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BRISBANE CITY COUNCIL
BRISBANE WATER

SP306 – Coronation Drive Pump Station

Operation & Maintenance Manual
Contract No. BW30079-02/03

Volume No. 2
Section 4

BRISBANE CITY COUNCIL
Brisbane Water
SP306 Coronation Drive Pump Station

BCC Contract No. BW30079-02/03

Coronation Drive Pump Station - SP306 Operation & Maintenance Manual
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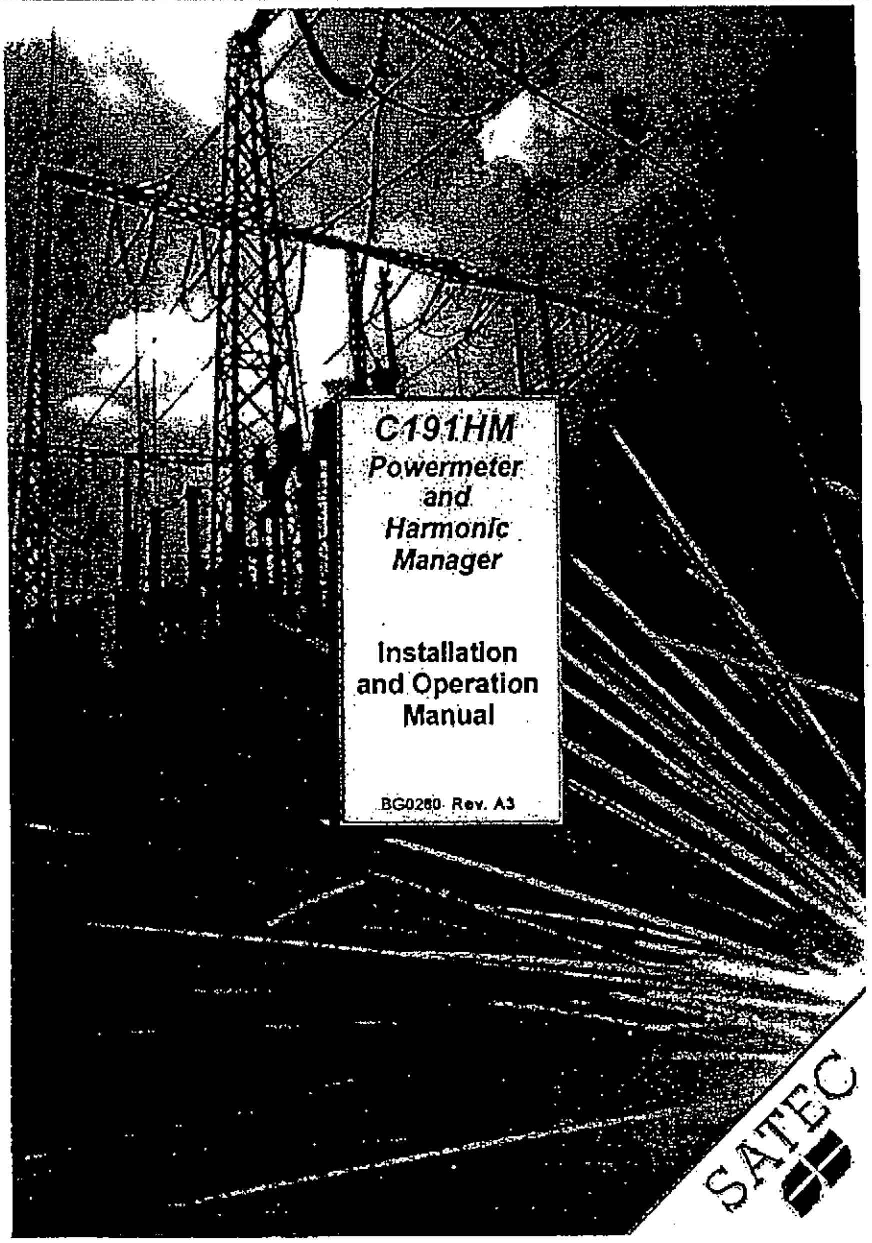

C191HM
Powermeter
and
Harmonic
Manager
Installation
and Operation
Manual
BG0260 Rev. A3
SATEC

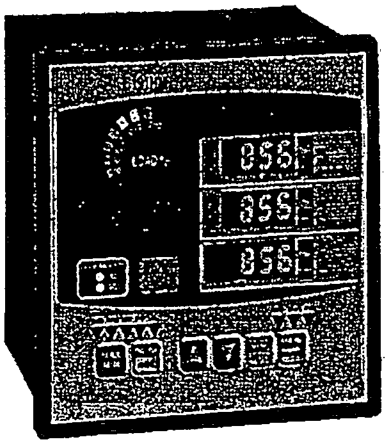
SERIES C191HM POWERMETERS

COMMUNICATIONS

Modbus Communications Protocol

REFERENCE GUIDE

C191HM Powermeter & Harmonic Manager



Installation and Operation Manual

LIMITED WARRANTY

The manufacturer offers the customer an 24-month functional warranty on the instrument for faulty workmanship or parts from date of dispatch from the distributor. In all cases, this warranty is valid for 36 months from the date of production. This warranty is on a return to factory basis.

The manufacturer does not accept liability for any damage caused by instrument malfunction. The manufacturer accepts no responsibility for the suitability of the instrument to the application for which it was purchased.

Failure to install, set up or operate the instrument according to the instructions herein will void the warranty.

Your instrument may be opened only by a duly authorized representative of the manufacturer. The unit should only be opened in a fully anti-static environment. Failure to do so may damage the electronic components and will void the warranty.

NOTE

The greatest care has been taken to manufacture and calibrate your instrument. However, these instructions do not cover all possible contingencies that may arise during installation, operation or maintenance, and all details and variations of this equipment are not covered by these instructions.

For additional information regarding installation, operation or maintenance of this instrument, contact the manufacturer or your local representative or distributor.

IMPORTANT

Please read the instructions this manual before performing installation, and take note of the following precautions:

- **Ensure that all incoming AC power and other power sources are turned OFF before performing any work on the instrument. Failure to do so may result in serious or even fatal injury and/or equipment damage.**
- Before connecting the instrument to the power source, check the labels on the side of the instrument to ensure that your instrument is equipped with the appropriate power supply voltage, input voltages, currents and communication protocol for your application.
- Under no circumstances should the instrument be connected to a power source if it is damaged.
- To prevent potential fire or shock hazard, do not expose the instrument to rain or moisture.

- The secondary of an external current transformer must never be allowed to be open circuit when the primary is energized. An open circuit can cause high voltages, possibly resulting in equipment damage, fire and even serious or fatal injury. Ensure that the current transformer wiring is made through shorting switches and is secured using an external strain relief to reduce mechanical strain on the screw terminals, if necessary.
- Setup procedures must be performed only by qualified personnel familiar with the instrument and its associated electrical equipment.
- DO NOT open the instrument under any circumstances.

Modbus is a trademark of Modicon, Inc.

Read this manual thoroughly before connecting the meter to the current carrying circuits. During operation of the meter, hazardous voltages are present on input terminals. Failure to observe precautions can result in serious or even fatal injury or damage to equipment.

BG0280 Rev. A3

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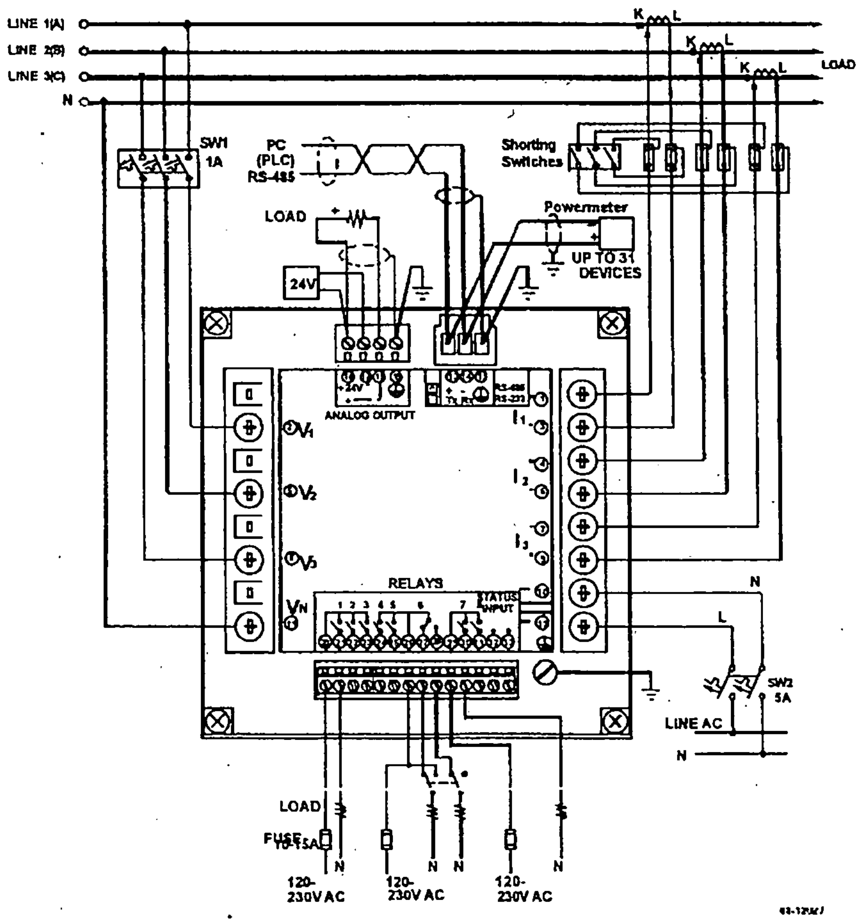
Quick Start

TYPICAL INSTALLATION

Wiring Mode 4LL3 (see *Section 2.2.4* for full instructions)



SETUP *(see Chapter 4 for full instructions)*

Setups can be performed directly on the front panel or via PComTest communication software.

Press SELECT → CHG → ENTER

Press SELECT to activate middle window.

Press ⇑⇓ to scroll to desired *option*.

Press SELECT to activate lower window.

Press ⇑⇓ to scroll to desired *value*.

Press ENTER to save selected value.

menu	bASc
option	ConF
value	4L-n

menu	Port
option	Prot
value	ASCII

Basic and Communications Default Setups

Code	Parameter	Options	Description
ConF	Wiring mode	*4Ln3*	4-wire Wye using 3 PTs (3 element), line to neutral voltage readings
Pt	PT ratio	*1.0*	The phase potential transformer ratio
Ct	CT primary current	*5*	The primary rating of the phase current transformer, A
d.P	Power demand period	*15*	The length of the demand period for power demand calculations, in minutes. E = external synchronization ①
n.dp	Number of power demand periods	*1*	The number of demand periods to be averaged for sliding window demands 1 = block interval demand calculation
A.dP	Ampere/Volt demand period	*900*	The length of the demand period for volt/ampere demand calculations, in seconds 0 = measuring peak current
buF	Averaging buffer size	*8*	The number of measurements for RMS sliding averaging
rSt	Reset enable/disable	*diS*	Protects all reset functions, both via the front panel or communications.
Freq	Nominal frequency	*50/, 60*	The nominal power utility frequency, Hz
LoAd	Maximum demand load current	*0*	The maximum demand load current used in TDD calculations (0 = CT primary current)
Prot	Communications protocol	*ASCII*	ASCII protocol
Addr	Address	*0 (ASCII)*	Powermeter address
bAud	Baud rate	*9600*	9600 bps
dAtA	Data format	*8n*	8 bits, no parity
CPtb	ASCII compatibility mode	*diS*	Disables ASCII compatibility mode (For more information, see ASCII Communications Protocol Reference Guide)

Chapter 1 Introduction

1.1 About This Manual

This manual is intended for the user of the *C191HM* Powermeter. This Powermeter is a microprocessor-based instrument used for the measurement, monitoring, and management of electrical parameters.

This chapter gives an overview of this manual and an introduction to the *C191HM.*

Chapter 2, *Installation*, provides instructions for mechanical and electrical installation.

Chapter 3, *Using the Menus*, presents the structure of menus for setup and status viewing.

Chapter 4, *Setup Menus*, provides instructions for performing parameter setup via the front panel.

Chapter 5, *Data Display*, guides you through the display pages.

Chapter 6, *Viewing Status Information*, tells you how to access additional status information on the instrument. This information may be useful during installation.

Technical Specifications for the *C191HM* are found in the Appendix.

1.2 About The *C191HM*

The *C191HM* is a compact panel mounted three-phase AC Powermeter and Harmonic Manager, specially designed to meet the requirements of users ranging from electrical panel builders to substation operators. The *C191HM* provides basic voltage, current, frequency, power, power factor and energy measurements, plus total harmonic distortion (THD, TDD and K-Factor) and individual harmonic measurements.

The *C191HM* is suitable for mounting on 136x136mm square cut-outs.

Features

Display

The front panel features bright LED displays (three windows, up to 45 pages) with adjustable display update time. Display auto scroll is available on the main screen with a programmable scroll interval of 2 to 15 seconds. Automatic return to the main screen is available after 30 seconds of uninterrupted use. The front panel also includes:

- bar graph showing percentage load with respect to user-definable nominal (100%) load current

- alarm LED providing a local indication when a predefined alarm condition appears. The alarm LED is shut off manually (by pressing on both up and down keys more than 5 sec)
- RXD/TXD LEDs showing communications receive/transmit status

Setup is menu driven, with optional password protection. 16 programmable setups are provided for alarm and control functions (for programmable parameters, see 'Measured Parameters' below).

Communications are available using an RS-232 or RS-485 standard (factory set), with ASCII/Modbus (and optional DNP3.0) protocols. 120 user assignable registers are available in ASCII/Modbus protocols.

Eight relays are provided for energy pulsing (KYZ) or alarm and remote control. Contacts of six relays may switch loads up to 250V, 5A AC and are recommended for alarm and remote control; contacts of two relays may switch loads up to 250V, 3A AC and may be used for energy pulsing.

One optically isolated analog output is provided for remote monitoring or control. Current loop options are 0-20 and 4-20 mA. The analog output must be used with an external power supply.

Four counters are provided for counting user-defined events or their duration. These can be used for counting total operation time of generators or overload time of transformers or power lines. The counters are operated and released by user-defined triggers.

One digital input can be used as a status input for monitoring external contacts or as an external synchronization input for power demand interval synchronization. When no external synchronization pulse is provided, the power demand interval can be synchronized through communications.

Three user-selectable options are provided:

Power calculation mode

Energy rollover value

This option specifies the point at which the energy value rolls over to zero.

Phase energy calculations mode

This option is used to enable or disable phase energy calculations.

Measured Parameters

Note: Real-time values are measured over 1 cycle of fundamental frequency; Average values are of 8, 16 or 32 real-time values

Parameter	Display	Com	Output		
			Analog	Pulse	Alarm
Average Amps, Volts, Frequency			$ = setup via PC # = setup via panel		
Average RMS voltage per phase L-N	v	v	#$		#$
Average RMS voltage per phase L-L ①	v	v	①		①
Average RMS current per phase	v	v	#$		#$

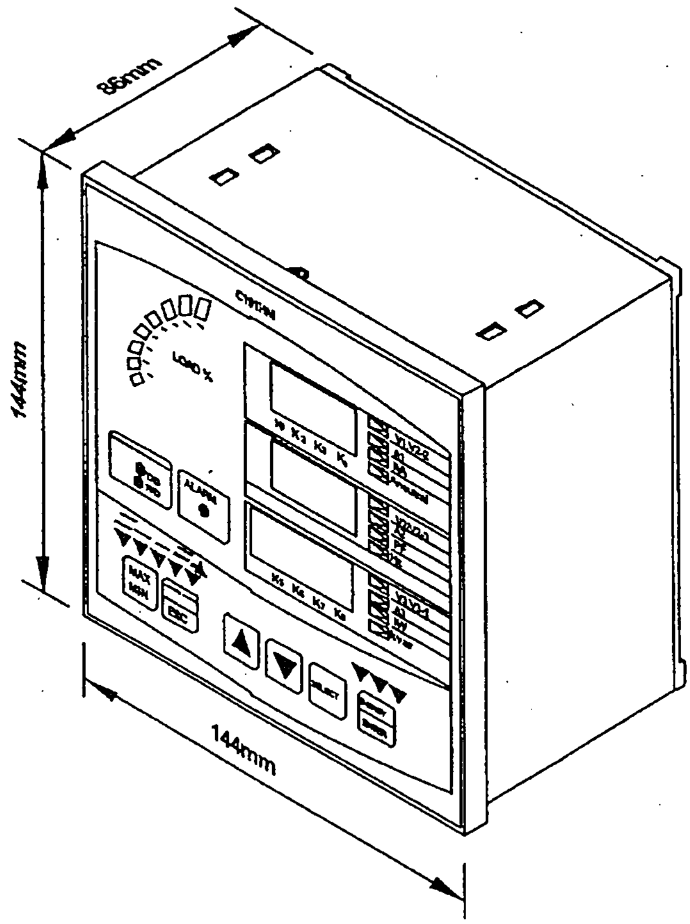
Parameter	Dis-play	Com	Output		
			Analog	Pulse	Alarm
Average frequency	v	v	#$		#$
Average neutral current	v	v	#$		#$
Voltage & current unbalance	v	v			
Amps & Volt Demand Parameters					
Ampere demand per phase		v			#$
Volt demand per phase		v			#$
Ampere maximum demand per phase	v	v			
Voltage maximum demand per phase	v	v			
Average Power Values					
Average active power per phase	v	v			
Average reactive power per phase	v	v			
Average apparent power per phase	v	v			
Average total active power	v	v	#$		#$
Average total reactive power	v	v	#$		#$
Average total apparent power	v	v	#$		#$
Average power factor per phase	v	v			
Average total power factor	v	v	#$		#$
Power Demand Parameters					
Active power accumulated demand		v	#$		#$
Apparent power accumulated demand		v	#$		#$
Active power demand		v			#$
Active power sliding demand		v			#$
Apparent power demand		v			#$
Apparent power sliding demand		v			#$
Active power predicted demand		v			#$
Apparent power predicted demand		v			#$
Active power maximum demand	v	v			
Apparent power maximum demand	v	v			
Energy Per Phase					
Active energy import per phase	v	v			
Reactive energy import per phase	v	v			
Apparent energy per phase	v	v			
Total Energy					
Total active energy import	v	v		#$	
Total active energy export	v	v		#$	
Total reactive energy import	v	v		#$	
Total reactive energy export	v	v		#$	
Total reactive energy net		v			
Total reactive energy absolute				#$	
Total apparent energy	v	v		#$	
Min/Max Log					
Min/Max volts	v	v			

Parameter	Display	Com.	Output Analog	Output Pulse	Output Alarm
Min/Max amps, neutral current	v	v			
Min/Max frequency	v	v			
Min/Max kW, kvar, kVA, PF	v	v			
Real-time Amps, Volts, Frequency					
RT RMS voltage per phase L-N		v	#$		#$
RT RMS voltage per phase L-L ①		v	①		①
RT RMS current per phase		v	#$		#$
RT frequency		v	#$		#$
RT neutral current		v			
Real-time Power Values					
RT active power per phase		v			
RT reactive power per phase		v			
RT apparent power per phase		v			
RT total active power		v	#$		
RT total reactive power		v	#$		
RT total apparent power		v	#$		
RT power factor per phase		v			
RT total power factor		v	#$		
Real-time Harmonic Values					
RT voltage THD per phase		v			#$
RT current THD per phase		v			#$
RT current TDD per phase		v			#$
RT K-Factor per phase		v			#$
Average Harmonic Values					
Average Voltage THD per phase	v	v			
Average Current THD per phase	v	v			
Average Current TDD per phase	v	v			
Average K-Factor per phase	v	v			
Fundamental Frequency Values (H01)					
Voltage & current per phase		v			
kW, PF per phase	v	v			
kvar, kVA per phase		v			
Total kW, PF	v	v			
Total kvar, kVA		v			
Individual Harmonics' Distortion					
Voltage harmonics 1-40 per phase		v			
Current harmonics 1-40 per phase		v			
Odd voltage harmonics 3-39 per phase	v				
Odd current harmonics 3-39 per phase	v				
High odd voltage harmonics 3-39 triggers					#$
High odd current harmonics 3-39 triggers					#$

Parameter	Display	Com	Output Analog	Output Pulse	Output Alarm
Phase Rotation	v				#$
Counters	v	v			
Status Input	v	v			#$
Relay Status	v	v			
Remote Relay Control		v			
Alarm Trigger Status		v			#$
Self-Diagnostic Tests	v	v			

① For **4Ln3** and **3Ln3** wiring configurations line to line and line to neutral voltages are displayed and transmitted via communication simultaneously; analog output and set points use **line to neutral** voltages. For other configurations only **line to line** voltages are used.

Instrument Dimensions



c99-10021/2

Figure 1-1 C191HM Dimensions

Chapter 2 Installation

2.1 Mechanical Installation

Prepare the panel cut-out, 136 x 136 mm, prior to mounting.

STEP 1: Place the instrument through the cut-out.

STEP 2: Assemble the latches onto the outer wall of the enclosure.

STEP 3: Tighten the screws.

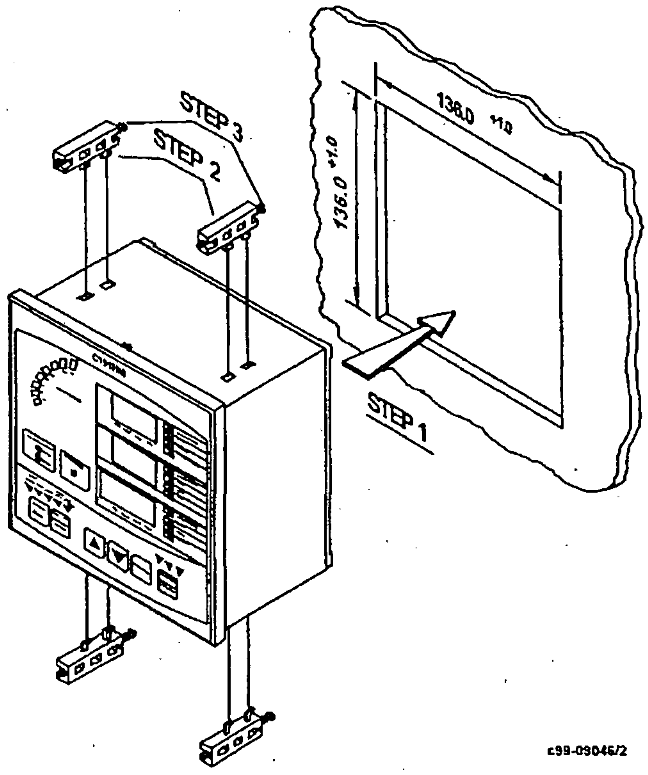


Figure 2-1 Mounting the C191HM

2.2 Electrical Installation

Before installation ensure that all incoming power sources are shut OFF. Failure to observe this practice can result in serious or even fatal injury and damage to equipment.

2.2.1 *Power Supply Connection*

The power supply can be dedicated-fused, or from a monitored voltage if it is within the instrument's power supply range. Use an external circuit breaker or switch.

AC power supply: line to terminal 12; neutral to terminal 10.
DC power supply: positive to terminal 12; negative to terminal 10.

2.2.2 *Current Inputs*

Connect the instrument to the current transformer as shown in *Figures* 2-2 through 2-*8*.

2.2.3 *Ground*

Connect the chassis ground *C191HM* terminal to the switchgear earth ground using dedicated wire of greater than 2.5 mm^2/13 AWG.

2.2.4 *Voltage Inputs*

Input of 690V (Standard): Use any of the seven wiring configurations shown in *Figures* 2-2 through 2-*8*.

Input of 120V (Option U): 120V input usually implies use of a potential transformer (PT). The PT requires use of any of the four wiring configurations shown in *Figures 2-4* through 2-7.

Wiring Configuration (See parameter setup instructions in Section 4.1)	Wiring	
	Setup Mode	Connection
3-wire direct connection using 2 CTs (2-element)	3dir2	Figure 2-2
4-wire WYE direct connection using 3 CTs (3-element)	4Ln3 or 4LL3	Figure 2-3
4-wire WYE connection using 3 PTs, 3 CTs (3-element)	4Ln3 or 4LL3	Figure 2-4
3-wire open delta connection using 2 PTs, 2 CTs (2-element)	3OP2	Figure 2-5
3-wire open delta connection using 2 PTs, 3 CTs (2½-element)	3OP3	Figure 2-6
4-wire WYE connection using 2 PTs, 3 CTs (2½-element)	3Ln3 or3LL3	Figure 2-7
4-wire delta direct connection using 3 CTs (3-element)	4Ln3 or 4LL3	Figure 2-8

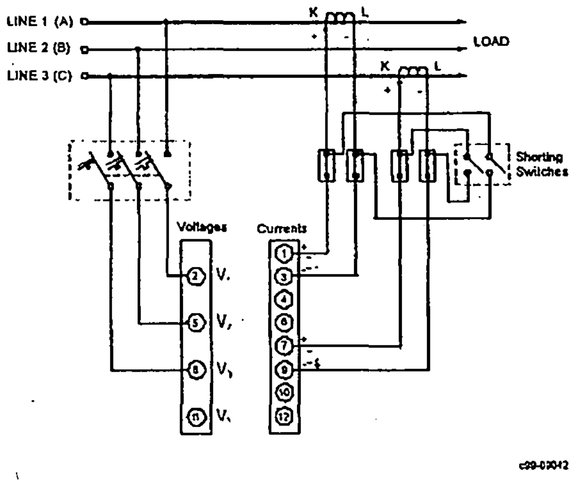


Figure 2-2

Three Wire Direct Connection Using 2 CTs (2-element)

Wiring Mode = **3dir2**

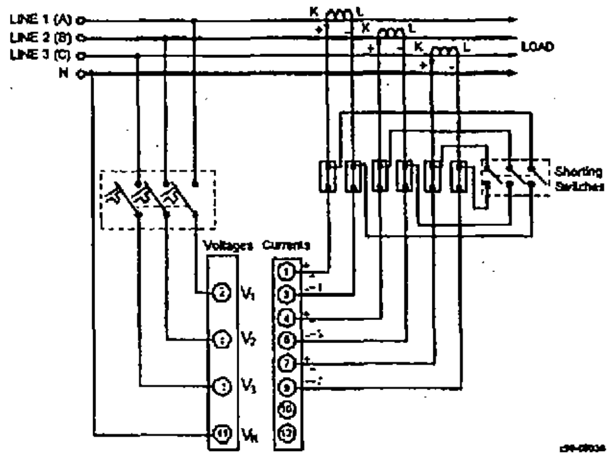


Figure 2-3

Four Wire WYE Direct Connection Using 3 CTs (3-element)

Wiring Mode = **4LL3** or **4Ln3**

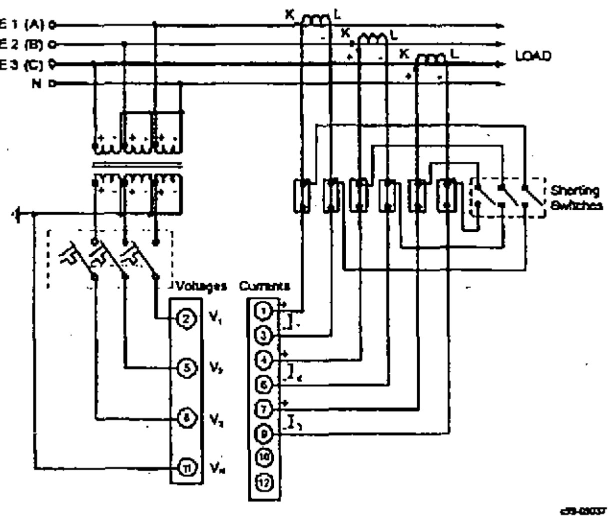


Figure 2-4

Four Wire WYE Connection Using 3 PTs, 3 CTs (3-element)

Wiring Mode = **4LL3** or **4Ln3**

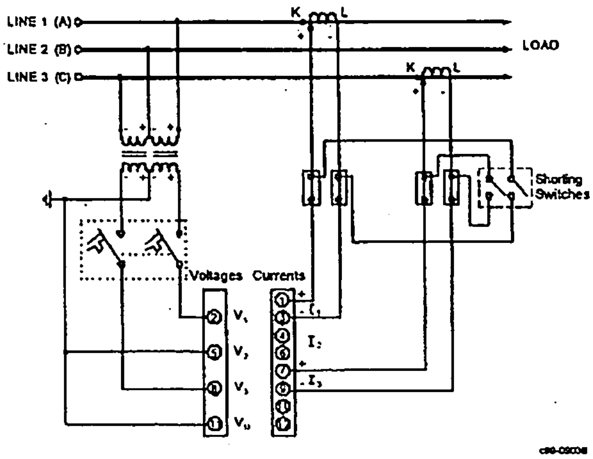


Figure 2-5

Three Wire Open Delta Connection Using 2 PTs, 2 CTs (2-element)

Wiring Mode = 3OP2

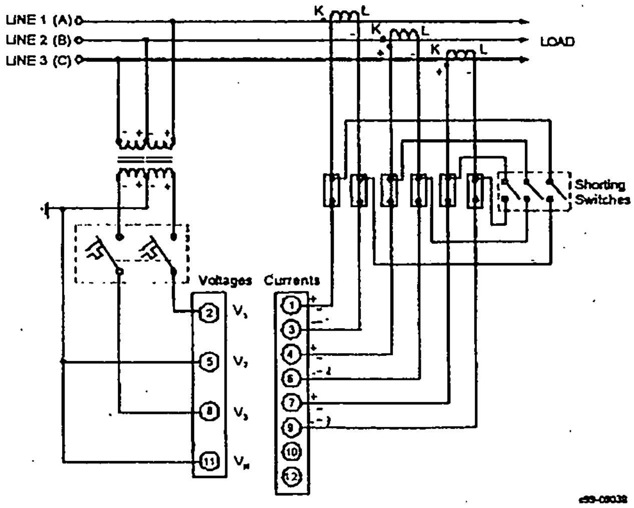


Figure 2-6

Three Wire Open Delta Connection Using 2 PTs, 3 CTs (2½-element)

Wiring Mode = 3OP3

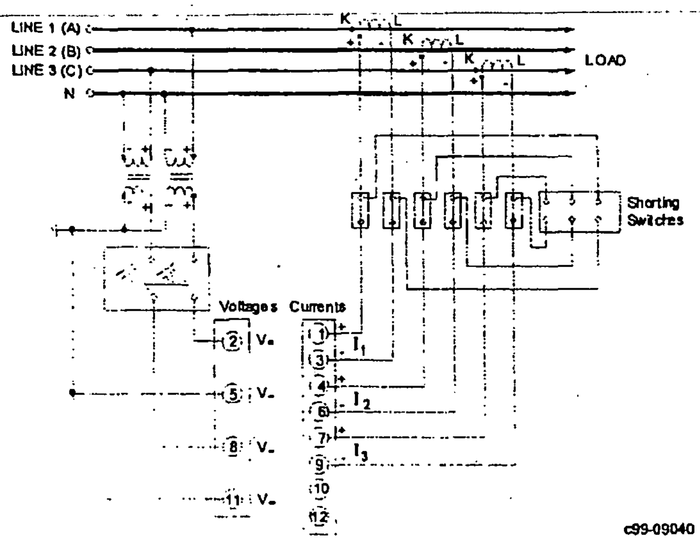


Figure 2-7

Four Wire Wye Connection Using 2 PTs, 3 CTs (2½-element)

Wiring Mode = **3Ln3** or **3LL3**

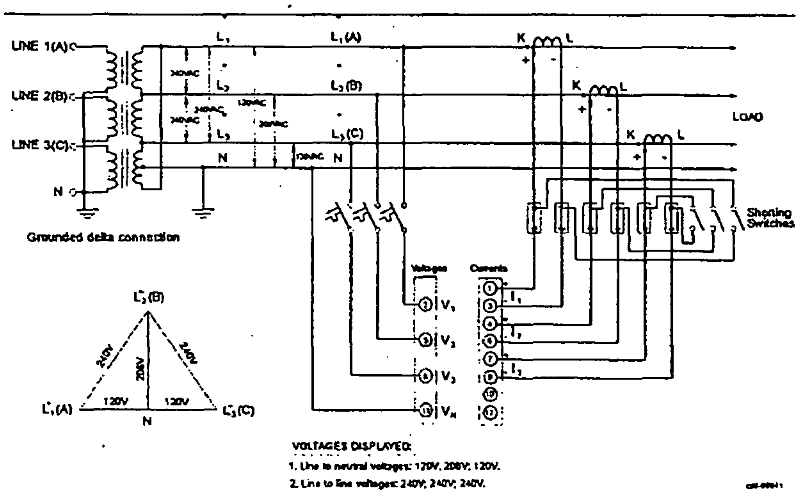


Figure 2-8 Four Wire Delta Direct Connection Using 3 CTs (3 element) Wiring Mode = **4LL3** or **4Ln3**

2.2.5 Relay

Eight relays are provided for energy pulsing, alarms or remote control.

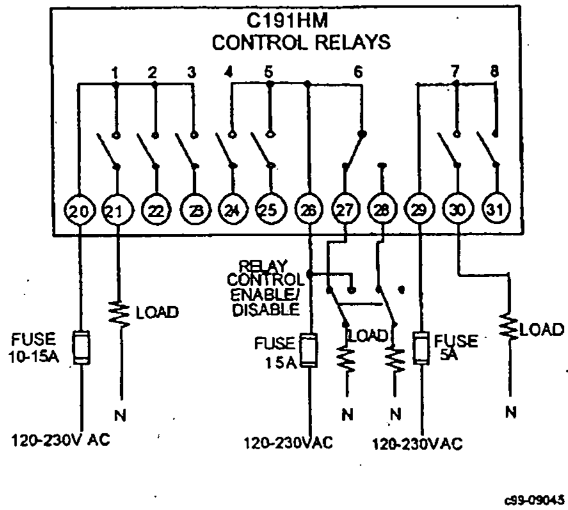


Figure 2-9 Relay Connection

2.2.6 Status Input

One status input is provided for status monitoring or external synchronization input for power demand period.

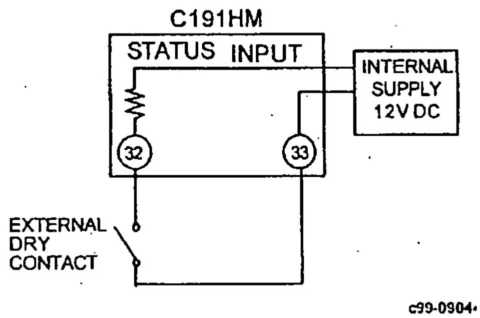


Figure 2-10 Status Input Connection

Chapter 2 Installation 13

2.2.7 *Analog Output*

The *C191HM* provides one optically isolated analog output with current output options of 0-20 mA and 4-20 mA (current loop load of up to 500 Ohm). The analog output must be used with a 24 V DC external power supply.

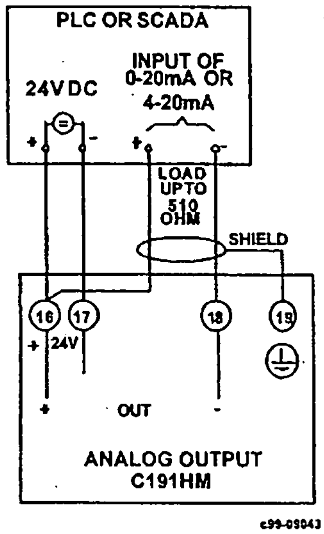


Figure 2-11 Analog Output Connection

2.2.8 *Communications*

The *C191HM* is provided with an RS-232 or RS-485 communication port. Connections can be made as follows:

RS-232: distance of up to 15 meters, one C191HM to one computer/PLC, using a flat or twisted pair cable of 0.33mm2/22AWG

RS-485: distance of up to 1200 meters, up to 32 instruments on one multi-drop line

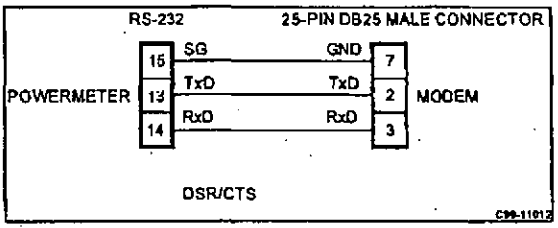


Figure 2-12 Connection for 25-pin Modem Connector

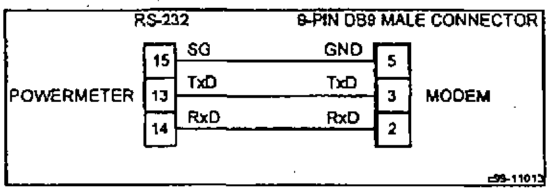


Figure 2-13 Connection for 9-pin Modem Connector

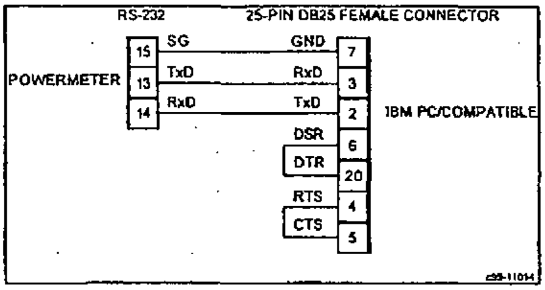


Figure 2-14 RS-232 Simple 3-Wire Computer Connection, 25-pin

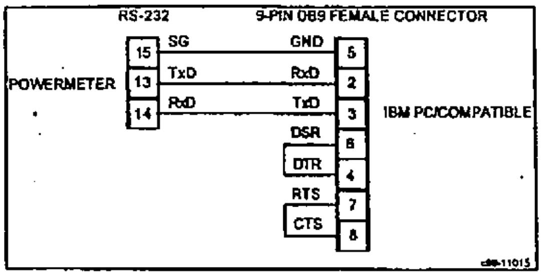


Figure 2-15 RS-232 Simple 3-Wire Computer Connection, 9-pin

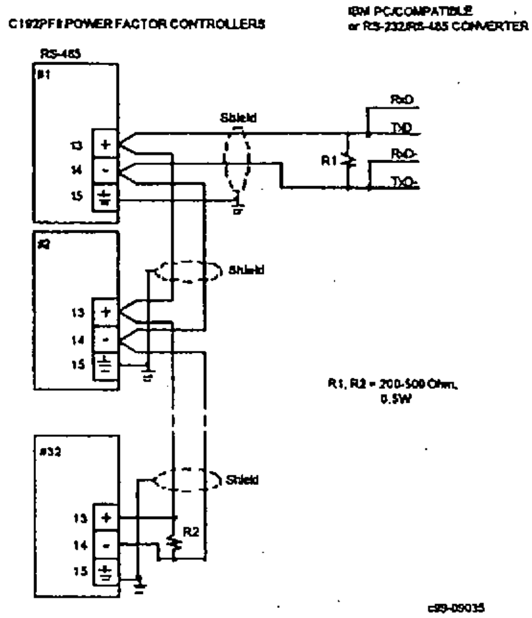


Figure 2-16 RS-485 Multi-drop Computer Connection

NOTE: Where an RS-232/RS-485 converter is used on a computer connection, R1 is not applicable since it is built in to the converter.

Activity on the communications port lines is indicated via the TXD and RXD LEDs, on the front panel and via the Status Information menu (see Chapter 6).

A full description of the communication protocols may be found in the *C191HM ASCII, Modbus and DNP3.0 Communications Manuals* provided with your instrument.

Chapter 3 Using The Menus

Press and release SELECT to enter the setup mode. The primary menus will appear:

StA	-	Status Information Menu (see Chapter 6)
OPS	-	Setup Options Menu
CHG	-	Setup Change Menu (see Chapter 4)

Press SELECT again to activate the window of the desired primary menu.
Press ENTER

Select *CHG* to initialize or modify the instrument setup, or to clear the accumulated values stored in the instrument. Entry to this menu can be protected by a password. SELECT → CHG → ENTER
Select *StA* to view extended status information which may be useful during installation and in certain applications. SELECT → StA → ENTER
Select *OPS* for *viewing* (not editing) the instrument setup options. SELECT → OPS → ENTER

After selecting either *OPS* or *CHG*, the list of setup menus is displayed in the upper window. Figure 3-1 presents a complete menu list. Depending on the model of your instrument, some menus may not appear.

Password

The *Setup Change Menu* can be secured by a user-defined password comprised of 4 digits. The instrument is shipped with password protection disabled. To enable password protection, go to the *Access Control Menu* (see Section 4.10).

The *Password Menu* appears if password protection is enabled.

PASS
0000

To enter a password:

- ✓ Set the first digit using the up and down arrow keys.
- ✓ Press SELECT to advance to the next digit.
- ✓ Set the other password digits in the same manner.
- ✓ Press ENTER to continue setup. If your password is incorrect, you will return to the *Primary Selection Menu.*

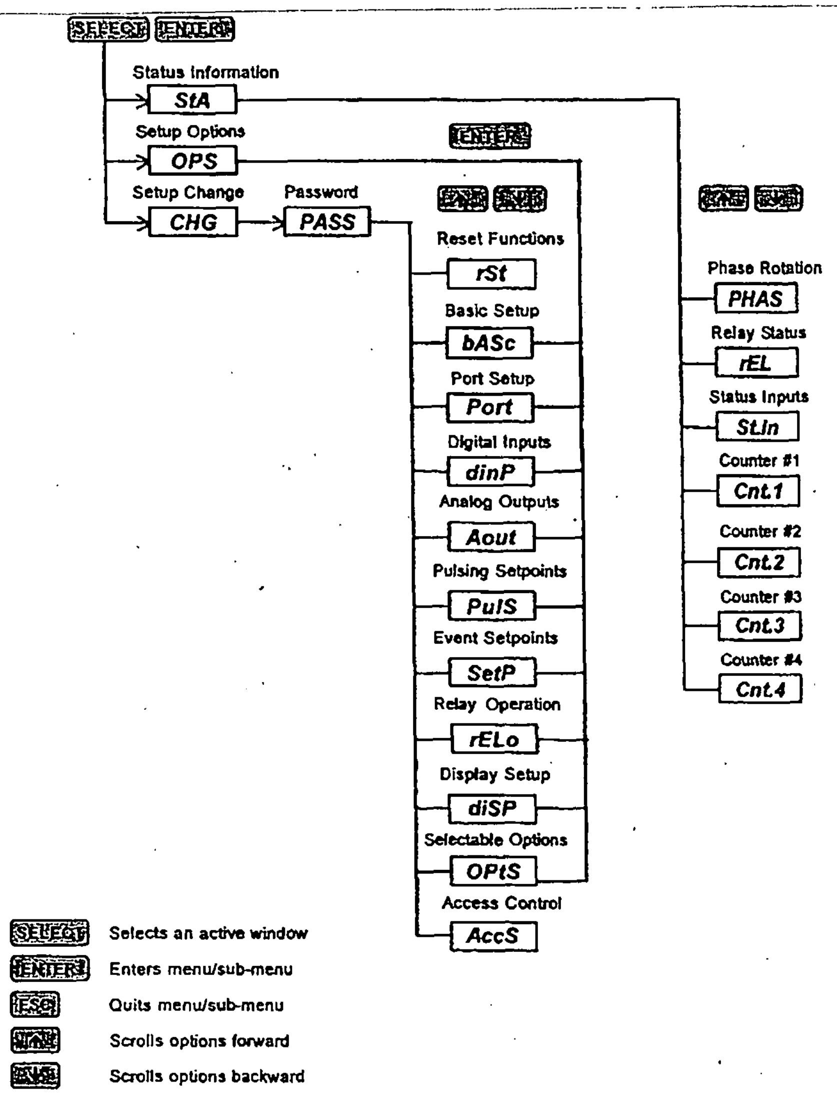


Figure 3-1 Menu Structure

Chapter 4 Setup Menus

NOTE: Instrument setup can be performed directly on the front panel using the setup menus or via communications using PComTest communication software. PComTest is supplied with your instrument and provides full setup capabilities for your instrument. For information on using PComTest, refer to the user documentation supplied with your instrument.

Setup	Display	PComTest
Basic	+	+
Communication port	++	+
User Selectable options	++	+
Analog output	+	+
Digital inputs	+	+
Alarm/Event set points	+	+
Pulsing output	+	+
Pulse counter	+	+
Assignable registers	-	++
Display	++	-

++ Recommended method

4.1 Basic Setup Menu

SELECT → CHG → ENTER → bASc → ENTER

This menu contains the basic configuration options which define the general operating characteristics of your instrument, such as wiring mode, input scales, the size of the RMS averaging buffer, etc. Table 4-1 lists the basic setup options, their code names and applicable ranges.

Activate the middle window to scroll through the list of available options, and then activate the lower window to set the option value.

bASc
ConF
4L-n

To select and view a setup option:

✓ Press SELECT to activate the middle window
✓ Use the up/down arrow keys to scroll to the desired option. The current value for this option appears in the lower window.

To change the value of the selected option:

✓ Press SELECT to make the lower window active.
✓ Press the up/down arrow keys to scroll to the desired value.
✓ Press ENTER to store the selected value, or press ESC to quit the setup menu.

Table 4-1 Basic Setup Options (• default setting)

Code	Parameter	Options	Description
ConF	Wiring mode	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 (2½ element)
		3Ln3	4-wire Wye using 2 PTs (2½ element), line to neutral voltage readings
		3LL3	4-wire Wye using 2 PTs (2½ element), line to line voltage readings
Pt	PT ratio	10•-6,500.0	The phase potential transformer ratio
Ct	CT primary current	1-6,500A (5•)	The primary rating of the phase current transformer
d.P	Power demand period	1, 2, 5, 10, 15•, 20, 30, 60, E	The length of the demand period for power demand calculations, in minutes. E = external synchronization ①
n.dp	Number of power demand periods	1-15 (1•)	The number of demand periods to be averaged for sliding window demands 1 = block interval demand calculation
A.dP	Ampere/Volt demand period	0-1800 s (900•)	The length of the demand period for volt/ampere demand calculations 0 = measuring peak current
buF	Averaging buffer size	8•,16,32	The number of measurements for RMS sliding averaging
rSt	Reset enable/disable	diS•, En	Protects all reset functions, both via the front panel or communications.
Freq	Nominal frequency	50, 60 Hz②	The nominal power utility frequency
LoAd	Maximum demand load current	0-6,500A (0•)	The maximum demand load current used in TDD calculations (0 = CT primary current)

① When the power demand period is specified in minutes, synchronization of the demand interval can be made through communications (see the *C191HM* ASCII/Modbus Reference Guides) or via the front panel (see Section 4.11). If the power demand period is set to External Synchronization, an external synchronization pulse denoting the start of the next demand interval can be provided through a digital input or can be simulated by using the synchronization command sent via communications.

② 60 Hz default for North America; elsewhere, default is 50Hz.

NOTES

1) The maximum value for CT PRIMARY CURRENT × PT RATIO is 10,000,000. If this product is greater, power related values will be zeroed.
2) Always specify WIRING MODE, PT RATIO and CT PRIMARY CURRENT prior to setting up alarm setpoints, otherwise the alarm/event setpoints which use these parameters will automatically be disabled.

4.2 Communications Port Setup Menu

SELECT → CHG → ENTER [illegible] [illegible] → Port → ENTER

This menu allows you to access the communications port options that the *C191HM* uses to communicate with a master computer. Table 4-2 lists the communications options, their code names and applicable choices.

Activate the middle window to scroll through the list of available options, and then activate the lower window to set the option value.

Port
Prot
ASCII

To select and view a setup option:

✓ Press SELECT to activate the middle window.
✓ Use the up/down arrow keys to scroll to the desired option. The option setting will appear in the lower window.

To change the selected option:

✓ Press SELECT to activate the lower window.
✓ Press the up/down arrow keys to scroll to the desired value.
✓ Press ENTER to store the selected value or press ESC to quit the setup menu.

Table 4-2 Communications Options (• default setting)

Code	Parameter	Options	Description
Prot	Communications protocol	*ASCII•* *rtu*	ASCII protocol Modbus RTU protocol
Addr	Address	*0•-99 ASCII* *1•-247 Modbus*	Powermeter address
bAud	Baud rate	*110* *300* *600* *1200* *2400* *4800* *9600•* *19.20*	110 baud 300 baud 600 baud 1200 baud 2400 baud 4800 baud 9600 baud 19,200 baud
dAtA	Data format	*7E* *8n•* *8E*	7 bits, even parity 8 bits, no parity 8 bits, even parity
CPtb	ASCII compatibility mode	*diS•, En*	Disables/enables ASCII compatibility mode. For more information, see ASCII Communications Protocol Reference Guide

4.3 Digital Input Setup Menu

SELECT → CHG → ENTER → dinP → ENTER

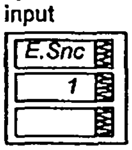
This menu is used to set up a digital input provided by the *C191HM*.

The digital input can be configured as:

- a **status input** to monitor external contact status, or
- an **external synchronization pulse input** to receive an external synchronization pulse indicating the beginning of a new demand interval for power demand measurements.

The setup menu is used for allocating an external synchronization pulse input. If you do not allocate the digital input as an external synchronization input, it is automatically configured as a status input

External synchronization input



To change the digital input allocation:

✓ Press SELECT to activate the middle window.
✓ Use the up/down arrow keys to set the input allocation status.
✓ Press ENTER to store your new inputs allocation.
✓ Press ESC to leave the allocation unchanged or to quit the menu.

"1" indicates that the input is allocated as the external synchronization pulse input; "0" indicates that the input is allocated as the status input.

NOTES

1. A digital input configured as the status input can be monitored via the *Status Information Menu* (see Chapter 6) and communications.
2. If the digital input has been allocated as the external synchronization pulse input, synchronization of the demand interval through communications is not available.

4.4 Analog Output Setup Menu

[This section is relevant to instruments ordered with this option.]

SELECT → CHG → ENTER → Aout → ENTER

This menu allows you to set up an output value and its zero and full scales for the internal analog output. Table 4-3 explains the analog output setup options, and Table 4-4 lists all measurement parameters that can be directed to analog output.

Output parameter	Zero-scale output	Full-scale output
Aout	Aout	Aout
Outp	Lo	Hi
rt U1	0	828

To view the setup options for the analog output:

✓ Press SELECT to activate the middle window.

✓ Use the up/down arrow keys to scroll to the desired option. The value associated with this option is displayed in the lower window.

To change the setup options for the selected channel:

✓ Press SELECT to activate the lower window.

✓ Use the up/down arrow keys to scroll to the desired value.

✓ Press ENTER to store the selected value, or press ESC to leave the value unchanged.

✓ Press ENTER again to store the setup for the channel.

To quit the setup without changes:

✓ From the middle or lower window, press ESC.

To quit the menu:

✓ From the upper window, press ESC or ENTER

NOTES

1. Except for the signed power factor, 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.
2. The output scale for the signed 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 -0.000/0.000.
3. Each time you select the output parameter for the analog channel, its zero and full scales are set by default to the lower and upper parameter limits, respectively.

Table 4-3 Analog Output Setup Options

Code	Option	Description
OutP	Output parameter	The output parameter for the analog output channel
Lo	Zero scale (0/4 mA)	The reading of the parameter corresponding to a zero-scale current output
Hi	Full scale (1/20 mA)	The reading of the parameter corresponding to a full-scale current output

Table 4-4 Analog Output Parameters

Code	Parameter	Unit	Scale
nonE	Output disabled		0
	Real-time Measurements		
r. U1	Voltage L1/L12	V/kV	0 to Vmax
r. U2	Voltage L2/L23	V/kV	0 to Vmax
r. U3	Voltage L3/L31	V/kV	0 to Vmax
r. C1	Current L1	A	0 to Imax
r. C2	Current L2	A	0 to Imax
r. C3	Current L3	A	0 to Imax
r. P	Total kW	kW/MW	-Pmax to Pmax
r. q	Total kvar	kvar/Mvar	-Pmax to Pmax
r. S	Total kVA	kVA/MVA	0 to Pmax
r. PF	Total PF		-0.000 to 0.000
r. PF.LG	Total PF lag		0 to 1.000
r. PF.Ld	Total PF lead		0 to 1.000
r. Fr	Frequency ①	Hz	0 to 100.00
	Average Measurements		
A. U1	Voltage L1/L12	V/kV	0 to Vmax
A. U2	Voltage L2/L23	V/kV	0 to Vmax
A. U3	Voltage L3/L31	V/kV	0 to Vmax
A. C1	Current L1	A	0 to Imax
A. C2	Current L2	A	0 to Imax
A. C3	Current L3	A	0 to Imax
A. P	Total kW	kW/MW	-Pmax to Pmax
A. q	Total kvar	kvar/Mvar	-Pmax to Pmax
A. S	Total kVA	kVA/MVA	0 to Pmax
A. PF	Total PF		-0.000 to 0.000
A. PF.LG	Total PF lag		0 to 1.000
A. PF.Ld	Total PF lead		0 to 1.000
A. neU.C	Neutral current	A	0 to Imax
A. Fr	Frequency ①	Hz	0 to 100.00
	Present Demands		
Accd.P	Accumulated kW demand	kW/MW	0 to Pmax
Accd.S	Accumulated kVA demand	kVA/MVA	0 to Pmax

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] @ wiring modes 4Ln3, 3Ln3
Pmax = (Imax × Vmax × 2) [kW x 0.001] @ wiring modes 4LL3, 3OP2, 3dir2, 3OP3, 3LL3

NOTE: Pmax is rounded to nearest whole kW units.

If Pmax is more than 9999.000 kW, it is truncated to 9999.000 kW

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] @ wiring modes 4Ln3, 3Ln3
Pmax = (Imax × Vmax × 2)/1000 [MW x 0.001] @ wiring modes 4LL3, 3OP2, 3dir2, 3OP3, 3LL3

NOTE: Pmax is rounded to nearest whole kW units.

① The actual frequency range is 45.00 - 65.00 Hz

4.5 Pulsing Output Setup Menu

SELECT → CHG → ENTER → PulS → ENTER

This menu allows you to program any of the eight relays provided by your *C191HM* instrument to output energy pulses. Relays #7 and #8 are especially recommended for use as pulsing relays because of their high endurance. Available pulsing parameters are listed in Table 4-5.

rEL.1
Ac.Ei
1

To select a pulse relay:

✓ Use the up/down arrow keys to scroll to the desired relay. The pulsing parameter assigned to the relay is displayed in the middle window, and the amount of unit-hours per pulse is displayed in the lower window.

To change the pulse relay setup:

✓ Press SELECT to activate the middle window.
✓ Use the up/down arrow keys to scroll to the desired output parameter. Selecting *nonE* disables pulsing through this relay.
✓ Press SELECT to activate the lower window.
✓ Use the up/down arrow keys to set the amount of unit-hours per pulse. The available range is 1-9999.
✓ Press ENTER to store the new setup, or press ESC to quit the setup without changes.

To quit the pulsing setup menu:

✓ From the upper window, press ESC or ENTER.

Table 4-5 Pulsing Output Parameters

Code	Parameter	Units
nonE	Output disabled	
Ac.Ei	Active energy import	kWh import (positive)
Ac.EE	Active energy export	kWh export (negative)
rE.Ei	Reactive energy import	kvarh import (inductive)
rE.EE	Reactive energy export	kvarh export (capacitive)
rE.Et	Reactive energy total	kvarh total (absolute)
AP.Et	Apparent energy total	kVAh total

NOTES

1. If your instrument is not equipped with the optional relay, then this setup parameter will not appear on the display.
2. You will not be able to store your setup in the instrument if you assigned a parameter to relay output with a zero number of unit-hours per pulse.
3. If a relay you allocated for pulsing has been manually operated or released, it reverts automatically to normal operation.
4. If a relay you allocated for pulsing has been engaged by an alarm/event setpoint, the setpoint is automatically disabled.

4.6 Alarm/Event Setpoints Setup Menu

SELECT → CHG → ENTER [illegible] [illegible] → SEtP → ENTER

Your instrument provides 16 alarm/event setpoints that can monitor a wide variety of events; in turn, these events can be programmed to trigger specific actions. This menu is used to specify the events to be monitored by the setpoints, and actions to be triggered by those events.

To program a setpoint, you might need to define up to six setup parameters which include: the setpoint trigger parameter, operate and release limits, optional operate and release delays, and the setpoint action. Table 4-6 explains the setpoint setup parameters. For the entire list of available triggers and setpoint actions, refer to Tables 4-7 and 4-8.

Example:

SP 1 / triG / RHi.C1	Trigger parameter	Setpoint 1 is set to monitor the real-time high current on phase 1 (the **trigger** parameter).
SP 1 / On / 1200	Operate limit }	The **operate (*On*) and release (*OFF*)** limits which determine setpoint operation are defined as 1200A and 1100A respectively.
SP 1 / OFF / 1100	Release limit }	
SP 1 / On d / 5	Operate delay }	The **delays before operation (*On d*) and release** (***OFFd***) are set at 5 seconds and 10 seconds respectively.
SP 1 / OFFd / 10	Release delay }	

SP 1 Act rEL.1	Setpoint action The action to be triggered is operation of relay #1.

To select a setpoint:
✓ Scroll to the desired setpoint using the up/down arrow keys.

To view the setup options for the setpoint:
✓ Press SELECT to activate the middle window.
✓ Use the up/down arrow keys to scroll to the desired setup option. The value associated with this option is displayed in the lower window.

To change the selected setup option:
✓ Press SELECT to activate the lower window.
✓ Use the up/down arrow keys to scroll to the desired value.
✓ Press ENTER to store the new value.
✓ Press ESC to leave the value unchanged.

To store your new setup for the setpoint:
✓ From the middle window, press ENTER.

To quit the setpoint setup without changes:
✓ From the middle window, press ESC.

To quit the setpoints setup menu:
✓ From the upper window, press ESC or ENTER.

NOTES

1. If your instrument is not equipped with the optional relay, then these setup parameters will not appear on the display.
2. When you enter the setpoints setup menu at the protected level, monitoring setpoints is temporarily suspended until you return to the main setup menu.
3. Each time you select a new trigger parameter, the operate and release limits are set by default to zero.
4. You will not be able to store your setpoint setup to the instrument if a setpoint action is directed to a relay allocated for pulsing.
5. The setpoint action directed to a relay output can be overridden using commands sent via communications. A relay can be manually operated or released. When the relay reverts to normal operation, it is automatically returned under setpoint control.

Table 4-6 Setpoint Setup Options (middle window)

Code	Option	Description
triG	Trigger parameter	The measurement parameter or signal to be monitored by the setpoint.
On	Operate limit	The threshold at which the setpoint becomes operative.
OFF	Release limit	The threshold at which the setpoint is released (becomes inoperative).
On d	Operate delay	The time delay (0.1 second resolution) before operation when the operate condition is fulfilled.
OFF d	Release delay	The time delay (0.1 second resolution) before release when the release condition is fulfilled.
Act	Setpoint action	The action performed when the setpoint is operative.

Table 4-7 Setpoint Triggers (lower window, when middle window is *triG*)

Code	Parameter	Unit	Range
nonE	Setpoint disabled		
	Status Inputs		
St.On	Status input ON		
St.OFF	Status input OFF		
	Phase Reversal		
POS.ro.	Positive phase rotation reversal ①		
NEG.ro.	Negative phase rotation reversal ①		
	Real-time Values on any Phase		
r. Hi. U	High voltage ③	V	0 to Vmax
r. Lo. U	Low voltage ③	V	0 to Vmax
r. Hi. C	High current	A	0 to Imax
r. Lo. C	Low current	A	0 to Imax
r. thd.U	High voltage THD	%	0 to 999.9
r. thd.C	High current THD	%	0 to 999.9
r. HFc.C	High K-factor	%	1.0 to 999.9
r. tdd.C	High current TDD	%	0 to 100.0
	Real-time Auxiliary Measurements		
r. Hi.Fr	High frequency ②	Hz	0 to 100.00
r. Lo.Fr	Low frequency ②	Hz	0 to 100.00
	Average Values per Phase		
A. Hi.C1	High current L1	A	0 to Imax
A. Hi.C2	High current L2	A	0 to Imax
A. Hi.C3	High current L3	A	0 to Imax
A. Lo.C1	Low current L1	A	0 to Imax
A. Lo.C2	Low current L2	A	0 to Imax
A. Lo.C3	Low current L3	A	0 to Imax
	Average Values on any Phase		
A. Hi. U	High voltage ③	V	0 to Vmax
A. Lo. U	Low voltage ③	V	0 to Vmax
A. Hi. C	High current	A	0 to Imax
A. Lo. C	Low current	A	0 to Imax
	Average Total Values		
A. Hi.P.i	High total kW import (positive)	kW	0 to Pmax
A. Hi.P.E	High total kW export (negative)	kW	0 to Pmax
A. Hi.q.i	High total kvar import (positive)	kvar	0 to Pmax
A. Hi.q.E	High total kvar export (negative)	kvar	0 to Pmax
A. Hi. S	High total kVA	kVA	0 to Pmax
A. PF.LG	Low total PF Lag		0 to 1.000

Code	Parameter	Unit	Range
A. PF.Ld	Low total PF Lead		0 to 1.000
	Average Auxiliary Measurements		
Ar neU.C	High neutral current	A	0 to Imax
Ar Hi.Fr	High frequency ②	Hz	0 to 100.00
Ar Lo.Fr	Low frequency ②	Hz	0 to 100.00
	Present Demands		
Hi d.U1	High volt demand L1 ③	V	0 to Vmax
Hi d.U2	High volt demand L2 ③	V	0 to Vmax
Hi d.U3	High volt demand L3 ③	V	0 to Vmax
Hi d.C1	High ampere demand L1	A	0 to Imax
Hi d.C2	High ampere demand L2	A	0 to Imax
Hi d.C3	High ampere demand L3	A	0 to Imax
Hi d.P	High block interval kW demand	kW	0 to Pmax
Hi d.S	High block interval kVA demand	kVA	0 to Pmax
Hi Sd.P	High sliding window kW demand	kW	0 to Pmax
Hi Sd.S	High sliding window kVA demand	kVA	0 to Pmax
Hi Ad.P	High accumulated kW demand	kW	0 to Pmax
Hi Ad.S	High accumulated kVA demand	kVA	0 to Pmax
Hi Pd.P	High predicted sliding window kW demand	kW	0 to Pmax
Hi Pd.S	High predicted sliding window kVA demand	kVA	0 to Pmax
	High Voltage Harmonic Distortions on any Phase		
Hd03.U	High voltage harmonic H03	%	0 to 100.00
Hd05.U	High voltage harmonic H05	%	0 to 100.00
...	...		
Hd39.U	High voltage harmonic H39	%	0 to 100.00
	High Current Harmonic Distortions on any Phase		
Hd03.C	High current harmonic H03	%	0 to 100.00
Hd05.C	High current harmonic H05	%	0 to 100.00
...	...		
Hd39.C	High current harmonic H39	%	0 to 100.00

For parameter limits, see notes to Table 4-4.

① The setpoint is operated when the actual phase sequence does not match the indicated normal phase rotation.

② The actual frequency range is 45.00 - 65.00 Hz.

③ 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.

Table 4-8 Setpoint Actions (lower window, when middle window is *Acf*)

Code	Action
NonE	No action ①
ALAr	Assert local alarm ②
rEL.1	Operate relay #1 ③
rEL.2	Operate relay #2
rEL.3	Operate relay #3
rEL.4	Operate relay #4
rEL.5	Operate relay #5
rEL.6	Operate relay #6
rEL.7	Operate relay #7
rEL.8	Operate relay #8
In.Cn.1	Increment counter #1
In.Cn.2	Increment counter #2
In.Cn.3	Increment counter #3
In.Cn.3	Increment counter #3
In.Cn.4	Increment counter #4
ti.Cn.1	Count operating time using counter #1 ④
ti.Cn.1	Count operating time using counter #2
ti.Cn.1	Count operating time using counter #3
ti.Cn.1	Count operating time using counter #4

① When a setpoint is operated, its status is always stored to the alarm status register even if no action is assigned to the setpoint. The alarm status register can be polled and cleared through communications.

② This action causes the alarm LED on the front panel to blink that gives the user a local alarm indication. The alarm LED operates in latched mode, i.e., even if an alarm condition disappears, the alarm LED is still blinking until the user acknowledges the alarm from the front panel (see Section 5.1). An alarm LED can be operated from any number of setpoints using an OR scheme.

③ Alarm relays operate in unlatched mode. This means that a relay is operated while an alarm condition is present and is automatically released when an alarm condition disappears. Each relay can be operated from any number of setpoints using an OR scheme, i.e., a relay will be in operate state while either of the alarm conditions is still present.

④ 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 that counts time at 1-second resolution before the corresponding time counter is incremented. The time counters can be inspected via the Status Information Menu. They are labeled by an *hour* mark in the middle window.

4.7 Relay Operation Control Menu

SELECT → CHG → ENTER → rELo → ENTER

This menu allows you to set the relay operation mode: non-failsafe or failsafe. Failsafe relay operation is the opposite of normal operation where relay contacts are closed when a relay is operated (activated), and are open when a relay is released (de-activated). In failsafe mode, an alarm is activated by a non-energized relay which will open in all cases when an alarm condition is present or an alarm setpoint is not operational either due to a loss of control power or due to corruption of the setpoint setup configuration. A failsafe relay is closed only if it is under setpoint control and no alarm conditions exist, or if it is manually operated via communications.

rELo
rEL1
nor

To select a relay:

✓ Press SELECT to activate the middle window, and then use the up/down arrow keys to scroll to the desired relay.

To change the relay operation mode:

✓ Press SELECT to activate the lower window.

✓ Use the up/down arrow keys to set the desired option. Select ***nor*** for normal (non-failsafe) relay operation, or select ***FSAFE*** for failsafe relay operation.

✓ Press ENTER to store your new setting or press ESC to leave your previous setting unchanged.

To quit the setup menu:

✓ From the middle window, press ESC or ENTER.

NOTES

1. You will not be able to change the relay operation mode if a relay has been allocated for pulsing.
2. When a failsafe relay is allocated for pulsing, it automatically reverts to normal operation.

4.8 Display Setup Menu

SELECT → CHG → ENTER [illegible] [illegible] → diSP → ENTER

This menu allows you to view and change display properties. Table 4-9 lists available options with their code names and applicable ranges.

Table 4-9 Display Options (* default setting)

Display	Code	Parameter	Options	Description
diSP UPdt 0.5	*UPdt*	Display update time	*0.1 - 10.0 s (0.5)**	Defines interval between display updates
diSP ScrL 5	*ScrL*	Auto scroll	*nonE** *2-15 s*	Disables/enables auto scroll on common measurements display (main screen) and defines scroll interval
diSP rEtn diS	*rEtn*	Auto return to the main screen	*diS*, En*	Disables/enables auto return to the main screen after 30 seconds of uninterrupted use
diSP bAr 5000	*bAr*	Nominal load current for LED bar graph	*0-6,500A (0*)*	Defines the nominal load (100%) level for the bar graph display (0 = CT primary current)
diSP Ph.P diS	*Ph.P*	Phase powers display mode	*diS*, En*	Disables/enables display of phase powers in common measurements (main screen)
diSP Fund diS	*Fund*	Fundamental values display mode	*diS*, En*	Disables/enables display of fundamental values in common measurements (main screen)

To select a display option:

✓ Press [SELECT] to activate the middle window, and then use the up/down arrow keys to scroll to the desired option.

To change the display option:

✓ Press [SELECT] to activate the lower window.
✓ Use the up/down arrow keys to set the desired option.
✓ Press [ENTER] to store your new setting or press [ESC] to leave your previous setting unchanged.

To quit the display setup menu:

✓ From the middle window, press [ESC] or [ENTER].

4.9 User Selectable Options Menu

SELECT → CHG → ENTER ▲ ▼ → OPtS → ENTER

This menu allows you to change options which relate to the instrument features and functionality. Table 4-10 lists all available options with their code names and applicable ranges.

OPtS
P.cAL
rEAc

To select an option:

✓ Press SELECT to activate the middle window, and then use the up/down arrow keys to scroll to the desired option.

To change the selected option:

✓ Press SELECT to activate the lower window.
✓ Use the up/down arrow keys to set the desired value.
✓ Press ENTER to store your new setting or ESC to leave the previous setting unchanged.

To quit the display setup menu:

✓ From the middle window, press ESC or ENTER

Table 4-10 User Selectable Options (* default setting)

Code	Parameter	Options	Description
P.cAL	Power calculation mode ①	*rEAc** *nAct*	Using reactive power Using non-active power
roLL	Energy roll value ②	*10.E4* *10.E5* *10.E6* *10.E7* *10.E8**	10,000 kWh 100,000 kWh 1,000,000 kWh 10,000,000 kWh 100,000,000 kWh
Ph.En	Phase energy measurements	*diS*, En*	Enables/disables measurements of energies per phase

① Power calculation mode (*P.cAL*):

Mode 1: Reactive power calculation (rEAc)

Active power P and reactive power Q are measured directly and apparent power $S = \sqrt{P^2 + Q^2}$

Mode 2: Non-active power calculation (nAct)

Active power is measured directly, apparent power $S = V \times I$ (where V, I - rms voltage and currents) and non-active power $N = \sqrt{S^2 - P^2}$

Mode 1 is recommended for electrical networks with low harmonic distortion (voltage THD < 5%, current THD < 10%); Mode 2 is recommended for all other cases.

② Energy roll value example: If roll value = 10.E4, the energy counter contains 4 digits, i.e., energy is displayed up to 9.999 MWh (Mvarh, MVAh) with resolution 0.001 MWh.

Rollover Value	Maximum Energy kWh (kvarh, kVAh)	Maximum Display Reading MWh (Mvarh, MVAh)	Display Resolution MWh (Mvarh, MVAh)
10.E4	9,999	9.999	0.001
10.E5	99,999	99.999	0.001
10.E6	999,999	999.99	0.01
10.E7	9,999,999	9,999.9	0.1
10.E8	99,999,999	99,999	1

The roll value may be changed in accordance with the average load of the power line. For example, if average power is 400 kW and the counter must be reset every 3 months (2160 hours), then energy during this period equals 864000 kWh (6 digits) and the roll value = 10.E6.

4.10 Access Control Menu

SETUP → CHG → ENTER → AccS → ENTER

This menu can be only accessed via the *Setup Change Menu (CHG)*. It is used in order to:

- change the user password
- enable or disable password check

To view an option setting:

✓ Press SELECT to activate the middle window.
✓ Use the up/down arrow keys to scroll to the desired option (*PASS* or *CtrL*).

Password Setting	Password Protection Control
AccS	AccS
PASS	CtrL
8780	OFF

To change the password:

✓ Press SELECT to activate the lower window.
✓ Use the up/down arrow keys to modify the password. The password can be up to four digits long.
✓ Press ENTER to store your new password, or ESC to leave the password unchanged.

To enable/disable password checking:

✓ Press SELECT to activate the middle window, and then use the up/down arrow keys to move to the ***CtrL*** entry.
✓ Press SELECT to activate the lower window.
✓ Use the up/down arrow keys to change the password checking status: select *OFF* to disable password protection, or select *On* to enable password protection.
✓ Press SELECT to store your new option, or ESC to leave the option unchanged.

To quit the setup menu:

✓ From the middle window, press ESC or ENTER.

Store your password in a safe place. If you do not provide the correct password, you will need to contact your local distributor for the super-user password to override password protection.

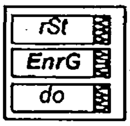
4.11 Reset/Synchronization Menu

SELECT → CHG → ENTER MAX MIN → rSt → ENTER

This menu allows you to reset to zero the accumulators and Min/Max registers in your instrument, and also to synchronize the power demand interval. The menu can be only accessed via the *Setup Change Menu (CHG)*. If the reset is disabled from the *Basic Setup Menu* (see Section 4.1), you will not be able to enter this menu.

The following designations are used in the menu to specify a data location to be affected:

EnrG	Resets total accumulated energies
dnd	Resets all total maximum demands
P.dnd	Resets total power maximum demands
A.dnd	Resets volt/ampere maximum demands
Cnt	Resets all event/time counters
Cnt.1	Resets counter # 1
Cnt.2	Resets counter # 2
Cnt.3	Resets counter # 3
Cnt.4	Resets counter # 4
Lo.Hi	Resets Min/Max registers (does not affect maximum demands)
d.Snc	Provides synchronization of the power demand interval (see **NOTES** below)



To reset the desired locations:

- ✓ Press SELECT to activate the middle window, and then use the up/down arrow keys to scroll to the desired data location entry.
- ✓ Press SELECT to activate the lower window.
- ✓ Press and hold ENTER for about 5 seconds until the *do* label is replaced with *done*, and then release the key. You will return to the middle window.
- ✓ Press ESC to quit the menu.

NOTES:

1. If the *CHG* menu is not secured by a password, fast reset of the Min/Max registers, maximum demands and energies can be done from the data display mode (see Section 5.1) and counters from the Status Information Menu (see Section 6.1) without entering the reset menu.
2. If you select the *d.Snc* entry, take into consideration the following:
   - Synchronization of the instrument's internal timer requires that the power demand period be specified in minutes (see Section 4.1, Basic Setup Options). If more than 30 seconds pass from the beginning of the current demand interval, the new demand interval starts immediately; otherwise synchronization is delayed until the next demand interval.
   - Synchronization occurs exactly 5 seconds from the time you first press ENTER while you hold the key.

Chapter 5 Data Display

5.1 Navigating in the Display Mode

The front panel has a simple interface that allows you to display numerous measurement parameters in up to 45 display pages. For easier reading, the parameters are divided into three groups, each accessible by a designated key. These are:

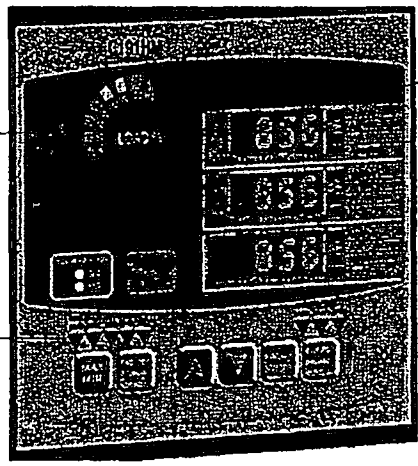
- **Common measurements** - no selection key
- **Min/Max measurements** - selected by the MAX/MIN key
- **Total Harmonic measurements** - selected by the H/ESC key
- **Individual Harmonics measurements** - selected by the H/ESC key
- **Energy measurements** - selected by the ENERGY key

The up/down arrow keys are used as follows in the *Display Mode*:

↓	Scrolls through the pages downward (forward)
↑	Scrolls through the pages upward (backward)
↑ ↓	Returns to the first page within current measurement group
↑ ↓	When pressed for 5 seconds, clears the alarm LED

Load bar graph - indicates % current load

round LEDs - indicate measurement group



arrow LEDs - indicate measured parameter

The front panel display is updated approximately twice per second; you can adjust the display update rate via the *Display Setup Menu* (see Section 4.8).

Table 5-1 lists all displayed parameters and their LED indicators.

Load Bar Graph

The load bar graph displays the amount, in percent, of the current load with respect to user-defined nominal load current. The highest current measured by the *C191HM* is divided by the nominal load current as defined in the Display Setup Menu (see Section 4.8) and expressed as a percent by the LEDs (40% to 110%) which are lit. For example, if all LEDs up to and including 90% are lit, this means that the load is 90% of the nominal load current. If the nominal load current is set to 0, it is taken from the CT primary current setup.

Alarm LED

The blinking Alarm LED gives you an alarm indication. It is controlled by the alarm/event setpoints (see Section 4.6) and operates in latched mode. Even if alarm conditions are no longer present, the alarm LED will continue to blink. To clear the alarm LED, press the up/down arrow keys simultaneously for 5 seconds.

Auto Scroll

If display Auto Scroll option is enabled (see Section 4.8), the common measurements display (main screen) will scroll automatically after 30 seconds of uninterrupted use.

✓ To stop auto scrolling at the current page, press either arrow key.

Auto Return to the Main Screen

If display Auto Return option is enabled (see Section 4.8), the display will automatically return to the main screen from any other measurement screen after 30 seconds of uninterrupted use.

Fast Reset of Accumulated Data

When changing data via the front panel is not secured by a password, you can reset the Min/Max registers, maximum demands and energies from the display mode without entering the reset menu.

NOTES

1. The common measurements display does not have a designated indicator LED. If no indicator LED is lit up below the display, this means that the common measurement parameters are being displayed at this time. To return to the common measurements from another group, press the illuminated key until it goes out.
2. When you move to another measurement group, the instrument stores your last location; when you return to the previous group, the instrument restores the last page. At power up, the instrument always returns to the common measurements group and shows you the last page that was displayed prior to loss of power.

Selecting a Display Page

✓ Press the down/up arrow keys to scroll through display pages.

Selecting Common Measurements

✓ Press the key pointed to by the illuminated round LED below the front panel display. If no LED is lit up, this means that the front panel displays the common measurements parameters.

Selecting Min/Max Measurements

✓ Press the MAX/MIN key. Use the up/down arrow keys to scroll through Min/Max measurements.

Selecting Total Harmonic Measurements

✓ Press the H/ESC key until the THD/TDD LED is illuminated. Use the up/down arrow keys to scroll through the different harmonic parameters.

Selecting Individual Voltage Harmonics Measurements

✓ Press the H/ESC key until the HARMONICS LED is illuminated and volts LEDs at the right are lit. Use the up/down arrow keys to scroll through the different harmonics readings.

Selecting Individual Current Harmonics Measurements

✓ Press the H/ESC key until the HARMONICS LED is illuminated and amps LEDs at the right are lit. Use the up/down arrow keys to scroll through the different harmonics readings.

Selecting Energy Measurements

✓ Press the ENERGY key. Use the up/down arrow keys to scroll through the different energy readings.

Fast Reset of Accumulated Data

✓ Select a display page where the data you want to reset is displayed. To reset:

- Min/Max log registers: select a Min/Max page from the Min/Max measurements display (where a MAX or MIN round LED is illuminated).
- Ampere and volt maximum demands: select the ampere or volt maximum demand page from the Min/Max measurements display (where a MAX DMD LED is illuminated, and volts or amps LEDs at the right are lit).
- Power maximum demands: select the power maximum demand page from the Min/Max measurements display (where a MAX DMD LED is illuminated, and kVA/MVA and kW/MW LEDs at the right are lit).
- Total and phase energies: select the energy measurements display.

✓ While holding the SELECT key, press and hold ENTER for about 5 seconds. The displayed data is reset to zero.

5.2 Data Display Formats

Table 5-1 specifies all front panel local displays available in the *display mode.* The display windows are labeled in the table as follows: 1 = upper window, 2 = middle window, 3 = lower window.

Table 5-1 Displayed Parameters

Page	Window	Indicator (LED)	Parameter ①	Digits	Unit ②
Common Measurements					
1	1	**V1/V1-2**	Voltage L12	4	V/kV
1	2	**V2/V2-3**	Voltage L23	4	V/kV
1	3	**V3/V3-1**	L. Voltage L31	4	V/kV
2	1	**V1/V1-2**	Voltage L1 ⑦	4	V/kV
2	2	**V2/V2-3**	Voltage L2 ⑦	4	V/kV
2	3	**V3/V3-1**	P. Voltage L3 ⑦	4	V/kV
3	1	**A1**	Current L1	4	A
3	2	**A2**	Current L2	4	A
3	3	**A3**	Current L3	4	A
4	1	**kVA**	Total kVA	4	kVA/MVA
4	2	**PF**	Total power factor	4	
4	3	**kW**	Total kW	4	kW/MW
5	1	**A NEUT**	Neutral current	4	A
5	2	**Hz**	Frequency	4	Hz
5	3	**kvar**	Total kvar	4	kvar/Mvar
6	1		**Ph.L1** ④		Label
6	2	**PF**	Power factor L1	4	
6	3	**kW**	kW L1	4	kW/MW
7	1	**kVA**	kVA L1	4	kVA/MVA
7	2		**Ph.L1** ④		Label
7	3	**kvar**	kvar L1	4	kvar/Mvar
8	1		**Ph.L2** ④		Label
8	2	**PF**	Power factor L2	4	
8	3	**kW**	kW L2	4	kW/MW
9	1	**kVA**	kVA L2	4	kVA/MVA
9	2		**Ph.L2** ④		Label
9	3	**kvar**	kvar L2	4	kvar/Mvar
10	1		**Ph.L3** ④		Label
10	2	**PF**	Power factor L3	4	
10	3	**kW**	kW L3	4	kW/MW
11	1	**kVA**	kVA L3	4	kVA/MVA
11	2		**Ph.L3** ④		Label
11	3	**kvar**	kvar L3	4	kvar/Mvar
12	1		**H01** (Fundamental harmonic)		Label
12	2	**PF**	H01 total power factor	4	
12	3	**kW**	H01 total kW	4	kW/MW
13	1		**H1.L1** ④		Label
13	2	**PF**	H01 power factor L1	4	
13	3	**kW**	H01 kW L1	4	kW/MW

Page	Window	Indicator LED	Parameter①	Digits	Unit②
14	1		H1.L2 ④		Label
14	2	PF	H01 power factor L2	4	
14	3	kW	H01 kW L2	4	kW/MW
15	1		H1.L3 ④		Label
15	2	PF	H01 power factor L3	4	
15	3	kW	H01 kW L3	4	kW/MW
16	1		U.Unb		Label
16	3		Voltage unbalance	4	%
17	1		C.Unb		Label
17	3		Current unbalance	4	%
			Min/Max Measurements		
		MIN			
1	1	V1/V1-2	Min. real-time voltage L1/L12 ⑤	4	V/kV
1	2	V2/V2-3	Min. real-time voltage L2/L23 ⑤	4	V/kV
1	3	V3/V3-1	Min. real-time voltage L3/L31 ⑤	4	V/kV
2	1	A1	Min. real-time current L1	4	A
2	2	A2	Min. real-time current L2	4	A
2	3	A3	Min. real-time current L3	4	A
3	1	kVA	Min. real-time total kVA	4	kVA/MVA
3	2	PF	Min. real-time total power factor	4	
3	3	kW	Min. real-time total kW	4	kW/MW
4	1	A NEUT	Min. real-time neutral current	4	A
4	2	Hz	Min. real-time frequency	4	Hz
4	3	kvar	Min. real-time total kvar	4	kvar/Mvar
		MAX			
5	1	V1/V1-2	Max. real-time voltage L1/L12 ⑤	4	V/kV
5	2	V2/V2-3	Max. real-time voltage L2/L23 ⑤	4	V/kV
5	3	V3/V3-1	Max. real-time voltage L3/L31 ⑤	4	V/kV
6	1	A1	Max. real-time current L1	4	A
6	2	A2	Max. real-time current L2	4	A
6	3	A3	Max. real-time current L3	4	A
7	1	kVA	Max. real-time total kVA	4	kVA/MVA
7	2	PF	Max. real-time total power factor	4	
7	3	kW	Max. real-time total kW	4	kW/MW
8	1	A NEUT	Max. real-time neutral current	4	A
8	2	Hz	Max. real-time frequency	4	Hz
8	3	kvar	Max. real-time total kvar	4	kvar/Mvar
		MAX DMD			
9	1	V1	Max. volt demand L1/L12 ⑤	4	V/kV
9	2	V2	Max. volt demand L2/L23 ⑤	4	V/kV
9	3	V3	Max. volt demand L3/L31 ⑤	4	V/kV
10	1	A1	Max. ampere demand L1	4	A
10	2	A2	Max. ampere demand L2	4	A
10	3	A3	Max. ampere demand L3	4	A
11	1	kVA	Max. sliding window kVA demand	4	kVA/MVA
11	2	PF	Power factor at max. kVA demand	4	

Page	Window	Indicator LED	Parameter ①	Digits	Unit ②
11	3	kW	Max. sliding window kW demand	4	kW/MW
			Total Harmonic Measurements		
		THD/TDD			
1	1	**V1/V1-2**	Voltage THD L1/L12	4	%
1	2	**V2/V2-3**	Voltage THD L2/L23	4	%
1	3	**V3/V3-1**	**thd.** Voltage THD L3	4	%
2	1	**A1**	Current THD L1	4	%
2	2	**A2**	Current THD L2	4	%
2	3	**A3**	**thd.** Current THD L3	4	%
3	1	**A1**	Current TDD L1	4	%
3	2	**A2**	Current TDD L2	4	%
3	3	**A3**	**tdd.** Current TDD L3	4	%
4	1	**A1**	Current K-Factor L1	4	
4	2	**A2**	Current K-Factor L2	4	
4	3	**A3**	HF. Current K-Factor L3	4	
			Individual Odd Voltage Harmonics H03-H39		
		HARMONICS			
1	1	**V1/V1-2**	Voltage harmonic H03 L1/L12	4	%
1	2	**V2/V2-3**	Voltage harmonic H03 L2/L23	4	%
1	3	**V3/V3-1**	03H Voltage harmonic H03 L3	4	%
			...		
20	1	**V1/V1-2**	Voltage harmonic H39 L1/L12	4	%
20	2	**V2/V2-3**	Voltage harmonic H39 L2/L23	4	%
20	3	**V3/V3-1**	39H Voltage harmonic H39 L3	4	%
			Individual Odd Current Harmonics H03-H39		
		HARMONICS			
1	1	**A1**	Current harmonic H03 L1	4	%
1	2	**A2**	Current harmonic H03 L2	4	%
1	3	**A3**	03H Current harmonic H03 L3	4	%
			...		
20	1	**A1**	Current harmonic H39 L1	4	%
20	2	**A2**	Current harmonic H39 L2	4	%
20	3	**A3**	39H Current harmonic H39 L3	4	%
			Total Energies		
1	1	**MWh**	Ac.En.		Label
1	2		IP.		Label
1	3		MWh import	5	MWh
2	1	**Mvarh**	rE.En.		Label
2	2		IP.		Label
2	3		Mvarh import	5	Mvarh
3	1	**MVAh**	AP.En.		Label
3	3		MVAh	5	MVAh
4	1	**MWh**	Ac.En.		Label
4	2		EP.		Label
4	3		MWh export	5	MWh

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Page	Window	Indicator LED	Parameter ①	Digits	Unit ②
5	1	Mvarh	rE.En.		Label
5	2		EP.		Label
5	3		Mvarh export	5	Mvarh
			Phase Energies ③		
6	1	MWh	Ac.En.		Label
6	2		IP.L1		Label
6	3		MWh import L1	5	MWh
7	1	Mvarh	rE.En.		Label
7	2		IP.L1		Label
7	3		Mvarh import L1	5	Mvarh
8	1	MVAh	AP.En.		Label
8	2		L1		Label
8	3		MVAh L1	5	MVAh
9	1	MWh	Ac.En.		Label
9	2		IP.L2		Label
9	3		MWh import L2	5	MWh
10	1	Mvarh	rE.En.		Label
10	2		IP.L2		Label
10	3		Mvarh import L2	5	Mvarh
11	1	MVAh	AP.En.		Label
11	2		L2		Label
11	3		MVAh L2	5	MVAh
12	1	MWh	Ac.En.		Label
12	2		IP.L3		Label
12	3		MWh import L3	5	MWh
13	1	Mvarh	rE.En.		Label
13	2		IP.L3		Label
13	3		Mvarh import L3	5	Mvarh
14	1	MVAh	AP.En.		Label
14	2		L3		Label
14	3		MVAh L3	5	MVAh

① Display readings for all electrical quantities except Min/Max log and energies are sliding average values.

② When using direct wiring (PT Ratio = 1), voltages are displayed 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 displayed in 1V units, currents in 0.01 A units, and powers in 0.001 MW/Mvar/MVA units. When the value width is over the window resolution, the right most digits are truncated

③ By default, the maximum range for energy readings is 99,999,999 MWh/Mvarh/MVAh. Beyond this value, the reading will roll over to zero. When the energy reading exceeds the window resolution, the right-most digits are truncated. To avoid truncation, you can change the energy roll value to lower limit via the *User Selectable Options* menu (see Section 4.9). Negative (exported) energy readings are displayed without a sign.

④ Per phase power and power factor readings are displayed only in 4LN3/4LL3 and 3LN3/3LL3 wiring modes (see Section 4.1) if the phase powers display is enabled in the *Display Setup* menu (see Section 4.8).

⑤ Phase energy readings are displayed only in 4LN3/4LL3 and 3LN3/3LL3 wiring modes if they are enabled in the *User Selectable Options* menu (see Section 4.9).

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 Displayed only in the 4LN3 or 3LN3 wiring mode.

5.3 Self-Test Diagnostics Display

The *C191HM* periodically performs self-test diagnostics during operation. If the instrument fails the test, it discards the last measurement results, and an error code is displayed for one second on all LEDs. Error codes are listed in Table 5-2. Code '8' indicates normal operation.

Frequent failures may be the result of excessive electrical noise in the region of the instrument. If the instrument continuously resets itself, contact your local distributor.

Table 5-2 Self-Test Diagnostic Codes

Code	Meaning
1	ROM error
2	RAM error
3	Watch dog timer reset
4	Sampling failure
5	Out of control trap
7	Timing failure
8	Normal power up
9	External reset (warm restart)

NOTE

The C191HM provides a self-check alarm register accessible through communications that indicates possible problems with 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, your instrument will use the default configuration. For more information on the self-check alarm register, refer to the communications reference guides shipped with your instrument.

Chapter 6 Viewing Status Information

Through the *Status Information Menu (StA)*, it is possible to view the status of various instrument features.

6.1 The Status Information Menu

SELECT → StA → ENTER

To enter the Status Information Menu:

✓ From the display mode, press SELECT to enter the *Primary Selection Menu*.
✓ Press SELECT to activate the *StA* window.
✓ Press ENTER.

To select a display page:

✓ Press the up/down arrow keys to scroll through the display pages.

To quit the menu and return to the display mode:

✓ Press ESC or ENTER

Front Panel Display

When you are in the *Status Information Menu*, the front panel display is updated approximately four times per second and shows you a wide variety of status information that you can review by scrolling through display pages.

The status parameters are designated by the abbreviated labels in the upper and/or middle window. The upper window flashes, indicating that you are in the menu display.

Fast Reset of Counters

When changing data via the front panel is not secured by a password, you can reset the counters from the *Status Information Menu* display without entering the reset menu:

✓ Select a display page where the counter you want to reset is displayed.
✓ While holding the SELECT key, press and hold ENTER for about 5 seconds. The displayed data is reset to zero.

6.2 Status Display Formats

Table 6-1 lists all the displays available from the *Status Information Menu*. The display windows are labeled in the table as follows: 1 = upper window, 2 = middle window, 3 = lower window.

Table 6-1 Status Information Display

Page	Window	Parameter	Digits	Unit
1	1	PHAS		Label
1	2	rOt		Label
1	3	Phase rotation sequence (POS/NEG/ERR)	4	
2	1	rEL		Label
2	2	Relay #1 - #4 status	4	
2	3	Relay #5 - #8 status	4	
3	1	St.In		Label
3	3	Status input	1	
4	1	Cnt.1		Label
4	3	Counter #1	5	
5	1	Cnt.2		Label
5	3	Counter #2	5	
6	1	Cnt.3		Label
6	3	Counter #3	5	
7	1	Cnt.4		Label
7	3	Counter #4	5	

Appendix: Technical Specifications

Input and Output Ratings

3 galvanically isolated voltage inputs	*690 V: (standard)*	DIRECT INPUT (690V line-to-line voltage and 400V line-to-neutral) Burden: <0.5 VA INPUT USING PT Burden: <0.15 VA
	120 V: (optional)	INPUT USING PT (120V line-to-line voltage) Burden: <0.1 VA
3 galvanically isolated current inputs	*5 A: (standard)*	INPUT VIA CT with 5A secondary output Burden: <0.1 VA Overload withstand: 10A RMS continuous, 250A RMS for 1 second
	1 A: (optional)	INPUT VIA CT with 1A secondary output Burden: <0.02 VA Overload withstand: 2A RMS continuous, 50A RMS for 1 second
Voltage and current input terminals		UL recognized Screws: Brass, M4 Maximum wire section: 2.5 mm^2 (12 AWG)
Optically isolated communication port		EIA RS-485 or RS-232 standard (factory set) Maximum wire section: 1.5 mm^2 (14 AWG)
Relay outputs		5 relays rated at 5A, 250 V AC / 5A, 30 V DC / 0.5A, 110 V DC 2 contacts (SPST Form A) 1 relay rated at 5A, 250 V AC / 5A, 30 V DC / 0.5A, 110 V DC 3 contacts (SPDT Form C) 2 relays rated at 3A, 250 V AC / 3A, 30 V DC / 0.5A, 110 V DC 2 contacts (SPST Form A) Maximum wire section: 1.5 mm^2 (16 AWG)
Analog output (optional) *4-20 mA* *0-20 mA*		Accuracy 0.5%, Non-linearity 0.2% Load up to 510 Ohm 24V DC external power supply required
Status input		Dry contact for external synchronization or monitoring

Display	3 windows high-brightness seven-segment digit LEDs 3 color LED bar graph 40-110%

Power Supply	
Galvanically isolated power supply (factory set)	
120&230V AC / 120&220 V DC	85 - 265V AC 50/60 Hz and 88- 290V DC 10 W
12 V DC	9.6 -19 V DC
24 V DC	19 - 37 V DC
48 V DC	37 - 72 V DC

Environmental Conditions

Operating temperature	-20°C to +60°C (-4°F to +140°F)
Storage temperature	-25°C to +80°C (-13°F to +176°F)
Humidity	0 to 95% non-condensing

Construction

Instrument body	Case enclosure: flame resistant ABS & Polycarbonate Blend Dimensions: 144 x 144 x 86 mm (5.67 x 5.67 x 3.39 ") Mounting: 136 x 136 mm square cut-out (DIN 43700)
Instrument weight	0.9 kg (2.04 lb.)

Standards Compliance

UL File # E129258 Pending

CE:
EMC: 89/336/EEC as amended by 92/31/EEC and 93/68/EEC
LVD: 72/23/EEC as amended by 93/68/EEC and 93/465/EEC

Harmonized standards to which conformity is declared:
EN55011:1991; EN50082-1:1992; EN61010-1:1993; A2/1995
Installation Category II, Pollution Degree 2
EN50081-2:1994 EMC Generic Emission Standard - Industrial Environment
EN50082-2:1995 EMC Generic Immunity Standard - Industrial Environment
EN55022: 1994 Class A
EN61000-4-2: 1995 Electrostatic Discharge
EN61000-4-4: 1995 Electrical Fast Transient
EN61000-4-8: 1993 Power Frequency Magnetic Field
ENV50140: 1993 Radio Frequency Electromagnetic Field, Amplitude Modulated
ENV50204: 1995 (200Hz) Radio Frequency Electromagnetic Field, Pulse Modulated
ENV50141: 1993 Radio Frequency Common Mode, Amplitude Modulated

ANSI C37.90.1: 1989 Surge Withstand Capability
ANSI IEEE C62.41-1991 Surge Voltages in Low-Voltage AC Power Circuits

Measurement Specifications

Parameter	Full scale		Accuracy, % Rdg	FS	Conditions	Range	Display resolution (%Rdg) ② @ range
Voltage	120V× PT @ 120V or 400V× PT @ 690V	For Ln reading and for 3OP2/3OP3 wiring modes		0.25	10% to 120% FS	0 to 999,000 V	Direct wiring (PT=1): 0.1 V @ 0.1V to 999.9 V Wiring via PTs (PT>1): 0.001 kV @ 0.001kV to 9.999 kV ≤0.1% @ 10.00 kV to 999.0 kV Starting voltage 1.5% FS
	208V× PT @ 120V or 690V× PT @ 690V	For LL reading except 3OP2/3OP3 wiring modes					
Line current	CT PRIMARY CURRENT			0.25	2% to 120% FS	0 to 9999 A	0.01 A @ 0.01A to 99.99 A ≤0.1% @ 100.0 A to 9999 A Starting current 0.5% FS
Active power	0.36×PT×CT @ 120V input 1.2×PT×CT @ 690V input			0.5	|PF| ≥ 0.5 ①	-2,000,000 to +2,000,000 kW	Direct wiring (PT=1): 0.001 kW @ 0.001kW to 9.999 kW Wiring via PTs (PT>1): 0.001 MW @ 0.001MW to 9.999 MW ≤0.1% @ 10.00 MW to 2000 MW
Reactive power	0.36×PT×CT @ 120V input 1.2×PT×CT @ 690V input			0.5	|PF| ≤ 0.9 ①	-2,000,000 to +2,000,000 kvar	Direct wiring (PT=1): 0.001 kvar @ 0.001kvar to 9.999 kvar Wiring via PTs (PT>1): 0.001 Mvar @ 0.001Mvar to 9.999 Mvar ≤0.1% @ 10.00 Mvar to 2000 Mvar
Apparent power	0.36×PT×CT @ 120V input 1.2×PT×CT @ 690V input			0.5	|PF| ≥ 0.5 ①	0 to 2,000,000 kVA	Direct wiring (PT=1): 0.001 kVA @ 0.001kVA to 9.999 kVA Wiring via PTs (PT>1): 0.001 MVA @ 0.001MVA to 9.999 MVA ≤0.1% @ 10.00 MVA to 2000 MVA
Power factor	1			1	|PF| ≥ 0.5, I ≥ 10% FSI	-0.999 to +1.000	0.001
Frequency			0.1			45.00 to 65.00 Hz	0.01 Hz

Parameter	Full scale	Accuracy, % Rdg	FS	Conditions	Range	Display resolution (%Rdg) ② @ range
Neutral (unbalanced) current	CT PRIMARY CURRENT	-	0.5	2% to 120% FS	0 to 9999 A	0.01 A @ 0.01A to 99.99 A ≤0.1% @ 100.0 A to 9999 A Starting current 0.5% FS
Ampere demand	same as for current					
KW demand (block & sliding)	same as for kW					
KVA demand (block & sliding)	same as for kVA					
Total Harmonic Distortion THD U (I), % U_1 (I_1)	999.9	1.5	0.2	≥ 0.1% FS, U (I) ≥ 10% FSU (FSI)	0 to 999.9	0.1
Total Demand Distortion TDD (I), %	100		1.5	≥ 1% FS, I ≥ 10% FSI	0 to 100	0.1
Active energy Import & Export		according to power accuracy ③			0 to 99,999 MWh	1 kWh @ 1 to 99,999 kWh 10 kWh @ 100 to 999.99 MWh 100 kWh @ 1,000 to 9,999.9 MWh 1MWh @ 10,000 to 99,999 MWh
Reactive energy Import & Export		according to power accuracy ③			0 to 99,999 Mvarh	1 kvarh @ 1 to 99,999 kvarh 10 kvarh @ 100 to 999.99 Mvarh 100 kvarh @ 1,000 to 9,999.9 Mvarh 1Mvarh @ 10,000 to 99,999 Mvarh
Apparent energy		according to power accuracy ③			0 to 99,999 MVAh	1 kVAh @ 1 to 99,999 kVAh 10 kVAh @ 100 to 999.99 MVAh 100 kVAh @ 1,000 to 9,999.9 MVAh 1MVAh @ 10,000 to 99,999 MVAh

PT = external potential transformer ratio   CT, CT Primary Current = primary current rating of external current transformer
FSU = voltage full scale   FSI = current full scale U_1 = voltage fundamental I_1 = current fundamental

① @ 10% to 120% of voltage FS and 2% to 120% of current FS ② Higher resolution is achievable via communications
③ Where the current is > 10% FS, the energy accuracy is better than 1.5% Rdg.

Additional Notes

1. Accuracy is expressed as ± (percentage of reading + percentage of full scale) ± 1 digit. This does not include inaccuracies introduced by the user's potential and current transformers.
2. Specifications assume: voltage and current wave forms with THD ≤ 5% for kvar, kVA and PF; reference operating temperature: 20 - 26°C.
3. Ordinary measurement error is considerably less than the specified accuracy which indicates maximum error.

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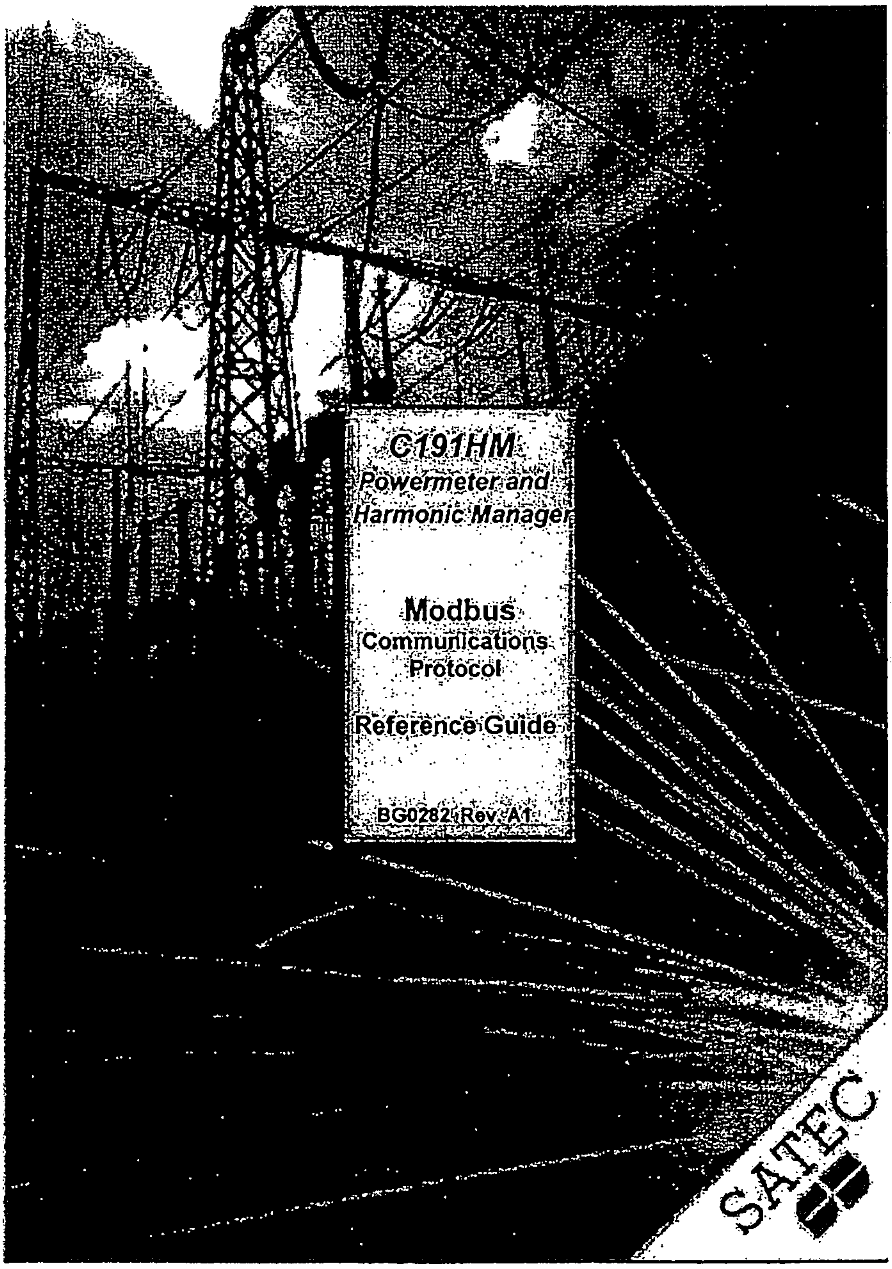
C191HM
Powermeter and
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SATEC

Table of Contents

BG0282 Rev.A1

1 GENERAL

This document specifies a subset of the Modbus serial communications protocol used to transfer data between a master computer station and the C191HM. The document provides the complete information necessary to develop a third-party communications software capable of communication with the Series C191HM Powermeters. Additional information concerning communications operation, configuring the communications parameters, and communications connections is found in "Series C191HM Powermeters, 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 4LN3, 4LL3, 3LN3 and 3LL3 wiring modes, harmonic voltages will represent line-to-neutral voltages. In a 3-wire direct connection, harmonic voltages will represent line-to-neutral voltages as they appear on the instrument's input transformers. In a 3-wire open delta connection, harmonic voltages will comprise L12 and L23 line-to-line voltages.
3. Most of the instrument 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 x 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 C191HM, 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 Word1	..	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 Word1	..	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 bytes

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 C191HM Modbus registers are referred to by using addresses in the range of 0 to 65535. From within the Modbus applications, the C191HM 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 C191HM register address to the range of the Modbus holding registers, add a value of 40001 to the C191HM register address. When a register address exceeds 9999, use a 6-digit addressing scheme by adding 400001 to the C191HM register address.

4.2 Data Formats

The C191HM 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 or signed 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:

$$Y = (X / 9999) \times (HI - LO) + LO$$

where:

Y - the true value in engineering units
X - 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.

EXAMPLE

Suppose you have read a value of 5000 from register 256 that contains a voltage reading (see *Table 5-1*). If your instrument has the 144V input option, and you use potential transformers with the ratings of 22,000V : 110V = 200, then the voltage high scale is HI = 144x200 = 28,800, and in accordance with the above formula, the voltage reading in engineering units will be as follows:

$$5000 \times (28800 - 0)/9999 + 0 = 14401V$$

When a value is written to the instrument, the conversion is carried out in reverse to produce the written value in the range of 0 - 9999:

$$X = 9999 \times (Y - LO) / (HI - LO)$$

Decimal Scaling

Decimal pre-scaling can be 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 or signed 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 C191HM 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.

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Table 4-1 User Assignable Registers

Register contents	Address	Size byte	Direction	Range
User definable data 0	0	①	①	①
User definable data 1	1	①	①	①
User definable data 2	2	①	①	①
...	...	...	...	...
User definable data 119	119	①	①	①

① - depends on the mapped register

Table 4-2 User Assignable Register Map

Register contents	Address	Size byte	Direction	Range
Register address for user data 0	120	2	R/W	240 to 9999
Register address for user data 1	121	2	R/W	240 to 9999
Register address for user data 2	122	2	R/W	240 to 9999
...	...	...	...	...
Register address for user data 119	239	2	R/W	240 to 9999

5 POWERMETER REGISTERS DESCRIPTION

5.1 Basic Data Registers

Table 5-1 Basic Data Registers

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

Parameter	Address	Size byte	Direction	Unit ②	Scale ① Low	Scale ① High	Conversion
Present sliding window kW demand ⑤	303	2	R	0.001kW/1kW	-Pmax	Pmax	LIN3
Present sliding window kVA demand ⑤	304	2	R	0.001kVA/1kVA	-Pmax	Pmax	LIN3
PF at maximum kVA siding window demand	305	2	R	0.001	-1.000	1.000	LIN3
Current TDD L1	306	2	R	0.1%	0	100.0	LIN3
Current TDD L2	307	2	R	0.1%	0	100.0	LIN3
Current TDD L3	308	2	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 or 3LL3

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 or 3LL3

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. When the value width is over the field resolution, the right most digits are truncated. All values are transmitted with a decimal point.

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	Address	Size byte	Direction	Range
Wiring mode ①	2304	2	R/W	0 = 3OP2, 1 = 4LN3, 2 = 3DIR2, 3 = 4LL3, 4 = 3OP3, 5 = 3LN3, 6 = 3LL3
PT ratio	2305	2	R/W	10 to 65000 × 0.1
CT primary current	2306	2	R/W	1 to 6500 A
Power demand period	2307	2	R/W	1,2,5,10,15,20,30,60 min, 255 = external synchronization ②
Volt/ampere demand period	2308	2	R/W	0 to 1800 sec
Averaging buffer size	2309	2	R/W	8, 16, 32
Reset enable/disable	2310	2	R/W	0 = disable, 1 = enable
Reserved	2311	2	R	Read as 65535
The number of demand periods	2312	2	R/W	1 to 15

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Parameter	Address	Size, byte	Direction	Range
Reserved	2313	2	R	Read as 65535
Reserved	2314	2	R	Read as 65535
Nominal frequency	2315	2	R/W	50, 60 Hz
Maximum demand load current	2316	2	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

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).

5.3 User Selectable Options Setup

Table 5-3 User Selectable Options Registers

Parameter	Address	Size, byte	Direction	Range
Power calculation mode	2376	2	R/W	0 = using reactive power, 1 = using non-active power
Energy roll value ①	2377	2	R/W	$0 = 1\times10^4$ $1 = 1\times10^5$ $2 = 1\times10^6$ $3 = 1\times10^7$ $4 = 1\times10^8$
Phase energy calculation mode	2378	2	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	Address	Size, bytes	Direction	Range
Reserved	2344	2	R	Read as 65535
Reserved	2345	2	R	Read as 65535
Address	2346	2	R/W	1 to 247
Baud rate	2347	2	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	2	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	Address	Size, byte	Direction	Reset value
Clear total energy registers	3404	2	W	0
Clear total maximum demand registers	3405	2	W	0 = all maximum demands 1 = power demands 2 = volt/ampere demands
Reserved	3406-3407	2		
Clear event/time counters	3408	2	W	0 = all counters 1-4 = counter #1 - #4
Clear Min/Max log	3409	2	W	0
Reserved	3410-3419	2		
Synchronize power demand interval ①	3420	2	W	0

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	Address	Size, byte	Direction	Range
Instrument reset register ①	2560	2	R/W	0 (when read) 65535 (when written) = reset the instrument
Reserved	2561	2	R	Read as 0
Relay status	2562	2	R	see Table 5-7
Reserved	2563	2	R	Read as 0
Status inputs	2564	2	R	see Table 5-11
Firmware version number	2565	2	R	0-65535
Instrument options 1	2566	2	R	see Table 5-8
Instrument options 2	2567	2	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
Options 1	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	Address	Size, byte	Direction	Value range
Relay status	3452	2	R	see Table 5-10
Reserved	3453	2	R	Read as 0
Status inputs	3454	2	R	see Table 5-11
Setpoints status	3455	2	R	see Table 5-12
Log status	3456	2	R	see Table 5-13
Reserved	3457-3473	2	R	Read as 0
Setpoint alarm status	3474	2	R/W	see Table 5-14
Self-check alarm status	3475	2	R/W	see Table 5-15

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

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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 Alarm Status

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

The self-check alarm 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 alarm register. The configuration corrupt status bit is also reset automatically when you change setup either via the front panel or through communications.

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 data 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. Data 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 5-16 Extended Data Registers

Parameter	16-bit Register		32-bit Register	Data ID	Dir	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	1536	R		0	3
Relays								
Relay status (see Table 5-10)	6976		12800-12801	2048	R		0	3
Event/time counters								
Counter #1	7056 7057		13056-13057	2560	R/W		0	99999
Counter #2	7058 7059		13058-13059	2561	R/W		0	99999
Counter #3	7060 7061		13060-13061	2562	R/W		0	99999

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Parameter	16-bit Register Reg.	16-bit Register Conv.	32-bit Register	Data ID	Dir.	Unit②	Range/Scale① Low	Range/Scale① High
Counter #4	7062 7063		13062-13063	2563	R/W		0	99999
Real-time values per phase								
Voltage L1/L12 ⑥	7136	LIN3	13312-13313	3072	R	0.1V/1V	0	Vmax
Voltage L2/L23 ⑥	7137	LIN3	13314-13315	3073	R	0.1V/1V	0	Vmax
Voltage L3/L31 ⑥	7138	LIN3	13316-13317	3074	R	0.1V/1V	0	Vmax
Current L1	7139	LIN3	13318-13319	3075	R	0.01A	0	Imax
Current L2	7140	LIN3	13320-13321	3076	R	0.01A	0	Imax
Current L3	7141	LIN3	13322-13323	3077	R	0.01A	0	Imax
kW L1	7142	LIN3	13324-13325	3078	R	0.001kW/1kW	-Pmax	Pmax
kW L2	7143	LIN3	13326-13327	3079	R	0.001kW/1kW	-Pmax	Pmax
kW L3	7144	LIN3	13328-13329	3080	R	0.001kW/1kW	-Pmax	Pmax
kvar L1	7145	LIN3	13330-13331	3081	R	0.001kvar/1kvar	-Pmax	Pmax
kvar L2	7146	LIN3	13332-13333	3082	R	0.001kvar/1kvar	-Pmax	Pmax
kvar L3	7147	LIN3	13334-13335	3083	R	0.001kvar/1kvar	-Pmax	Pmax
kVA L1	7148	LIN3	13336-13337	3084	R	0.001kVA/1kVA	0	Pmax
kVA L2	7149	LIN3	13338-13339	3085	R	0.001kVA/1kVA	0	Pmax
kVA L3	7150	LIN3	13340-13341	3086	R	0.001kVA/1kVA	0	Pmax
Power factor L1	7151	LIN3	13342-13343	3087	R	0.001	-1.000	1.000
Power factor L2	7152	LIN3	13344-13345	3088	R	0.001	-1.000	1.000
Power factor L3	7153	LIN3	13346-13347	3089	R	0.001	-1.000	1.000
Voltage THD L1/L12	7154	LIN3	13348-13349	3090	R	0.1%	0	999.9
Voltage THD L2/L23	7155	LIN3	13350-13351	3091	R	0.1%	0	999.9
Voltage THD L3	7156	LIN3	13352-13353	3092	R	0.1%	0	999.9
Current THD L1	7157	LIN3	13354-13355	3093	R	0.1%	0	999.9
Current THD L2	7158	LIN3	13356-13357	3094	R	0.1%	0	999.9
Current THD L3	7159	LIN3	13358-13359	3095	R	0.1%	0	999.9
K-Factor L1	7160	LIN3	13360-13361	3096	R	0.1	1.0	999.9
K-Factor L2	7161	LIN3	13362-13363	3097	R	0.1	1.0	999.9
K-Factor L3	7162	LIN3	13364-13365	3098	R	0.1	1.0	999.9
Current TDD L1	7163	LIN3	13366-13367	3099	R	0.1%	0	100.0
Current TDD L2	7164	LIN3	13368-13369	3100	R	0.1%	0	100.0
Current TDD L3	7165	LIN3	13370-13371	3101	R	0.1%	0	100.0
Voltage L12	7166	LIN3	13372-13373	3102	R	0.1V/1V	0	Vmax
Voltage L23	7167	LIN3	13374-13375	3103	R	0.1V/1V	0	Vmax
Voltage L31	7168	LIN3	13376-13377	3104	R	0.1V/1V	0	Vmax
Real-time total values								
Total kW	7256	LIN3	13696-13697	3840	R	0.001kW/1kW	-Pmax	Pmax
Total kvar	7257	LIN3	13698-13699	3841	R	0.001kvar/1kvar	-Pmax	Pmax
Total kVA	7258	LIN3	13700-13701	3842	R	0.001kVA/1kVA	0	Pmax
Total PF	7259	LIN3	13702-13703	3843	R	0.001	-1.000	1.000
Reserved	7260		13704-13705	3844	R		0	0
Reserved	7261		13706-13707	3845	R		0	0
Real-time auxiliary values								
Reserved	7296		13824-13825	4096	R		0	0
Neutral current	7297	LIN3	13826-13827	4097	R	0.01A	0	Imax
Frequency ③	7298	LIN3	13828-13829	4098	R	0.01Hz	0	100.00
Voltage unbalance	7299	LIN3	13830-13831	4099	R	1%	0	300
Current unbalance	7300	LIN3	13832-13833	4100	R	1%	0	300
Average values per phase								
Voltage L1/L12 ⑥	7336	LIN3	13952-13953	4352	R	0.1V/1V	0	Vmax
Voltage L2/L23 ⑥	7337	LIN3	13954-13955	4353	R	0.1V/1V	0	Vmax
Voltage L3/L31 ⑥	7338	LIN3	13956-13957	4354	R	0.1V/1V	0	Vmax
Current L1	7339	LIN3	13958-13959	4355	R	0.01A	0	Imax
Current L2	7340	LIN3	13960-13961	4356	R	0.01A	0	Imax
Current L3	7341	LIN3	13962-13963	4357	R	0.01A	0	Imax

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