18563	0x3501	R	0.001kvar/1kvar	-Pmax	Pmax
Total kVA	8778	LIN3	18564-18565	0x3502	R	0.001kVA/1kVA	0	Pmax
Total PF ④	8779	LIN3	18566-18567	0x3503	R	0.001	0	1.000
Maximum real-time auxiliary values (M)								
Reserved	8816		18688-18689	0x3600	R		0	
Neutral current	8817	LIN3	18680-18681	0x3601	R	0.01A	0	Imax
Frequency ③	8818	LIN3	18682-18683	0x3602	R	0.01Hz	0	100.00
Maximum demands (M)								
Max. volt demand L1/L12 ⑥	8856	LIN3	18816-18817	0x3700	R	0.1V/1V	0	Vmax
Max. volt demand L2/L23 ⑥	8857	LIN3	18818-18819	0x3701	R	0.1V/1V	0	Vmax
Max. volt demand L3/L31 ⑥	8858	LIN3	18820-18821	0x3702	R	0.1V/1V	0	Vmax
Max. ampere demand L1	8859	LIN3	18822-18823	0x3703	R	0.01A	0	Imax
Max. ampere demand L2	8860	LIN3	18824-18825	0x3704	R	0.01A	0	Imax
Max. ampere demand L3	8861	LIN3	18826-18827	0x3705	R	0.01A	0	Imax
Reserved	8862		18828-18829	0x3706	R		0	0
Reserved	8863		18830-18831	0x3707	R		0	0
Reserved	8864		18832-18833	0x3708	R		0	0
Max. sliding window kW demand (import)	8865	LIN3	18834-18835	0x3709	R	0.001kW/1kW	0	Pmax
Reserved	8866		18836-18837	0x370A	R		0	0
Max. sliding window kVA demand	8867	LIN3	18838-18839	0x370B	R	0.001kVA/1kVA	0	Pmax

① For the parameter limits, see note ① to Table 5-1.

② When using direct wiring (PT Ratio = 1), voltages are transmitted in 0.1 V units, currents in 0.01 A units, and powers in 0.001 kW/kvar/kVA units. For wiring via PTs (PT Ratio > 1), voltages are transmitted in 1V units, currents in 0.01 A units, and powers in 1 kW/kvar/kVA units.

③ The actual frequency range is 45.00 - 65.00 Hz.

④ Absolute min/max value (lag or lead).

⑤ The exported energy registers are read as positive unsigned long (32-bit) integers.

⑥ When the 4LN3 or 3LN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.

⑦ When the 4LN3, 4LL3 or 3LN3 wiring mode is selected, the harmonic voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages. The line-to-line harmonic voltages in the 3DIR2, 3LL3 and 2LL1 wiring modes, and the L31 harmonic voltage in the 3OP2 and 3OP3 wiring modes will be calculated accurately if the voltages are balanced.

(M) These parameters are logged to the Min/Max log

5.9 Analog Output Setup

Table 5-18 Analog Output Allocation Registers

Channel	Registers (see Table 5-19)
Channel #1	3148-3150

Table 5-19 Analog Channel Allocation Registers

Parameter	Offset	Type	R/W	Range
Output parameter ID	+0	UINT16	R/W	see Table 5-20
Zero scale (0-4 mA)	+1	UINT16	R/W	see Table 5-20
Full scale (1/20 mA)	+2	UINT16	R/W	see Table 5-20

Except for the signed power factor (see Note 3 to Table 5-20), the output scale is linear within the value range. The scale range will be inverted if the full scale specified is less than the zero scale.

Table 5-20 Analog Output Parameters

Output parameter	Point ID	Type	Unit ②	Scale ①		Con-version
				Low	High	
None						
None	0	UINT16		N/A	N/A	NONE
Real-time values per phase						
Voltage L1/L12 ⑤	0x0C00	UINT16	0.1V/1V	0	Vmax	LIN3
Voltage L2/L23 ⑤	0x0C01	UINT16	0.1V/1V	0	Vmax	LIN3
Voltage L3/L31 ⑤	0x0C02	UINT16	0.1V/1V	0	Vmax	LIN3
Current L1	0x0C03	UINT16	0.01A	0	Imax	LIN3
Current L2	0x0C04	UINT16	0.01A	0	Imax	LIN3
Current L3	0x0C05	UINT16	0.01A	0	Imax	LIN3
Real-time total values						
Total kW	0x0F00	UINT16	0.001kW/1kW	-Pmax	Pmax	LIN3
Total kvar	0x0F01	UINT16	0.001kvar/1kvar	-Pmax	Pmax	LIN3
Total kVA	0x0F02	UINT16	0.001kVA/1kVA	0	Pmax	LIN3
Total PF ④	0x0F03	UINT16	0.001	-1.000	1.000	LIN3
Total PF Lag	0x0F04	UINT16	0.001	0	1.000	LIN3
Total PF Lead	0x0F05	UINT16	0.001	0	1.000	LIN3
Real-time auxiliary values						
Frequency ③	0x1002	UINT16	0.01Hz	0	100.00	LIN3
Average values per phase						
Voltage L1/L12 ⑤	0x1100	UINT16	0.1V/1V	0	Vmax	LIN3
Voltage L2/L23 ⑤	0x1101	UINT16	0.1V/1V	0	Vmax	LIN3
Voltage L3/L31 ⑤	0x1102	UINT16	0.1V/1V	0	Vmax	LIN3
Current L1	0x1103	UINT16	0.01A	0	Imax	LIN3
Current L2	0x1104	UINT16	0.01A	0	Imax	LIN3
Current L3	0x1105	UINT16	0.01A	0	Imax	LIN3
Average total values						
Total kW	0x1400	UINT16	0.001kW/1kW	-Pmax	Pmax	LIN3
Total kvar	0x1401	UINT16	0.001kvar/1kvar	-Pmax	Pmax	LIN3
Total kVA	0x1402	UINT16	0.001kVA/1kVA	0	Pmax	LIN3
Total PF ④	0x1403	UINT16	0.001	-1.000	1.000	LIN3
Total PF Lag	0x1404	UINT16	0.001	0	1.000	LIN3
Total PF Lead	0x1405	UINT16	0.001	0	1.000	LIN3
Average auxiliary values						
Neutral current	0x1501	UINT16	0.01A	0	Imax	LIN3
Frequency ③	0x1502	UINT16	0.01Hz	0	100.00	LIN3
Present demands						
Accumulated kW demand (import)	0x160F	UINT16	0.001kW/1kW	0	Pmax	LIN3
Accumulated kVA demand	0x1611	UINT16	0.001kVA/1kVA	0	Pmax	LIN3

① For parameter limits, see note ① to Table 5-1.

② When using direct wiring (PT Ratio = 1), voltages are transmitted in 0.1 V units, currents in 0.01 A units, and powers in 0.001 kW/kvar/kVA units. For wiring via PTs (PT Ratio > 1), voltages are transmitted in 1V units, currents in 0.01 A units, and powers in 1 kW/kvar/kVA units.

③ The actual frequency range is 45.00 to 65.00 Hz

④ The output scale for signed (bi-directional) power factor is symmetrical with regard to ±1.000 and is linear from -0 to -1.000, and from 1.000 to +0 (note that -1.000 ≡ +1.000). Negative power factor is output as [-1.000 minus measured value], and non-negative power factor is output as [+1.000 minus measured value]. To define the entire range for power factor from -0 to +0, the scales would be specified as -0/0. Because of the fact that negative zero may not be transmitted, the value of -0.001 is used to specify the scale of -0, and both +0.001 and 0.000 are used to specify the scale of +0. To define the range of -0 to 0, you must send -0.001/0.001 or -0.001/0.

⑤ When the 4LN3 or 3LN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.

5.10 Digital Input Allocation

Table 5-21 Digital Input Allocation Registers

Parameter	Register	Type	R/W	Range
Status inputs allocation ①	3292	UINT16	R/W	see Table 5-22
Pulse inputs allocation ①	3293	UINT16	R/W	see Table 5-22
Not used ①	3294	UINT16	R/W	Read as 0
External synchronization pulse input allocation	3295	UINT16	R/W	see Table 5-22

① Writing to these locations is ignored. No error will occur.

NOTE

When a digital input is allocated for the external synchronization pulse, it is automatically configured as a pulse input, otherwise it is configured as a status input.

Table 5-22 Digital Input Allocation Mask

Bit	Description
0	Digital input allocation status
1-15	Not used (read as 0)

Bit meaning: 0 = input is not allocated, 1 = input is allocated to the group

5.11 Alarm/Event Setpoints

Table 5-23 Setpoint Registers

Setpoint	Setup registers (see Table 5-24)
Setpoint #1	2576-2583
Setpoint #2	2584-2591
Setpoint #3	2592-2599
Setpoint #4	2600-2607
Setpoint #5	2608-2615
Setpoint #6	2616-2623
Setpoint #7	2624-2631
Setpoint #8	2632-2639
Setpoint #9	2640-2647
Setpoint #10	2648-2655
Setpoint #11	2656-2663
Setpoint #12	2664-2671
Setpoint #13	2672-2679
Setpoint #14	2680-2687
Setpoint #15	2688-2695
Setpoint #16	2696-2703

Table 5-24 Setpoint Setup Registers

Parameter	Offset	Type	R/W	Range
Trigger parameter ID	+0	UINT16	R/W	see Table 5-25
Action	+1	UINT16	R/W	see Table 5-26
Operate delay	+2	UINT16	R/W	0-9999 (× 0.1 sec)
Release delay	+3	UINT16	R/W	0-9999 (× 0.1 sec)
Operate limit	+4, +5	INT32	R/W	see Table 5-25
Release limit	+6, +7	INT32	R/W	see Table 5-25

1. The setpoint is disabled when its trigger parameter is set to NONE. To disable the setpoint, write zero into this register.
2. When writing the setpoint registers (except the event when the setpoint is to be disabled), it is recommended to write all the setpoint registers using a single request, or disable the setpoint before writing into separate registers. Each value being written is checked for compatibility with the other setpoint parameters; if the new value does not conform to these, the request will be rejected.

3. Operate and release limits for the trigger parameters and their conversion scales are indicated in Table 5-25. Each limit value occupies two contiguous registers, the first of which (low word) contains the limit value, and the second (high word) is reserved for long parameters. This register is always read as zero. When written, its value is ignored.
4. Limits indicated in Table 5-25 by a N/A mark are read as zeros. When writing, they can be omitted or should be written as zeros.
5. When a setpoint action is directed to a relay allocated to output energy pulses, an attempt to re-allocate it for a setpoint will result in a negative response.

Table 5-25 Setpoint Trigger Parameters

Trigger parameter	Trigger ID	Type	Unit ②	Limit/scale ①		Con-version
				Low	High	
None						
None	0	UINT16		N/A	N/A	NONE
Status inputs						
Status input ON	0x0600	UINT16		N/A	N/A	NONE
Status input OFF	0x8600	UINT16		N/A	N/A	NONE
Phase reversal						
Positive phase rotation reversal ③	0x8901	UINT16		N/A	N/A	NONE
Negative phase rotation reversal ③	0x8902	UINT16		N/A	N/A	NONE
Fault triggers						
Device Fault (diagnostics error) ⑥	0x0907	UINT16		N/A	N/A	NONE
No-Volt ⑦	0x0908	UINT16		N/A	N/A	NONE
Uncompensated reactive power⑧	0x0909	UINT16		N/A	N/A	NONE
High/low real-time values on any phase						
High voltage ⑤	0x0E00	UINT16	0.1V/1V	0	Vmax	LIN3
Low voltage ⑤	0x8D00	UINT16	0.1V/1V	0	Vmax	LIN3
High current	0x0E01	UINT16	0.01A	0	Imax	LIN3
Low current	0x8D01	UINT16	0.01A	0	Imax	LIN3
High voltage THD	0x0E07	UINT16	0.1%	0	999.9	LIN3
High current THD	0x0E08	UINT16	0.1%	0	999.9	LIN3
High K-Factor	0x0E09	UINT16	0.1	1.0	999.9	LIN3
High current TDD	0x0E0A	UINT16	0.1%	0	100.0	LIN3
High L-L voltage	0x0E0B	UINT16	0.1V/1V	0	Vmax	LIN3
Low L-L voltage	0x8D0B	UINT16	0.1V/1V	0	Vmax	LIN3
High/low real-time auxiliary values						
High frequency ④	0x1002	UINT16	0.01Hz	0	100.00	LIN3
Low frequency ④	0x9002	UINT16	0.01Hz	0	100.00	LIN3
High/low average values per phase						
High current L1	0x1103	UINT16	0.01A	0	Imax	LIN3
High current L2	0x1104	UINT16	0.01A	0	Imax	LIN3
High current L3	0x1105	UINT16	0.01A	0	Imax	LIN3
Low current L1	0x9103	UINT16	0.01A	0	Imax	LIN3
Low current L2	0x9104	UINT16	0.01A	0	Imax	LIN3
Low current L3	0x9105	UINT16	0.01A	0	Imax	LIN3
High/low average values on any phase						
High voltage ⑤	0x1300	UINT16	0.1V/1V	0	Vmax	LIN3
Low voltage ⑤	0x9200	UINT16	0.1V/1V	0	Vmax	LIN3
High current	0x1301	UINT16	0.01A	0	Imax	LIN3
Low current	0x9201	UINT16	0.01A	0	Imax	LIN3
High L-L voltage	0x130B	UINT16	0.1V/1V	0	Vmax	LIN3
Low L-L voltage	0x920B	UINT16	0.1V/1V	0	Vmax	LIN3
High/low average total values						
High total kW import	0x1406	UINT16	0.001kW/1kW	-Pmax	Pmax	LIN3
High total kW export	0x1407	UINT16	0.001kW/1kW	-Pmax	Pmax	LIN3
High total kvar import	0x1408	UINT16	0.001kvar/1kvar	-Pmax	Pmax	LIN3
High total kvar export	0x1409	UINT16	0.001kvar/1kvar	-Pmax	Pmax	LIN3
High total kVA	0x1402	UINT16	0.001kVA/1kVA	0	Pmax	LIN3
Low total PF Lag	0x9404	UINT16	0.001	0	1.000	LIN3
Low total PF Lead	0x9405	UINT16	0.001	0	1.000	LIN3
High/low average auxiliary values						
High neutral current	0x1501	UINT16	0.01A	0	Imax	LIN3
High frequency ④	0x1502	UINT16	0.01Hz	0	100.00	LIN3
Low frequency ④	0x9502	UINT16	0.01Hz	0	100.00	LIN3
High present demands						
High volt demand L1/L12 ⑤	0x1600	UINT16	0.1V/1V	0	Vmax	LIN3

Trigger parameter	Trigger ID	Type	Unit ②	Limit/scale ①		Con-version
				Low	High	
High volt demand L2/L23 ⑤	0x1601	UINT16	0.1V/1V	0	Vmax	LIN3
High volt demand L3/L31 ⑤	0x1602	UINT16	0.1V/1V	0	Vmax	LIN3
High ampere demand L1	0x1603	UINT16	0.01A	0	Imax	LIN3
High ampere demand L2	0x1604	UINT16	0.01A	0	Imax	LIN3
High ampere demand L3	0x1605	UINT16	0.01A	0	Imax	LIN3
High block kW demand (import)	0x1606	UINT16	0.001kW/1kW	0	Pmax	LIN3
High block kVA demand	0x1608	UINT16	0.001kVA/1kVA	0	Pmax	LIN3
High sliding window kW demand (import)	0x1609	UINT16	0.001kW/1kW	0	Pmax	LIN3
High sliding window kVA demand	0x160B	UINT16	0.001kVA/1kVA	0	Pmax	LIN3
High accumulated kW demand (import)	0x160F	UINT16	0.001kW/1kW	0	Pmax	LIN3
High accumulated kVA demand	0x1611	UINT16	0.001kVA/1kVA	0	Pmax	LIN3
High predicted kW demand (import)	0x1612	UINT16	0.001kW/1kW	0	Pmax	LIN3
High predicted kVA demand	0x1614	UINT16	0.001kVA/1kVA	0	Pmax	LIN3

① For parameter limits, see note ① to Table 5-1.

② When using direct wiring (PT Ratio = 1), voltages are transmitted in 0.1 V units, currents in 0.01 A units, and powers in 0.001 kW/kvar/kVA units. For wiring via PTs (PT Ratio > 1), voltages are transmitted in 1V units, currents in 0.01 A units, and powers in 1 kW/kvar/kVA units.

③ The setpoint is operated when the actual phase sequence does not match the indicated phase rotation.

④ The actual frequency range is 45.00 - 65.00 Hz.

⑤ When the 4LN3 or 3LN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.

⑥ The Device Fault trigger is active when the self-diagnostics test detects a critical (unrecoverable) error. This could happen when a corrupted configuration setup or incompatible setup setting is detected. In this event, the device will reset the corrupted setup to default. The trigger is cleared when the setup is rewritten or device diagnostics is cleared either through the Status Information Menu, or through communications. When a non-critical error is detected, the device will only set a corresponding fault bit in the self-check diagnostics register and restart operations.

⑦ The No-Volt trigger is intended for the use as a fast setpoint override condition for PFC operations in order to protect the capacitor banks against voltage interruptions. When used with the Hard Switch-Off action, it can de-energize the output relays in approximately 25 ms. This avoids bringing the still charged capacitors back after the voltage is restored. When used with other setpoint actions, this trigger can provide the response time to alarm conditions at 25-75 ms.

⑧ The Uncompensated reactive power trigger is active when the device fails to bring the power factor or reactive power into the target setpoint range.

Table 5-26 Setpoint Actions

Action	ID
No action	0
Operate relay #1	0x3000
Operate relay #2	0x3001
Operate relay #3	0x3002
Operate relay #4	0x3003
Operate relay #5	0x3004
Operate relay #6	0x3005
Operate relay #7	0x3006
Operate relay #8	0x3007
Assert local alarm	0x3200
Hard switch-off (immediate release) of the PFC capacitor banks	0x3300
Soft switch-off (in turn release) of the PFC capacitor banks	0x3400
Stop (freeze) the automatic operation of the PFC	0x3500
Increment counter #1	0x4000
Increment counter #2	0x4001
Increment counter #3	0x4002
Increment counter #4	0x4003
Count operating time using counter #1 ①	0x4400
Count operating time using counter #2 ①	0x4401
Count operating time using counter #3 ①	0x4402
Count operating time using counter #4 ①	0x4403

① This action converts a common event counter to the time counter, which measures time at 0.1-hour resolution while the setpoint is in the operated state. Each time counter has a non-volatile shadow counter which counts time at 1-second resolution before the corresponding time counter is incremented.

5.12 Pulsing Setpoints

Table 5-27 Pulsing Registers

Relay	Setup registers (see Table 5-27)
Relay #1	2892-2893
Relay #2	2894-2895
Relay #3	2896-2897
Relay #4	2898-2899
Relay #5	2900-2901
Relay #6	2902-2903
Relay #7	2904-2905
Relay #8	2906-2907

Table 5-28 Pulsing Setup Registers

Parameter	Offset	Type	R/W	Range
Output parameter ID	+0	UINT16	R/W	see Table 5-28
Number of unit-hours per pulse	+1	UINT16	R/W	1-9999

Table 5-29 Pulsing Output Parameters

Pulsing parameter	ID
None	0
kWh import	1
kWh export	2
kvarh import	4
kvarh export	5
kvarh total (absolute)	6
kVAh total	7

5.13 Relay Operation Control

These registers allow the user to manually override setpoint relay operations. Either relay may be manually forced operated or released using commands sent via communications.

NOTES

1. A relay allocated as a pulsing relay may not be manually operated or released. When a relay is allocated for pulsing, it automatically reverts to normal operation.
2. A relay is energized when forced operated, and is de-energized when forced released.

Table 5-30 Relay Operation Control Registers

Parameter	Register	Type	R/W	Range
Relay #1 control status	3244	UINT16	R/W	see Table 5-23
Relay #2 control status	3245	UINT16	R/W	see Table 5-23
Relay #3 control status	3246	UINT16	R/W	see Table 5-23
Relay #4 control status	3247	UINT16	R/W	see Table 5-23
Relay #5 control status	3248	UINT16	R/W	see Table 5-23
Relay #6 control status	3249	UINT16	R/W	see Table 5-23
Relay #7 control status	3250	UINT16	R/W	see Table 5-23
Relay #8 control status	3251	UINT16	R/W	see Table 5-23

Table 5-31 Relay Operation Status

Operation status	Value
Normal operation	0
Force operate	1
Force release	2

5.14 Min/Max Log

The Min/Max log registers are supported only for compatibility with other models of instruments. Because the Min/Max log is not time stamped in the C192PF8-RPR, reading these registers returns you only values of the Min/Max log parameters which you can read directly via extended data registers (see Table 5-17).

Table 5-32 Min/Max Log Windows Registers

Min/Max log window	Registers (see Table 5-33)
Min/Max log window #1	4174-4181
Min/Max log window #2	4182-4189
Min/Max log window #3	4190-4197
Min/Max log window #4	4198-4205
Min/Max log window #5	4206-4213
Min/Max log window #6	4214-4221
Min/Max log window #7	4222-4229
Min/Max log window #8	4230-4237
Min/Max log window #9	4238-4245
Min/Max log window #10	4246-4253
Min/Max log window #11	4254-4261
Min/Max log window #12	4262-4269

Table 5-33 Min/Max Log Window Registers

Parameter	Offset	Type	R/W	Range
Second	+0	UINT16	R	0
Minute	+1	UINT16	R	0
Hour	+2	UINT16	R	0
Day	+3	UINT16	R	0
Month	+4	UINT16	R	0
Year	+5	UINT16	R	0
Parameter value ➀	+6, +7	UINT32	R	see Table 5-17

➀ The Min/Max parameter value can be read in one or two registers depending on the value type. For the value length and conversion scales, refer to Table 5-17. The time stamp is not available in the C192PF8-RPR and is read as zeros.

Table 5-34 Min/Max Log Mapping Register

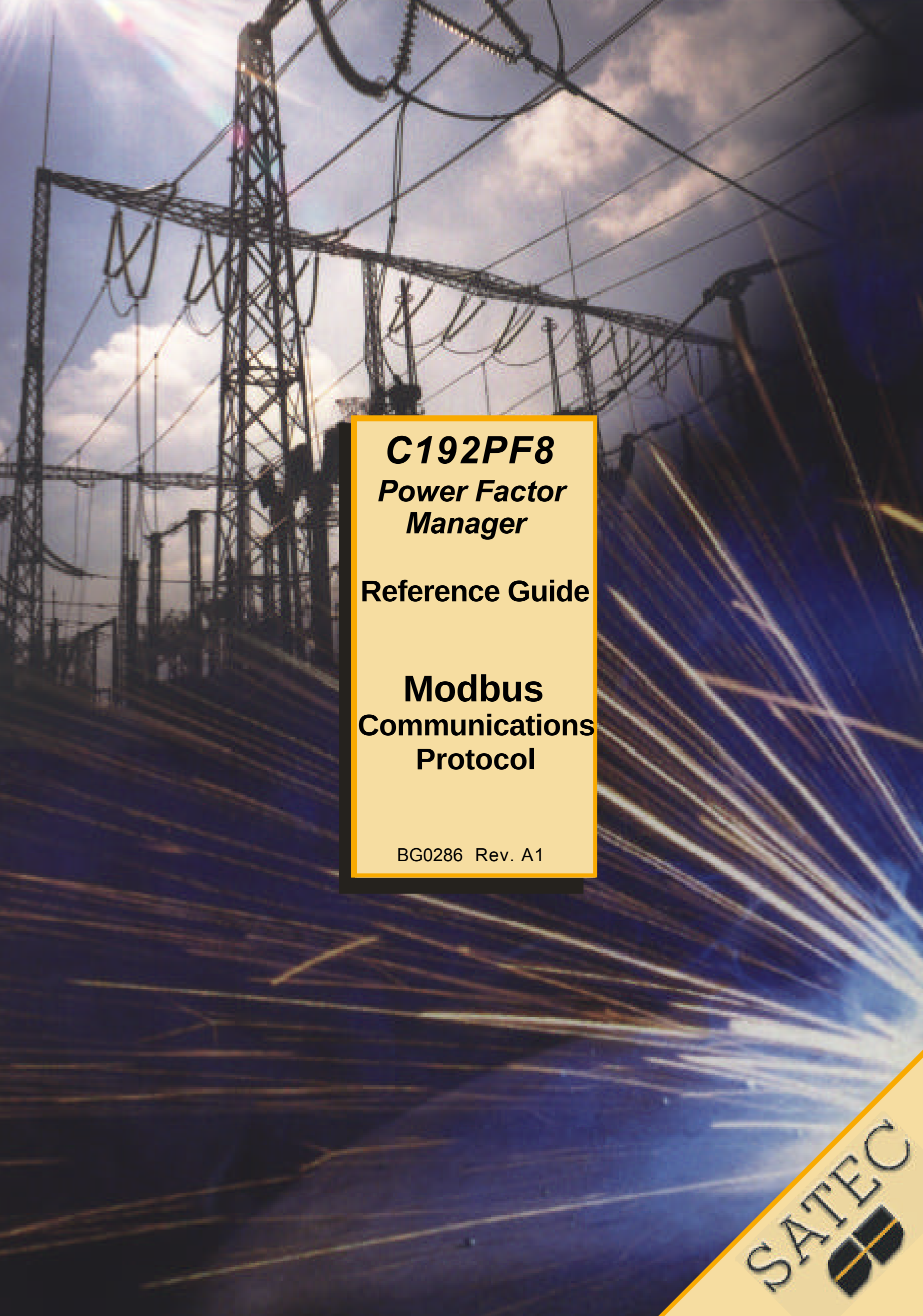
Parameter	Register	Type	R/W	Range
Min/Max log start parameter ID for window #1	4172	UINT16	R/W	see Table 5-17

From 1 to 12 adjacent Min/Max log records can be read at a time via the Min/Max log windows. The starting window #1 can be mapped to any Min/Max log parameter listed in Table 5-17 by writing the parameter ID to the Min/Max log mapping register. This must be written before reading the Min/Max log windows. Note that through Min/Max log windows, you can read only adjacent parameters within the same Min/Max log data group. Reading parameters outside of the selected Min/Max log data group will return zero.

5.15 Power Factor Controller Setup

Table 5-35 Power Factor Controller Setup Registers

Parameter	Register	Type	R/W	Range
Operating mode	2408	UINT16	R/W	0 = OFF 1 = AUTO 1 (self-adapting mode) 2 = AUTO 2 (optimizing mode) 3 = Manual/Remote
Setpoint trigger	2409	UINT16	R/W	0 = true power factor - PFC mode 1 = power factor displacement (fundamental harmonic's power factor) - PFC mode 2 = true kvar - RPR mode 3 = fundamental's kvar - RPR mode



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Parameter	Register	Type	R/W	Range
Operational setpoints	2410	UINT16	R/W	0 = Setpoint 1 1 = Setpoint 1 and Setpoint 2 (switching via a digital input)
Nominal voltage of the capacitor banks	2411	UINT16	R/W	1V to 999V if PT RATIO = 1 100 to 9999 x 0.01kV if PT RATIO > 1 0 = disable automatic adjusting the capacitor bank powers to the measured line voltage (assumed that those have been adjusted manually)
Setpoint 1: Low target PF1 (in PFC mode) Low target kvar 1 (in RPR mode)	2412	INT16	R/W	PF1: -500 to 500 x 0.001 kvar 1: -10,000 to 10,000
Setpoint 1: High target PF1 (in PFC mode) High target kvar 1 (in RPR mode)	2413	INT16	R/W	PF1: -500 to 500 x 0.001 kvar 1: -10,000 to 10,000
Setpoint 2: Low target PF2 (in PFC mode) Low target kvar 2 (in RPR mode)	2414	INT16	R/W	PF2: -500 to 500 x 0.001 kvar 2: -10,000 to 10,000
Setpoint 2: High target PF2 (in PFC mode) High target kvar 2 (in RPR mode)	2415	INT16	R/W	PF2: -500 to 500 x 0.001 kvar 2: -10,000 to 10,000
Setpoint operate delay	2416	UINT16	R/W	1 to 3600 sec
Switch-on time (connection interval)	2417	UINT16	R/W	3 to 3600 sec
Switch-off time (disconnection interval)	2418	UINT16	R/W	3 to 3600 sec
Reconnection time (discharge time)	2419	UINT16	R/W	5 to 3600 sec
Size of the capacitor bank #1	2420	INT16	R/W	1 to 10,000 kvar, 0 = not used, -1 = permanently switched in
Size of the capacitor bank #2	2421	INT16	R/W	1 to 10,000 kvar 0 = not used, -1 = permanently switched in
Size of the capacitor bank #3	2422	INT16	R/W	1 to 10,000 kvar, 0 = not used, -1 = permanently switched in
Size of the capacitor bank #4	2423	INT16	R/W	1 to 10,000 kvar, 0 = not used, -1 = permanently switched in
Size of the capacitor bank #5	2424	INT16	R/W	1 to 10,000 kvar, 0 = not used, -1 = permanently switched in
Size of the capacitor bank #6	2425	INT16	R/W	1 to 10,000 kvar, 0 = not used, -1 = permanently switched in
Size of the capacitor bank #7	2426	INT16	R/W	1 to 10,000 kvar, 0 = not used, -1 = permanently switched in
Size of the capacitor bank #8	2427	INT16	R/W	1 to 10,000 kvar, 0 = not used, -1 = permanently switched in

NOTE

The PFC setup registers except of operating mode are protected from being changed while the PFC is running. Writing to these locations will result in a negative response with the exception code 01 (illegal operation).

5.16 PFC Control Registers

These registers allow the user to manually connect/disconnect the capacitor banks by issuing commands through communications when the PFC operates in the manual mode, and synchronize the PFC relay status with the external breakers when they are operated outside of the PFC either manually or through a PLC.

Table 5-36 PFC Control Registers

Parameter	Register	Type	R/W	Range
PFC manual command register	2456	UINT16	W	1 = switch in (connect) a capacitor bank 2 = switch off (disconnect) a capacitor bank. See Note 1 below.
External breaker status register	2457	UINT16	R/W	See Table 5-37 and Note 2 below.

Parameter	Register	Type	R/W	Range
Operating mode (alias for register 2408, see Table 5-35)	2458	UINT16	R/W	0 = OFF 1 = AUTO 1 (self-adapting mode) 2 = AUTO 2 (optimizing mode) 3 = Manual/Remote

NOTES

1. The manual command register is used for manual/remote switching of the capacitor banks. If the PFC is not in the manual/remote mode or a previous user command was not yet completed, the instrument will respond with the exception code 01 (illegal operation).

   If a requested command cannot be completed because of an alarm condition or because there are no additional capacitor banks that can be operated, the command is discarded. No error is reported.
2. The external breaker status register is used to synchronize the status of the PFC output relays with the capacitor bank breakers' status in the event that they are controlled outside of the PFC. This register is taken only in the manual/remote mode. When a new breaker status is written, it is immediately transferred to the output relays. No switching or reconnection (discharge) delays will be followed. It is responsibility of the master PLC to block relay outputs for the time required for discharging capacitors where it is required. After switching the PFC into the automatic mode, all disconnected banks will be put into operation after full discharge time. In all automatic modes, writing into this register has no effect.

Table 5-37 External Breaker Status Register

Bit	Description
0	Capacitor bank #1 breaker status
1	Capacitor bank #2 breaker status
2	Capacitor bank #3 breaker status
3	Capacitor bank #4 breaker status
4	Capacitor bank #5 breaker status
5	Capacitor bank #6 breaker status
6	Capacitor bank #7 breaker status
7	Capacitor bank #8 breaker status
8-15	Not used (write as 0)

Bit meaning: 0 = breaker is open, 1 = breaker is closed