Configuration Software for the JEMStar & Ci20 Meter

User Manual

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Table Of Contents

INTRODUCTION

JEMWare™ is a Microsoft Windows® based program used with the Scientific Columbus polyphase electricity meters. The primary function of the program is to establish communications with the meter and select and configure all register types displayed on the meter. You can also configure the meter's primary calibration, communications interface, load-profile configuration, time-of-use schedules, and other meter parameters.

JEMWare can be used to program the meter, retrieve the meter's configuration, and set the time on the meter. The application includes file-management capabilities to save, open, and delete meter configurations that are stored on the computer's hard drive.

The program is easy to use, and each operation is accessible through simple Windows pull-down menus and toolbar icons. *JEMWare* has many functions that enable you, the user, to more efficiently process and organize data from metering devices. *JEMWare* does not have the capability to download Load Profile data from the meter; the sole purpose of the *JEMWare* program is to configure or change the meter's configuration parameters. For meter data downloading, refer to the *JEMRead* application and instruction manual.

MINIMUM SYSTEM REQUIREMENTS

To operate *JEMWare* successfully, you must have a Personal Computer with the following features:

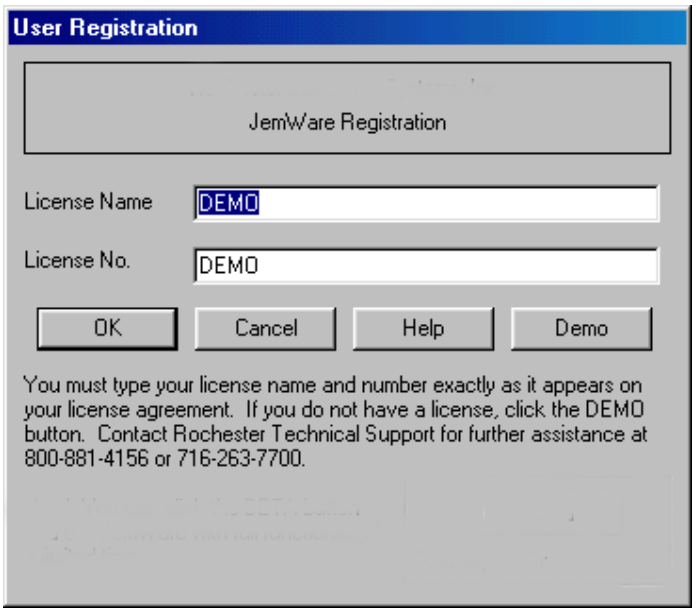
Pentium™-90 processor or equivalent using Windows 95/98/NT 4.0 or better
CD-ROM drive
16 MB RAM
10 MB Hard disk space for the application
5 MB Hard disk space for storing meter configuration files
RS-232C Serial Communications Port
Modem using a Hayes command set (if sending data over telephone lines)

If you intend to connect to a network of meters, you must have an RS-232 serial data cable and RS-232 to RS-485 converter or use an Ethernet connection over TCP/IP. These items are available from Scientific Columbus or your local electronics supplier.

SOFTWARE INSTALLATION (WINDOWS 95/98/NT 4.0):

Installation is easy using the InstallShield™ Wizard to guide you through the steps.

- The program will have a Name/Serial Number combination that must be entered once at program installation. The program will not operate unless a valid combination is entered. If this is a Demo installation, the Name/Serial Number is not required.
- Both individual and multiple-site licensing are supported.



To begin the installation procedure:

1. Insert the *JEMWare* CD in your computer's drive.
2. The CD will auto-start (if you have Windows configured this way), or you can select "Run..." from the Start menu.
3. If manually starting, type "d:\setup.exe" (where "d" is the letter of your CD drive). Click on "OK".
4. Follow the InstallShield™ Wizard instructions on the screen to complete the installation.

Note: If your operating system is Windows 95/98, the "Hunt" feature will only work if you install the JEMWare application in a directory path containing filenames of 8 or less characters.

For example:
C:\Program Files\AMETEK… will not work because "Program Files" is too long.
C:\AMETEK\Jemware… will work because each filename is 8 or fewer characters. This is the default location that the program offers during the installation process.

Uninstalling JEMWare

There are two ways to run the Uninstall program. Each method will have the same results.
Method 1: Select the "*JEMWare* Software/Uninstall" icon in the Start Menu Program Folder in which *JEMWare* was placed during setup. Follow the simple instructions to remove the program.
Method 2: Click on Start, then Settings. In the Control Panel, double-click on the "Add/Remove Programs" icon. Select "Ametek *JEMWare Software*" from the list and click on the "Add/Remove" button. If you then click on the Yes button, all files and shortcuts installed during setup will be removed.

CHANGING METER CONFIGURATIONS

The meters are provided from the factory with a "default" configuration setting (which is listed in the JEMStar User Manual 1083-600 and Ci20 User Manual 1086-381). This allows the meter to initialize and operate in its basic form; however you will want to customize the configuration to your specific application and features. The Meter's front panel User Interface offers several basic setup features, however to make most changes in a meter configuration, you will need *JEMWare* software.

Certain features of the meter are forced to be re-initialized when portions of the configuration are changed. This page summarizes the changes that will force a re-initialization. Note that when a new configuration is loaded into a meter, the meter determines individually if each section has changed from the currently stored configuration. These features are re-initialized ONLY if the particular configuration sections are different.

NOTE: You may use the latest version of JEMWare to open a configuration file saved with a prior version, or to read the configuration from a meter that was programmed with a prior version. If you do this, however, you must verify all settings in the configuration before saving it or programming it into a meter. Verify the settings by opening each item in the Meter Settings menu and reviewing the settings. This allows you to be confident that the correct settings are in place and also allows JEMWare to insert appropriate default settings for features that may not have been present in the older version of JEMWare.

Display Registers

The Display Registers feature includes the following parts:

- Registers in the Normal display list
- Registers in the Alternate display list
- Registers in the Test display list
- Self Read registers
- Register Thresholds
- Site Monitor alarms

The following configuration sections, if modified, will cause the Display Registers feature to be re-initialized, erasing all previous data:

- Normal display list
- Alternate display list
- Test display list
- Demand settings
- Self Read settings
- Primary Scaling settings (including changing VT Ratio or CT Ratio from the meter front panel.)
- Register Threshold settings
- Demand, Load Profile Interval Timing settings
- Auto BPR Reset changes from the Timekeeping and DST tab.

Load Profile

The Load Profile feature (which does not include individual Event Logs) will be erased and re-initialized if these configuration sections are modified:

- Demand, Load Profile Interval Timing settings
- Load Profile channel assignments

Energy Pulses

The Energy Pulse feature will be re-initialized if these configuration sections are changed:

- Energy pulse channel assignments

SECURITY KEYS

Meters include two security keys to protect the meter from tampering and unwanted access to meter functions. There are two removable jumpers (keys) located inside the meter on the Metrology board. One security key is used to disable all configuration changes from the front panel keypad menus, plus the following serial port commands when accessing the meter via JEMWare. Numbers shown in parentheses are the hex equivalent of the command in JEM binary (see Command Protocol manual 1083-803).

Enter Test Mode (4D 01)
Preset Normal Registers (57 01)
Preset Alternate Registers (57 02)
Configure Timekeeping (43 07)
Configure Interval Timing (43 08) (demand and Load Profile intervals)
Configure Demand Parameters (43 09) (subinterval length, outage deferral)
Configure Load Profile (43 0A)
Configure Pulse I/O (43 0B)
Configure Analog Outputs (43 0C)
Configure Primary Scaling (43 0D)
Configure Normal display List (43 0E)
Configure Alternate Display List (43 0F)
Configure Test Display List (43 10)
Configure TOU Schedules (43 12)
Configure TOU Seasons (43 13)
Configure TOU Holidays (43 14)
Configure Loss Compensation (43 15)
Configure Reactive Selection (43 16)
Configure Thermal Time Characteristic (43 18)
Configure Threshold Alarms (43 19)
Configure Site Monitor (43 1A)
Configure DST Schedule (43 1C)
Configure Energy Pulses (43 1D)
Calibrating/Loading Flash Memory

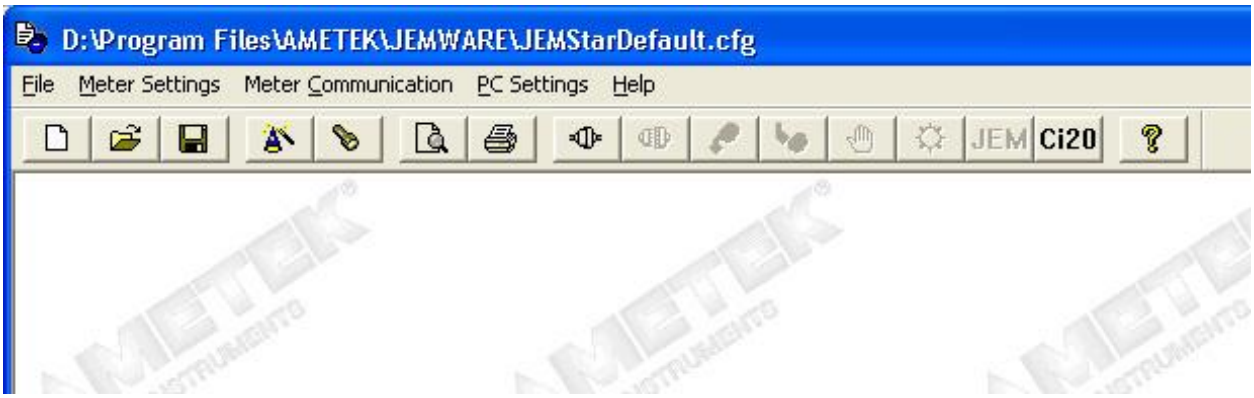
The other key is used to disable just the meter's RESET pushbutton. With the jumpers installed, access is enabled. Remove the jumpers to restrict access.

The meters are provided from the factory with both keys installed, thus ready for your new configuration using JEMWare. If you want to remove the key(s) after proper configuration in your meter shop, follow the procedure located in the Maintenance section of the User Manuals 1083-600 and 1086-381.

If you attempt to download a new configuration via JEMWare and experience errors related to the above commands, the security key has probably been removed. You can verify this by attempting to download a non-protected feature, such as setting the time clock. If this is accepted, then it most likely means the meter has been security-locked.

MAIN MENU OVERVIEW

JEMWare is comprised of five Main Menu items (File, Meter Settings, Meter Communication, PC Settings, and Help) that appear at the top of the program screen.



File Menu

JEMWare manages meter configuration files through the File Menu. From this menu, *JEMWare* opens, saves, and deletes configuration files. The File Menu also provides you access to a default configuration as a point of reference. You can also compare two configurations at the same time to determine the differences between them. This is also the menu that allows the user to change passwords and exit the program.

Meter Settings Menu

The Meter Settings Menu is the section of the program that defines the meter configuration. Each item listed on the menu brings up a screen that defines certain aspects of the meter's configuration. Some of the menus, such as Registers and TOU Setup, bring up submenus that break down the setup of these parameters even further. When creating a configuration for the registers or TOU Setup, it is important to complete all of the Menu screens.

Meter Communication Menu

The Meter Communication Menu performs the actual communication with the meter to download or retrieve meter configurations, and Set or Get the meter's time.

PC Settings Menu

The PC Settings Menu is used to set up the program for use with your computer's COM port and to view/set the internal PC clock.

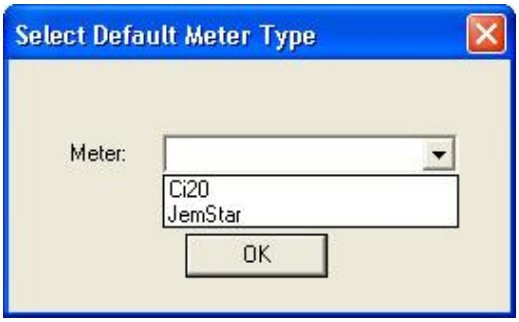
Help Menu

JEMWare is equipped with a Help Menu to provide the user with assistance for each screen and program function. Most Help screens include pop-up descriptions of each function.

USING JEMWARE

FIRST TIME USE

Open the program by double-clicking on the *JEMWare* icon on your desktop.
You first select the Default Meter type you wish to use. This can be changed later by pressing either the JEM or Ci20 buttons on the main menu.



The Main Screen will appear with the Login screen superimposed over the top, as shown below.

The JEMWare Login screen is used to assign the initial User Privileges that allow access to the software.

User Privileges

JEMWare is designed with built-in security protection that allows only designated users to access and edit important meter configuration files. There are two levels of access to the program: **Engineer** and **Technician**.

- The **Engineer** level allows access to all the menu features. Passwords can be changed, and all meter configuration controls are available.

- The **Technician** level restricts the user from the "Meter Settings" Menu and the Configuration Wizard. Also, the Technician level cannot change passwords or "Save" a configuration. "Save As" is available, which requires a new file name to be assigned, thus preventing an overwrite of an existing file.

Engineer Login

If this is a first-time use, select **Engineer** from the drop-down box and click OK. You must enter the default password 000000 (six zeros) and click OK. Note: Once you have access to the program, you can change the password to something of your choosing by going to the File | Passwords menu.

Technician Login

The Technician login does not require a password. Choose Technician and click OK to continue.

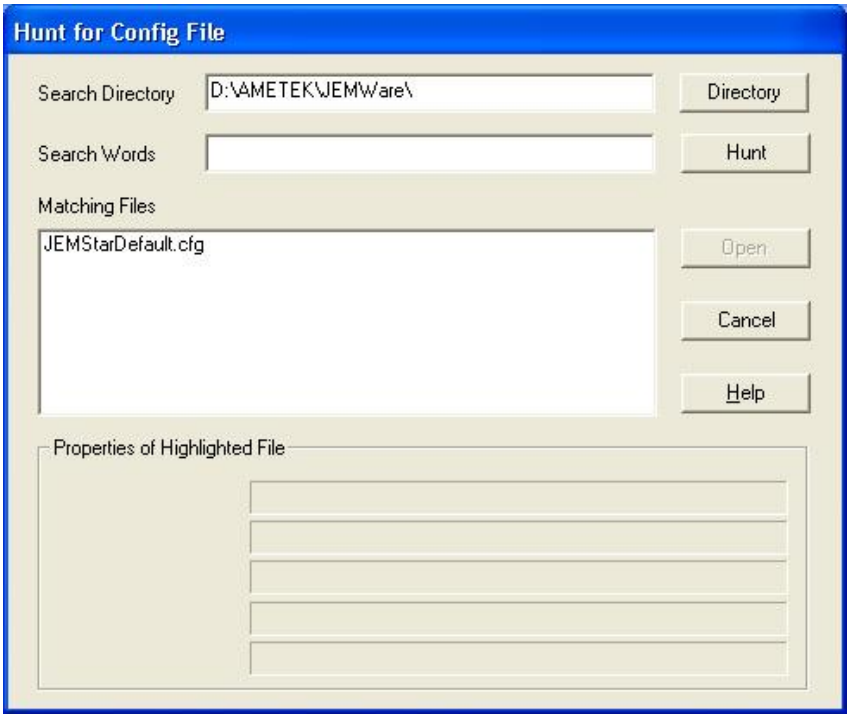
After you select a Login type and click OK, the Wizard Source File screen will appear. If this is the first time that you are using the program, the only configuration (.cfg) file available will be the factory Default Configuration (Default.cfg). Click OK to open the Default file and begin editing it for your particular meter settings. If you already have custom configuration files, click the Browse button to locate the desired file on your hard drive.

Each custom configuration is saved as an individual file. The Default.cfg file is a special file that is loaded whenever you start a new configuration. The Default file can be edited and saved (with a new file name), and the newly saved file will then become the default when the program is opened the next time.

When a configuration file is accessed by *JEMWare*, its filename is displayed at the bottom of the Main Menu screen. This is a reference to which file is currently active in the program. Once a configuration file is opened, you can access the menus and edit it as necessary.

Locating a File

JEMWare can help you find configuration files on your hard drive by choosing File | Hunt or by clicking the Hunt button (flashlight icon) in the toolbar. Simply type in a "keyword" and a directory in the top two fields, then click the Hunt button. The keyword can consist of any text that you entered in the five Meter ID fields (such as the Meter Name, Location, etc.). The program will search the specified directory in your hard drive for **.cfg** files. JEMWare will locate and display all the .cfg files that contain your keyword(s). Click on the file you wish to open and continue.



Note: If you are using *Windows 95/98*, the Hunt feature will only work if you installed the JEMWare application in a directory path containing filenames of 8 or less characters.
For example:

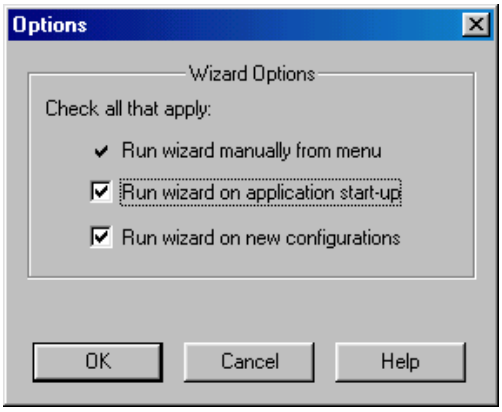
- C:\Program Files\AMETEK… will not work because "Program Files" is too long.
- C:\AMETEK\Jemware… will work because each filename is 8 or fewer characters. This is the default location that the program offers during the installation process.

If you are using other Windows applications (NT, etc.), there is no limit to the filename sizes.

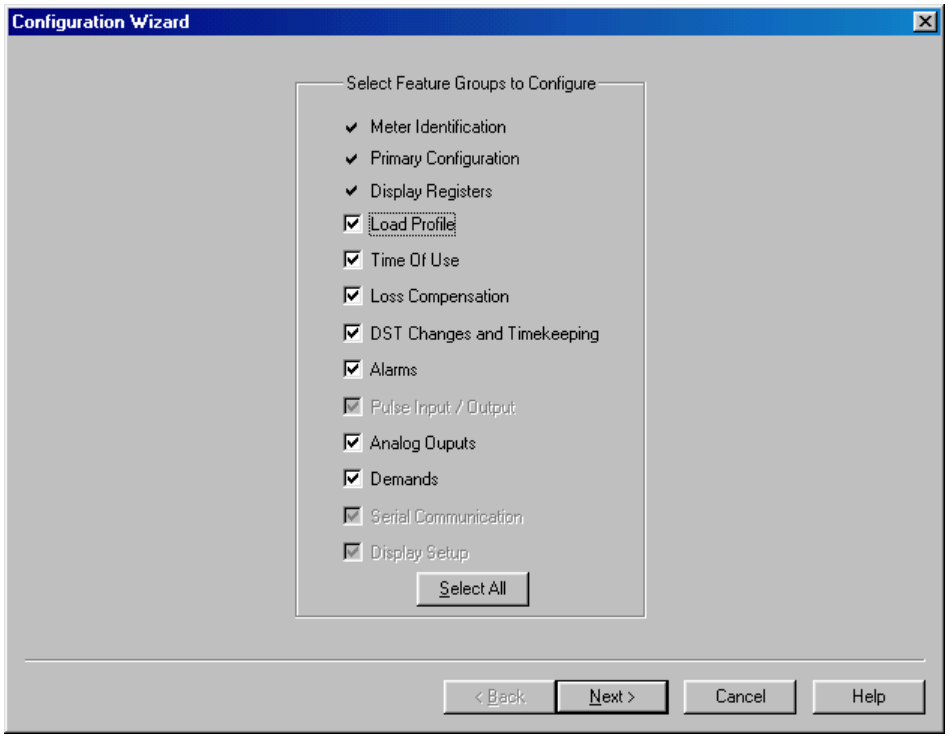
THE CONFIGURATION WIZARD

There are two methods available to use *JEMWare:* the Configuration Wizard and the manual Windows pull-down menus. The Wizard is designed to be self-explanatory and automatically guide you through step-by-step procedures to build a configuration file that corresponds to your meter usage. As you progress through each step of the Wizard, you will logically insert information as needed. Once you become familiar with the JEMWare process and have some saved configurations, you may wish to bypass the Wizard and go directly to the pull-down menus for editing specific sections.

To choose when you want the Wizard to be activated, go to the pull-down menu File | Options and check the screen with your preferences.



To begin the Configuration Wizard from the pull-down menus, go to File | Wizard, or click the icon on the toolbar. The default arrangement will have all the check boxes selected. If you do not have or use a particular option, you can de-select it and the Wizard will bypass those setups.



Once you have selected the correct features for your meter, step through the Wizard by clicking the Next button at the end of each progressive screen. The features you selected in the first Wizard screen will determine which screens must be filled in and also the sequence. Use the online Help buttons available on each screen if you have any questions about setting up a particular field.

Each Wizard screen has a matching standalone dialog window that is accessible through the pull-down menus. Refer to the next section of this manual for a detailed description of each menu function.

MENU FEATURES

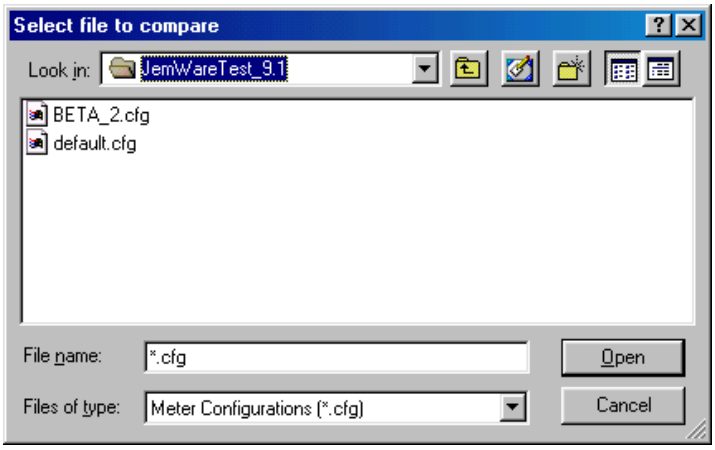
Whether you use the Wizard or the basic pull-down menus, each configuration window will look the same. The Wizard will automatically switch from window to window progressively, where the pull-down menus must be accessed individually. This section will explain each menu in detail.

FILE MENU

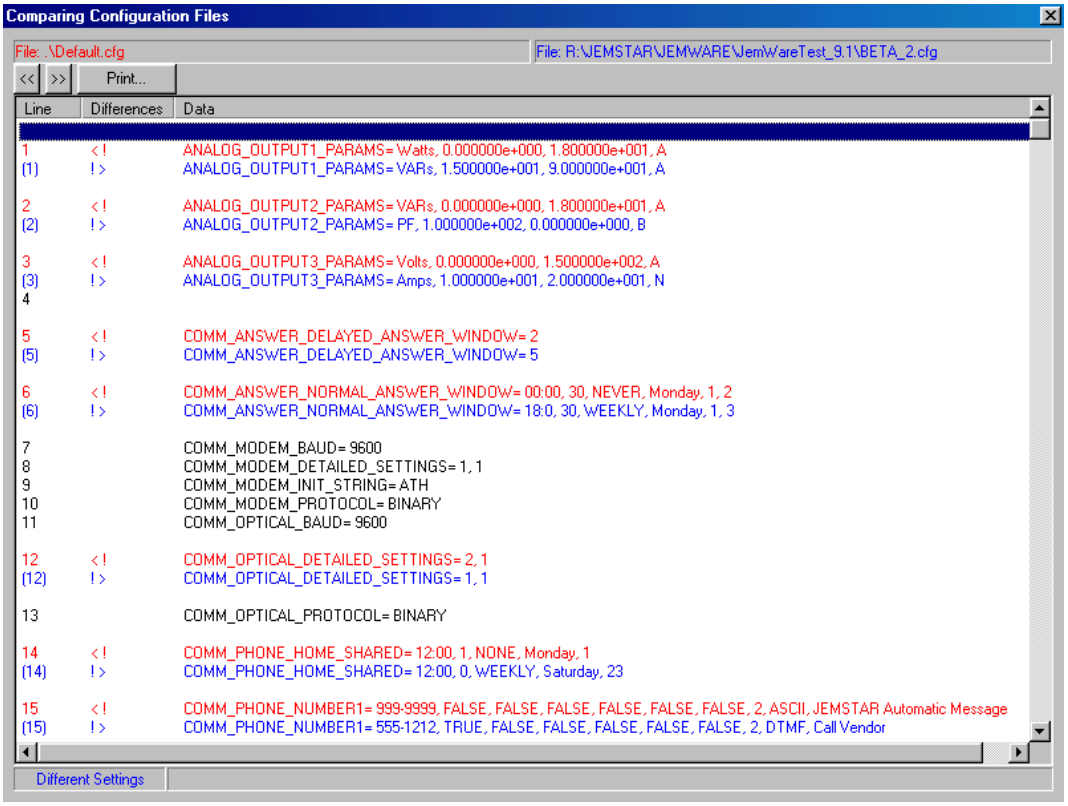
The File menu includes the standard Windows functions such as Open, Save As, Print, etc. In addition, the following features are special to the JEMWare application.

Compare Configurations

This feature will compare configuration parameters between the currently open .cfg file and any other saved .cfg file. This can be useful when you are trying to determine the differences in two setups. From the File Menu, click on Compare Configurations, and the following screen will appear.



Highlight a .cfg file in the list and open it. The parameters will be listed in comparison to the currently running file.



The two files are compared, line-by-line, to each other. The line number shown in the left column is used to itemize each parameter. When you see a line number listed twice, this indicates that there is a mismatch between the two files. In the example above, line 1 has a discrepancy, whereas line 7 does not. The two lines are discernable both by color and style. The top line of each pair is red and indicates the working file. The bottom line of each pair is blue and indicates the compared file. The black (single) line items indicate that both files match for those parameters.

The alphanumeric codes shown in the above line descriptions are defined in the command Set Instruction Manual – JEMStar 1083-603 and Ci20 1086-684.

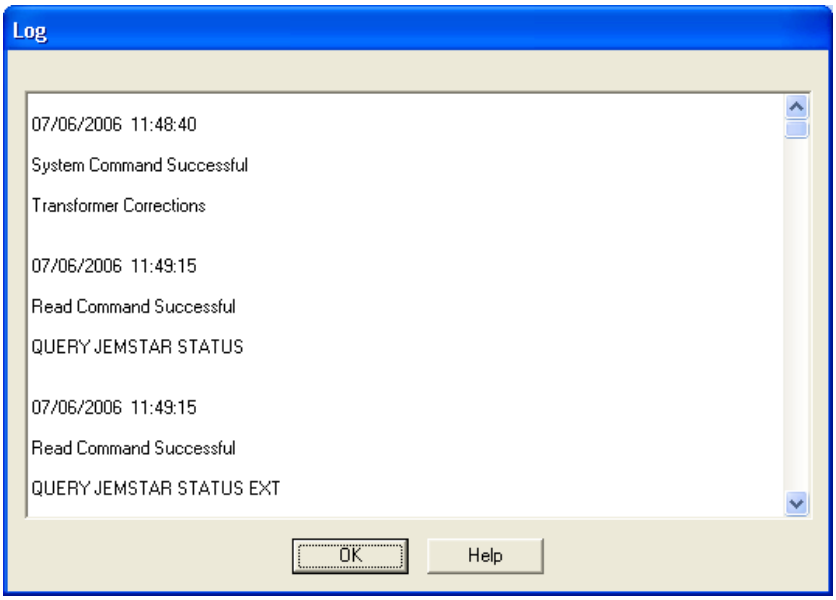
Show Log File

The Log file shows a list of communication activities that occur during normal program operation. Errors, connections, and validations are shown in chronological order, and may be used as a historical reference when troubleshooting a problem.

When you open the JEMWare program, the log file jemwarelog.txt is created. As you perform operations, this file will accumulate data and you can view it by going to the File | Show Log File menu.

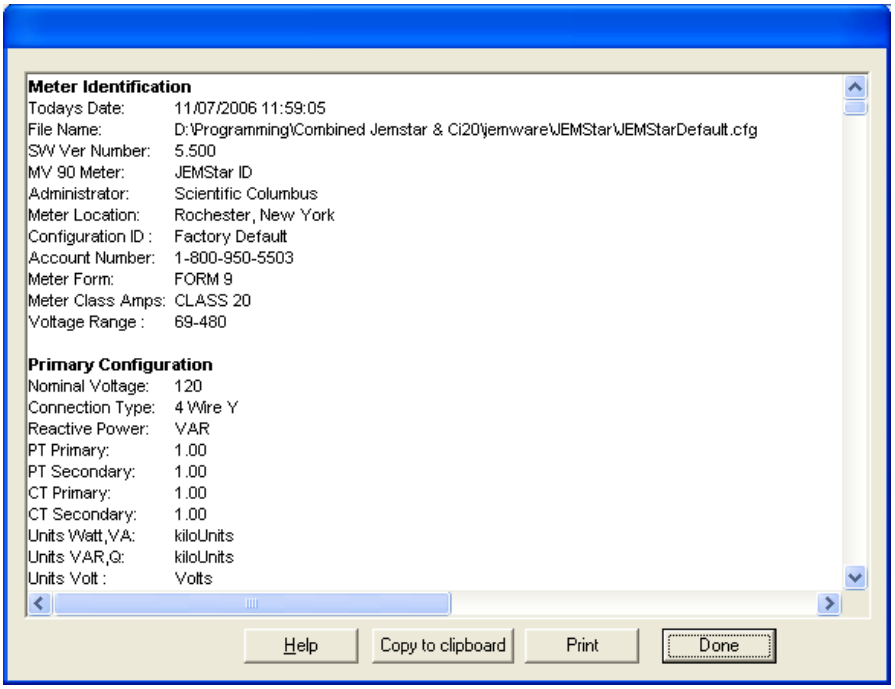
When JEMWare is closed, this file is immediately renamed to oldjemwarelog.txt. You can view this file by clicking on it and viewing through your Windows text editor. Note that this file does not accumulate data; it is overwritten with new data every time that

JEMWare is closed. If you want to create a library and save the old data, you must rename the oldjemwarelog.txt file to a new name.

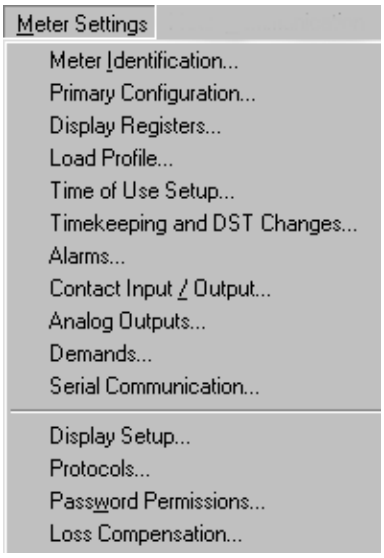


View Configuration

This shows the configuration of the currently loaded file.
It can be printed or copied to the clipboard for future use.



METER SETTINGS



Depending on what meter type you select either by default at startup or by selecting either the Jem or Ci20 button on the main menu the meter settings may vary depending on which meter you wish to connect to.

Use this menu to configure all the meter's parameters. Each menu selection opens a dialog box that allows you to access and enter data specific to that feature. In some instances, the information that you enter in one location is automatically copied to other menu features as necessary to perform the internal calculations.

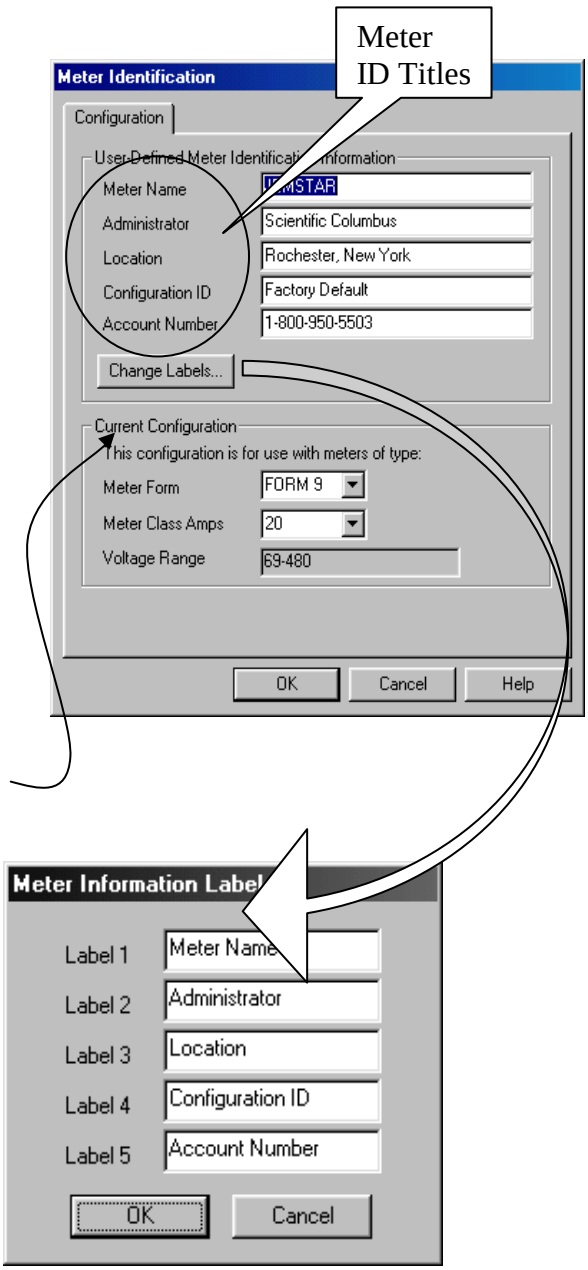
The "Meter Settings" Menu is restricted from the **Technician** permission level.

Meter Identification

The command group "User-Defined Meter Identification Information" provides basic information about a meter. However, this information is not necessary for meter operation. If nothing is entered, there are no defaults assumed. Each of the five ID fields will accept up to 20 alphanumeric characters. The text in these fields is searched when you use the "Hunt" feature.

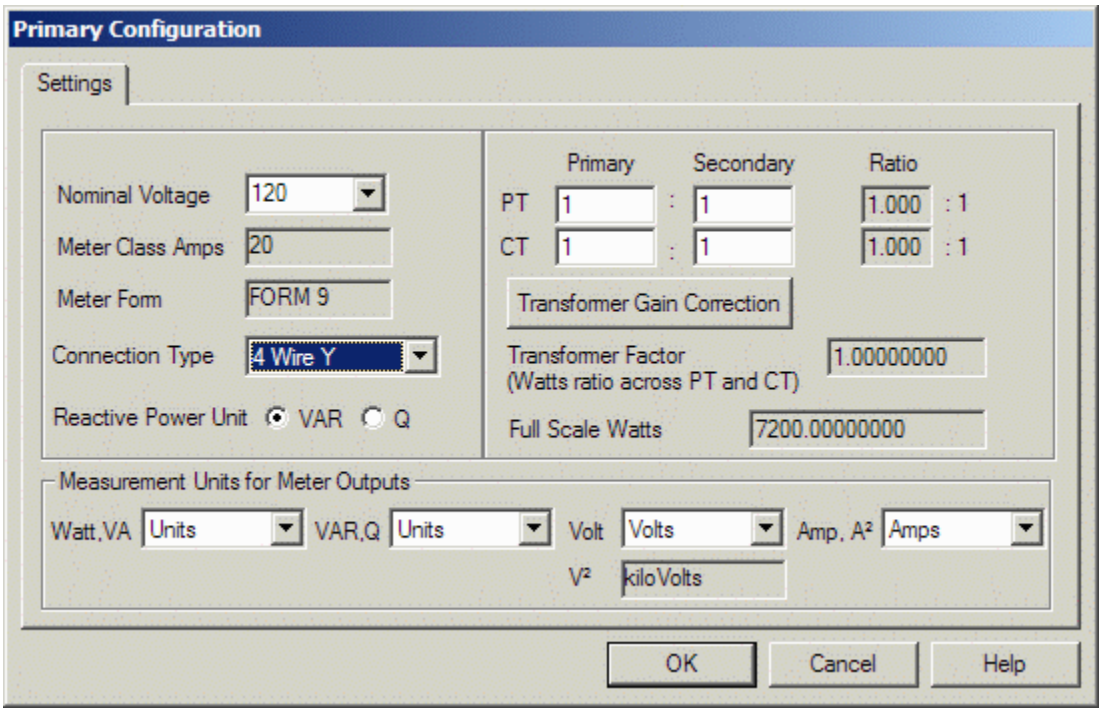
The Meter ID Titles shown in the illustration are the defaults, however you can customize the titles by selecting the "Change Labels" button, then entering a new title. In this manner, you can create any category you wish to keep as part of the meter data record.

The Current Configuration group box contains key configuration fields that must be filled in because this information is used in other setup screens. Make sure that your choices are correct for the meter you are configuring. If they do not match, the configuration cannot be written to the meter, and a mismatch error will appear.



Primary Configuration

The data in this window *must* be entered correctly for proper meter operation. These are the fields that define the nominal voltage, circuit type, voltage and current ratios, and other scaling factors. The grayed-out fields are view-only in this screen and cannot be edited, the data having been calculated or taken from other setup screens.



Nominal Voltage: Use the pull-down menu to select the meter's operating voltage.

Meter Class Amps and **Meter Form:** These fields were entered on the previous "Meter Identification" screen and are view-only here.

Connection Type: Use the pull-down menu to select the circuit category.

VT/CT ratios: Enter the nominal primary and secondary voltage of the VTs to be metered. Enter primary and secondary amps for the CTs. JEMWare will automatically calculate the ratio to its lowest form. The Transformer factor is a read-only calculation derived by multiplying the VT and CT ratio. The Full Scale Watts calculation is derived with the following formula:

Full Scale Watts = (Nominal Voltage) X (Meter Class Amps) X (number of elements) X (Transformer Factor)

Measurement Units for Meter Outputs: Select the scaling of units (kilo, mega, etc.) that will be used in the meter's calculations. *It is important to remember these units.* The Display Registers, Analog Outputs, Digital Outputs, Alarms, and Load Profile will use these units of measure in their calculations.

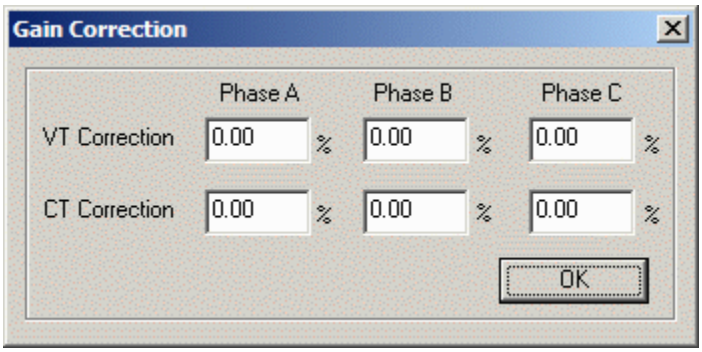
Transformer Gain Correction (Ci20): Pressing this button opens another screen where the user may enter gain correction percentages for each voltage and current phase input.

Entering a positive percentage increases the meter's registration of the corresponding signal (volts or amps) and all measurements that depend on it (watts, VARs, etc.) The user may enter any percentage between -10.00% and +10.00% in 0.01% increments.

This correction does not affect the meter's factory-established calibration.

Changing the gain of a voltage or current input will cause any single-phase measurement using that input to increase or decrease by the amount of the change. For example, changing the Phase A Volts by +1.00% will cause all Phase A measurements to read 1% high (except for amp quantities).
Polyphase measurements will change by the average of the changes made to each individual phase. For example, if Phase A Volts is changed by +1.00%, Phase B Volts by +2.00% and Phase C Volts by +4.00%, the change to polyphase watts is (1+2+4)/3=2.333%.

NOTE: When sharing a single configuration file among multiple meters, be sure to verify that the gain corrections are correct for all meters, or else edit them to the appropriate value for the meter about to be programmed.



Transformer Gain Correction (JEMStar): Pressing this button opens another screen where the user may enter gain correction percentages for each voltage and current phase input. Entering a positive percentage increases the meter's registration of the corresponding signal (volts or amps) and all measurements that depend on it (watts, VARs, etc.) The user may enter any percentage between -10.00% and +10.00% in 0.01% increments.

This correction does not affect the meter's factory-established calibration.

Changing the gain of a voltage or current input will cause any single-phase measurement using that input to increase or decrease by the amount of the change. For example, changing the Phase A Volts by +1.00% will cause all Phase A measurements to read 1% high (except for amp quantities).
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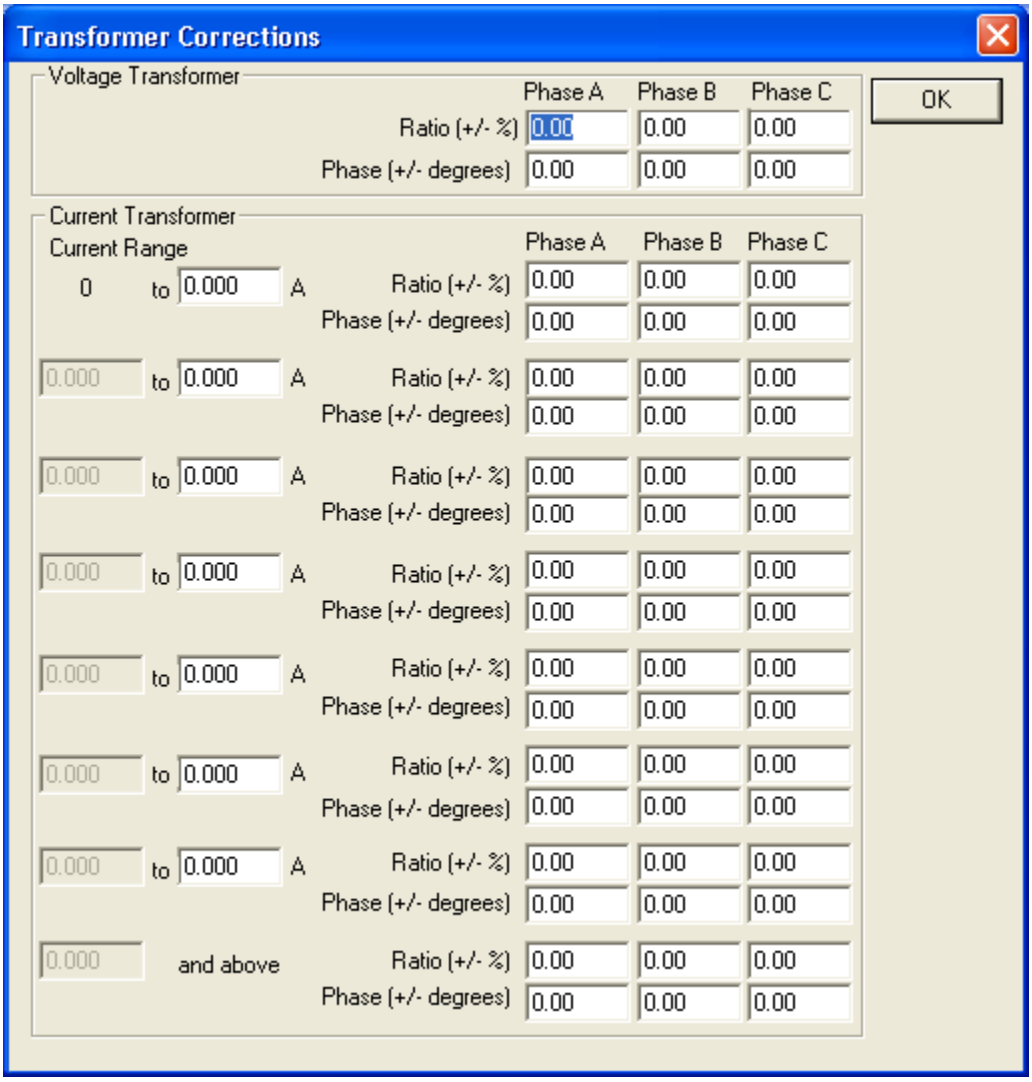
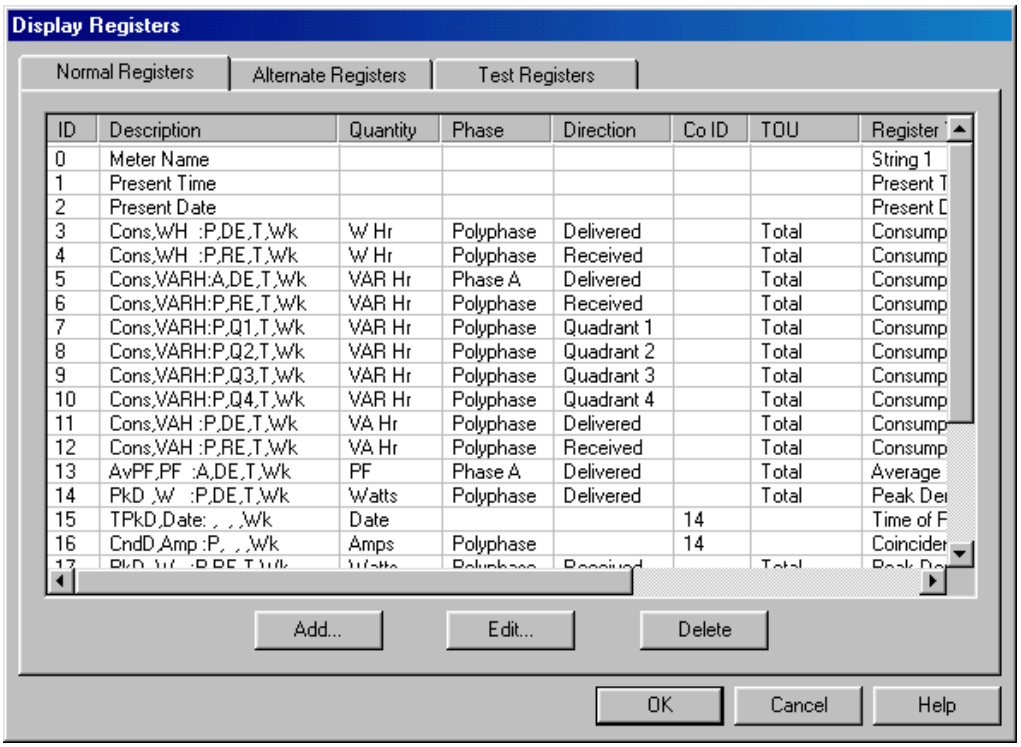


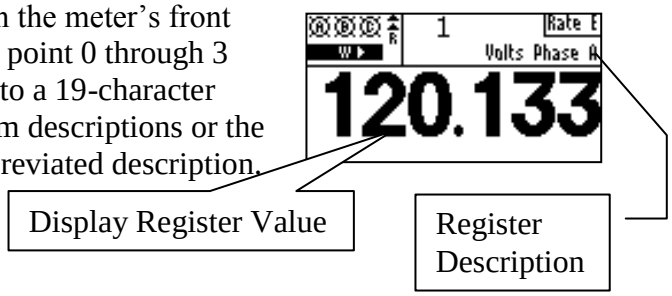
Display Registers

This menu choice allows the user to determine which electrical quantities are to be stored in the meter's memory (registers). The information in the Display Registers can be viewed on the meter's LCD panel and also can be read via serial communications. In the JEMStar, there are 50 Normal registers, 50 Alternate registers, and 50 Test registers available. The Ci20 meter has a total of 50 registers available distributed between Normal and Alternate and 50 Test Registers. Normal and Alternate registers can be used interchangeably to store any parameters. It is your choice whether to assign a quantity to a Normal or Alternate register, and it is simply a preference to sort functions as you choose. The Test registers are for temporary storage and only used when in the Test Mode. All the data in a Test register is cleared when Test Mode is exited.

The following illustration shows the main Display Registers configuration screen. At the top, you will notice that the screen has three page tabs: Normal, Alternate, and Test. Click on the tab for the section you will be modifying, then proceed to Add, Edit, or Delete registers as described in the following pages.



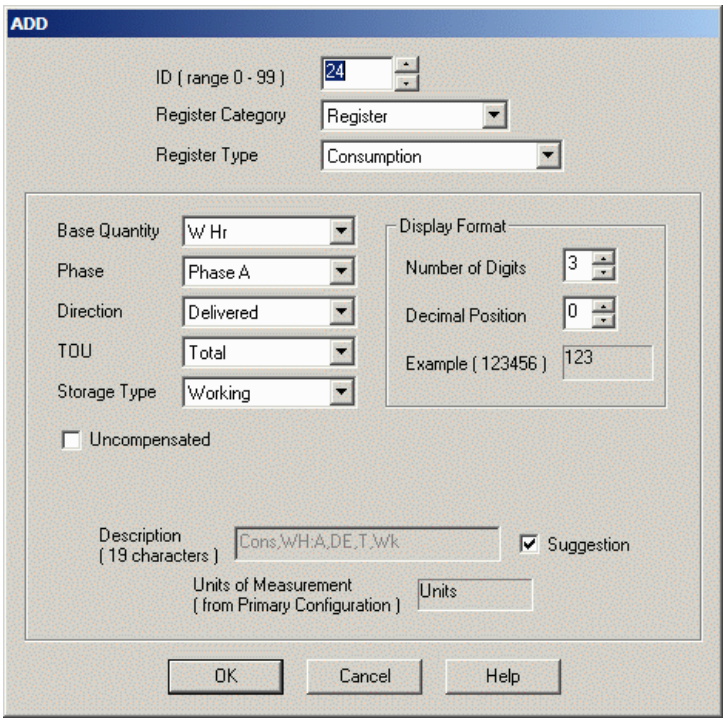
The display register values can be shown on the meter's front panel as up to 8 numerals, with the decimal point 0 through 3 places from the right. Each register has up to a 19-character description. You can enter your own custom descriptions or the program will automatically generate an abbreviated description.



Adding a new Display Register

From the Display Registers screen, click the Add button to access the Add Display Register screen.

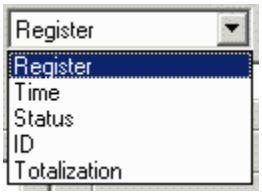
Fill in the fields sequentially from the top of the screen down, because some selections affect the settings of other later ones. Each field is described as follows.



ID
Assign a Register Identification number.

Register	**Valid ID Numbers**
Normal	0 – 99
Alternate	100 – 199
Test	200 – 299

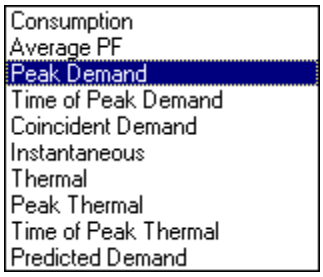
Register Category
Select from the four register categories:



Register: Stores all types of quantitative data
Time: Stores time/date information, and associates timeof other event occurrences such as BPR, freezes, etc.
Status: Stores meter health status, firmware versions, segment check, BPR count, and diagnostics vector display
ID: Stores descriptive user text information
Totalization: Display the contents of one of the totalization channels.

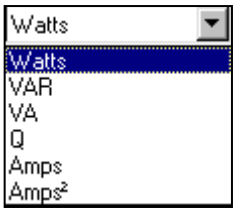
Note: Your selection of Register Category determines which choices are available in the following fields. The "Register" selection is used for the following examples. Your choices may be different if you choose Time, Status, or ID.

Register Type
Choose the type of register from the 10 selections shown.

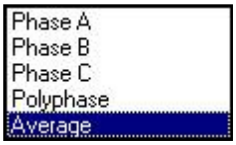


Note: Your selection of Register Type determines which choices are available below. The "Peak Demand" selection is used for the following examples. Your choices may be different if you select a different Register Type.

Base Quantity
Select an electrical quantity from the pull-down list. Your options may vary, depending on your previous choices.



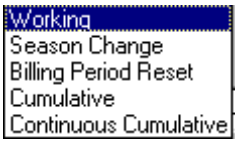
Phase
Choose from the available choices. In this case, choose Phase A, B, C, or Polyphase. Average is available for Amps or $Amps^2$ only.



Direction
Depending upon your earlier selections, you may be able to choose the power flow direction. Note: If you are configuring an Instantaneous register, you can also set it for Bi-directional.

TOU
The Time Of Use rate is selected next, if you are using this feature. The default is "Total", but any of eight other rates can be chosen. Refer to the Time Of Use Setup menu for configuring the actual rate schedules.

Storage Type
The Storage Type selection is used to define how the register data will be saved.

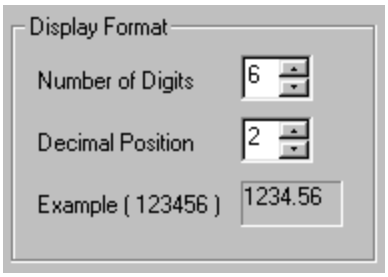


A *Working Register* will store the selected data in real time and update the displayed quantity on a continual basis. When a BPR is performed, the contents of the working register are transferred to the BPR storage register. All peak registers will reset to zero when a BPR is performed. All other register types will continue to increment.
A *Season Change* register stores the selected quantity only when a Season Change command occurs. The quantity in the register is saved until the next Season Change command, at which time the data is overwritten.

A *Billing Period Reset* register will update the selected quantity only when a BPR occurs. The quantity in this register will be saved until the next BPR command, at which time the old quantity is overwritten.
A *Cumulative* register will store the selected quantity when a BPR occurs. The quantity in the register is saved until the next BPR command, at which time the quantity is added to the existing quantity.
A *Continuous Cumulative* register will sum the selected quantity read at BPR plus the quantity from the Working register. The sum is continuously updated. Note that any alteration to the BPR configuration will reset these registers.

Uncompensated
Checking this box will cause the values displayed by the register to never have Loss Compensation applied, regardless of the Loss compensation configuration.

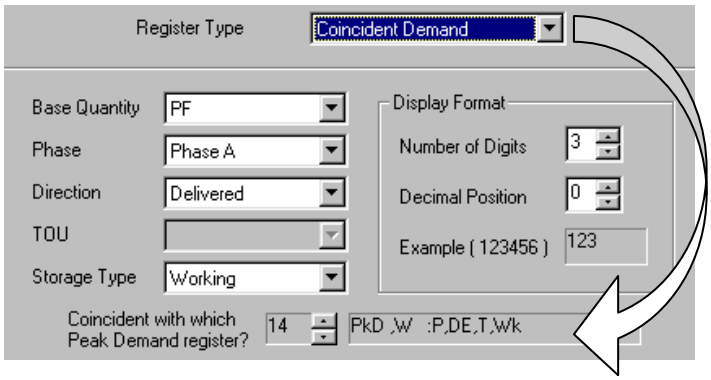
Display Format
Choose the total number of digits you want to display (up to 8), and then select the number of digits to be displayed to the right of the decimal point. An example will be shown below your choices to confirm that your selection is correct.
Note: If you select an 8-digit display using the meter front panel menu or the "Display Setup" screen, the setting shown here will be overridden.



Coincident Registers
You can set the following register types as Coincident Registers:

- Time of Peak
- Time of Peak Thermal
- Coincident Demand

If you are configuring one of the three register types listed above, an additional field is available to select the coincident register. Use the up/down arrows to select the register ID# that you want to associate as a coincident register to the one you are setting up.

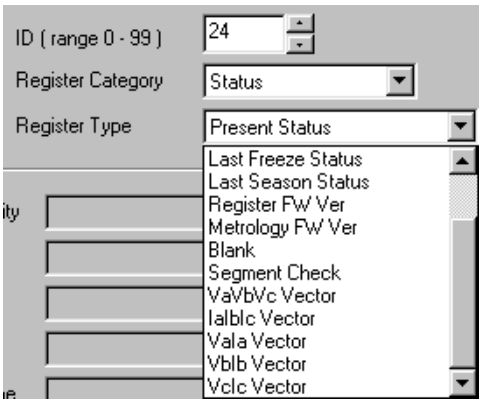


Description
A description of the register's use should be entered for reference purposes. This can be in your own words or abbreviations (up to 19 characters), or click the "Suggestion" box to use the default description. The default abbreviations are defined in the following table.

Default Register Abbreviation Definitions

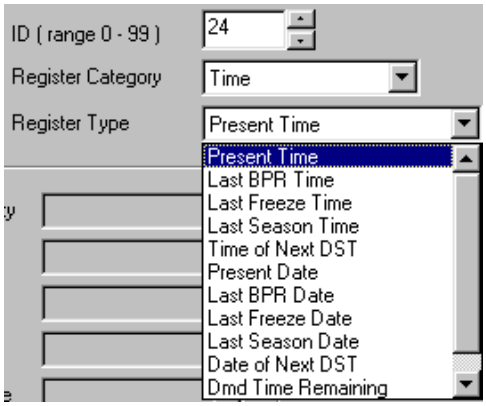
Abbreviation	Description
Cons	Consumption
AvPF	Average Power Factor
PkD	Peak Demand
TPkD	Time of Peak Demand
CndD	Coincident Demand
Inst	Instantaneous
Thrm	Thermal
PkT	Peak Thermal
TPkT	Time of Peak Thermal
CndT	Coincident Thermal
PresD	Present Demand
PastD	Past Demand
Pred	Predicted Demand
WH	Watthour
VARH	VARhour
VAH	VoltAmp hour
QH	Qhour
AmpH	Amp hour
PF	Power Factor
W	Watt
VAR	VAR
Q	Q
Amp	Ampere
Volt	Volt
Time	Time
Date	Date
Freq	Frequency
VTHD	Volts Total Harmonic Distortion
ATHD	Amps Total Harmonic Distortion
A	Phase A
B	Phase B
C	Phase C
P	Polyphase
N	Neutral
RE	Received
DE	Delivered
Q1 (2,3,4)	Quadrant 1(2,3,4)
T	Total
Wk	Working
SC	Season Change
BP	Billing Period Reset
Fr	Freeze
Cm	Cumulative
CC	Continuous Cumulative
Amp^2	Amp Squared
$Volt^2$	Volt Squared
Amp^2H	Amp Squared Hour
$Volt^2H$	Volt Squared Hour
Av	Average

Register Categories



If you select the "Status" Register category, there are several functions that can be assigned to a register.

- *Five "Status" functions* that display the meter's health status at the listed occurrence.
- *Two meter Firmware Version (FW Ver) choices:* Metrology or Register FW.
- *A Blank display* that can be used for data security if you do not want any information viewable on the meter.
- *Segment Check* to verify that the entire meter display is working. This will turn on all the LCD segments, resulting in a black screen with no spaces.
- *Five "Vector" functions* that display voltage and current quantities as a vector diagram on the meter.
- *Reset Count* register that displays the number of times the meter has performed a Billing Period Reset since the last register reconfiguration.



The "Time" Register category includes the following functions:

- *Five "Time" functions* that display the meter's time of day at the listed occurrence.
- *Five "Date" functions* that display the meter's date at the listed occurrence.
- *Demand Time Remaining* that displays the time (in seconds) remaining before the next demand (sub)interval closure.
- *Days on Battery, which* displays the number of days that the meter has operated under the internal battery. The internal battery is used to retain memory and clock functions whenever the meter is not powered (see Maintenance section for further information). This register will continue to accumulate until the battery is replaced. A status indicator will appear after 730 days (2 years) are accumulated.

The "Totalization" register category allows the user to select one of the twelve Totalization channels for display. See the section for Totalization for details on configuring Totalization channels.

Edit an Existing Display Register

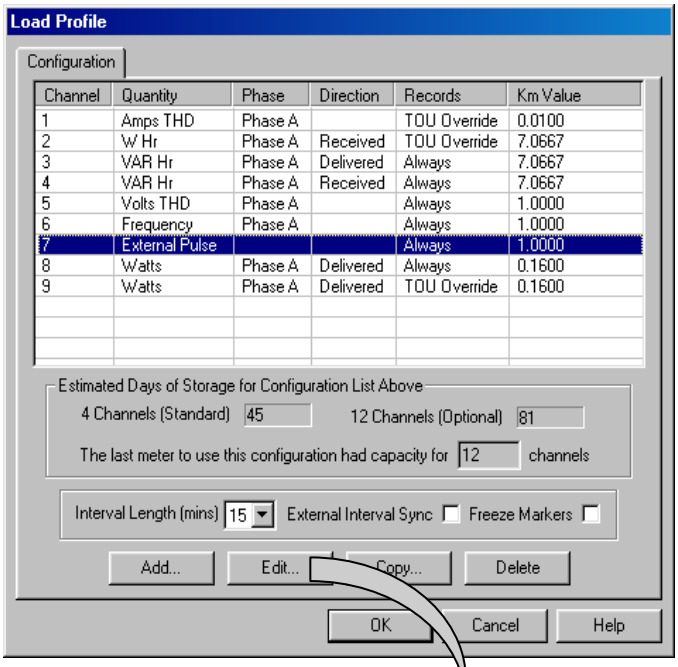
Highlight the register in the list that you want to change, and then click the Edit button. The Edit function for an existing register is identical to adding a new register (see above). Go to the area to be changed and select the correct new setting. Click OK after all the changes have been made.

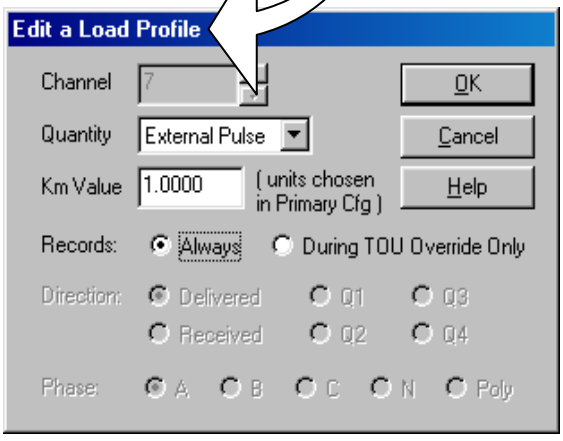
Delete a Display Register

Highlight the register in the list that you want to remove, and then click the Delete button. You will be asked if you are sure you want to remove the selected register. If you click "Yes", the highlighted register will be removed from the configuration.

Load Profile

The Load Profile screen contains parameters that set up the Load Profile storage areas in the meter. This configuration is only necessary if you are using the Load Profile features of the meter.
A meter can be equipped with 4 Load Profile channels (standard) or 12 channels (optional). The following parameters are common to all channels:





Number of Load Profile Days
These are read-only fields that display the approximate number of days of Load Profile data the meter can store in memory. The amount of storage is based on the number of LP channels in the meter.

Interval Length
Each Load Profile is divided into a user-defined interval. The interval length is the same for all channels so that the channel data can be compared to each other. Choose from the pull-down choices of 1 to 60 minutes.

External Interval Sync
The External Interval Sync can be used to trigger the start of a Load Profile Interval from a remote source. If enabled, this will override the Interval Length setting and start a new interval immediately upon sensing an input pulse. To use this feature, you must have the Pulse Input option in your meter, and configure one of the two input channels for "Interval Sync".

Freeze Markers
Check this box if you want the event list to include data showing when Freezes are generated. Note that this will use some of the Load Profile storage memory, thus decreasing the total number of LP days available.

Edit a Load Profile

Note: JEMWare will always allow up to 12 Load Profile channels to be configured. However, if you are downloading the configuration to a meter with only four active channels, only the first four will be used.

To edit an existing profile, highlight the channel number and click the "Edit" button. The following attributes can be specified for each individual channel:

Quantity
From the pull-down list, choose the electrical quantity that will be profiled for this channel:
Watt-Hour | VAR-Hour | VoltAmp-Hours | Amp-Hours | Watts | VARs | VoltAmps | Volts | Amps | Power Factor | Hertz | Volts-THD | Amps-THD | Pulses | Status | A^2 | V^2 | A^2-Hour | V^2-Hour | Q | Q-hours | Totalization 1 - 12

Km Value
Enter a Km constant that represents the desired Load Profile pulse weight. This value should be based on the units (kilo, mega, etc.) that were previously chosen in the Primary configuration screen under "Measurement Units for Meter Outputs".

Uncompensated
Checking this box forces the quantity measured by this Load Profile channel to never have Loss Compensation applied, regardless of the settings of the Loss Compensation configuration.

Records
Choose how you want the LP Channel to record data. The standard selection is "Always". If you want to control the recording of LP data, you can select "During TOU Override Only". The Time of Use Override feature is set on the Contact Input/Output screen. By using one of the Contact Inputs as an external trigger, you can switch Load Profile recording on and off in conjunction with the Time of Use register settings. Refer to the Load Profile description in the JEMStar User Manual 1083-600 and Ci20 User Manual 1086-381 for more details.

Direction
Select whether the measured quantity is Received or Delivered power. Note: If Amp-Hours, Volts, Amps, Hz, Volts-THD, A^2, V^2, A^2-Hour, V^2-Hour or Amps-THD is chosen as the Quantity, the Direction is not selectable. Q1, Q2, Q3, and Q4 are enabled only when VAR or VAR-Hours is selected.

Phases
Choose the phase(s) to be profiled: A | B | C | N | Polyphase.

- If Quantity is Volts, Watts, Watt-Hours, VARs, VAR-Hours, VA, VoltAmp-Hours, A^2, V^2, A^2-Hour, V^2-Hour, or PF, select one choice of A, B, C, or Polyphase.
- If Quantity is Amps or $Amps^2$, select one choice of A, B, C, N, or Poly.

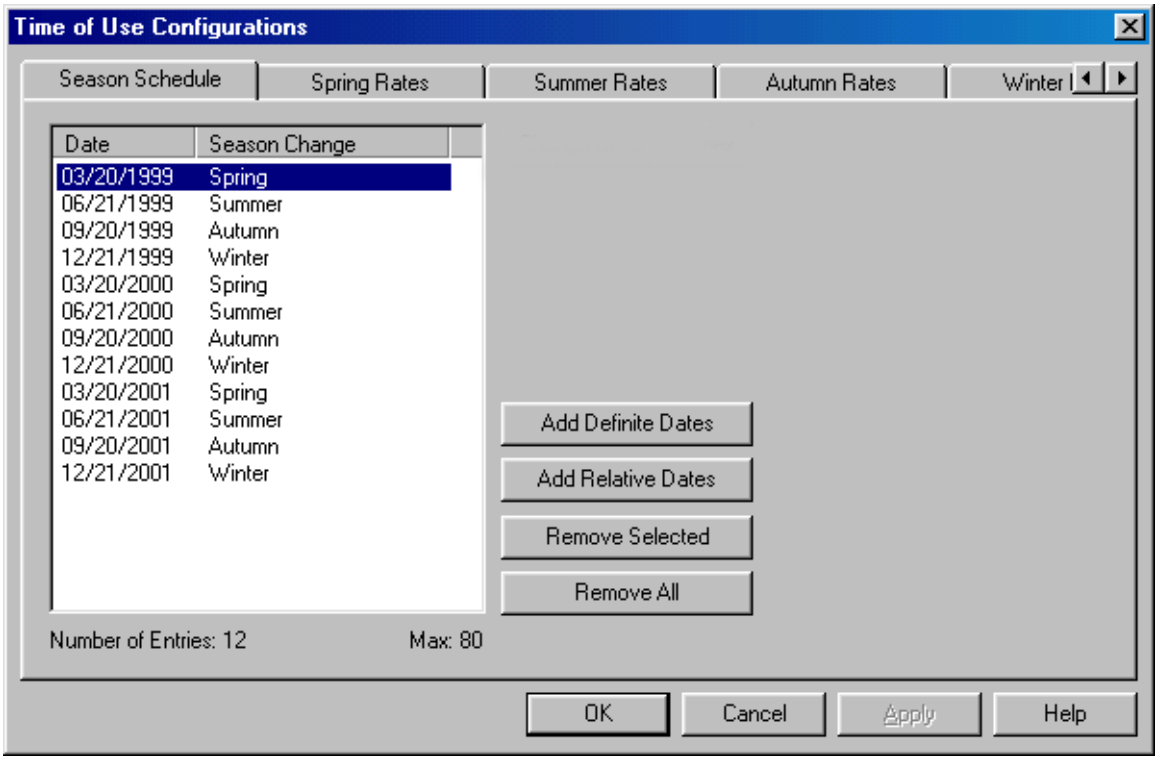
- If Quantity is V-THD, or A-THD, select one choice A, B, or C.
- If Quantity is any other, there are no phase choices.

Time of Use Setup

Time of Use is a standard feature that is used to automatically adjust billing rates on a user-defined calendar. There are up to 8 possible TOU rates that can be programmed to meet a wide variety of scheduling needs. Each rate can be set to take effect at any time of any day. In addition, schedules can be arranged to change on the start of a season period or a single holiday date.

There are six category tabs at the top of the TOU screen. Use the arrow buttons at the right side of the window to scroll back and forth. The function of each tab is described below.

- Season Schedule – programs the start dates of the season changes.
- Spring, Summer, Autumn, and Winter Rates – allows up to 8 rate changes per day for each day of the week, plus two holidays. Note that the seasons can be re-named, and yours may be different (see below).
- Holiday Schedule – programs single date occurrences for holiday rate changes.

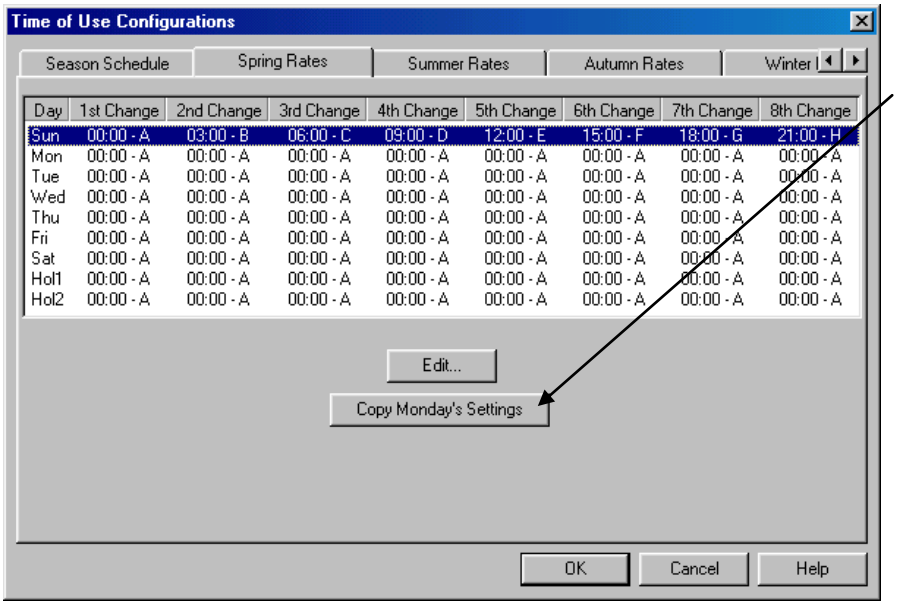


Season Schedule

There are 4 season schedules available. When entering seasonal data, you can program up to 80 season changes (20 years). Season changes can be added as definite dates (i.e. 4th of July), or as relative dates (i.e. first Sunday of May).

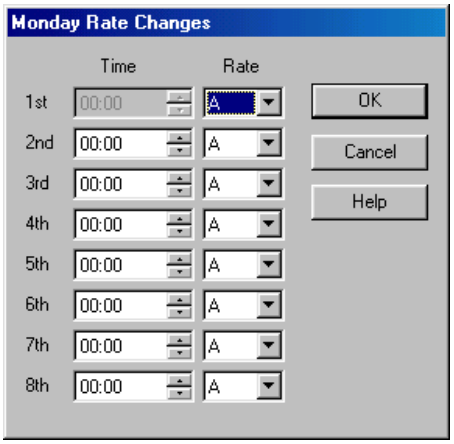
Rate Schedules (one for each of the 4 seasons)

There are up to 8 configurable TOU rates available (A-H), plus a Total (T).
Each schedule can accept up to 8 rate changes per day, for each day of the week, and two holidays. Each rate change must be configured with the time of day when it will occur, and the rate (A – H) that is to apply.



As a time saver if each day of the week is similar, you can program Monday's settings, then simply copy these to other days.

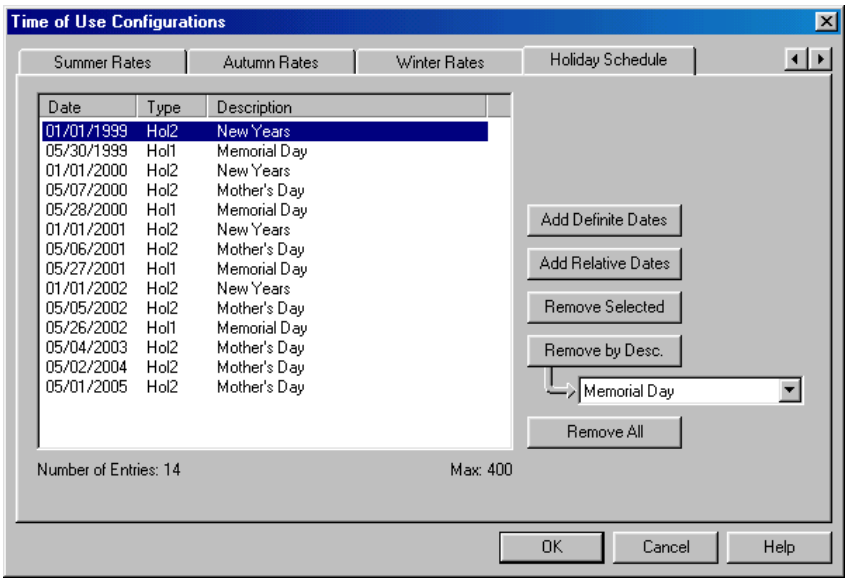
To set a Rate Change configuration, go to the proper season tab, highlight a line in the above rate list, and then click the Edit button. The following screen will appear.



You can enter up to eight rate-change times for the chosen day, then map a rate (A – H) for each time. Time is always entered in 24-hour format. Click OK when this day is complete and continue in the same manner for the rest of your daily TOU settings.

Holiday Schedule

This schedule can list up to 400 holidays. Each holiday definition consists of a date when it occurs and a corresponding designation for "Holiday 1" or "Holiday 2". A description is optional, and is only used for reference when viewing JEMWare (the description is not stored in the meter). Holidays can be added as definite dates (i.e. 4th of July) or as relative dates (i.e. first Sunday of May) over a range of years.



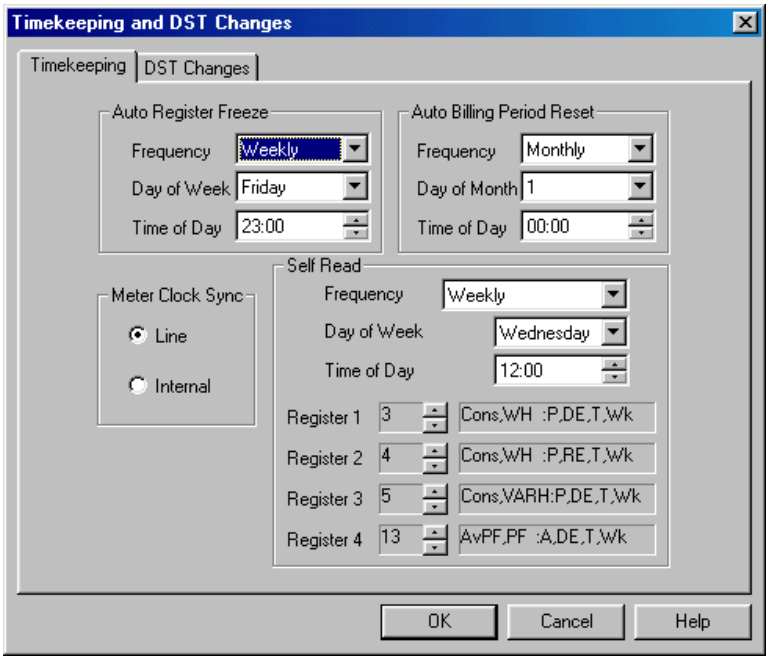
Note that each rate period (Spring, Summer, Autumn, Winter) can have separate Hol1 and Hol2 rates. Be sure that you are in the correct rate period that encompasses the holiday date when you configure the TOU rate.

Timekeeping and DST Changes

Use this menu to set up the meter's Time and Date functions, including Daylight Savings Time (DST) adjustments. Note that there are two pages to this screen. The first one to appear is the Timekeeping page. Click the tab labeled "DST Changes" to set up the meter for Daylight Savings Time.

Auto Register Freeze
Configure this Group Box for the exact time you want a Register Freeze to occur.

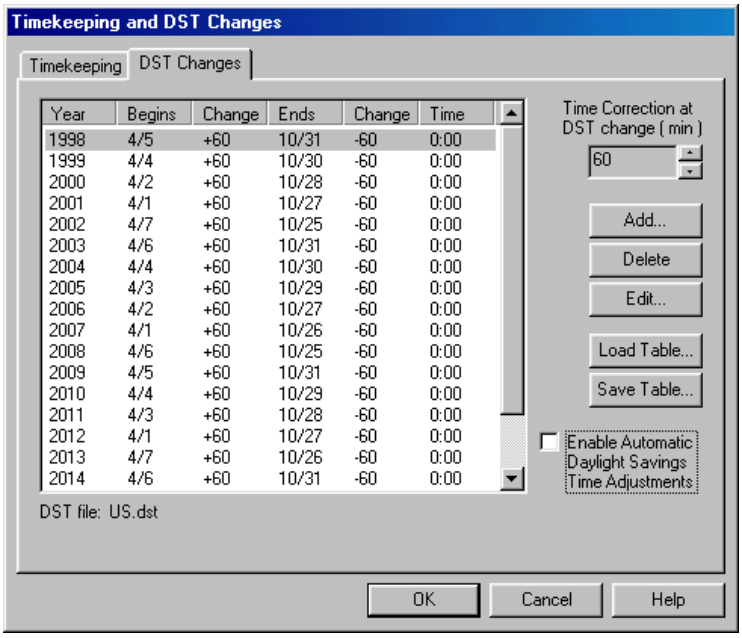
Auto Billing Period Reset
Configure this Group Box for the exact time you want to perform a BPR. The "Season" selection will perform a BPR at every Time of Use season change occurrence.



Meter Clock Sync
Click the radio button in this Group Box to set how the meter clock will be synchronized. The line frequency option is taken directly from the A-phase input and automatically interprets whether the meter is 50Hz or 60Hz. Internal sync uses the meter's internal crystal oscillator.

Self Read
The Self Read function can be used in a manner similar to Load Profile, whereby the meter can automatically read up to four registers on a user-selected schedule. Click the up/down arrows to scroll through the currently configured Normal and Alternate registers. The Display Register ID numbers are shown, along with the register's abbreviated description.
Note: Self Read registers should not be used a *replacement* for Load Profile channels. Memory is very limited and only can store up to two days of readings.

DST Changes



This page is used to incorporate Daylight Savings Time adjustments that may be required, depending upon the meter's location. The standard United States DST table is saved as the factory default (see example at right), but this can be edited or deleted at any time. The DST table is saved in the JEMWare program directory on your computer as a completely independent file. This allows you to make a custom table based on your particular time zone, save it, and easily load it into multiple meters, just as you would a configuration (.cfg) file.

IMPORTANT: When you open a configuration file (.cfg), it will look for its associated Daylight Savings Time (.dst) file. *The .dst file must be located in the same directory as the .cfg to find it.* If the .cfg doesn't find its associated .dst file, JEMWare will post an error during download and prompt you to enter or Browse to the location of the file.

Using the DST Settings

You can add a new year (up to 2036) to the table at any time. Use the Edit button to make changes to an existing year.

Load Table is used to assign an existing .dst file to the current configuration. When you click the button, it will prompt you to browse your JEMWare directory and select a .dst file. Save Table will save a new or modified .dst table. You must assign a name to the new table, just as you would save any Windows file.

Click the "Enable Automatic Daylight Savings Time Adjustments" check box to activate the settings you have just created. Make sure this box is unchecked if you are not using DST.

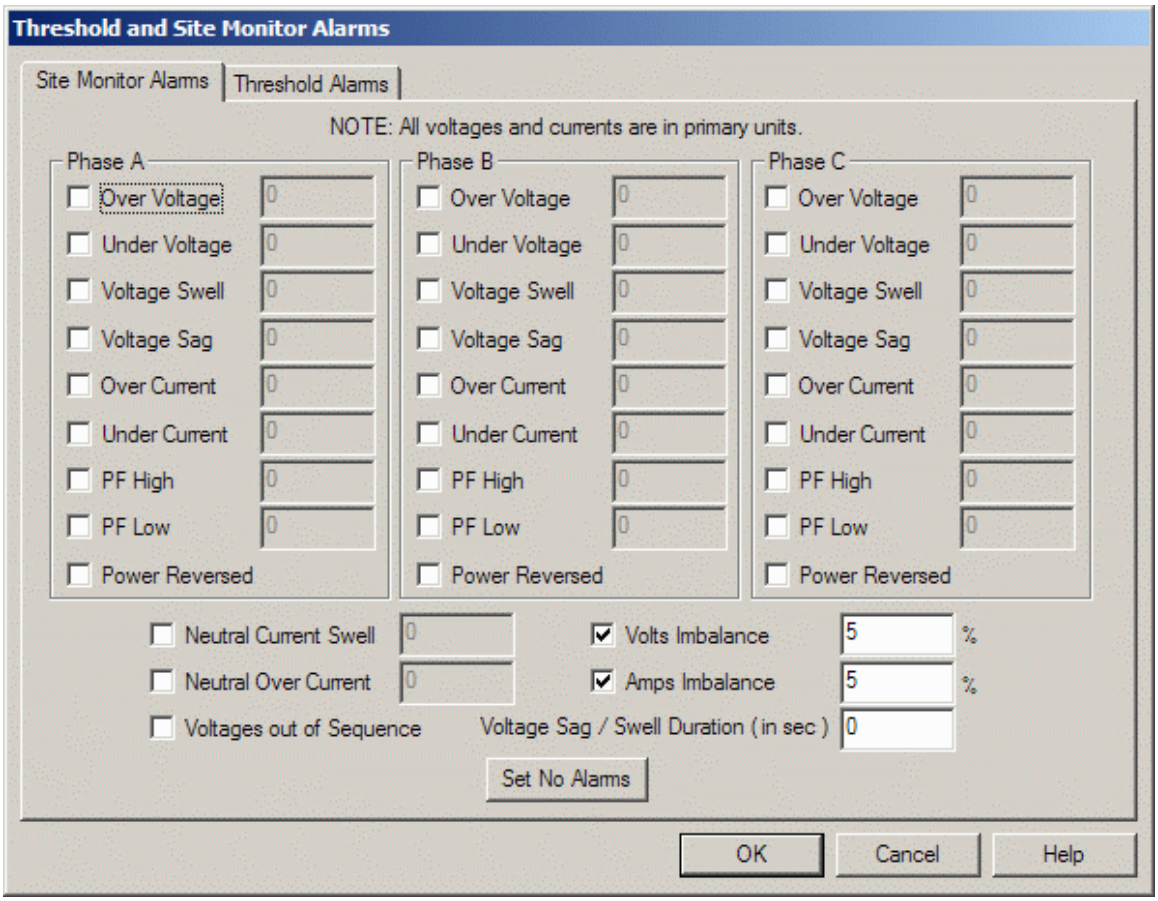
Alarms

This selection configures the various alarm conditions that can be used to activate the display annunciator, the digital pulse outputs, and the phone-home modem. The basic default settings are all Alarms turned off; you must turn on each one that you want active.

A *Site Monitor Alarm* is used to indicate power line anomalies associated with the voltage or current of each power line phase. You can select any or all phase(s) and specify one or more conditions on each phase to trigger an alarm. Note that there is only one Site Monitor alarm output. If you set multiple conditions, any one of the conditions will activate the alarm. Note: JEMWare allows you to query the meter to determine the condition that caused the alarm.

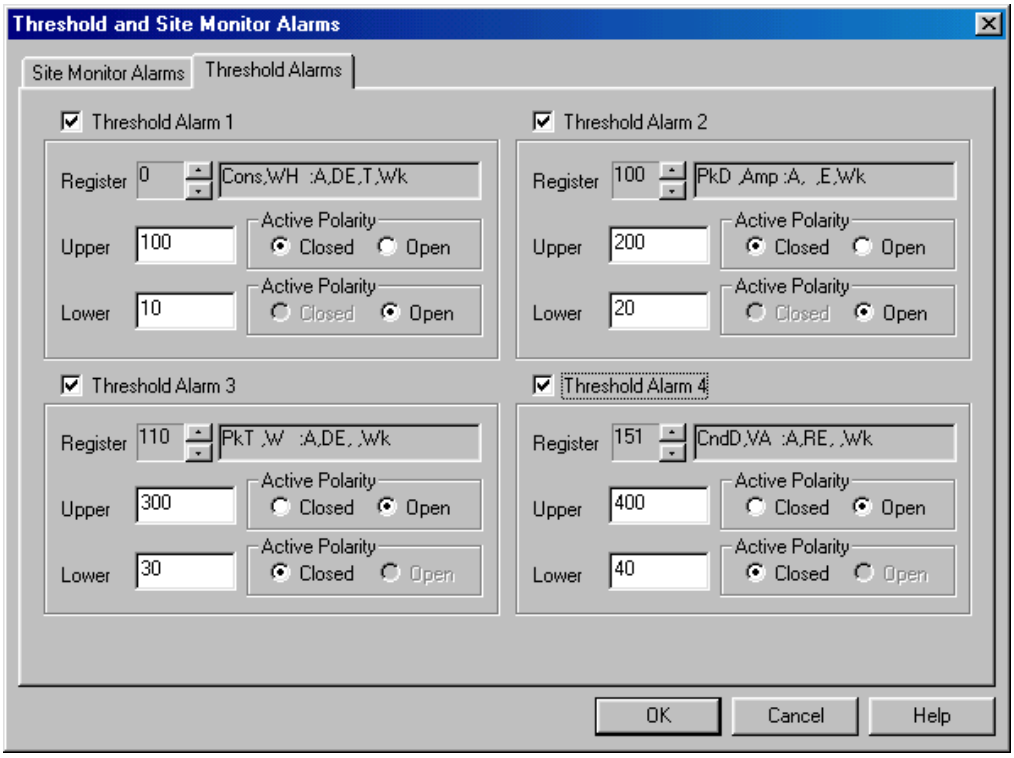
A *Threshold Alarm* provides an indication when a user-selected storage register exceeds predetermined limits. Any Instantaneous electrical quantity can be used to trigger an alarm (time & date are not valid registers for alarms). Note that there are four Threshold Alarms available, but you can only monitor one register with each.

To enable a *Site Monitor Alarm*, click the check box associated with the parameter and enter a value in the corresponding edit field. When the value is exceeded, an alarm will be generated.



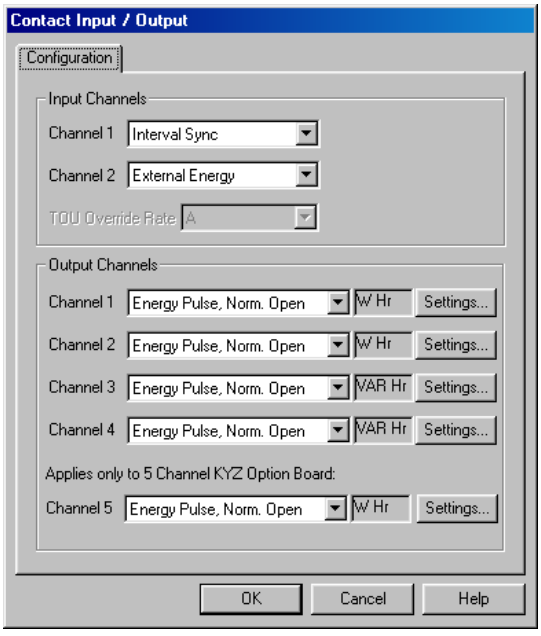
Alarms can also be configured to drive one of the meter's Pulse Outputs. Refer to the Pulse Input / Output section of this manual for further setup instructions.

To enable a *Threshold Alarm*, choose a register number by scrolling through the list of currently configured registers with the up/down arrows, then entering an upper and lower limit where the alarm will trigger and reset, respectively.



Note: The Active Polarity (Open | Closed) of the Lower Threshold must be opposite of the Upper threshold polarity.

Contact Input / Output (JEMStar)



This screen is used to assign the operating conditions of the Contact Input and Output channels.

Inputs

There are two Contact Input channels available on both types of I/O board. The inputs require a switched external voltage source of 10 – 40 Vdc to activate them. Refer to the JEMStar User Manual 1083-600 for input ratings and wiring information.

Any of the following functions can be assigned to each Contact Input channel:

Interval Sync
This setting can be used to accept an external momentary contact closure that will trigger the start of a Demand Interval. By wiring a series of meters to operate from the same contact closure, you can synchronize the Demand Interval timing among the group. You must enable this feature on the Demand Information menu by selecting a check box on that screen.

External Status
This setting will monitor an external contact and report its open/closed status in the Load Profile.

External Energy
This setting can be used to record KYZ pulse outputs from another meter and report them as Load Profile in the JEMStar.

TOU Rate Override
This setting will permit an external contact closure to trigger a forced override of the current Time of Use rate. When this type of Pulse Input is active, it will switch the pre-existing TOU rate (that was programmed in the Time Of Use menu) to the one set on this screen. As long as the external contact is closed, the override rate is in effect. When the contact opens, the meter will automatically revert to the scheduled TOU rate.

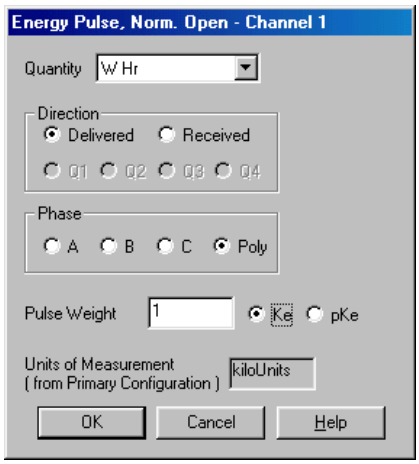
Totalization Input
This setting can be used to collect energy measurements from external devices for Totalization purposes. See the section on Totalization setup for more details.

Outputs

JEMStar can be equipped with either of two optional contact I/O boards: the **DI/DO** board that consists of four Form A (N.O.) contact outputs; or the **5-KYZ** board that consists of five Form C (N.O. / N.C.) contact outputs. Note: Only one type of I/O board can be installed in a JEMStar.
Any of the following functions can be assigned to each channel:

Energy Pulse
First choose from the pull down menu how you want the energy pulse output to respond:

- Normally Open (NO): Output closes on first count, then opens on second count
- Normally Closed (NC): Output opens on first count, then closes on second count
- 1-shot: Output closes, then opens for one count



Next, click the Settings button next to the channel that you want to configure and this submenu will appear. Select the Energy Quantity from the pull- down choices, the power flow direction, and the phase(s) to be considered. The energy pulse output can be set with any desired pulse weight. The Units of Measurement

shown as a reference at the bottom of the screen was previously selected in the Primary Configuration menu. Enter the pulse weight, along with whether it is in secondary (Ke) or primary (pKe) units.

Application notes:

- If you have selected the quantity "A Hr" or "A^2 Hr", then "Delivered" and "Received" are invalid choices.
- The only time Q1, Q2, Q3, and Q4 are valid choices is when "VAR Hr" is selected.

Tip: You can simulate a KYZ (Form-C) output on the DI/DO board by assigning two outputs, one set for N.O. and one set for N.C., then connecting one side of each output externally to create a Form-C arrangement.

End of Demand Interval
When chosen, a single contact closure will be generated that indicates when a Demand interval (or sub-interval, if a sliding window has been selected) has ended.

Site Monitor Alarm
When chosen, a single contact closure will be generated when a Site Monitor alarm is activated. Refer to the Alarms section for setting the Site Monitor conditions.

Threshold Alarm
When chosen, a single contact closure will be generated when a Threshold alarm is activated. Refer to the Alarms section for setting the Threshold alarm conditions.

Note: The Threshold Alarm number in the Output channels screen must match the channel number in the Alarms screen (i.e.: Threshold Alarm 2 must be used with Pulse Output Channel 2). The Threshold Alarm is selected on this screen, but is actually configured for operation in the "Alarms" menu (shown previously).

Threshold Alarms cannot be assigned to Output Channel 5 (5-KYZ board).

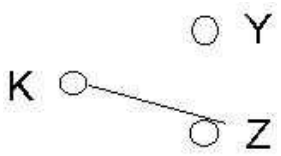
Sag / Swell Alarm
When chosen, a single contact closure will be generated when a Voltage Sag or Swell alarm is activated. Refer to the Voltage Sag / Swell section for setting the sag / swell conditions.

System Error Alarm
When chosen, the contact output channel will close if a System Error (e.g. a Battery Warning) is detected. Performing a Billing Period Reset on the meter will clear all System Error indications.

Configuring Contact Outputs on a 5-KYZ board

The **5-KYZ** board provides five Form-C (KYZ) contact outputs for connection to external devices. The first four outputs operate with all the same functions as the DI/DO contact outputs, and have all the same features and specifications. The fifth contact output can be configured to operate with all functions except Threshold Alarms.

The configuration of the 5-KYZ Board is the same as setting up a DI/DO Board. However, when you set up a contact output for Normally Open, you are setting the "K-Y" section of the output for NO, and the "K-Z" section for NC. You may also set the output for reverse operation. That is, if you configure JEMWare for Normally Closed, you are setting the "K-Y" section for NC, and the "K-Z" section for NO.

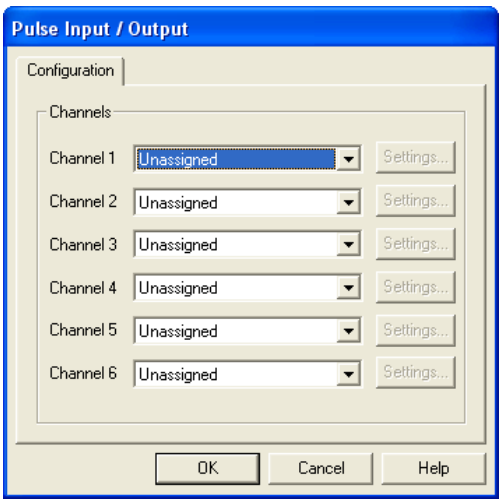


Contact state shown with JEMWare configured for Normally Open.

Pulse Input / Output (Ci20)

This window assigns the operating conditions of the Contact Input and Output channels. There are two components to this window:

- *Configuration Tab* - Sets the input and output channels.
- *Settings* - Configures the output channels functions, where available.



Pulse Input / Output Screen

Configuration Tab

Channel

Select the input or output channel. These types include:

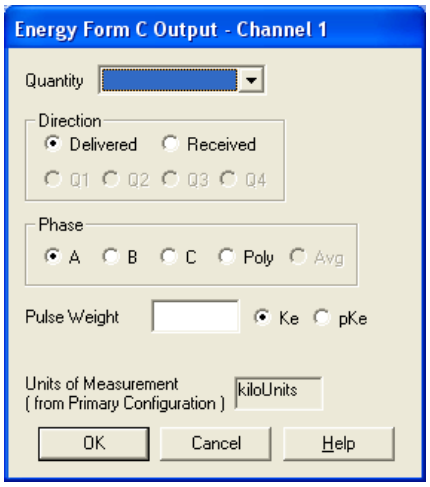
- Inputs - There are up to 6 Contact Input channels available on the I/O board. The inputs require a switched external voltage source of 10 – 40 VDC to activate them, unless the internal supply option has been ordered. Refer to the Ci20 User Manual 1086-381 for input ratings and wiring information. Any of the following functions can be assigned to each Contact Input channel:
  - ***Interval Sync*** - Accepts an external momentary contact closure that triggers the start of a Demand Interval. By wiring a series of meters to operate from the same contact closure, you can synchronize the Demand Interval timing among the group. You must enable this feature on the Demand Information menu by selecting a check box on that screen.
  - ***End of Demand Interval*** - Select and a single contact closure is generated that indicates when a Demand interval (or sub-interval, if a sliding window has been selected) has ended.
  - ***Site Monitor Alarm*** - Select and a single contact closure is generated when a Site Monitor alarm is activated. Refer to the Alarms section for setting the Site Monitor conditions.
  - ***Threshold Alarm*** - Select and a single contact closure is generated when a Threshold alarm is activated. Refer to the Alarms**Error! Reference source not found.** section for setting the Threshold alarm conditions.
  - ***Sag / Swell Alarm*** - Select and a single contact closure is generated when a Voltage Sag or Swell alarm is activated. Refer to the Voltage Sag / Swell section for setting the sag / swell conditions.
  - ***System Error Alarm*** - Select and the contact output channel closes if a System Error (e.g. a Battery Warning) is detected. Performing a Billing Period Reset on the meter clears all System Error indications.
  - ***External Status*** - Monitors an external contact and report its open/closed status in the Load Profile.
  - ***External Energy Pulse*** - Records KYZ pulse outputs from another meter and report them as Load Profile in the Ci20.
  - ***TOU Rate Override*** - Sets an external contact closure to trigger a forced override of the current Time of Use rate. When this type of Pulse Input is active, it switches the pre-existing TOU rate, programmed in the Time Of Use menu, to the one set on this window. As long as the external contact is closed, the override rate is in effect. When the contact opens, the meter automatically reverts to the scheduled TOU rate.
  - ***Totalization Input*** - Collects energy measurements from external devices for Totalization purposes. See Totalization section for more details.

Settings - Outputs

Ci20 is equipped with 6 I/O contacts that are user-programmed and can be ordered with or without wetting voltage.

***Note: Only one type of I/O board can be installed in a Ci20.**

Click **Settings** and the required Output window appears.



Energy Pulse Options

To configure the output:

1. Select the energy Quantity from the pull-down.
2. Select the power flow *Direction* and the phase(s).
3. Enter the pulse weight, along with whether it is in secondary (Ke) or primary (pKe) units.

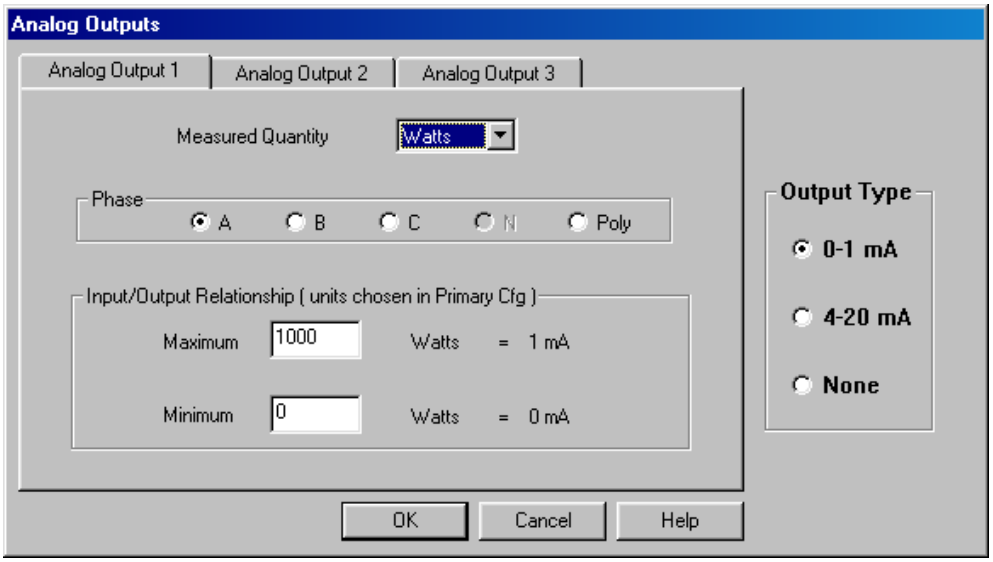
The *Units of Measuremen*t shown as a reference at the bottom of the screen were previously selected in the Primary Configuration.

***Note: If you have selected the quantity *A Hr* or *A2 Hr*, then *Delivered* and *Received* are invalid choices.**

The only time Q1, Q2, Q3, and Q4 are valid choices is when *VAR Hr* is selected.

Analog Outputs (JEMStar)

This menu selection defines the operation of the analog outputs. Each of the 3 channels can be configured independently.
Note: Analog Outputs are not available if you are using the 5-KYZ board.



The first step to configuring Analog outputs is to select an energy quantity from the pull-down menu. Choose between Watts | VARs* | Q* | VA | Volts | Amps | PF | Hz | V-THD | A-THD | $Amps^2$ | $Volts^2$.

*Note: Either VARs or Q is available, but not both. Your available choice will match what you previously selected in the Primary Configuration screen.

Second, select the phase(s) that will be monitored. Select A | B | C | N | Polyphase.
Note: If the Quantity selected above is Hz, the only choice is Phase A.

Output Type
The analog outputs are factory configured for either 0-1 mA or 4-20 mA; consult the model number ordering code to determine which type is provided and set this appropriately. If your meter does not have the Analog Output Option, select None.

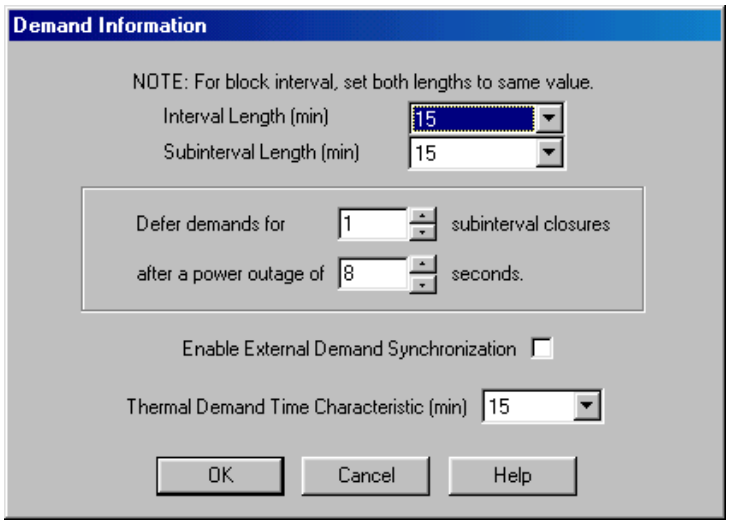
Enter the maximum and minimum input values for the range that you will monitor. From the above data, the meter will calculate and display an output table.

Example:

Quantity	Analog Output
+1000 Watts	20 mA
0 Watts	9.33 mA
- 500 Watts	4 mA

Repeat this procedure for up to three channels. Note that all outputs must be the same (i.e. 0-1mA, or 4-20mA, but not both).

Demands



This menu selection contains setup data that configures the timing parameters for all types of Demand Registers. The actual Demand Register types (Peak, etc.) are defined in the Display Registers menu (See the Display Registers section for a list of all available Demand types). This configuration is only necessary if you are using the optional Demand functions of the meter.

Interval Length
The Demand Interval is the user-defined period of time that is used to calculate the average of the measured quantity. Use the pull-down menu to choose the Demand Interval length in minutes (1 – 60).

Subinterval Length
Optionally, subintervals can be assigned to a Demand Interval to create a "Rolling Interval" or "Sliding Window". This type of measurement consists of the average value calculated over multiple consecutive subintervals. A calculation is performed at the completion of each subinterval, and then the calculations are averaged over the length of the main Interval. Use the pull-down menu to choose the Demand Subinterval length in minutes (1 – 60).
The subinterval length must be set less than the interval length and must be an integral divider of it.

*Note: If the Subinterval Length is set to equal the Interval Length, the meter will record standard Block Intervals consisting of the time period you have set.

Demand Deferral Period
After a power outage occurs, the initial demand upon restoration of power can be a tremendous surge. Demand recording can be delayed for a user-specified amount of time, so that this large surge is not factored into the regular measurements.

Assign a time period (0 to 60 seconds) that the length of the power outage must exceed to initiate the delay, and then select the number of *subintervals* that will be ignored (0 to 60) after the delay is triggered.

External Demand Synchronization
You can use the Pulse Input option to trigger the start of a Demand Interval. Refer to the Pulse Input/Output menu section for instructions on assigning operating parameters to the I/O ports. This feature is enabled when the check box is selected.

Thermal Demand Time Characteristic
Thermal Demand is a measurement filtered through a time delay such that step changes in the measurement are reflected slowly in the output. This is commonly used to simulate the effects of current heating on power distribution equipment.

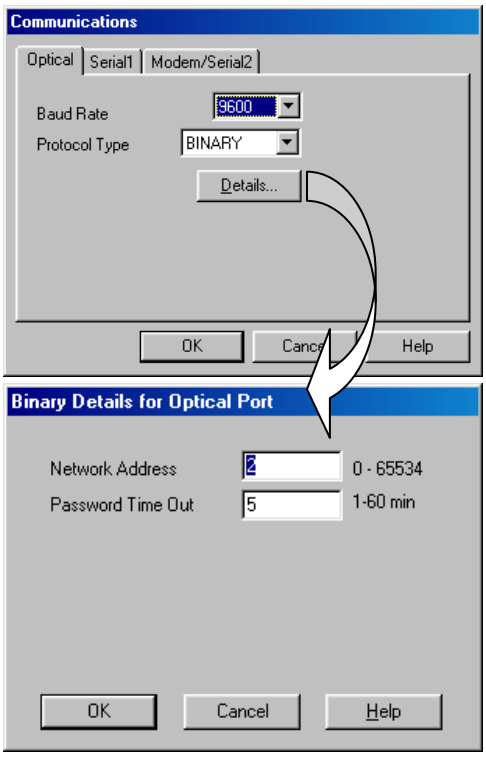
The *Thermal Time Characteristic* is the time required for a Thermal Demand Register to reflect 90% of a step change in input. This is similar to the time characteristic of mechanical thermal demand meters. Select from 1 to 60 minutes if you are using this feature.

Serial Communication (JEMStar)

This menu group configures the parameters of the communications ports and internal modem in the meter. Some communication functions are optional features such as a modem and dual serial ports. You need to configure only the type(s) of communication functions you are using in the meter.

Optical Port

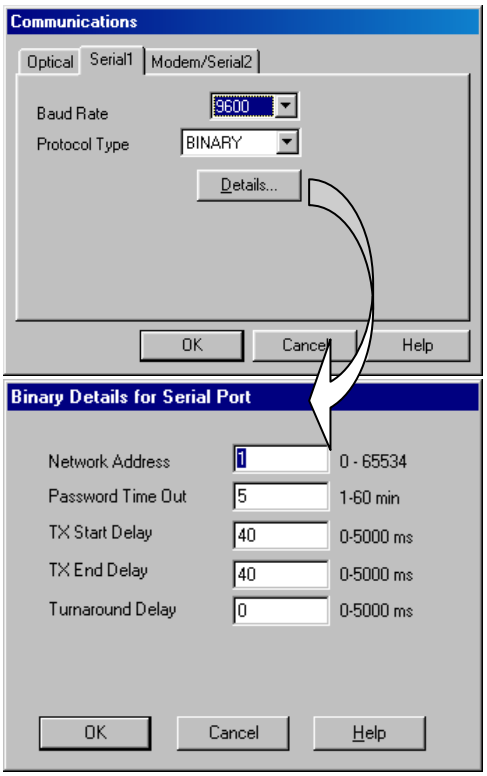
To configure the meter's front panel optical interface, open the Serial Communications menu and select the Optical page. Use the pull-down menu to choose the baud rate that you want to use for communicating with your optical adapter.



Set the Protocol Type for Binary if you are connecting the port to a meter, or ANSI Tables if you are using the port for that protocol.

Click the Details button to configure the following parameters:
Network Address: Assign a unique number for each meter to be connected on a single network. Only numbers 0 – 254 are valid addresses for connecting JEMWare to a meter, or if you are using the port for ANSI Tables protocol.
Password Timeout: Once communication commands have ceased, a timeout cycle will begin. Assign an amount of time that the meter will wait before the active session times out. When the timeout takes place, you must re-enter the meter password before communications can continue.

Serial Port 1 (RS-232 / RS-485):



To configure the meter's serial data interface, open the Serial Communications menu and select the Serial1 or Serial2 tab. Note: the Modem/Serial2 features are optional; check your model number to determine if this is available on your meter. Use the pull-down menu to choose the baud rate that you want to use for communicating with your meter.

The Protocol Type should be set for Binary unless you are using ANSI Tables, Modbus, or DNP 3.0 (see Protocols menu).

Click the Details button to configure the following parameters:

Network Address: Assign a unique number for each meter if you are connecting meters in a network. Use address numbers 0 – 254 for connecting JEMWare to a meter or the optional Modbus or ANSI Tables protocols. Any address 0 – 65534 may be used with DNP 3.0 protocol.

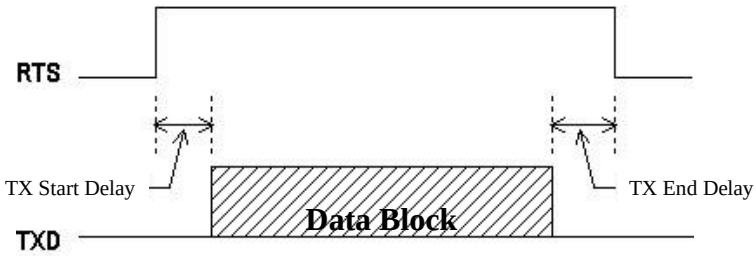
Password Timeout: Once communication commands have ceased, the timeout cycle will begin. Assign an amount of time that the meter will wait before the active session times out. Once a timeout takes place, you must re-enter the meter password before communications can continue.

TX Start Delay / TX End Delay / Turnaround Delay:

Communication delays may be necessary to allow proper timing of the transmitted data. In half duplex mode, the delay intervals are inserted to make sure that data going one direction does not interfere with data going the other direction.

- If you are using radio-modem applications that use the RS-232 Request To Send (RTS) handshaking signal.
- If you are using RS485 communications, you will need to set *meter port delays* in this screen, and *PC port delays* in the Connect menu (ref. Connect section of this manual).

If JEMStar is not used in such applications, simply set the TX Start, TX End, and Turnaround delays to 0 ms.

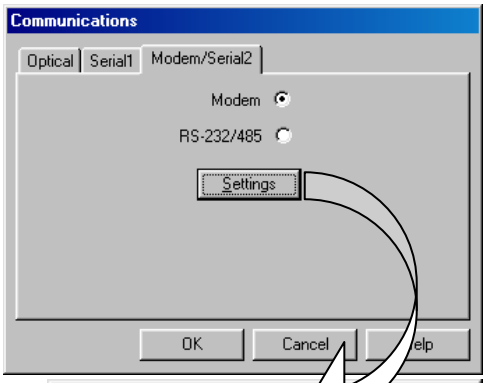


TX Start Delay
Corresponds to the delay between the time that the RTS line is asserted and the time that the data is transmitted.
TX End Delay
Corresponds to the delay from the time that JEMStar stops sending data and the time that the RTS line is de-asserted.
Turnaround Delay
Corresponds to the delay from the time that JEMStar finishes receiving a command and asserts RTS to begin transmitting a reply. Allows the master station time to turn off its own transmitter.

Modems:

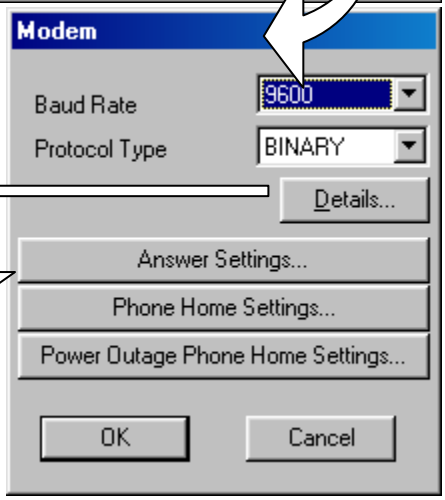
The JEMStar internal modem has two modes of operation; it has the capability to call-originate and to answer incoming phone calls.

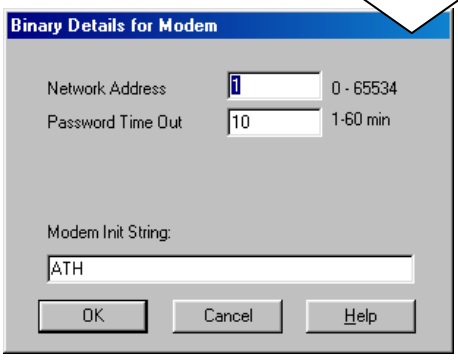
To configure JEMStar's internal modem, open the Serial Communications menu and select the Modem/Serial2 page. Choose the Modem radio button, then click on Settings.



Use the pull-down menu to choose the baud rate that you want to use for modem communications. The Protocol Type should be set for Binary unless you are using ANSI Tables, Modbus, or DNP 3.0.

Click the Details button to configure the following parameters:





Network Address: Assign a unique number for each meter to be connected on a single network. Only numbers 0 – 254 are valid addresses for connecting JEMWare to a meter.
Password Timeout: Once communication commands have ceased, the timeout cycle will begin. Assign an amount of time that the meter will wait before the active session times out. When the timeout takes place, you must re-enter the meter password before communications can continue.

Modem Init String: Use the standard default shown unless you have a special requirement. The complete AT command set is listed in Appendix A of this manual.

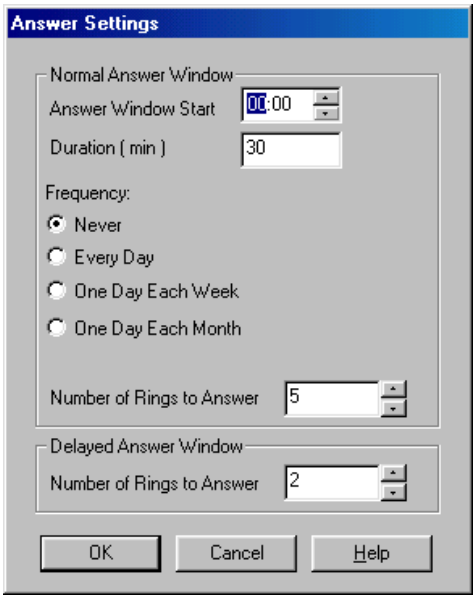
The JEMStar internal modem can be used to perform three categories of communications:

- **Answer modem** is the standard setting used when you want to call the meter from a remote computer with a dialup modem.
- **Phone Home** settings will instruct the JEMStar to call a phone number and report a predetermined text message. The call will be initiated upon a user-defined event occurrence such as a Site Monitor alarm or Threshold alarm.
- **Phone Home on Power Outage** settings will instruct the JEMStar to call a phone number and report a predetermined message. The call is initiated only if meter power fails (the modem is powered by an internal battery pack).

Each category of modem usage is described in the following pages.

Answer Modem Settings

To set up the modem's answer settings, configure the following parameters:



An Answer Window is a user-selectable period of time when JEMStar expects to receive a call. The **Answer Window Start** time specifies the beginning of the answer window. The **Duration** field specifies the length of the window, therefore the stop time of the answer window. If a call is received outside this answer window, the meter will answer after the number of rings specified in the Delayed Answer Window field. The maximum duration that can be accepted is 1439 minutes.

Frequency
This choice defines the window as to day or date. Select Never if you are not using this feature.

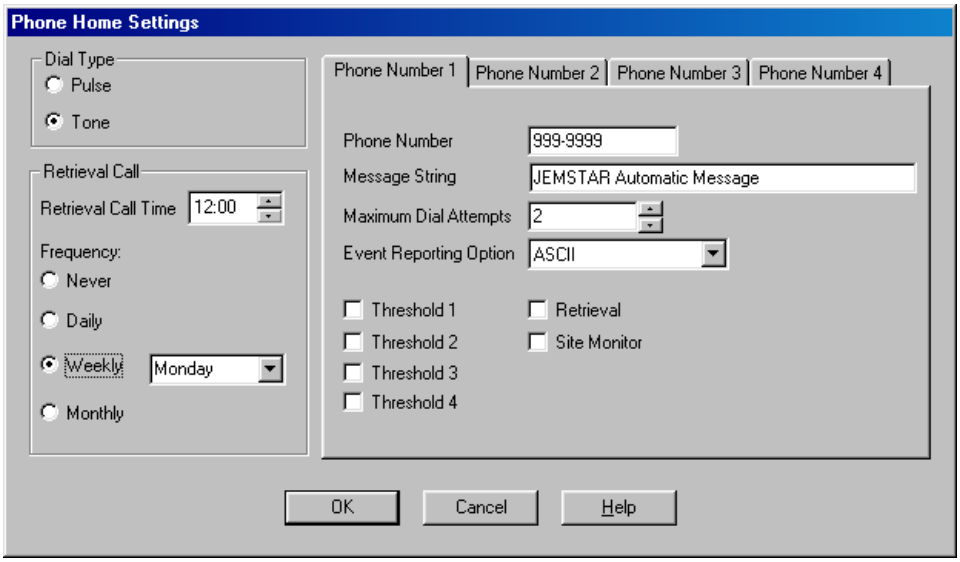
Number Rings to Answer
This will define when the modem will answer if the call occurs within the Answer Window time period. If "0" is selected, the modem never answers. Choices are 0 – 20.

Delayed Answer Window
This will define when the modem will answer if the call is *not* within the Answer Window. If "0" is selected, the modem never answers. Choices are 0 – 20.

Phone Home Modem Settings

This feature allows JEMStar to call any of four specified numbers if any of the selected events occur. The meter can have four different phone numbers programmed to call. Each phone number has an associated alarm event assigned to it. This event determines the action the meter will take when calling the number. The meter will send a text string in a user-selectable format indicating which meter called, the time the call was initiated, and the event(s) that occurred. This allows the phone-home features to be utilized without the need of any special software or system. All that is required is either a serial printer hooked up to a modem or a computer running terminal-emulation software (such as PROCOMM). The meter can also communicate via a serial protocol, such as DNP 3.0, or ANSI Tables, provided it is equipped with the option. This is useful if you are using a data management program such as MV-90.

Configure the necessary information for the Phone Home modem.



Dial Type
Select whether the meter will use *pulse* or *tone* dialing when calling any of the phone numbers.

Retrieval Call
This event occurs at a user-entered time and is used for scheduled data retrieval by a data system such as MV-90. The timing parameters of the call need to be sent to the meter by MV-90. Set the time and day that the retrieval will take place.

Meter Phone Numbers 1, 2, 3, 4
You can dial up to four separate phone numbers, each with its own message. For each phone number where events are set to cause a call-out, the user can enable or disable the following events in any combination for each phone number.

- Threshold 1 (See Alarms menu for defining an event)
- Threshold 2 (See Alarms menu for defining an event)
- Threshold 3 (See Alarms menu for defining an event)
- Threshold 4 (See Alarms menu for defining an event)
- Retrieval (See previous paragraph)
- Site Monitor Alarm (See Alarms menu for defining an event)

When entering the phone number, be sure it is exactly as you would dial it, including line access codes, area codes, etc. You can enter up to 50 characters in the phone number field.

You can configure the following for each phone number:

Message Text String
Enter your custom alphanumeric message, up to 99 characters. In addition to the specific message, you can add the following text to implement macros in the JEMStar firmware.

$T = time of the phone-home call
$D = date of the phone-home call

The following macros can also be added to your message to enhance the amount of information that will be reported. These macros access the information that was previously configured in the "Meter Identification" screen.

$M0 = Label 1 (default header is "Meter Name"*)
$M1 = Label 1 User description field
$M2 = Label 2 (default header is "Administrator"*)
$M3 = Label 2 User description field
$M4 = Label 3 (default header is "Location"*)
$M5 = Label 3 User description field
$M6 = Label 4 (default header is "Configuration ID"*)
$M7 = Label 4 User description field
$M8 = Label 5 (default header is "Account Number"*)
$M9 = Label 5 User description field

Example:
DT$M0$M1$M4$M5Bank#2 outage
will send the Date, Time, Meter Name, Meter Location, and custom message upon power failure

* Note that these default labels can be changed by the user to any other descriptor. See "Meter Identification".

Maximum Dial Attempts
Enter the number of times that the JEMStar modem should try to establish a connection (1 – 30).

Event Reporting Option
Choose a format how the message will be interpreted:

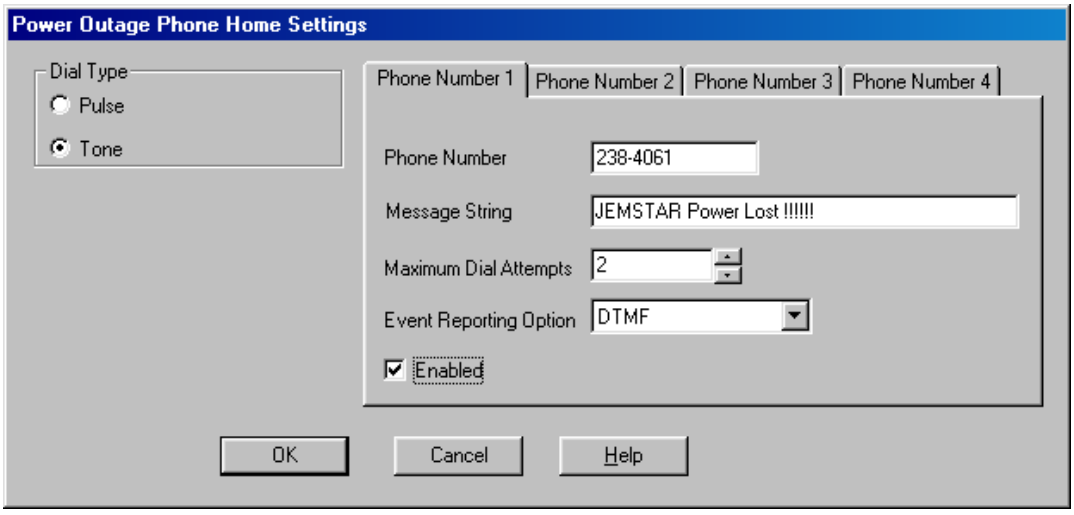
- ASCII: Sends message string as standard text
- ASCII & Protocol: Sends message string as standard text, and then reverts to the protocol (DNP, Modbus, or ANSI Tables) that was originally configured in the modem.
- DTMF (Dial Tone Multi-Frequency): Sends standard phone tones corresponding to message string, use with pagers
- Normal: Sends message via protocol originally configured in the modem.

Power Outage Phone Home Modem Settings

This feature allows JEMStar to call up to four phone numbers if the meter experiences a loss of power. Power Outage operates independently from the other modem settings and must have the battery back-up option installed. Refer to the meter model number and the JEMStar User Manual to determine if this feature has been installed.

The meter will send a text string in a user-selectable format indicating which meter called and the time the call was initiated. This allows the phone-home features to be utilized without the need of any special software or system. All that is required is either a serial printer hooked up to a modem or a computer running terminal-emulation software (such as PROCOMM).

Note that phone communication is discontinued *immediately* upon restoration of power. Therefore, if power is restored during a call sequence, the phone home function will not be completed. The Load Profile report will show an entry for the time of power failure and the time of restoration.



Configure the necessary information for the Phone Home Power Outage modem.

Dial Type
Select whether the meter will use *pulse* or *tone* dialing when calling any of the phone numbers.

Meter Phone Numbers 1, 2, 3, 4
You can dial up to four separate phone numbers, each with its own message. Each phone number can be set for Enable or Disable, thus keeping a library of numbers and only using ones that are necessary at this time.

When entering a phone number, be sure it is exactly as you would dial it, including line access codes, area codes, etc. You can enter up to 50 characters in the phone number field.

You can configure the following for each power outage phone number:

Message Text String
Enter your custom alphanumeric message, up to 99 characters. In addition to the specific text, you can add the following macro to send the time and date of power failure occurrence.

> **$TIME** = time and date of the power outage call
>
> *Example:*
> JEMStar Meter #123 Power Loss at $TIME

Your custom message and the time/date of power loss will be reported.

Maximum Dial Attempts
Enter the number of times that the JEMStar modem should try to establish a connection (1 – 30).

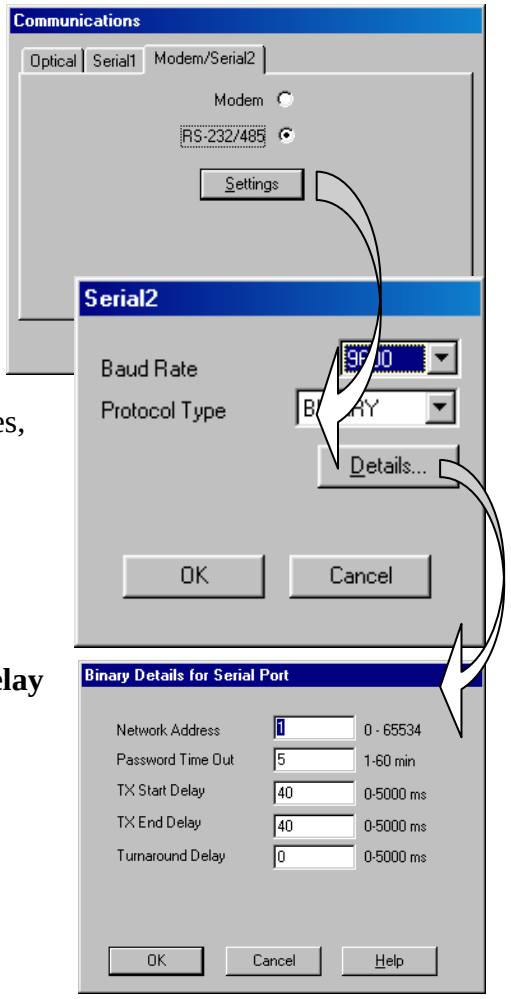
Event Reporting Option
Choose one of the following formats for sending the message:

- ASCII: Sends message string as standard text
- DTMF (Dial Tone Multi-Frequency): Sends standard phone tones corresponding to the message string; use with pagers

Enabled
When this box is checked (enabled), it means that this phone number will be dialed upon power outage. Each of the four numbers must be enabled or disabled individually. For example, if only Phone Number 1 and Phone Number 4 are Enabled (box checked), they will be dialed upon power failure. Phone Numbers 2 and 3 will not be dialed.

Serial Port 2 (RS-232 / RS-485):

A second serial port is available as an optional "Dual Communications" feature. To configure the meter's serial data interface, open the Serial Communications menu and select the Modem/Serial2 page. Click on the RS-232/485 button and then select Settings.



Use the pull-down menu to choose the baud rate that you want to use for communicating with the meter. The Protocol Type should be set for Binary unless you are using the port for ANSI Tables, DNP 3.0, or Modbus (see Protocols menu).

Click the Details button to configure the following parameters:
Network Address
Password Timeout
TX Start Delay / TX End Delay / Turnaround Delay

Refer to the previous section "Serial Port 1" for a complete explanation of these parameters.

Ethernet Option

The Ethernet option allows users to communicate serially with the JEMStar meter over a typical Ethernet LAN. It supports up to four simultaneous connections, which are treated as virtual serial channels. Any serial command protocol installed in the JEMStar may be used over one or more of these virtual connections.
The Ethernet option consists of a JEMStar comm option board and Ethernet pigtail cable. The board installs in the comm option position within the JEMStar and the pigtail runs from that position out through the base of the meter to a standard RJ-45 Ethernet jack. (For Switchboard models; Ethernet connections are on the terminal block.)
The Ethernet interface is compatible with any 10Base-T Ethernet network that transports TCP/IP packets. It also works on 100Base-T networks that can accept 10-megabit connections.

Terminology

Some computer networking terms that are defined here:

- ***10Base-T****:* A standard Ethernet physical interface that uses unshielded twisted pair (UTP) wiring. 10Base-T can carry up to 10 megabits of data per second although most devices cannot sustain that rate except in short bursts.
- ***IP Address*** (Internet Protocol)***:*** The numeric address of a device on a TCP/IP network. An IP address is usually expressed as four numbers separated by dots (periods), such as 192.168.1.2. An IP address can be assigned to a network device

automatically using DHCP (an automatic address), or manually by the network's administrator (a fixed address). IP addresses may be duplicated on different networks, but using the same IP address on two or more devices on the same network causes confusion and communication failures.

- ***MAC Address*** (Media Access Controller)***:*** A six-byte number that is unique to every network-capable device and is assigned by the device manufacturer. It is used for low-level Ethernet communications and to help DHCP servers identify devices that have been assigned automatic IP addresses.
- ***DHCP (***Dynamic Host Configuration Protocol): A method for automatically providing suitable IP address settings to a network device when it is connected or turned on. A network that supports DHCP has a server that newly-connected devices contact to obtain an IP address, Netmask, Default gateway, and other settings necessary to communicate on the network.
- ***Netmask:*** A bit field, usually expressed in the same format as an IP address, that helps the device to recognize messages from other legitimate network devices and reject messages from foreign devices. The netmask may be assigned automatically using DHCP or manually by the network's administrator.
- **Default Gateway:** The IP address to which network devices send messages when they don't know where else to send them. The default gateway is responsible for deciding whether to route messages to other devices on the network or to devices on other networks. The default gateway address may be provided automatically by DHCP or manually by the network administrator.
- **Network administrator (Net Admin):** The person responsible for setting up, operating, and maintaining a network. The network administrator may provide IP addresses, netmask values, and default gateway addresses manually, or may set up a DHCP server to provide them automatically.
- **TCP/IP** (Transmission Control Protocol / Internet Protocol): The set of network protocols used by the JEMStar Ethernet interface.

Physical Connection

Connecting the JEMStar Ethernet interface to a local network is straightforward. Use a standard 10Base-T patch cable (with RJ-45 plugs on each end) to connect the JEMStar's Ethernet pigtail to a network hub or router. Dress the wiring to avoid power leads that may couple electrical noise into the Ethernet cables.

If you are going to configure the JEMStar to use a fixed IP address; obtain the correct IP address, netmask, and default gateway address from your network administrator and configure them into the meter before connecting it to the network. Failure to do this may cause network problems that extend beyond the meter.

If you are going to let the JEMStar use DHCP to get network information automatically you may connect the meter to the network at any time. The default configuration in all JEMStar meters when they leave the factory is to use DHCP, so a new unconfigured meter may be connected safely to the network.

You may also bypass the network and connect the JEMStar directly to a computer's Ethernet jack using a crossover Ethernet cable. You must configure both your computer and JEMStar with fixed IP addresses first since neither will have access to a DHCP server.

Selecting an IP Address

When permanently connecting a JEMStar meter to a network, it is best practice to assign the meter a fixed IP address. Addresses automatically assigned by DHCP are subject to change and if the meter's automatic address changes you will not be able to contact it again without visiting the meter in person.

To display the meter's network settings remove the meter cover and press any arrow button to activate the menus. Press the Right button once to move the highlight to the middle columns, then the Down button until the word Ethernet is highlighted.

Press the Right button to move the highlight to the word Type. If there is an Ethernet option board installed the field in the upper right corner of the screen will say ETHERNET, otherwise it will say NOT INSTALLED.

Press the Down button to select and display the network settings. Here are sample images:

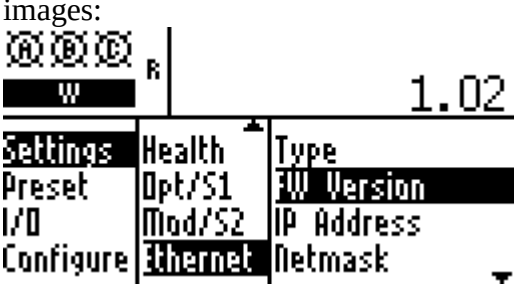


Figure 2: Ethernet Board Firmware Version

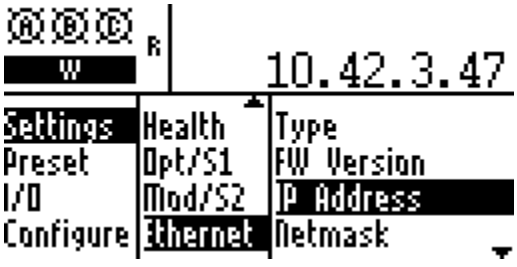


Figure 3: IP Address

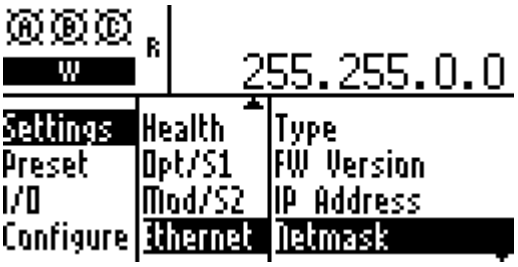


Figure 4: Netmask

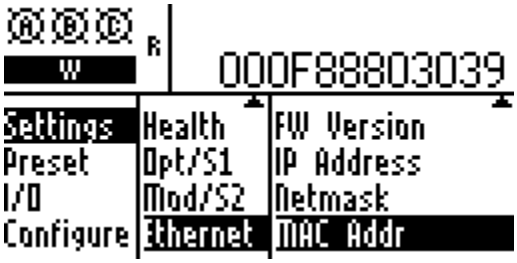


Figure 5: MAC Address

Once you have connected the JEMStar to the network and determined its IP address; check the connection by issuing a "ping" command from a computer on the same network. On most computers, get a command prompt and type "ping" followed by the meter's IP address, then Enter. For example: "Ping 10.42.3.47 <enter>". If you see one or more messages saying, "Reply from (IP address)…" the meter is connected and communicating. If you see "No reply…" messages, re-check the meter's configuration and wiring.

Setting up Virtual Serial Ports

The TCP/IP network protocol used by the JEMStar Ethernet interface uses "ports" which are virtual data connections within a single device. Different ports are used by different functions within the JEMStar much as different phone extensions are used by different departments of a company. Ports are identified by number.

Each of the serial command protocols available in a JEMStar meter (Binary, DNP, MODBUS ASCII or RTU, etc.) may be assigned a port number. For example, in the JEMStar default configuration the Binary protocol is assigned to Port 2001. When a user makes a connection to the meter's IP address at port 2001, he may use Binary protocol to

communicate with the meter. If he wants to use MODBUS RTU, he must configure the meter to assign that protocol to a different port number, such as 2003. Then he can connect to the meter's IP address at port 2003 to use MODBUS to communicate.
The JEMStar's Ethernet interface can support up to 4 simultaneously connected ports. That means up to 4 separate conversations may be going on at the same time on the Ethernet interface. Each connection is treated as a separate conversation: nothing that a user does on one port (such as activating a password) has any effect on any other port. The only exception is if one port is used to reconfigure the meter. At the end of the configuration session all active connections may be broken as the Ethernet interface is reset along with the rest of the meter.
Each serial protocol in the JEMStar must be assigned its own port number and the number of simultaneous connections it must support. Each protocol must have a unique port number. You may have more than one of a given protocol's port, however. For example, if you know the meter must be able to support 2 simultaneous Binary Protocol connections, you may configure Binary Protocol to use port 2001 and permit up to 2 connections. Any users (up to a maximum of 2) may then establish a connection to port 2001 at that meter's IP address and get a live connection; any more users who try will be rejected. To prevent an unused or uninstalled protocol from being accessed, set its number of connections to zero. This will also free up additional ports to be used on the desired protocols.
When assigning protocols to ports, keep these rules in mind:

- You can have no more that 4 active ports.
- If an optional protocol such as DNP is not installed in the meter, you must set its number of connections to zero. Otherwise it uses up one of the 4 connections but still doesn't work.
- Port numbers may be any number from 1 to 65535. However, certain port numbers are traditionally assigned to network functions that the JEMStar does not support, such as Web page serving which uses port 80. The JEMStar and compatible software can still use these ports, but if someone using a different program (such as a Web browser) accidentally connects to the meter's IP address the result is unpredictable. Generally port numbers above 1024 are fair game. For more information on common port numbers see http://www.iana.org/assignments/port-numbers
- You may have DNP assigned to only one port and single user, either virtual or serial, in any given meter. The DNP code used in the JEMStar does not support multiple ports. All other meter protocols may be assigned to any number of ports in the JEMStar.
- Every JEMStar serial protocol requires a serial device address, just as if it was being used on an RS-485 network. For convenience, it is recommended to use '1' for all virtual port serial addresses.

A typical virtual port configuration may look like this:

Binary Protocol: IP Port number 2001, Max connections 2, Device address 1
MODBUS RTU: IP Port number 2002, Max connections 1, Device address 1
DNP: IP Port number 2003, Max connections 1, Device address 1
ANSI Tables: IP Port number 2004, Max connections 0, Device address 1
MODBUS ASCII: IP Port number 2005, Max connections 0, Device address 1

DPMS: IP Port number 2006, Max connections 0, Device address 1

This configuration will allow up to 2 Binary connections, one DNP connection, and one MODBUS RTU connection simultaneously (assuming the Modbus and DNP protocols were purchased with the meter). It will block all other protocols.

The JEMStar default configuration is to use DHCP to obtain an automatic IP address and uses Binary Protocol on port 2001, max connections 4, device address 1. All other protocols are set for max connections = 0.

Configuring the JEMStar Ethernet Interface

JEMWARE is used to program the JEMStar meter, including the Ethernet interface. Use the Meter Settings: Serial Communication: Ethernet tab in JEMWARE to set up the desired Ethernet operation.

The first screen is used to set the Ethernet address of the meter. Enter the IP address, Subnet mask (netmask), and default gateway addresses provided to you by your network administrator, or check the "Use DHCP" box to have the meter obtain these values automatically.

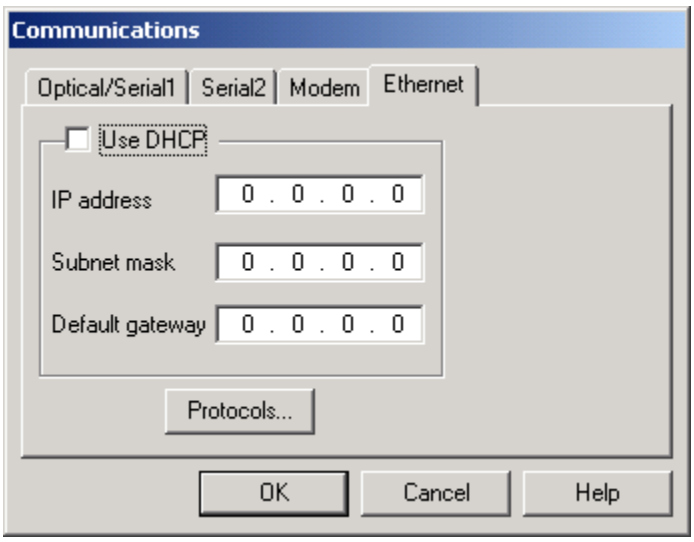


Figure 6. Ethernet address setup

To set up the serial protocol ports, click Protocols. Enter the desired port number, max connections, and device address for Binary Protocol.

Figure 7: Binary Protocol setup

To set up other protocol ports, pull down the Protocol list and select the next one in the list.

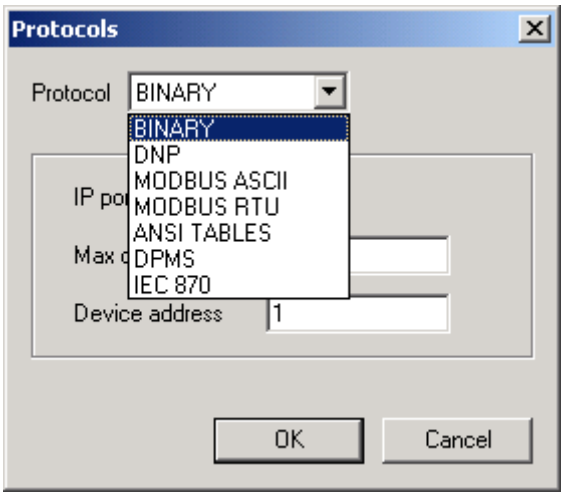


Figure 8: List of protocols

Visit each protocol in the list and make sure that it has the correct number of max connections for your needs.
When you are finished save your configuration and then send it to the JEMStar. In most cases you'll need to configure the meter for the first time using a serial port but if you know the meter's network address and port setup it is possible to configure the meter via the Ethernet interface.
If you try to configure a meter for more than four (4) simultaneous connections JEMWARE will display a warning when you send the configuration to the meter. It will still send the config but once the first 4 connections have been assigned all further port assignments are ignored. Ports are assigned to protocols in the order of the list shown in Figure 8.

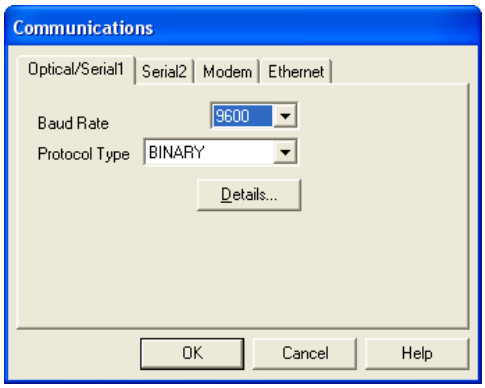
Serial Communication (Ci20)

This window (see Communication Parameters – Optical/Serial1 Tab) configures the parameters of the communications ports and internal modem in the meter. Some communication functions are optional features such as a modem and dual serial ports. You need to configure only the type(s) of communication functions you are using in the meter. There are four tabs:

- Optical/Serial
- Serial Port 2 (RS-232/RS-485)
- Modem
- Ethernet

Optical/Serial1

Use this tab (see Communication Parameters – Optical/Serial1 Tab) to configure the meter's front panel optical interface. Use the pull-down menu to choose the baud rate that you want to use for communicating with your optical adapter.



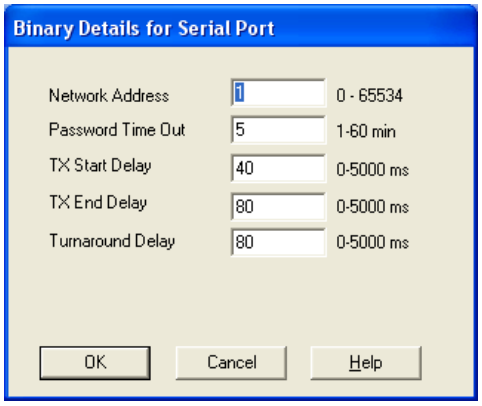
Communication Parameters - Optical/Serial1 Tab

Protocol Type

Set for:

- Binary if you are connecting to a portable computer via an optical probe
- *DNP* if you are using a distributed network.
- *Modbus ASCII* or *Modbus RTU*
- *ANSI Tables* if you are using the port for that protocol
- *None*

Click **Details** and the to configure the Binary Details (Binary Details Pop-Up Screen).



Binary Details Pop-Up Screen

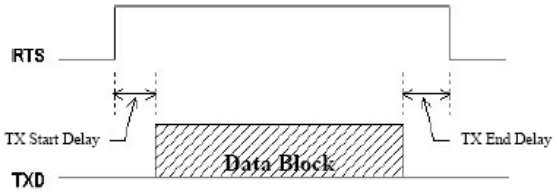
Network Address
Assign a unique number for each meter if you are connecting meters in a network. Use address numbers 0 – 254 for connecting *JEMWare* to a meter or the optional Modbus or ANSI Tables protocols. Any address 0 – 65534 may be used with DNP 3.0 protocol.

Password Timeout
Once communication commands have ceased, the timeout cycle begins. Assign an amount of time that the meter waits before the active session times out. Once a timeout takes place, you must re-enter the meter password before communications can continue.

TX Start Delay / TX End Delay / Turnaround Delay
Communication delays may be necessary to allow proper timing of the transmitted data. In half duplex mode, the delay intervals are inserted to make sure that data going one direction does not interfere with data going the other direction (TX Start Delay / TX End Delay / Turnaround Delay Diagram).

If you are using:

- Radio-modem applications that use the RS-232 Request To Send (RTS) handshaking signal.
- RS485 communications, set *meter port delays* on this tab
- If Ci20 is not used in such applications, simply set the TX Start, TX End, and Turnaround delays to 0 ms.



TX Start Delay / TX End Delay / Turnaround Delay Diagram

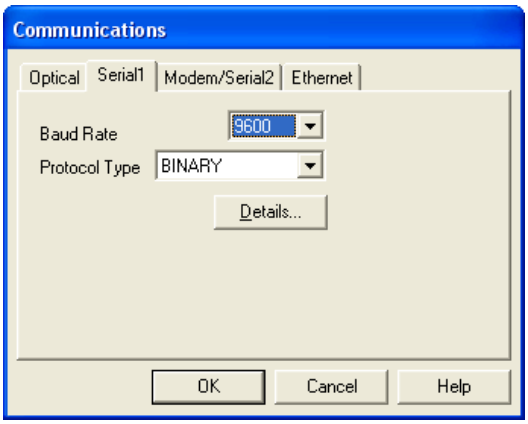
TX Start Delay
Corresponds to the delay between the time that the RTS line is asserted and the time that the data is transmitted.

TX End Delay
Corresponds to the delay between the time that Ci20 stops sending data and the time that the RTS line is de-asserted.

Turnaround Delay
Corresponds to the delay between the time that Ci20 finishes receiving a command and asserts RTS to begin transmitting a reply. Allows the master station time to turn off its own transmitter.

Serial Port 2 (RS-232 / RS-485)

Use this tab (Figure\ 3) to configure the meter's serial data interface. Use the pull-down menu to choose the baud rate that you want to use for communicating with your Ci20 meter.



Communication Parameters - Serial12 Tab

Set the Protocol Type for Binary unless you are using ANSI Tables, Modbus, or DNP 3.0

See Optical/Serial1 section58 for field descriptions.

Modem

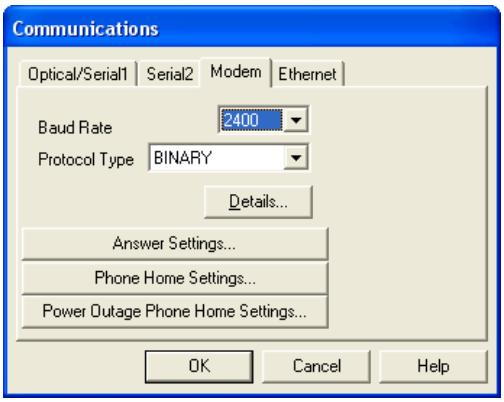
The Ci20 internal modem has two modes of operation:

- The capability to call-originate and,
- To answer incoming phone calls.

***NOTE: The Modem features are optional; check your model number to determine if this is available on your meter.**

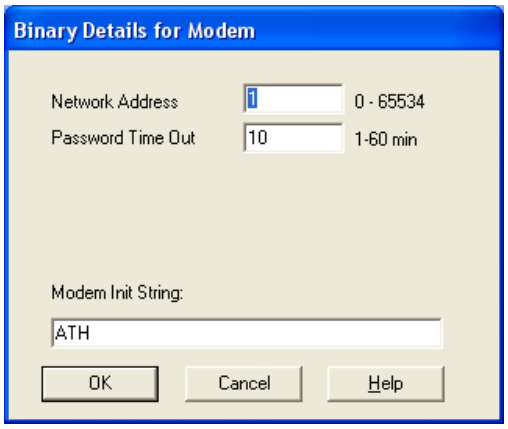
Use this tab (see Modem Settings) to configure Ci20's internal modem.

Use the pull-down menu to choose the baud rate that you want to use for modem communications. Set the Protocol Type for Binary unless you are using ANSI Tables, Modbus, or DNP 3.0.



Modem Settings

Click Details to configure the Binary Details (Binary Details for Modem).



Binary Details for Modem

Network Address
Assign a unique number for each meter to be connected on a single network. Only numbers 0 – 254 are valid addresses for connecting *JEMWare* to a meter.

Password Timeout
Once communication commands have ceased, the timeout cycle begins. Assign an amount of time that the meter waits before the active session times out. When the timeout takes place, you must re-enter the meter password before communications can continue.

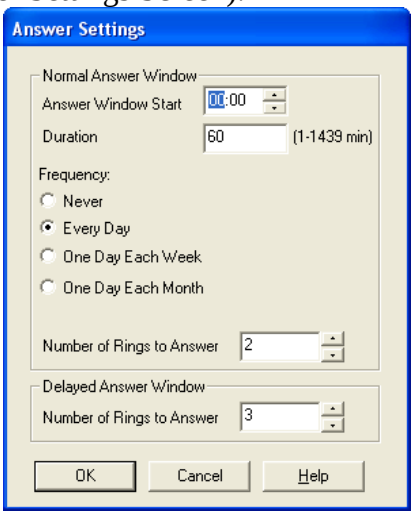
Modem Init String
Use the standard default shown unless you have a special requirement. The complete AT command set is listed in Appendix A of this manual.

The Ci20 internal modem can be used to perform three categories of communications:

- Answer Settings
- Phone Home Settings
- Phone Home on Power Outage Settings

Answer Settings

This is the standard setting used when you want to call the meter from a remote computer with a dialup modem (Answer Settings Screen).



Answer Settings Screen

The following fields are available:

Normal Answer Window
A user-selectable period of time when Ci20 expects to receive a call.

Answer Window Start
This time specifies the beginning of the answer window.

Duration
Specifies the length of the window, and therefore the stop time of the answer window. If a call is received outside this answer window, the meter answers after the number of rings specified in the Delayed Answer Window field. The maximum duration that can be accepted is 1439 minutes.

Frequency
Defines the window as to day or date.

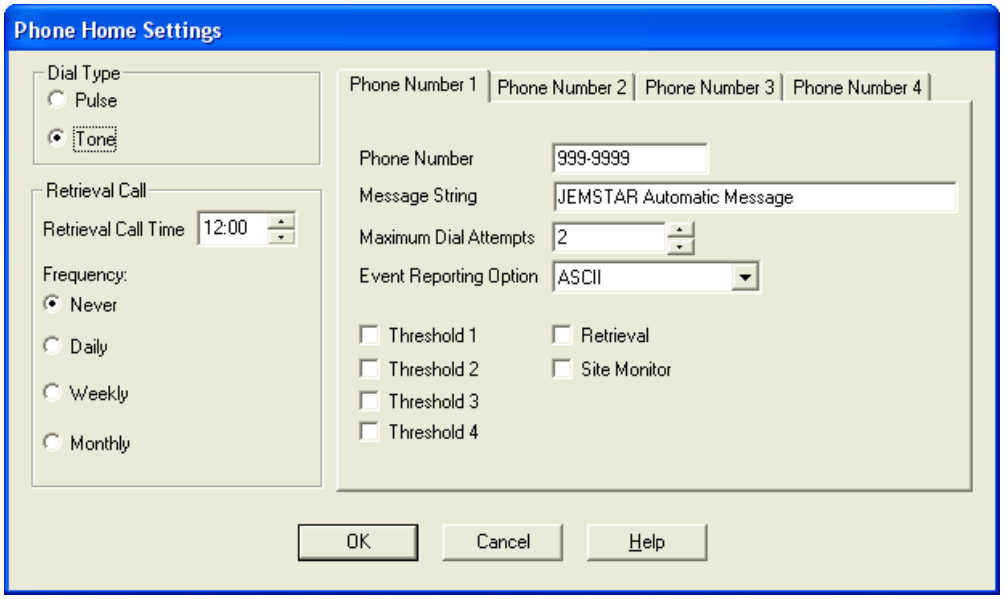
Number Rings to Answer
Defines when the modem answers if the call occurs within the Answer Window time period. If *0* is selected, the modem never answers. Choices are 0 – 20.

Delayed Answer Window
Defines when the modem answers if the call is not within the Answer Window. If *0* is selected, the modem never answers. Choices are 0 – 20.

Phone Home Settings

Instructs the Ci20 to call a phone number and report a predetermined text message. The call is initiated upon a user-defined event occurrence such as a Site Monitor alarm or Threshold alarm (Phone Home Setting).

This feature allows Ci20 to call any of four specified numbers if any of the selected events occur. The meter can have four different phone numbers programmed to call. Each phone number has an associated alarm event assigned to it. This event determines the action the meter takes when calling the number. The meter sends a text string in a user-selectable format indicating which meter called, the time the call was initiated, and the event(s) that occurred. This allows the phone-home features to be utilized without the need of any special software or system. All that is required is either a serial printer hooked up to a modem or a computer running terminal-emulation software (such as PROCOMM). The meter can also communicate via a serial protocol, such as DNP 3.0, or ANSI Tables, provided it is equipped with the option. This is useful if you are using a data management program such as MV-90.



Phone Home Setting

The following fields are available:

Dial Type
Select whether the meter uses *pulse* or *tone* dialing when calling any of the phone numbers.

Retrieval Call
Configure a retrieval call by selecting the *Retrieval Call Time* and a *Frequency* radio button, as well as the *Phone Number* fields. This is used for scheduled data retrieval by a data system such as MV-90. The timing parameters of the call need to be sent to the meter by MV-90.

Phone Numbers 1, 2, 3, 4

You can dial up to four separate phone numbers, each with its own message. For each phone number where events are set to cause a call-out, the user can enable or disable the following events in any combination for each phone number.

Threshold 1 ,2,3, 4

Retrieval
See above.

Site Monitor

Phone Number
Ensure it is exactly as you would dial it, including line access codes, area codes, etc. You can enter up to 50 characters in the phone number field.

Message Text String
Enter your custom alphanumeric message, up to 99 characters. In addition to the specific message, you can add the following text to implement macros in the Ci20 firmware:

- *$T* = time of the phone-home call
- *$D* = date of the phone-home call

The following macros can also be added to your message to enhance the amount of information that is reported. These macros access the information that was previously configured:

- *$M0* = Label 1 (default header is *Meter Name**)
- *$M1* = Label 1 User description field
- *$M2* = Label 2 (default header is *Administrator**)
- *$M3* = Label 2 User description field
- *$M4* = Label 3 (default header is *Location**)
- *$M5* = Label 3 User description field
- *$M6* = Label 4 (default header is *Configuration ID**)
- *$M7* = Label 4 User description field
- *$M8* = Label 5 (default header is *Account Number**)
- *$M9* = Label 5 User description field

Example: *DT$M0$M1$M4$M5Bank#2 outage will send the Date, Time, Meter Name, Meter Location, and custom message upon power failure*

* These default labels can be changed by the user to any other descriptor.

Maximum Dial Attempts
Enter the number of times that the Ci20 modem tries to establish a connection (1 – 30).

Event Reporting Option
Choose a format how the message is interpreted:

- ASCII - Sends message string as standard text
- ASCII & Protocol - Sends message string as standard text, then reverts to the protocol. (DNP, Modbus, or ANSI Tables) that was originally configured in the modem.
- DTMF (Dial Tone Multi-Frequency) - Sends standard phone tones corresponding to message string, use with pagers.
- Normal - Sends message via protocol originally configured in the modem.

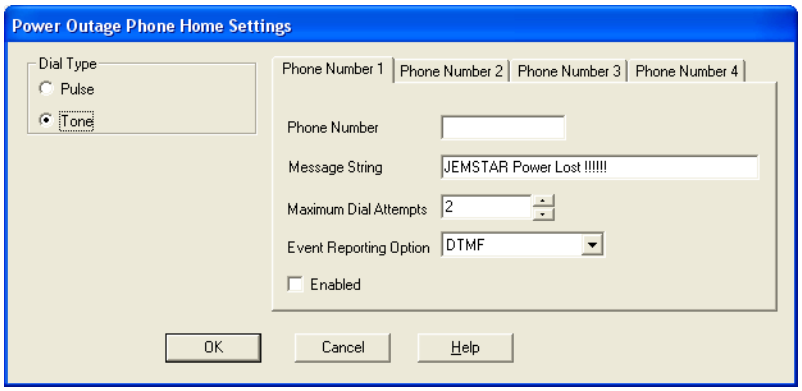
Phone Home on Power Outage Settings

Instructs the Ci20 to call a phone number and report a predetermined message. The call is initiated only if meter power fails. The modem is powered by an internal battery pack (Power Outage Phone Home Settings).

This feature allows Ci20 to call up to four phone numbers if the meter experiences a loss of power. Power Outage operates independently from the other modem settings and must have the battery back-up option installed. Refer to the meter model number and the Ci20 User Manual to determine if this feature has been installed.

The meter sends a text string in a user-selectable format indicating which meter called and the time the call was initiated. This allows the phone-home features to be utilized without the need of any special software or system. All that is required is either a serial printer hooked up to a modem or a computer running terminal-emulation software (such as PROCOMM).

Phone communication is discontinued *immediately* upon restoration of power. Therefore, if power is restored during a call sequence, the phone home function is not completed. The Load Profile report shows an entry for the time of power failure and the time of restoration.



Power Outage Phone Home Settings

The following fields are available:

Dial Type
Select whether the meter uses *pulse* or *tone* dialing when calling any of the phone numbers.

Phone Numbers 1, 2, 3, 4
You can dial up to four separate phone numbers, each with its own message. Each phone number can be set for Enable or Disable, thus keeping a library of numbers and only using ones that are necessary at this time.

When entering a phone number, be sure it is exactly as you would dial it, including line access codes, area codes, etc. You can enter up to 50 characters in the phone number field.

Message Text String
Enter your custom alphanumeric message, up to 99 characters. In addition to the specific text, you can add the following macro to send the time and date of power failure occurrence:

- *$TIME* = time and date of the power outage call

Example:
Ci20 Meter #123 Power Loss at $TIME

Your custom message and the time/date of power loss is reported.

Maximum Dial Attempts
Enter the number of times that the Ci20 modem tries to establish a connection (1 – 30).

Event Reporting Option
Choose one of the following formats for sending the message:

- ASCII - Sends message string as standard text.
- DTMF (Dial Tone Multi-Frequency) - Sends standard phone tones corresponding to the message string; use with pagers.

Enabled
Enable and this phone number is dialed on power outage. Each of the four numbers must be enabled or disabled individually. For example, if only Phone Number 1 and Phone Number 4 are enabled, they are dialed upon power failure. Phone Numbers 2 and 3 is not dialed.

Ethernet

The Ethernet option allows users to communicate serially with the Ci20 meter over a typical Ethernet LAN. It supports up to four simultaneous connections which are treated as virtual serial channels. Any serial command protocol installed in the Ci20 may be used over one or more of these virtual connections.

The Ethernet option consists of a Ci20 comm option board and Ethernet pigtail cable. The board installs in the comm option position within the Ci20 and the pigtail runs from that position out through the base of the meter to a standard RJ-45 Ethernet jack.

The Ethernet interface is compatible with any 10Base-T Ethernet network that transports TCP/IP packets. It also works on 100Base-T networks that can accept 10 megabit connections.

Terminology

Some computer networking terms defined here:

10Base-T: A standard Ethernet physical interface that uses unshielded twisted pair (UTP) wiring. 10Base-T can carry up to 10 megabits of data per second although most devices cannot sustain that rate except in short bursts.

IP (Internet Protocol) Address: The numeric address of a device on a TCP/IP network. An IP address is usually expressed as four numbers separated by dots (periods), such as 192.168.1.2. An IP address can be assigned to a network device automatically using DHCP (an automatic address), or manually by the network's administrator (a fixed address). IP addresses may be duplicated on different networks, but using the same IP address on two or more devices on the same network causes confusion and communication failures.

MAC (Media Access Controller) Address: A six-byte number that is unique to every network-capable device and is assigned by the device manufacturer. It is used for low-level Ethernet communications and to help DHCP servers identify devices that have been assigned automatic IP addresses.

DHCP (Dynamic Host Configuration Protocol): A method for automatically providing suitable IP address settings to a network device when it is connected or turned on. A network that supports DHCP has a server that newly-connected devices contact to obtain an IP address, Netmask, Default gateway, and other settings necessary to communicate on the network.

Netmask: A bit field, usually expressed in the same format as an IP address, that helps the device to recognize messages from other legitimate network devices and reject messages from foreign devices. The netmask may be assigned automatically using DHCP or manually by the network's administrator.

Default Gateway: The IP address to which network devices send messages when they don't know where else to send them. The default gateway is responsible for deciding whether to route messages to other devices on the network or to devices on other networks. The default gateway address may be provided automatically by DHCP or manually by the network administrator.

Network administrator (Net Admin): The person responsible for setting up, operating, and maintaining a network. The network administrator may provide IP addresses, netmask values, and default gateway addresses manually, or may set up a DHCP server to provide them automatically.

TCP/IP (Transmission Control Protocol / Internet Protocol): The set of network protocols used by the Ci20 Ethernet interface.

Physical Connection

Connecting the Ci20 Ethernet interface to a local network is straightforward. Use a standard 10Base-T patch cable (with RJ-45 plugs on each end) to connect the Ci20's

Ethernet pigtail to a network hub or router. Dress the wiring to avoid power leads that may couple electrical noise into the Ethernet cables.

If you are going to configure the Ci20 to use a fixed IP address; obtain the correct IP address, netmask, and default gateway address from your network administrator and configure them into the meter before connecting it to the network. Failure to do this may cause network problems that extend beyond the meter.

If you are going to let the Ci20 use DHCP to get network information automatically you may connect the meter to the network at any time. The default configuration in all Ci20 meters when they leave the factory is to use DHCP, so a new unconfigured meter may be connected safely to the network.

You may also bypass the network and connect the Ci20 directly to a computer's Ethernet jack using a crossover Ethernet cable. You must configure both your computer and Ci20 with fixed IP addresses first since neither will have access to a DHCP server.

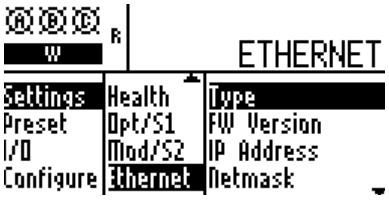
Selecting an IP Address

When permanently connecting a Ci20 meter to a network, it is best practice to assign the meter a fixed IP address. Addresses automatically assigned by DHCP are subject to change and if the meter's automatic address changes you will not be able to contact it again without visiting the meter in person.

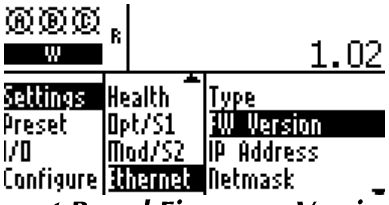
To display the meter's network settings remove the meter cover and press any arrow button to activate the menus. Press the Right button once to move the highlight to the middle columns, then the Down button until the word Ethernet is highlighted.

Press the Right button to move the highlight to the word Type. If there is an Ethernet option board installed the field in the upper right corner of the screen will say ETHERNET, otherwise it will say NOT INSTALLED.

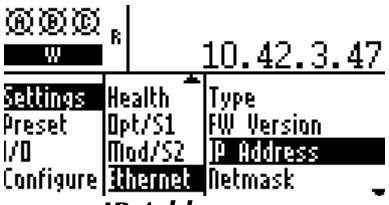
Press the Down button to select and display the network settings. Here are sample images:



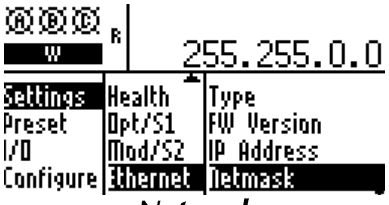
Type



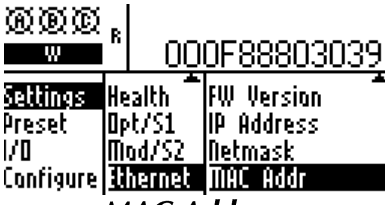
Ethernet Board Firmware Version



IP Address



Netmask



MAC Address

Once you have connected the Ci20 to the network and determined its IP address; check the connection by issuing a "ping" command from a computer on the same network. On most computers, get a command prompt and type "ping" followed by the meter's IP address, then Enter. For example: "Ping 10.42.3.47 <enter>". If you see one or more messages saying "Reply from (IP address)…" the meter is connected and communicating. If you see "No reply…" messages, re-check the meter's configuration and wiring.

Setting up Virtual Serial Ports

The TCP/IP network protocol used by the Ci20 Ethernet interface uses "ports" which are virtual data connections within a single device. Different ports are used by different functions within the Ci20 much as different phone extensions are used by different departments of a company. Ports are identified by number.

Each of the serial command protocols available in a Ci20 meter (Binary, DNP, MODBUS ASCII or RTU, etc.) may be assigned a port number. For example, in the Ci20 default configuration the Binary protocol is assigned to Port 2001. When a user makes a connection to the meter's IP address at port 2001, he may use Binary protocol to communicate with the meter. If he wants to use MODBUS RTU, he must configure the meter to assign that protocol to a different port number, such as 2003. Then he can connect to the meter's IP address at port 2003 to use MODBUS to communicate.

The Ci20's Ethernet interface can support up to 4 simultaneously connected ports. That means up to 4 separate conversations may be going on at the same time on the Ethernet

interface. Each connection is treated as a separate conversation: nothing that a user does on one port (such as activating a password) has any effect on any other port. The only exception is if one port is used to reconfigure the meter. At the end of the configuration session all active connections may be broken as the Ethernet interface is reset along with the rest of the meter.

Each serial protocol in the Ci20 must be assigned its own port number and the number of simultaneous connections it must support. Each protocol must have a unique port number. You may have more than one of a given protocol's port, however. For example, if you know the meter must be able to support 2 simultaneous Binary Protocol connections, you may configure Binary Protocol to use port 2001 and permit up to 2 connections. Any users (up to a maximum of 2) may then establish a connection to port 2001 at that meter's IP address and get a live connection; any more users who try will be rejected. To prevent an unused or uninstalled protocol from being accessed, set its number of connections to zero. This will also free up additional ports to be used on the desired protocols.

When assigning protocols to ports, keep these rules in mind:

- You can have no more that 4 active ports.
- If an optional protocol such as DNP is not installed in the meter, you must set its number of connections to zero. Otherwise it uses up one of the 4 connections but still doesn't work.
- Port numbers may be any number from 1 to 65535. However, certain port numbers are traditionally assigned to network functions that the Ci20 does not support, such as Web page serving which uses port 80. The Ci20 and compatible software can still use these ports, but if someone using a different programs (such as a Web browser) accidentally connects to the meter's IP address the result is unpredictable. Generally port numbers above 1024 are fair game. For more information on common port numbers see http://www.iana.org/assignments/port-numbers
- You may have DNP assigned to only one port and single user, either virtual or serial, in any given meter. The DNP code used in the Ci20 does not support multiple ports. All other meter protocols may be assigned to any number of ports in the Ci20.
- Every Ci20 serial protocol requires a serial device address, just as if it was being used on an RS-485 network. For convenience, it is recommended to use '1' for all virtual port serial addresses.

A typical virtual port configuration may look like this:

Binary Protocol: IP Port number 2001, Max connections 2, Device address 1

MODBUS RTU: IP Port number 2002, Max connections 1, Device address 1

DNP: IP Port number 2003, Max connections 1, Device address 1

ANSI Tables: IP Port number 2004, Max connections 0, Device address 1

MODBUS ASCII: IP Port number 2005, Max connections 0, Device address 1

DPMS: IP Port number 2006, Max connections 0, Device address 1

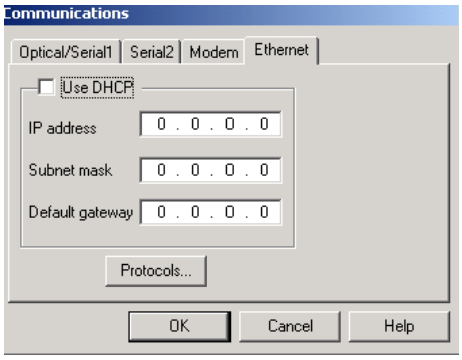
This configuration will allow up to 2 Binary connections, one DNP connection, and one MODBUS RTU connection simultaneously (assuming the Modbus and DNP protocols were purchased with the meter). It will block all other protocols.

The Ci20 default configuration is to use DHCP to obtain an automatic IP address and uses Binary Protocol on port 2001, max connections 4, device address 1. All other protocols are set for max connections = 0.

Configuring the Ci20 Ethernet Interface

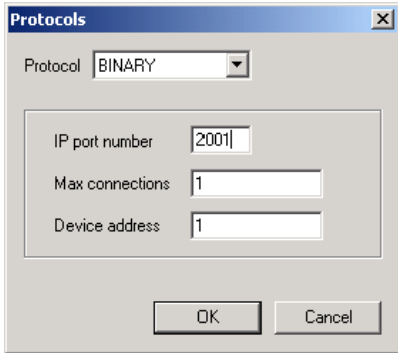
JEMWare is used to program the Ci20 meter, including the Ethernet interface. Use the Meter Settings: Serial Communication: Ethernet tab in JEMWare to set up the desired Ethernet operation.

The first screen is used to set the Ethernet address of the meter. Enter the IP address, Subnet mask (netmask), and default gateway addresses provided to you by your network administrator, or check the "Use DHCP" box to have the meter obtain these values automatically.



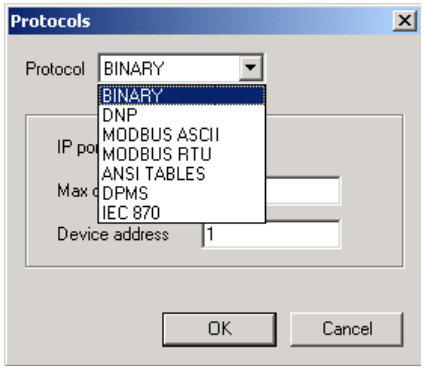
Ethernet address setup

To set up the serial protocol ports, click Protocols. Enter the desired port number, max connections, and device address for Binary Protocol.



Binary Protocol Setup

To set up other protocol ports, pull down the Protocol list and select the next one in the list.



List of Protocols

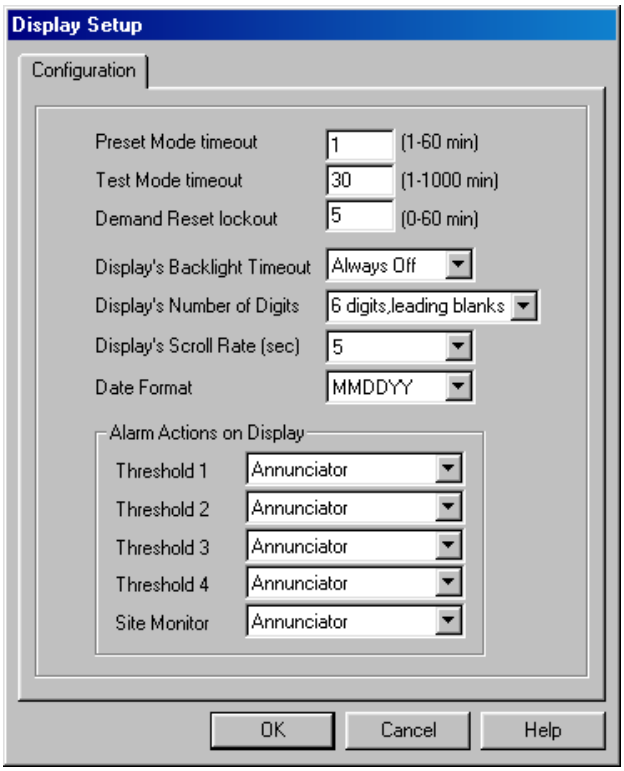
Visit each protocol in the list and make sure that it has the correct number of max connections for your needs.

When you are finished save your configuration and then send it to the Ci20. In most cases you'll need to configure the meter for the first time using a serial port but if you know the meter's network address and port setup it is possible to configure the meter via the Ethernet interface.

If you try to configure a meter for more than 4 simultaneous connections JEMWare will display a warning when you send the configuration to the meter. It will still send the config but once the first 4 connections have been assigned all further port assignments are ignored. Ports are assigned to protocols in the order of the list shown in List of Protocols .

Display Setup

Use this configuration menu to set up how the meter LCD will display information.



Preset Mode Timeout
Enter a number (1-60) for the number of minutes that the LCD will display a Preset quantity before automatically returning to the standard display mode.

Test Mode Timeout
Enter a number (1-1000) for the number of minutes that the LCD will remain in Test Mode before automatically returning to the standard display mode.

Demand Reset Lockout
This also is referred to as a Billing Period Reset Lockout. The purpose is to eliminate accidental multiple BPR commands that could cause a loss of data. The Lockout only affects actions from the meter's front panel; a command from JEMRead will override the lockout and initiate a BPR. Enter a number (0-60) for the number of minutes that you must wait before the next BPR is valid.

Display's Backlight Timeout (JEMStar only)
If your meter is equipped with the optional backlit display, you can choose how the light will operate. Refer to the Model Number Description in the User Manual 1083-600 to determine if you have this feature in your meter. Selections include Always ON, Always OFF, or 5, 10, 15, or 60 minutes ON after the last front panel button is pushed.
Note: If your meter is not equipped with the backlighting feature, it will simply ignore this setting.

Display's Number of Digits
Choose either 6 or 8 digits for the Main Display readout. You can also choose to display leading blanks or leading zeros. Leading blanks means that there is nothing displayed to the left of the most significant digit. Leading zeros means that places to the left of the MSD will be filled in with zeros.

Display's Scroll Rate
Enter a numeric integer for the number of seconds that the LCD will display each register before scrolling to the next one. The Scroll Rate can be selected from 1 to 20 seconds. To turn this feature off so that only the manually selected register is displayed, choose "No" in the pull-down menu.

Date Format
Use the pull-down menu to choose how you want the date displayed. Choices are MMDDYY, DDMMYY, or YYMMDD (where M=month, D=day, and Y=year).

Alarm Actions on Display
Note: Threshold and Site Monitor alarms are actually configured in the "Alarms" menu.
Use this menu to set how the alarms will be displayed on the meter LCD. The types of action are:

Ignore: The meter will not display any alarms. You can still have alarms active as a pulse output.

Annunciator: The meter will display the alarm indication at the bottom of the main display and disappear when the alarm clears.

Latch Annunciator: The meter displays the alarm indication and remain after the alarm clears. You must manually clear the annunciator by pressing the Reset button twice.

Override Display: The meter will override the currently displayed quantity and display the alarm indication. The annunciator disappears when the alarm clears.

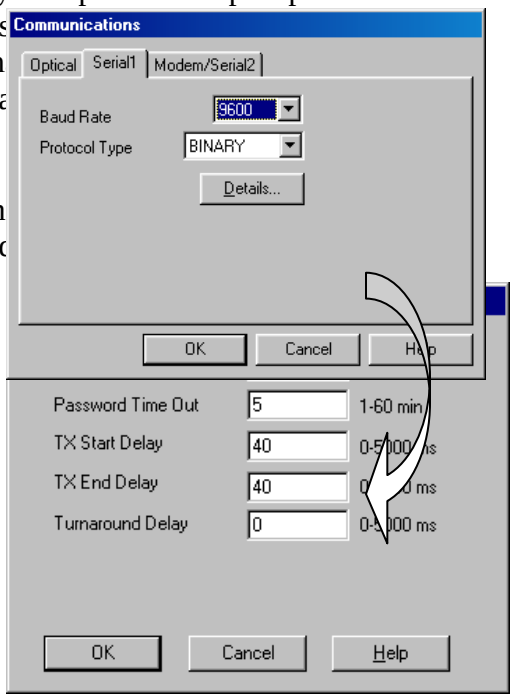
Latch Override Display: The meter will override the currently displayed quantity and display the alarm indication. You must manually clear the annunciator by pressing the Reset button twice.

Protocols

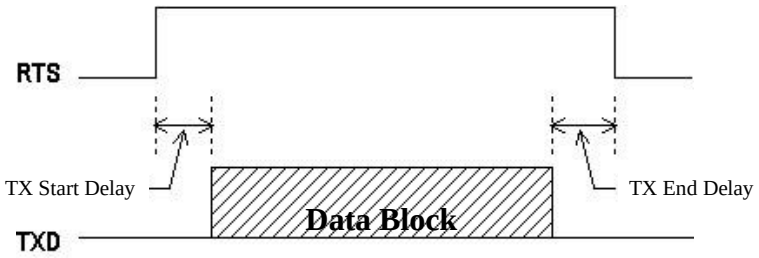
Use this configuration menu to set up the optional DNP 3.0 or Modbus communication protocols. Please refer to the appendices at the end of this manual for a complete description of features, including the DNP Device Profile Document and point lists.

To configure the DNP option for a meter:

1. Start by setting up a communication port for DNP. Determine whether you will use the Serial 1 or (optional) Serial 2 port. You can only set up one DNP port per meter. Go to Meter Settings | Serial Communication, and then s
Choose the baud rate from the pull-down box that m
communication port (Meters are always considered a
Type to DNP.



2. Click the Details button to configure the followin
Network Address: Several meters can be networke
the CommRepeater option. Assign a unique number for each meter connected on a network. If this is a single meter-to-master connection, use the default address 1. Any address 0 – 65534 may be used with DNP 3.0.
Password Timeout: Once communication commands have ceased, a timeout cycle will begin. Assign an amount of time that the meter will wait before the active session times out. Once a timeout takes place, you must re-enter the meter password before communications can continue.
TX Start Delay / TX End Delay / Turnaround Delay: Certain parameters are required for radio-modem applications that use the RS-232 Request To Send (RTS) handshaking signal. If a meter is not used in such applications, simply set the TX Start, TX End, and Turnaround delays to 0 ms.



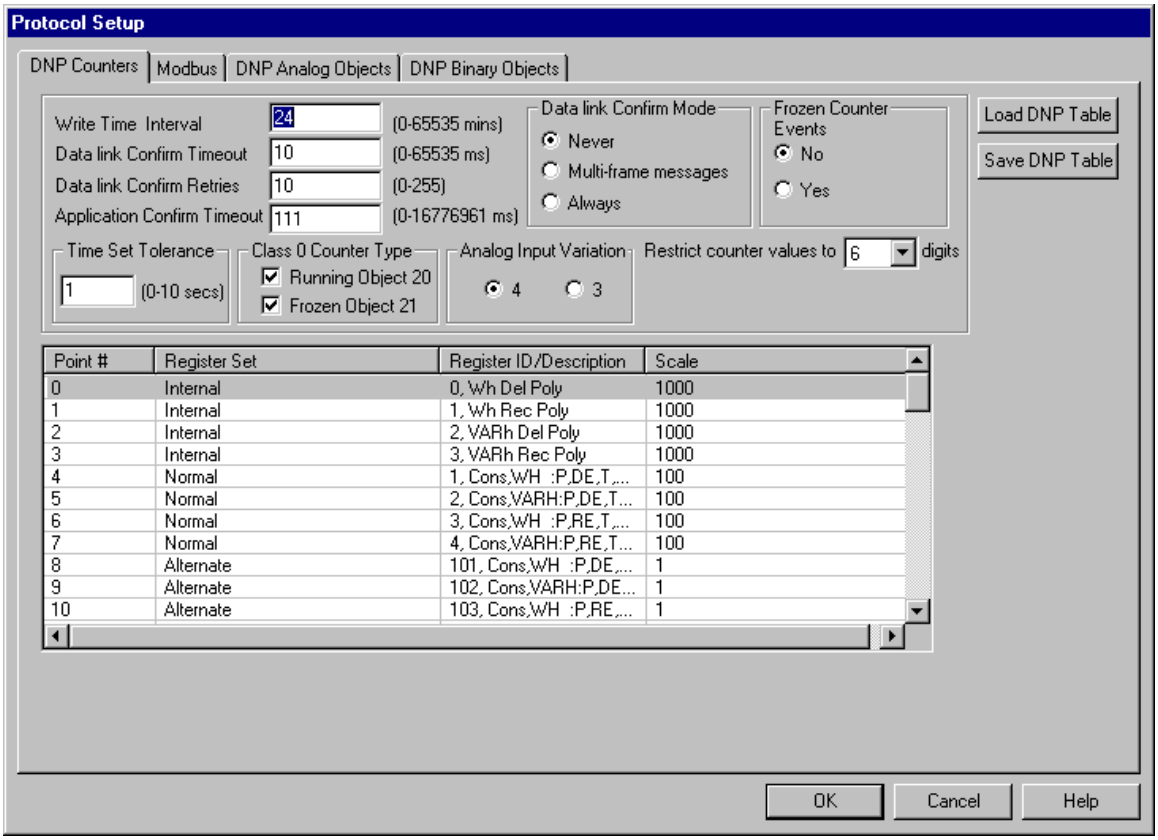
TX Start Delay
Corresponds to the delay between the time that the RTS line is asserted and the time that the data is transmitted.

TX End Delay
Corresponds to the delay from the time that a meter stops sending data and the time that the RTS line is de-asserted.

Turnaround Delay
Corresponds to the delay from the time that a meter finishes receiving a command and asserts RTS to begin transmitting a reply. Allows the master station time to turn off its own transmitter.

3. Click OK to accept the Serial port setup.

4. The next step is to configure the DNP-specific parameters and assign meter registers for DNP queries. Go to the Meter Settings | Protocols menu, and the following screen will appear.



5. Now configure the parameters at the top of the screen. The following paragraphs define these fields.

Write Time Interval
This field sets up a time synchronization request. The number of minutes between time sets requested from the master is specified here. Zero (0) means that no time sets will occur.

Data Link Confirm Timeout

Time (in milliseconds) to wait for master Data Link confirm of the last frame sent before doing retries (only if frame sent with confirm requested).

Data Link Confirm Retries
The number of times the meter will re-transmit a confirmed data link frame before aborting the transaction.

Application Confirm Timeout
Required for multi-fragment responses or event data.
Note: If Application Layer Confirms is used with Data Link Confirms, ensure the Application Layer Confirm Timeout is set long enough for all data link retries to complete. The following formula describes this requirement:

Application Confirm Timeout > Data Link Confirm Timeout * (Data Link Retries + 1)

Time Set Tolerance
This field sets the sensitivity of the meter to time set operations. If the master performs a time set that causes a change in the meter's time of less than the number of seconds entered here, it is not recorded in the meter's Load Profile. This feature prevents Load Profile from being filled with time set events when regular time synchronizations occur.

Class 0 Counter Type: Running Object 20
Checking this field causes all of the meter's working (i.e. displayed) register values to be included in a Class 0 data poll.

Class 0 Counter Type: Frozen Object 21
Checking this field causes all of the meter's frozen register values (as of the last Register Freeze event) to be included in a Class 0 data poll.

Data Link Confirm Mode
Determines whether the master sends a data link confirm of the last frame sent. The choices are: Always, Sometimes, or Never. Sometimes means only on multiframe fragments.

Frozen Counter Events
Configurable as YES or NO. If YES, the meter will create a frozen counter event (Object 21 var 9) whenever an internal register freeze occurs. The scanning period is fixed at 5 seconds.

Analog Input Variation
Analog Inputs can be configured as 32-bit analog input without flag (object 30 Var 3) points, or 16-bit analog input without flag (object 30 Var 4) points. Refer to Appendix A for the complete list of points.

Restrict Counters to <N> Digits
A meter register configured as a DNP Counter point may contain a value as large as 999,999,999 (nine digits). Some DNP master devices cannot accept counter values this large. You may use this field to configure a meter to restrict the reported value of Counter points to 3, 4, 5, 6, 7, or 8 digits, or allow the full 9-digit precision to be reported.

Restricting the number of digits reported affects only DNP counter points, not the actual display registers.

6. The bottom half of the screen is used to configure which data will be sent to the DNP Master. Since the DNP data usually depends upon your Display Register settings, the display registers (Normal and Alternate) should be configured before proceeding with DNP. Once the display registers are determined, fill in these columns from left to right.

Point #
There are 64 DNP "points" sent during a communication session, numbered 0 – 63. You can arrange the sequence of your transmitted data by assigning the first data to point 0, next to point 1, etc.

Register Set
This determines which meter register group will be used to assign data to the DNP point. The choices are:

- **Unused** (default setting): Instructs DNP that no data is sent related to this point number.
- **Normal:** Takes data from one of the 50 Normal display registers.
- **Alternate:** Takes data from one of the 50 Alternate display registers.
- **Internal:** Takes data from one of the 49 factory-assigned Internal registers; see Appendix A for descriptions of the assigned quantities.

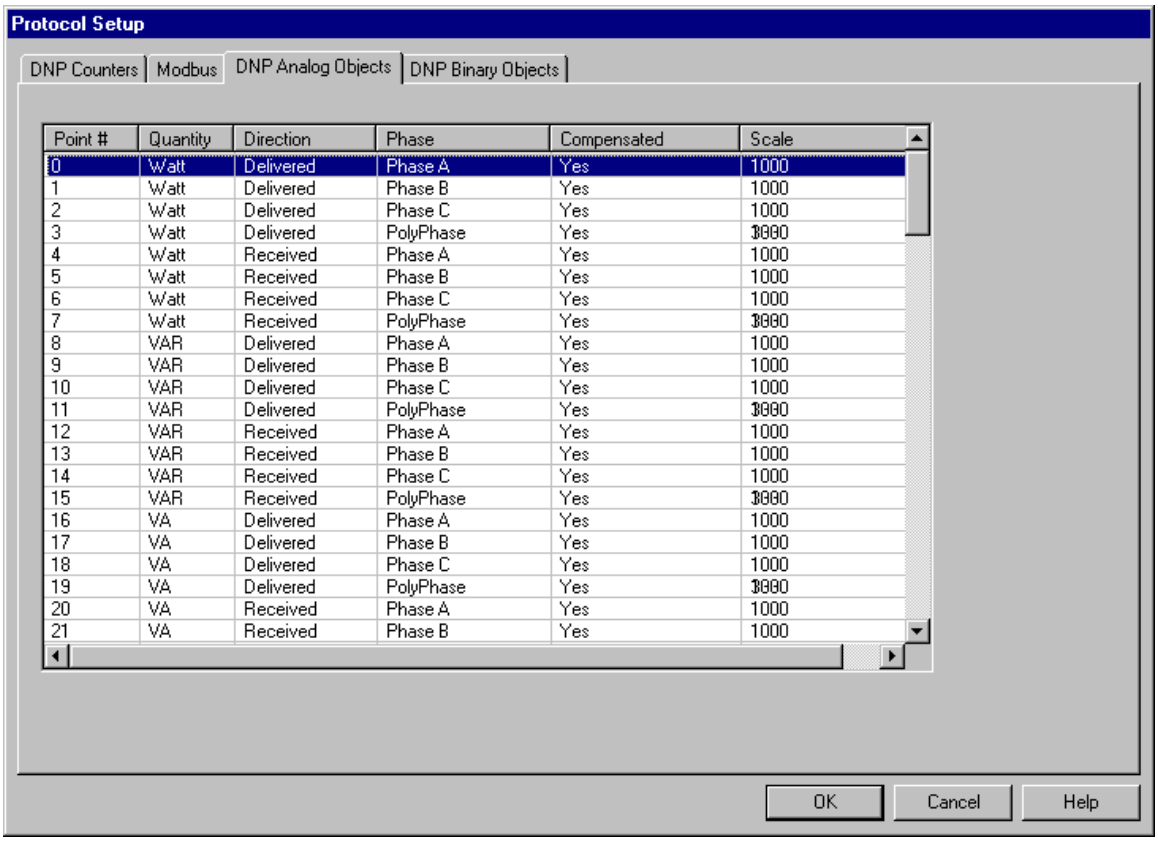
Register ID & Description
Select the ID number and description of the register that you want to associate with the DNP point. Valid register numbers are:

Normal display registers: 0 – 99
Alternate display registers: 100 – 199
Internal DNP registers: 0 – 10 (see Appendix A)

Scale
Enter a positive numeric value. The value of the display register associated with this point will be multiplied by this scale value when it is transmitted.

Meter display registers can have up to 3 decimal places, but DNP deals only with integer numbers. To transmit a register value with 3 decimal places, it is necessary to multiply it by 1000 first.

7. Select the DNP Analog Objects tab to set up your DNP Analog objects. Fill in the columns for each point from left to right.



Point #	Quantity	Direction	Phase	Compensated	Scale
0	Watt	Delivered	Phase A	Yes	1000
1	Watt	Delivered	Phase B	Yes	1000
2	Watt	Delivered	Phase C	Yes	1000
3	Watt	Delivered	PolyPhase	Yes	1000
4	Watt	Received	Phase A	Yes	1000
5	Watt	Received	Phase B	Yes	1000
6	Watt	Received	Phase C	Yes	1000
7	Watt	Received	PolyPhase	Yes	1000
8	VAR	Delivered	Phase A	Yes	1000
9	VAR	Delivered	Phase B	Yes	1000
10	VAR	Delivered	Phase C	Yes	1000
11	VAR	Delivered	PolyPhase	Yes	1000
12	VAR	Received	Phase A	Yes	1000
13	VAR	Received	Phase B	Yes	1000
14	VAR	Received	Phase C	Yes	1000
15	VAR	Received	PolyPhase	Yes	1000
16	VA	Delivered	Phase A	Yes	1000
17	VA	Delivered	Phase B	Yes	1000
18	VA	Delivered	Phase C	Yes	1000
19	VA	Delivered	PolyPhase	Yes	1000
20	VA	Received	Phase A	Yes	1000
21	VA	Received	Phase B	Yes	1000

Point #
There are up to 120 DNP Analog "points" sent during a communication session, numbered 0 – 119. You can arrange the sequence of your transmitted counter data by assigning the first data to point 0, next to point 1, etc.

Quantity
For each DNP Analog point you must select a measurement quantity. You may choose from Watt, VAR, VA, Q, Amp, Volt, Amp Squared, Volt Squared, PF, Frequency, Volt THD, and Amp THD.

If you want to limit the number of DNP Analog points in the meter to less than 120, enter only the points you need and set the rest to Unused.

Direction
For each DNP Analog point you must select a Direction. For Watt, VAR, VA, PF, and Q quantities you may choose from Delivered, Received, or Bidirectional. Delivered and Received quantities are always positive, while Bidirectional quantities may be positive or negative depending on power flow. VAR measurements may also be selected to be from a single quadrant: Q1, Q2, Q3, or Q4. All single quadrant values are positive.
For "directionless" quantities such as Volt, Amp, Volt Squared, Amp Squared, Frequency, or THD the Direction setting is ignored and should be set to "N/A."

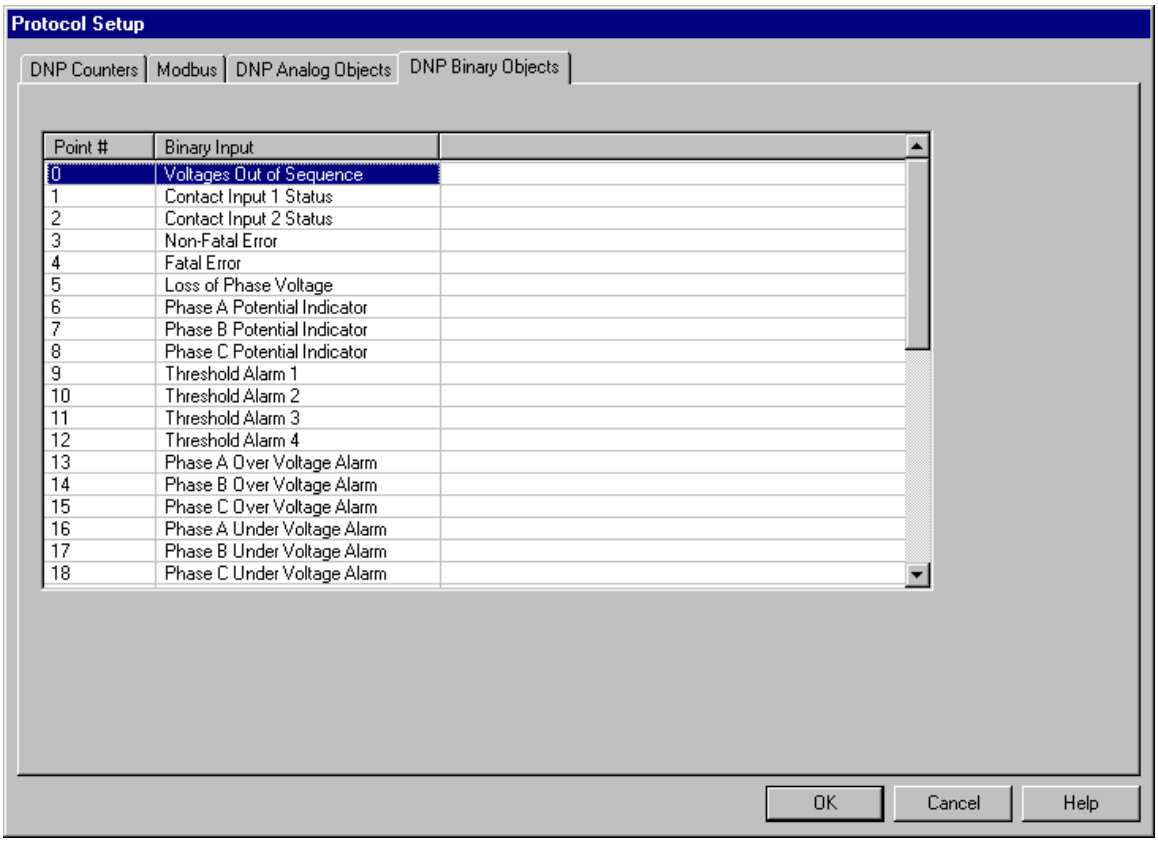
Phase
For each DNP Analog point you must select a Phase. You may choose from Phase A, Phase B, Phase C, or Polyphase. If the Analog point quantity is Frequency, the phase is

ignored. (Meters always measure frequency on Phase A.) If the Analog point quantity is Amps, you may also choose a phase of Neutral.

Compensated
For each DNP Analog point you must select whether to send a Compensated or Uncompensated value. Loss Compensation is available on any Watt, VAR, VA, Q, or PF quantity. For any other quantity, this setting is ignored.

Scale
Enter a positive numeric value. For 32-bit analog points (Object 30 Var 3) the value of the analog quantity (in secondary units) associated with this point will be multiplied by this scale value when it is transmitted. This allows analog values to be scaled to read in primary units.

8. Select the DNP Binary Objects tab to set up your DNP binary objects. Fill in the Binary Input column for each point.



Point #
There are up to 40 DNP binary "points" sent during a communication session, numbered 0 – 39. You can arrange the sequence of your transmitted counter data by assigning the first data to point 0, next to point 1, etc.

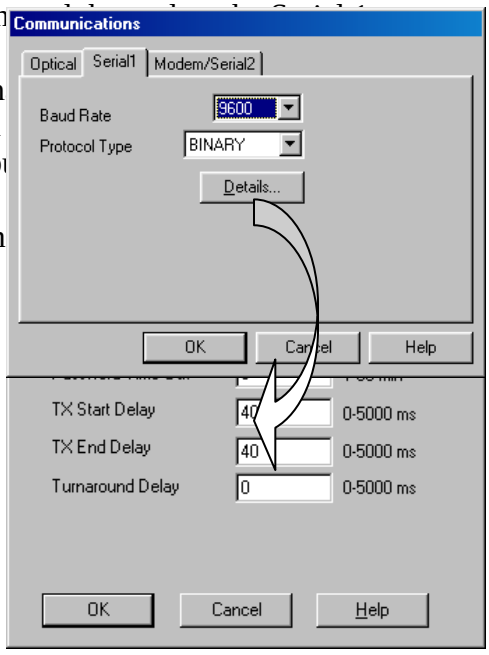
Binary Input
For each DNP binary point, you must select a binary input assignment. You may select from the following inputs:

- Contact Input 1 status
- Contact Input 2 status
- Voltages out of sequence alarm
- Neutral over current alarm
- Neutral current swell alarm
- Phase C under current alarm
- Phase C over current alarm
- Phase C power reversed alarm
- Phase C PF high alarm
- Phase C PF low alarm
- Phase C voltage sag alarm
- Phase C under voltage alarm
- Phase C voltage swell alarm
- Phase C over voltage alarm
- Phase B under current alarm
- Phase B over current alarm
- Phase B power reversed alarm
- Phase B PF high alarm
- Phase B PF low alarm
- Phase B voltage sag alarm
- Phase B under voltage alarm
- Phase B voltage swell alarm
- Phase B over voltage alarm
- Phase A under current alarm
- Phase A over current alarm
- Phase A power reversed alarm
- Phase A PF high alarm
- Phase A PF low alarm
- Phase A voltage sag alarm
- Phase A under voltage alarm
- Phase A voltage swell alarm
- Phase A over voltage alarm
- Threshold Alarm 1
- Threshold alarm 2
- Threshold alarm 3
- Threshold alarm 4
- Phase A potential status
- Phase B potential status
- Phase C potential status
- End of Demand Interval
- Phase Potential Lost
- Fatal Error
- Non-fatal Error
- Unused

If you want to limit the number of DNP binary points in the meter to less than 40, enter only the points you need and set the rest to Unused.

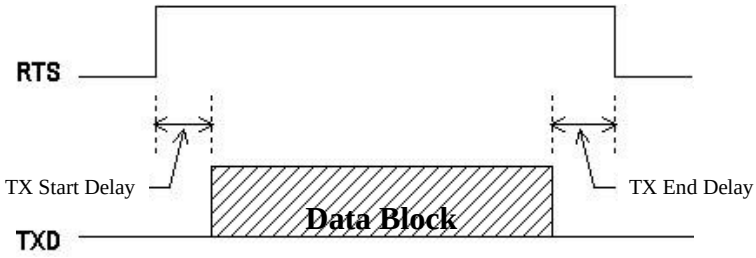
To configure the MODBUS option:

1. Start by setting up a communication port for Modbus. Determine whether you will use the Serial 1 or (optional) Serial 2 port. You can set up one or two Modbus ports per meter. Go to Meter Settings | Serial Communication
Serial 2 tab.
Choose the baud rate from the pull-down box that m
communication port (a meter is always considered a
Type from Binary to either Modbus ASCII or Modbu



2. Click the Details button to configure the followin
Network Address: Several meters can be networked together if they are equipped with the CommRepeater option. Assign a unique number for each meter connected on a network. *Use only address numbers from 0 – 254 with Modbus*. If this is a single meter-to-master connection, use the default address 1.
Password Timeout: Once communication commands have ceased, a timeout cycle will begin. Assign an amount of time that the meter will wait before the active session times out. Once a timeout takes place, you must re-enter the meter password before communications can continue.

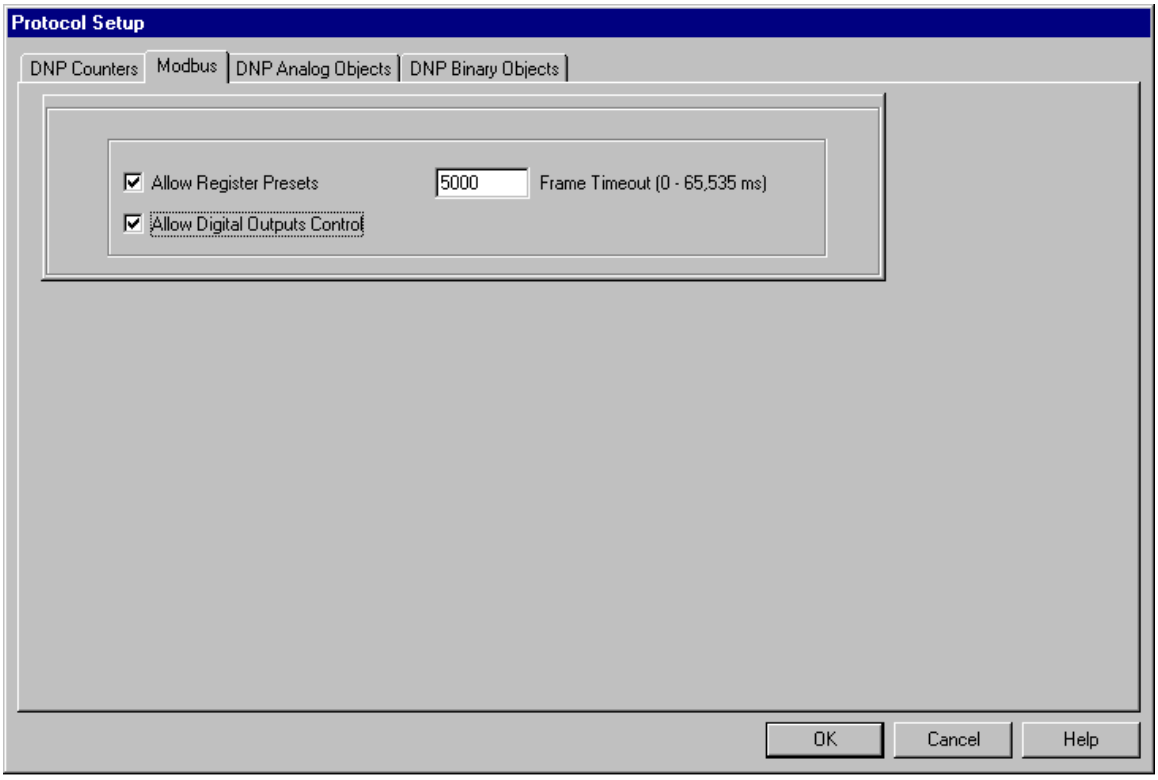
TX Start Delay / TX End Delay / Turnaround Delay: Certain parameters are required for radio-modem applications that use the RS-232 Request To Send (RTS) handshaking signal. If a meter is not used in such applications, simply set the TX Start and TX End delays to 0 ms.



TX Start Delay
Corresponds to the delay between the time that the RTS line is asserted and the time that the data is transmitted.
TX End Delay
Corresponds to the delay from the time that a meter stops sending data and the time that the RTS line is de-asserted.
Turnaround Delay
Corresponds to the delay from the time that a meter finishes receiving a command and asserts RTS to begin transmitting a reply. Allows the master station time to turn off its own transmitter.

3. Click OK to accept the Serial port setup.

4. The next step is to configure the Modbus-specific parameters. Go to the Meter Settings | Protocols menu, and click on the "Modbus" tab at the top of the screen. The following page will appear.



5. Now configure the parameters at the top of the screen. The following paragraphs define these fields.

Allow Register Presets
Check this box if you want the meter to be able to receive and process register preset data from the Modbus Master.

Frame Timeouts
Select the amount of time that the meter's Modbus port will wait to complete a query from the Master before it times out. A timeout begins as soon as there is no data flow, and continues for the user-specified time. If a command is not completed when the port times out, the Master must initiate a new command.

Allow Digital Outputs Control
The Modbus port can be used by the Master to drive any of the meter's four digital outputs. There are four discrete points in the Modbus implementation, corresponding to meter contact outputs 1 thru 4. The outputs may be controlled via Modbus Functions 05 and 15.

To set up a Contact output for Modbus control:

1. Click the check box "Allow Digital Outputs Control" in the above screen.
2. Go to the Meter Settings / Contact Input/Output menu. Choose which Output Channels (1 - 4) you want to assign as Modbus-controlled. Use the drop-down list and set it for "Not Used".

Note: The Meter will return the Modbus "Illegal Function" exception to the Master if the outputs are not set properly.

Output point list:

MODBUS Address	PLC Address	Register Contents
REG 00	10001	Output Channel 1
REG 01	10002	Output Channel 2
REG 02	10003	Output Channel 3
REG 03	10004	Output Channel 4

Refer to **Appendix B** for further Modbus Register Mapping information.

Password Permissions

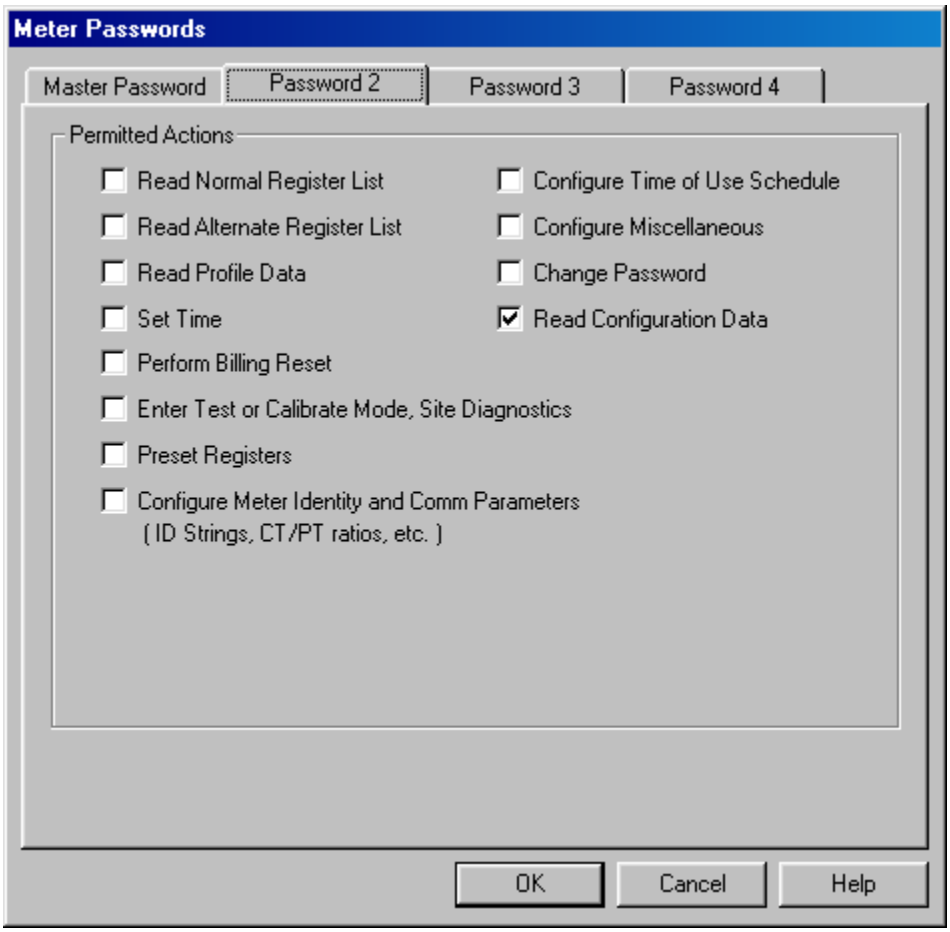
This menu selection associates a custom list of privileges to each Meter Password. The Meter Password is used to gain access to the meter, and should not be confused with the Login password (i.e.: Engineer and Technician levels) that is used to access the JEMWare program. Meter Passwords are *not* stored in the JEMWare configuration file, they are sent directly to the meter each time access is requested. The list of privileges associated with each Meter Password is stored in the .cfg configuration file.

Only the Master meter password will allow changes to privileges. If you use an incorrect password level to perform a download, you will receive an error message.

Master Password
The Master password provides access privileges for all program features. *The password must be exactly 6 alphanumeric characters.* In order to change the privilege list for Password 2, 3, or 4, you must login to JEMWare using an Engineer level password.

Password 2, 3, 4
For Passwords 2 through 4, there is an associated list of features that can be selected. If the user attempts an operation not allowed by the current session password, that operation will fail and a failure status will be recorded in the Log for the user to view. Failed operations do not affect the success or failure of subsequent operations. *The password must be exactly 6 alphanumeric characters.* Any of the following features can be separately assigned to each Password (2,3,4).

- Read Normal register list
- Read Alternate register list
- Read Load Profile Data
- Set Time
- Perform Billing Reset
- Enter Test or Calibrate Mode
- Preset Registers
- Configure meter identity (ID strings, CT / PT ratios, etc.) and Comm parameters
- Configure TOU schedule
- Change the Password (for the *active* level only)
- Configure Miscellaneous (everything not listed above, except passwords)
- Read Configuration Data


Meter Passwords
Master Password
Password 2
Password 3
Password 4
Permitted Actions
Read Normal Register List
Read Alternate Register List
Read Profile Data
Set Time
Perform Billing Reset
Enter Test or Calibrate Mode, Site Diagnostics
Preset Registers
Configure Meter Identity and Comm Parameters
(ID Strings, CT/PT ratios, etc.)
Configure Time of Use Schedule
Configure Miscellaneous
Change Password
Read Configuration Data
OK
Cancel
Help

Loss Compensation

Transformer Loss Compensators are defined in the IEEE Standard Dictionary of Electrical and Electronic Terms (reference 1) to be:

> "A(n)… electric network that is connected in series-parallel with a meter to add or subtract from the meter registration active or reactive components of registration proportional to predetermined iron and copper losses of transformers and transmission lines."

Typically, power dissipated in the transmission lines and in the cores of transformers cannot be measured by meters connected to the transformer secondary circuits. The technique of Transformer-Loss Compensation has been developed over the years to electrically or computationally account for the lost active and reactive power.

A set of equations has been derived which describes the amount of active (Watts) and reactive (VARs) power lost due to both copper and iron effects.

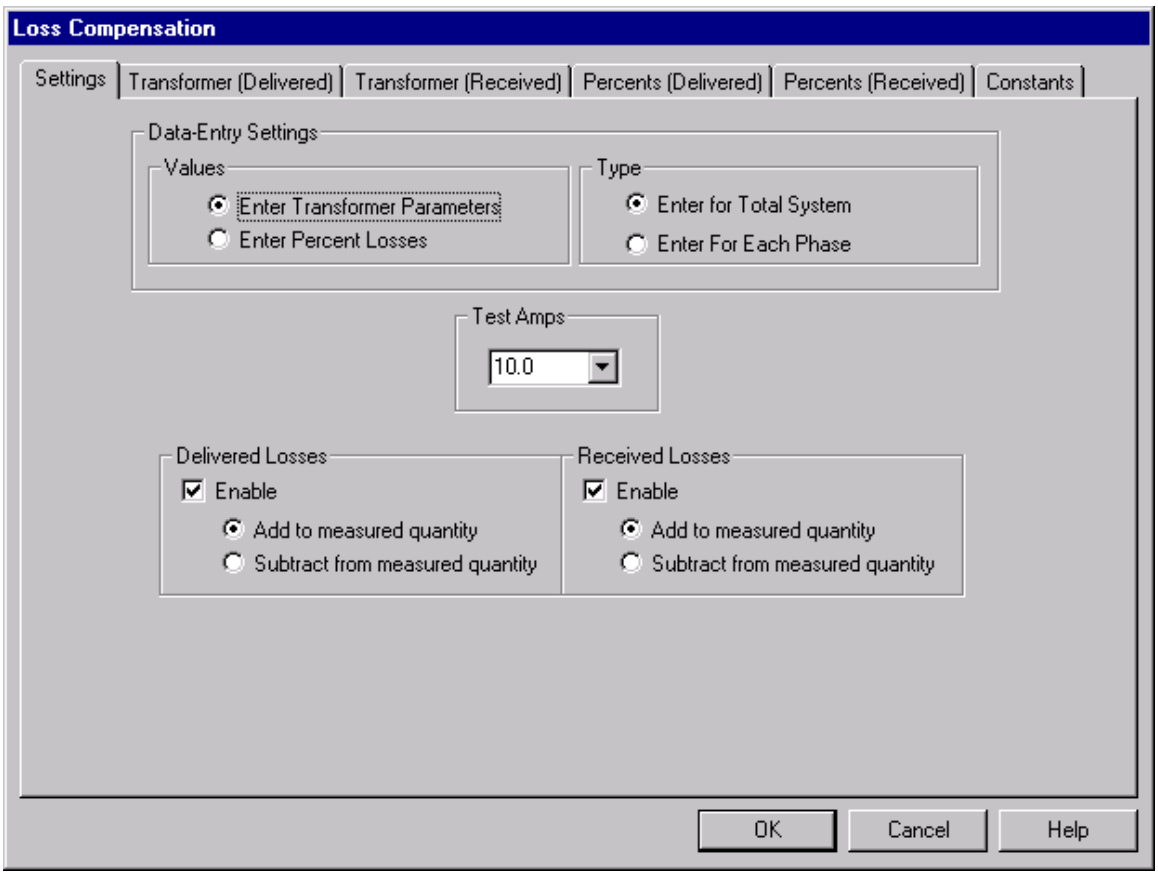
Loss Compensation in the meter is a mathematical method used to determine the amount of power loss in a transformer and power lines. This is a significant factor when you are using the meter to measure a large load (secondary side), and the utility billing point is prior to the transformer (primary side). Transformer losses such as hysteresis and eddy currents will affect the reading obtained at the meter, and create a deviation from the utility reading.

Power transformers are tested for losses by the manufacturer prior to shipping, and test results are usually provided for each transformer. You will need specific data concerning the transformers involved. If specific test reports are not available, you may be able to obtain information from the transformer data plate.

When the proper information is entered on the Loss Compensation screen, the meter will calculate and add or subtract the transformer and line losses to the actual reading at the meter. The resultant output of the meter will accurately reflect the amount of power used prior to the transformer. Loss Compensation is an optional configuration and can be enabled or disabled at any time.

Using Loss Compensation

Choose the Loss Compensation menu, and the following screen will appear.



You will notice there are six separate pages:

Settings allows you to select the way by which you will enter transformer loss data.

Transformer (Delivered) is used to configure power sent to a load by entering transformer data. These values are typically *added* to the measured Watts and VARs (although JEMWare permits adding or subtracting). If "Enter Percent Losses" is selected on the Settings page, this page is left blank.

Transformer (Received) is used to configure power received from a load by entering transformer data. These values are typically *subtracted* from the measured Watts and VARs (although JEMWare permits adding or subtracting). If "Enter Percent Losses" is selected on the Settings page, this page is left blank.

Percents (Delivered) is used to configure power sent to a load by entering the percentage of compensation required at the Test Amps value selected on the Settings page. If "Enter Transformer Parameters" is selected on the Settings page, this page will display a summary of the loss percentages calculated from transformer data.

Percents (Received) is used to configure power sent to a load by entering the percentage of compensation required at the Test Amps value selected on the Settings page. If "Enter Transformer Parameters" is selected on the Settings page, this page will display a summary of the loss percentages calculated from transformer data.
Constants is used for factory reference and troubleshooting only.

Setting up Loss Compensation

A. Select the Settings page.

B. If you want to enter transformer data, select Enter Transformer Parameters. If you want to enter loss percentages directly, select Enter Percent Losses.

C. If you want to enter a single set of Transformer data or loss percentages that will apply to all phases, select Enter Total System. If you want to enter loss data for each phase individually, select Enter For Each Phase.

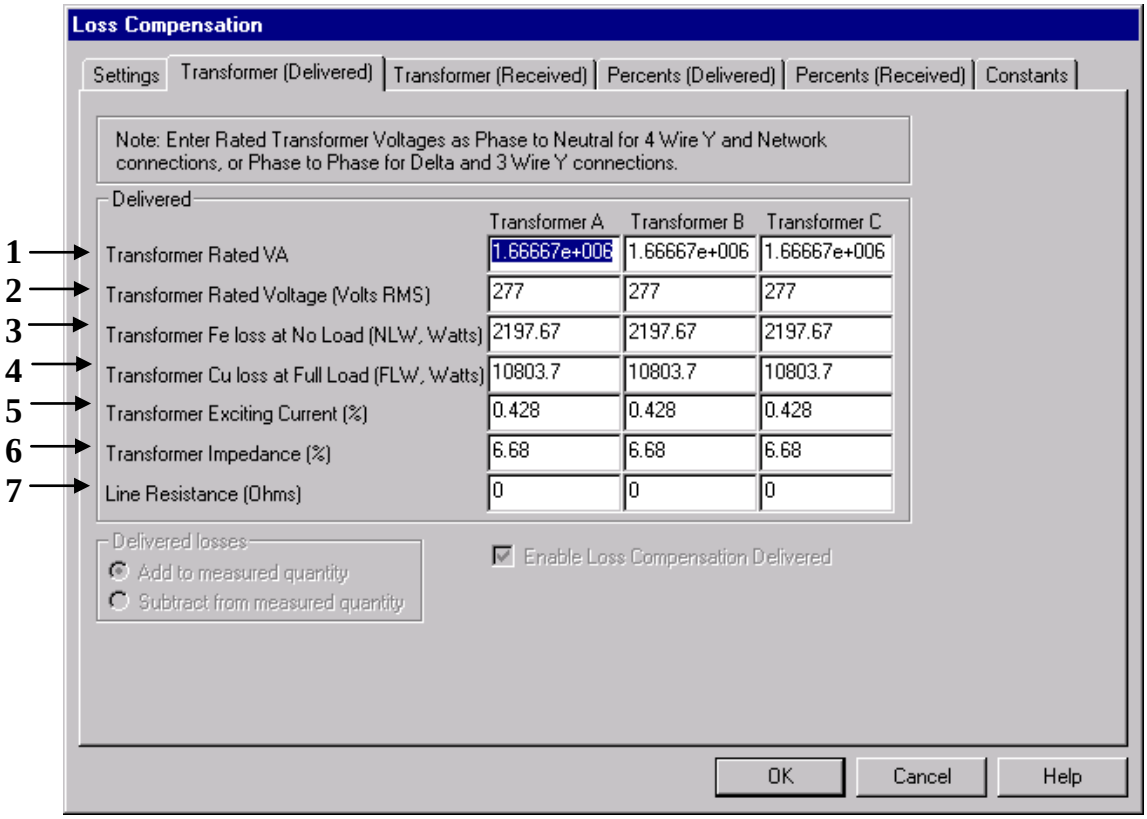
D. At Test Amps, select the test current at which percent losses will be entered or displayed.

E. If you want to compensate Delivered power flow, select Enabled under Delivered Losses and choose whether to add or subtract compensation from measured quantities. If you want to compensate Received power flow, select Enabled under Received Losses and choose whether to add or subtract compensation from measured quantities.

If you selected Enter Transformer Parameters:

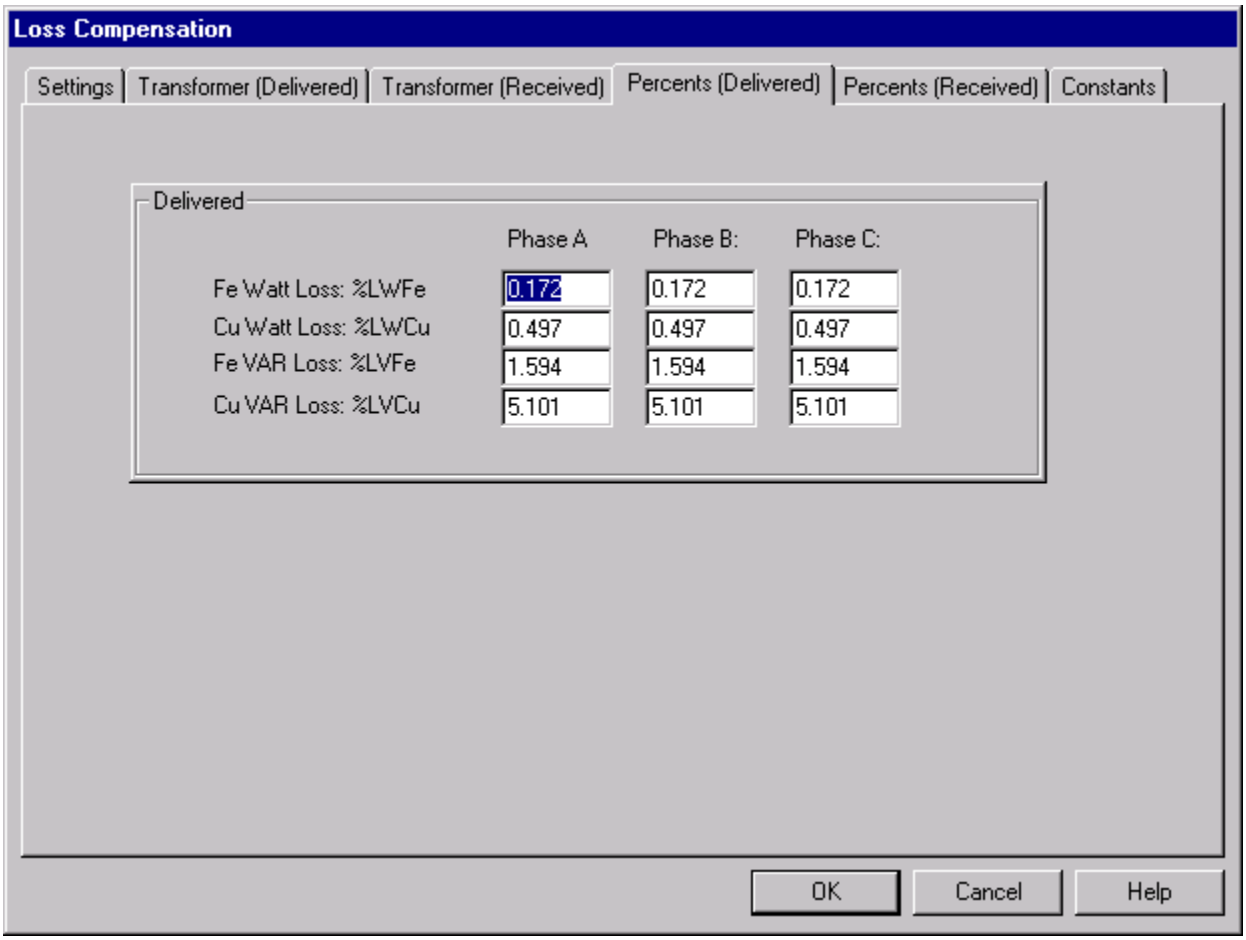
A. Select the Transformer (Delivered) or Transformer (Received) page as shown, depending upon power flow.

B. Enter the appropriate data in the three columns of edit fields labeled **Transformer A, B,** and **C**. Transformer rating information for items 1 through 6 should be taken from the transformer test data sheet (see the following example), or transformer rating plate. Each value to be entered is *per phas*e if you selected Enter for Each Phase on the Settings page. Use separate values for individual transformer units. If your transformer test data sheet provides data for the entire multi-phase transformer bank, or if a common core 3-phase transformer is used, select Enter Total System on the Settings page and enter the values in the fields indicated.



1. **Transformer Rated VA:** VA rating of the transformer tap used. This is a PER PHASE value, not the VA rating of the entire 3-phase bank or common core transformer. Data must be entered as VA (not kVA). In the following example, the total is 27,000,000VA. Divide the total by three phases and enter 9,000,000 in each field of the screen above. When you click OK to accept the entries, the number is displayed exponentially.
2. **Transformer Rated Voltage (Volts RMS):** Rated voltage of the transformer. Use line to neutral voltage for 4-wire Wye (Forms 6 and 9), or 3-wire Network (Form 5 meter configured for network) services. Use line to line voltage for 3-wire and 4-wire Delta, and 3-wire ungrounded Wye services (Form 5 meters configured for Delta, Open Delta, or 3-wire Wye).
3. **Transformer Fe loss at No Load:** PER PHASE no load loss watts at rated voltage. This represents the watts loss due to the transformer core.
4. **Transformer Cu loss at Full Load:** PER PHASE loss watts at rated voltage and rated VA. This represents the watts loss due to the transformer windings.
5. **Transformer Exciting Current:** % exciting current at rated voltage expressed as a percentage of the rated VA. This represents the VA loss due to the transformer core.
6. **Transformer Impedance:** % impedance at rated voltage and rated VA expressed as a percentage of rated VA. This represents the VA loss due to the transformer windings.
7. **Line Resistance:** Enter the total DC resistance (in ohms) of the lines between the transformer secondary and the CT primary. Note: The Line Loss entry is not required for JEMWare to calculate Transformer Loss Compensation.

If you selected Enter Percent Losses:

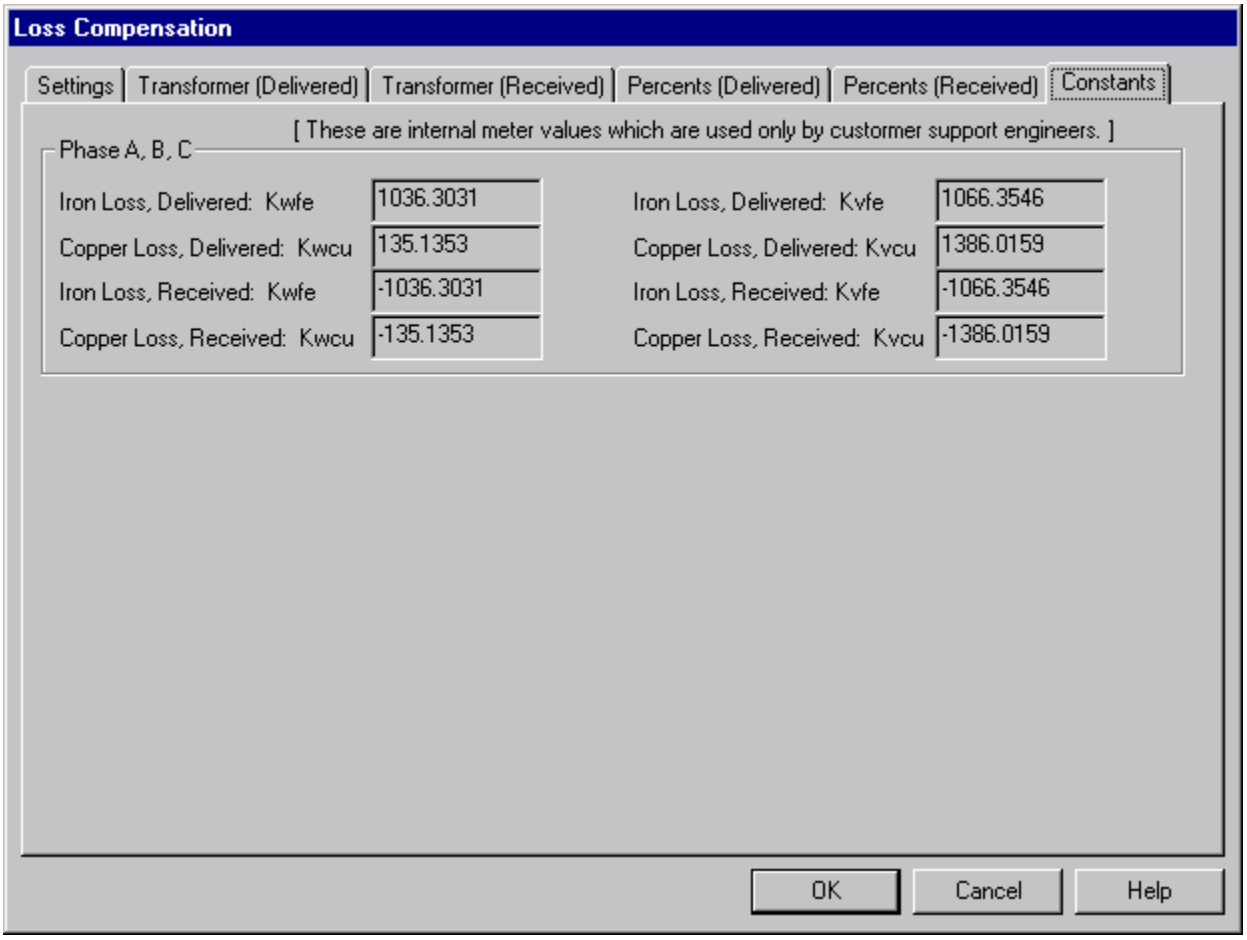


A. Select the Percents (Delivered) or Percents (Received) page as shown above, depending upon power flow.

B. Enter the desired percent Watt Iron (Fe), Watt Copper (Cu), VAR Iron, and VAR Copper losses in the fields indicated. Enter the percentages desired when the meter is operating at the Test Amps selected on the Settings page and the Nominal Voltage entered on the Primary Configuration screen.

If you selected Enter Transformer Parameters on the Settings page, this page will only display the percentages calculated from the transformer data entered elsewhere. It will not allow changes to be made to the displayed values.

For either loss entry method:



The Constants page displays calculated values that are used only for factory reference purposes. No changes may be made on this page.

TYPICAL TRANSFORMER DATA SHEET

Thomas Edison Power Transformer Company

Purchaser Generic Electric & Gas Co.
Date of Test 04-20-99 Purchaser's Order No. P1230127 G.O. NA30722 S.O. SLM5409

Type OA/FA/FA Core Phase Three Hertz 60 Insulating Fluid Oil L. Spec. SLM5409-08 Polarity See I.P.

Winding H.V. Winding L.V. Winding
KVA 27000/36000/45000 KVA 27000/36000/45000 KVA
Voltage 230000 Voltage 13800Y/7967 Voltage

1. For polarity, additional tap voltages and connections, see Instruction Plates SLM5409-10 and SLM5409-11

RESISTANCES, EXCITING CURRENT, LOSSES AND IMPEDANCE---Based on normal rating, unless otherwise stated. Losses and regulation are based on wattmeter measurements. For three phase transformers, the resistances are the sum of the three phases in series.

SERIAL NO	RESISTANCE IN OHMS AT 85°C WINDINGS H.V.	L.V.		% EXCITE CURRENT AT 100 % RATED VOLTAGE	NO LOAD LOSS WATTS AT 100 % RATED VOLTAGE	230-0 kV TO 13.8 kV 27000 kVA Load Loss Watts 85°C	% IMP 85°C	kV TO kV kVA Load Loss Watts 85°C	% IMP 85°C	kV TO kV kVA Load Loss Watts 85°C	% IMP 85°C
SLM540	18.009	0.0171		0.353	23884	74837	14.49				
						TOTAL LOSS	% IMP 85°C	TOTAL LOSS	% IMP 85°C	TOTAL LOSS	% IMP 85°C
AVERAGE				0.353	23884	98721	14.49				
GUARANTEE				0.340	28200		15.00				

REGULATION AT 85°C		100% PF	% PF	80% PF	% PF
	AVERAGE	1.319		9.513	
	GUARANTEE	1.390		9.910	

TEMPERATURE RISE---Average rise in degrees C, corrected to instant of shutdown of transformer.

Serial No. SLM54091 (Duplicate unit built on same S.O.) with windings connected and loaded as follows:

H.V. Winding 218.500 kV 71.3 Amp.; L.V. Winding 12.506 kV 1246.2 Amp.

Winding kV Amp. until constant temperature rise was reached.

LOAD CONSTANT	RISE OF WINDINGS BY RESISTANCE H.V.	L.V.		GUARANTEE	TOP FLUID RISE	AMBIENT TEMP. INGOING WATER	IDLER OR ROOM	WINDING HOT SPOT RISE H.V.	L.V.	
100%	34.3	39.1		65	37.8		21.8	42.4	47.2	
167%	42.4	50.3		65	43.3		21.8	52.0	59.9	
222%	67.2	79.5			69.0		24.5	78.7	91.0	

INSULATION TESTS	WINDING	VOLT RATING	TEST VOLTAGE APPLIED IN kV	DURATION OF TEST IN SECONDS
APPLIED POTENTIAL TESTS	H.V.	230000	325	60
(Voltage applied between each winding and all other	L.V.	13800	34	60
windings connected to core and ground.)	Wiring, Fans		1.5	60

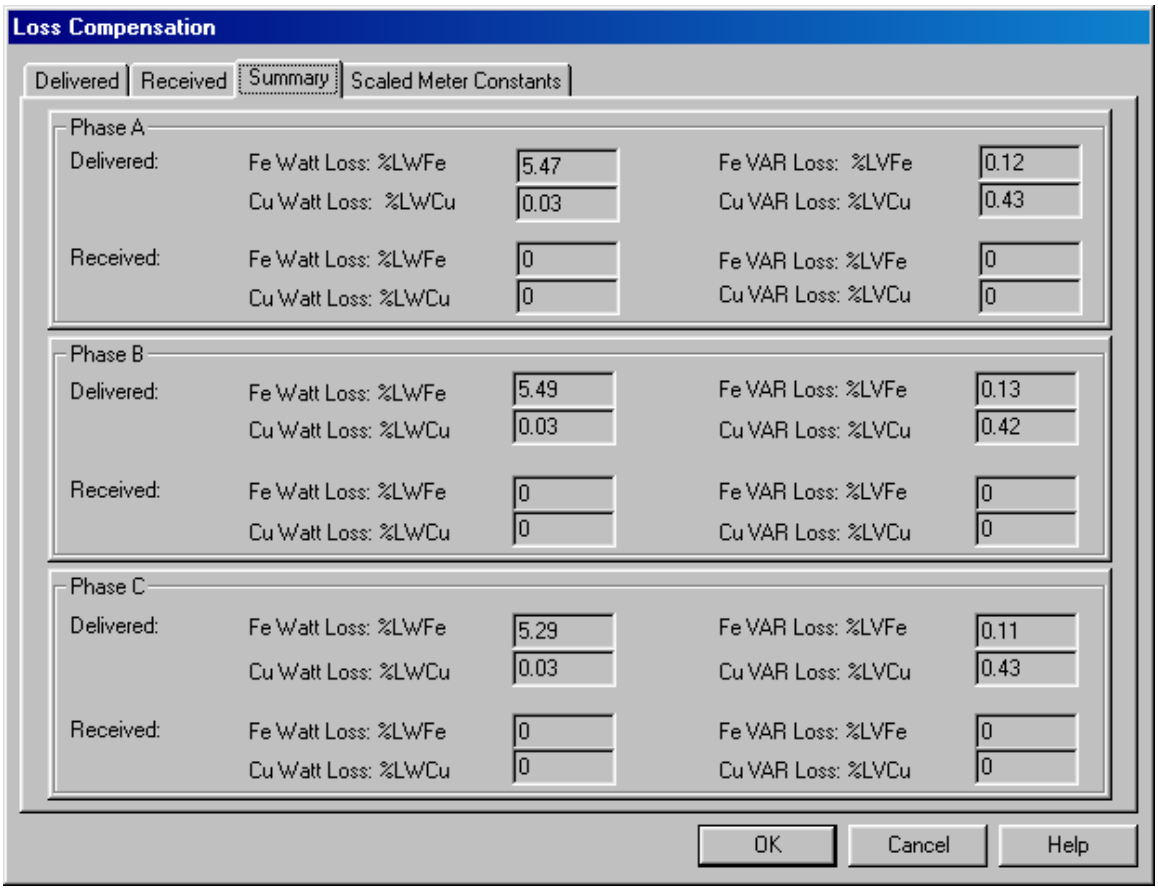
REMARKS: This transformer was subjected to, and successfully withstood the impulse and switching surge tests applied in accordance with the latest ANSI test codes. Copies of the oscillograms are on permanent file at the Manufacturer's Plant.

I hereby certify that this is a true report based on factory tests made in accordance with the latest Transformer Test Code of the ANSI Specifications.

Signed: John Smith Date: 05/08/99 Approved: L. Jones

A. Check the "Enable Loss Compensation Delivered (or Received)" box to turn on the Loss Compensation function.

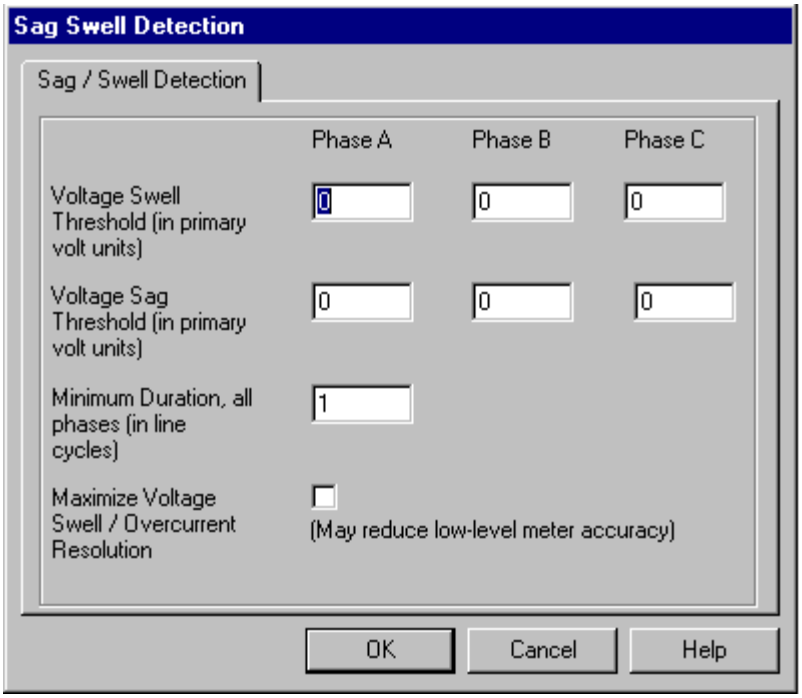
B. Refer to the Summary page shown below for loss calculations of each phase.



Note: The Scaled Meter Constants page is used for factory reference only.

Voltage Sag / Swell Detection and Logging

The meter has the ability to detect and record over- and under-voltage conditions on any voltage input on a cycle-by-cycle basis. The user may configure this feature using the Sag / Swell Detection screen:



Enter upper voltage limits for each phase in the Voltage Swell Threshold fields in primary volts. Voltages that go above these limits will be recorded as a Voltage Swell.

Enter lower voltage limits for each phase in the Voltage Sag Threshold fields in primary volts. Voltages that go below these limits will be recorded as a Voltage Sag.

For both Voltage Sag and Voltage Swell settings, keep in mind that the meter's secondary operating voltage range is 55 to 530 volts. Settings should be within those limits.

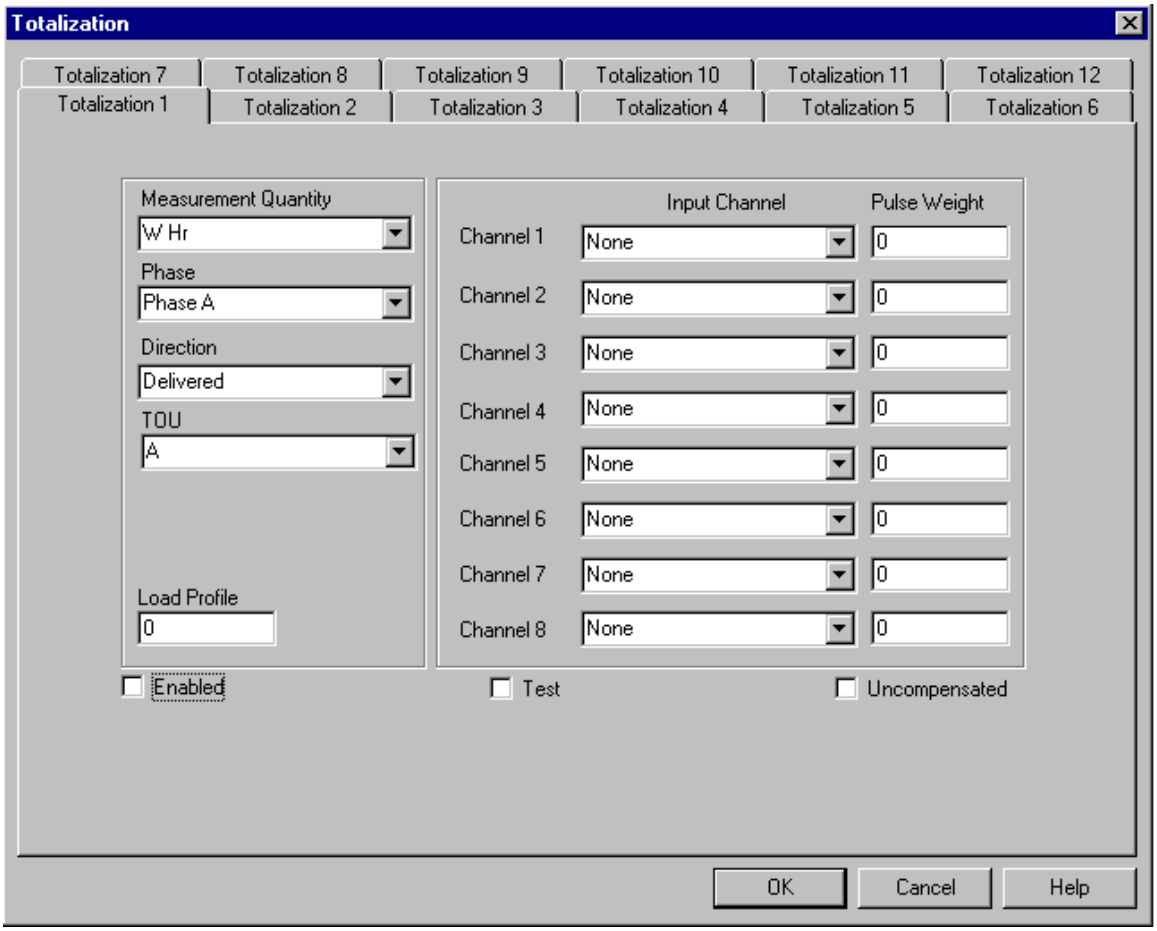
Enter the minimum duration, in line cycles, of events to be logged in the Minimum Duration field. Events that are shorter than this duration will be detected but not logged.

If it is important to accurately measure short-duration high voltages (i.e. voltage swells higher than 10% above the normal circuit voltage) or high currents (i.e. greater than 10% above the average current over the last few seconds), check the Maximize Voltage Swell / Overcurrent Resolution checkbox.

WARNING: Enabling the Maximize Voltage Swell / Overcurrent Resolution feature seriously degrades the accuracy of power and energy readings at low currents. See the Votlage Sag / Swell Detection and Logging section of the User Manual, JEMStar 1083-600 or Ci20 1086-381, for accuracy specifications while this feature is enabled.

Totalization (JEMStar)

The meter is able to add energy readings from external devices to Consumption measurements taken by the meter itself and display the result. To configure this feature, use the Totalization dialog:



There are twelve Totalization channels, each having a tab at the top of the screen. Choose the tab for the channel you wish to configure, and then enter the following information:

Measurement Quantity: Choose an integrated measurement from the pull-down list. This quantity will be measured directly by the meter and added to the Totalization channel's contents continuously.

If you want to display only energy measured outside the meter (i.e. only from external pulses), select "Zero."

Phase: Choose an input element (phase) or Polyphase for the total of all elements.

Direction: Choose a direction of power flow.

TOU: Choose a Time of Use rate period during which to accumulate energy, or Total to accumulate continuously.

Load Profile: If this Totalization channel is to be recorded in Load Profile, enter the Km value in primary units here.

Enabled: Check the box to activate this Totalization channel.

Input Channels: Eight input channels are shown for each Totalization channel to support future expansion. The meter currently supports two input channels. Choose the input channels you want added to this Totalization channel and the pulse weight (in primary units of the Measurement Quantity) to add for each pulse received on that channel.

NOTE: Enter a negative pulse weight if you want energy subtracted from the Totalization channel's total for each pulse received on that channel. Totalization channels always contain zero or a positive number, and will not roll under.

Different Totalization channels may share one or more Input Channels, but the Pulse Weight may be different.

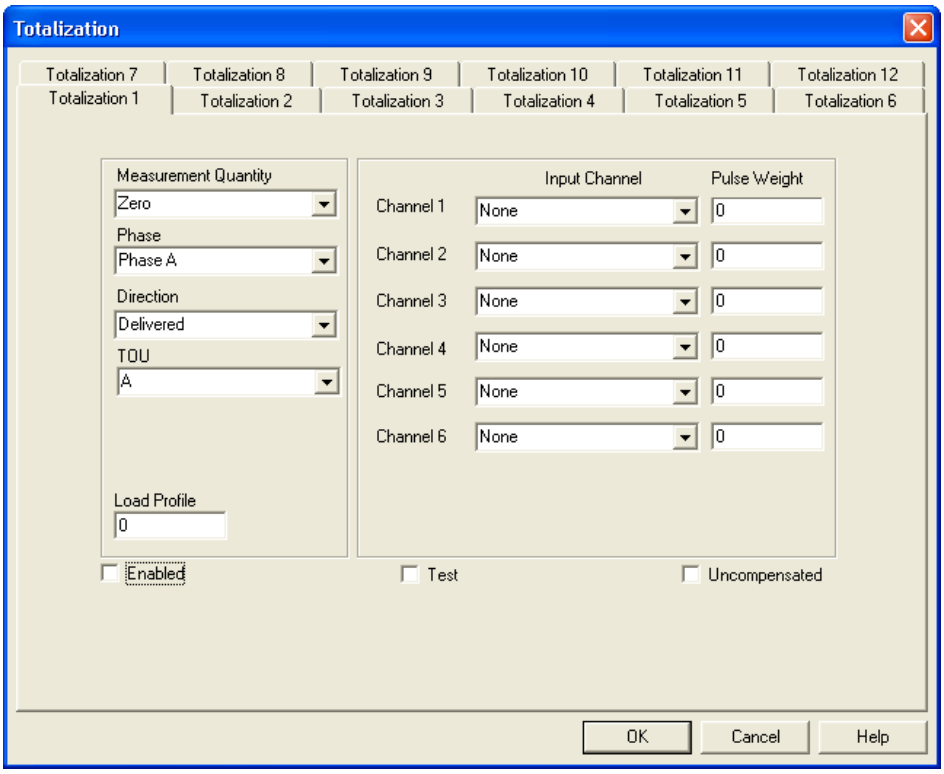
Test: Check the box if the Totalization channel is to be displayed in Test Mode. If this box is checked, this Totalization channel will not operate unless the emter is in Test Mode.

Uncompensated: If this box is checked the measurement quantity selected will not have Loss Compensation applied regardless of the Loss Compensation configuration. Contributions from external Pulse Input channels are never compensated.

TIP: Load Profile channels may not have a Time of Use rate associated with them, but Totalization channels may. If you require a Load Profile channel associated with a TOU rate, create a Totalization channel with no input channels and record it in Load Profile.

Totalization (Ci20)

The meter is able to add energy readings from external devices to Consumption measurements taken by the meter itself and display the result. To configure this feature, use the Totalization dialog:



There are twelve Totalization channels, each having a tab at the top of the screen. Choose the tab for the channel you wish to configure, then enter the following information:

Measurement Quantity
Choose an integrated measurement from the pull-down list. This quantity is measured directly by the Ci20 and added to the Totalization channel's contents continuously. If you want to display only energy measured outside the Ci20 (i.e. only from external pulses), select *Zero*.

Phase
Choose an input element (phase) or Polyphase for the total of all elements. When adding or subtracting the pulse energy from the input, chose whether the base measurement is a phase or polyphase measurement being summed.

Direction
Choose a direction of power flow.

TOU
Choose a Time of Use rate period during which to accumulate energy, or Total to accumulate continuously.

Load Profile
If you want to record this Totalization channel in Load Profile, enter the Km value in primary units here.

Enabled
Check the box to activate this Totalization channel.

Input Channels
Eight input channels are shown for each Totalization channel. Choose the input channels to add to this Totalization channel and the pulse weight (in primary units of the Measurement Quantity) to add for each pulse received on that channel. Enter a negative pulse weight if you want energy subtracted from the Totalization channel's total for each pulse received on that channel. Totalization channels always contain zero or a positive number. Ensure that your readings don't cause rollover if used in the Load Profile. Different Totalization channels can share one or more Input Channels and the Pulse Weight can be different.

Test
Check the box to display the Totalization channel in Test Mode. If this box is checked, this Totalization channel does not operate unless the meter is in Test Mode.

NOTE Load Profile channels may not have a Time of Use rate associated with them, but Totalization channels may. If you require a Load Profile channel associated with a TOU rate, create an additional Totalization channel with no TOU Rate selected and record it in Load Profile.

METER COMMUNICATION

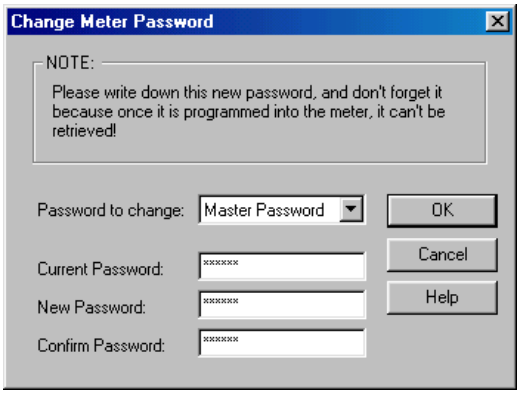
The Meter Communication menu is used to set up all the parameters necessary to talk with the meter. After you have created a configuration file for a meter (using the Meter Settings menus, previous), these items are used to transfer that configuration file to the meter.

This menu also includes functions for retrieving meter health and status information. Note that JEMWare does not retrieve Load Profile and other stored register data. You will need JEMRead or MV-90 software to perform those functions.

Meter Password

This menu is used to enter the six-digit Meter password, which is required to send and retrieve data. You must first establish a connection to the meter before you can enter the password (see the Connect menu). If you do not enter a password before a communication session, JEMWare will prompt you to enter it before data can be obtained. The Meter password can be configured or changed from the "Change Meter Password" menu item (as follows), but only if you are using the Master Password level.

Change Meter Password



This screen is used to actually program the meter's password. You must first establish a connection to the meter before you can enter the password (see the Connect menu). The password must be a 6-digit alphanumeric string.

Using the pull-down edit field, select either the Master Password or Password 2, 3, or 4. You can have up to four passwords, each with its own set of permissible features (see the Passwords/Permissions menu).

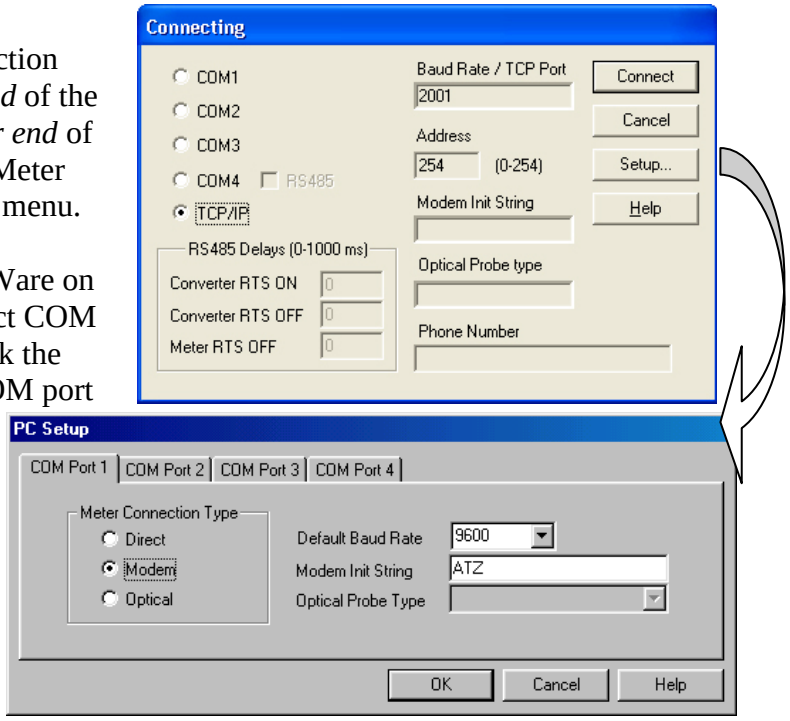
If this is a new meter, the factory-default password setting is 000000 (six zeros). Enter this in the Current Password box, then enter your custom password in the New Password and Confirm Password boxes and click OK.

Caution: If the Meter Password is lost, the only way to access the meter is to perform a Cold Start. *This will erase all data in memory* and return the meter to factory default settings.

To perform a cold start:

1. Remove power from the meter.
2. Simultaneously press the UP and DOWN arrow buttons while applying power to the meter, until a *meter* logo is displayed.

Connect



This menu establishes the connection parameters required at the *PC end* of the communications link. The *meter end* of the link is configured under the Meter Settings | Serial Communication menu.

If this is a first time use of JEMWare on your computer, choose the correct COM port (1 - 4) on your PC, then click the Setup button to configure the COM port parameters (See "PC Communication Setup" for further port instructions).

The computer's COM port will be recognized as RS232 communications unless you check the RS485 box. If you choose RS485, you will need to enter the appropriate delay times (in mS) as follows:

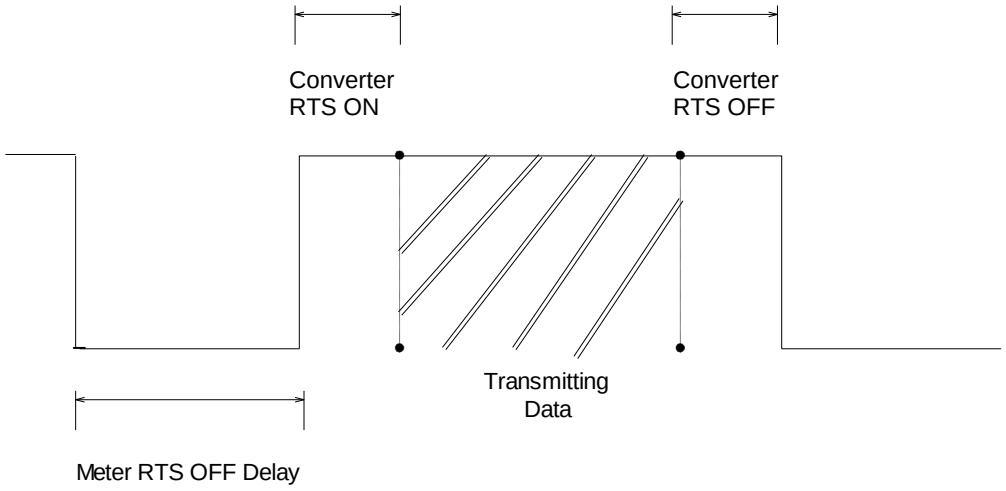
Converter RTS ON / OFF

The "Converter RTS ON" and "Converter RTS OFF" delay times depend on the model of your RS232-to-RS485 converter. Insert an ON and OFF delay time of 5 mS each if you are using the BlackBox™ converter that is available from Scientific Columbus. A different converter may require a different delay time. The appropriate delays should be defined in the documentation included with your converter.

Meter RTS OFF

The "Meter RTS OFF" setting pertains to the delay that is configured in the meter at this point. This is important; it is NOT the value that you intend to configure the meter for when you write a configuration to the meter. Therefore, you must know how the meter is already configured. The factory default setting for "Meter RTS OFF" is 20 mS. This will be your setting unless you have previously changed it.

The delays are necessary to allow proper timing of the transmitted data. In half duplex mode, the delay intervals are inserted to make sure that data going one direction does not interfere with data going the other direction.

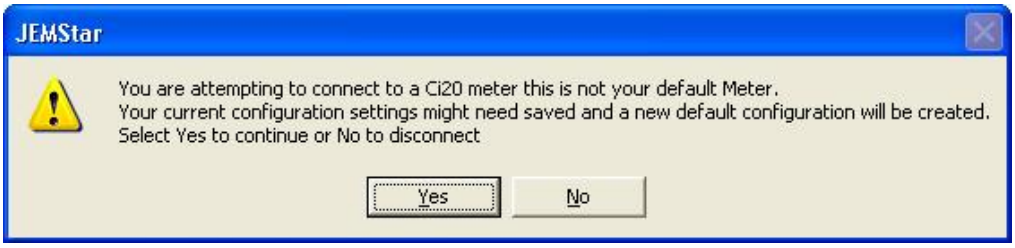


IMPORTANT: The "Converter RTS OFF" setting *must be less than* the "TX Start Delay" that is set in the Serial Communication menu for the meter. Communication errors may result if this is not configured correctly.

Once this has been done, click "Connect" to link your PC to the meter. You do not need to enter a Meter Password to connect, however you will be restricted from accessing data until a password is entered and accepted.

NOTE:

When you connect to a meter that is a different type from your configuration loaded (JEMStar or Ci20), the following error screen will appear. You will be prompted to either select Yes, ignoring the current configuration file and switching over to the other meter type or select No, to save the current configuration file and then switch over to the correct meter type.



Connecting to the meter over the Ethernet Interface

Any software that supports communication with a meter over an Ethernet interface will require at least the meter's IP address and port number. Some software may also give you a choice of using TCP or UDP protocols. In that case, always use TCP.

To connect using JEMWARE open the Meter Communication: Connect dialog.

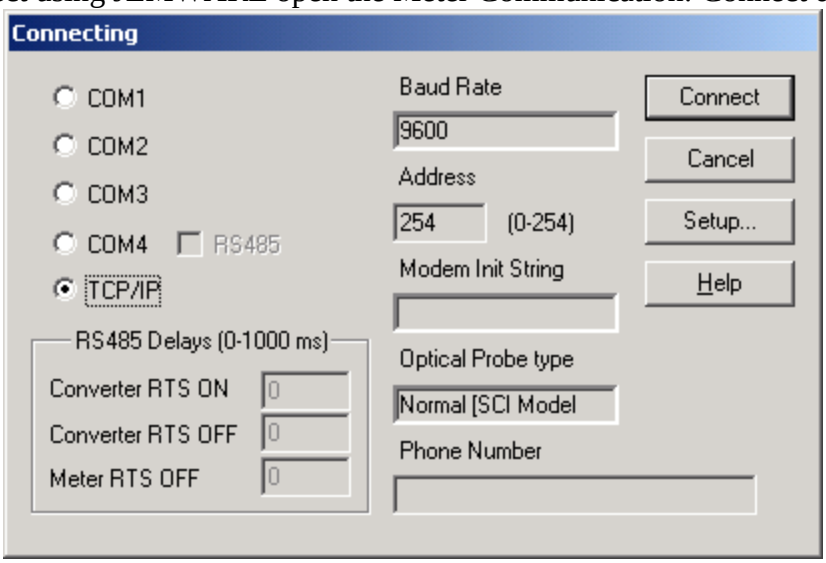


Figure 9: JEMWARE Connect dialog

Click the Setup button, then select the TCP/IP tab.

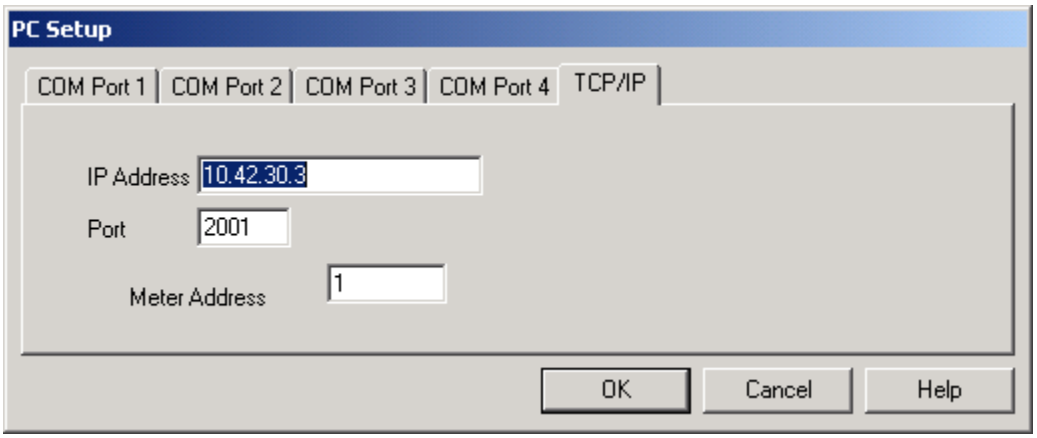


Figure 10: JEMWARE Ethernet connection settings

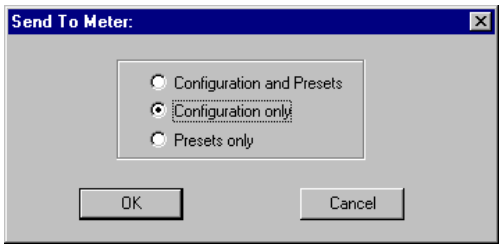
Enter the IP address, port number, and meter address (device address) of the Binary Protocol port on the meter you wish to contact. Click OK to go back to the Connecting dialog, then click Connect. After a moment you should see the typical Connection Status dialog. You may now perform whatever functions you'd normally do over a serial connection.

Validate Configuration

You can select this menu to make sure that there are no conflicts in the current configuration (.cfg) file. If there is a problem, an error message will appear and ask if you want to view the configuration details screen (see Details menu).

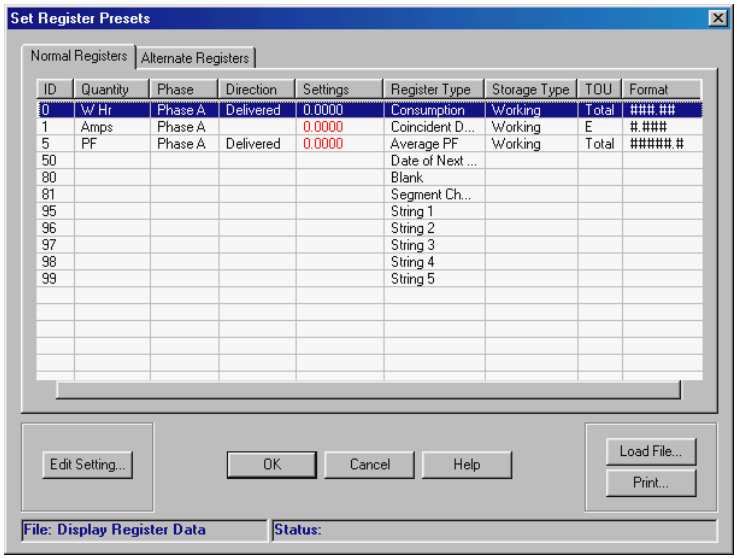
Note: *JEMWare* validates the configuration automatically when you perform a Write Meter command.

Write Meter Configuration



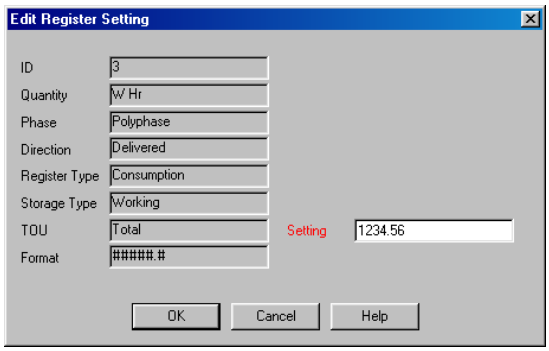
This selection is used to send the active configuration file to the meter. After you click on this menu choice, you must choose whether you want to send Configuration information, Preset register data, or both. When you click OK, JEMWare will begin to send the new configuration (if selected) to the meter.

Preset register values that have been stored on your PC (.pre file suffix) are sent to the meter by choosing "Presets" or "Configuration and Presets", which will display the following screen.



The register settings (Normal or Alternate) can be taken from previously read data, or they can be edited on this screen. When you send preset registers, JEMWare will compare the ID numbers and register types you are trying to send with the meter's existing Display Registers. If there are discrepancies, they will be reported as an error message.

Editing Presets

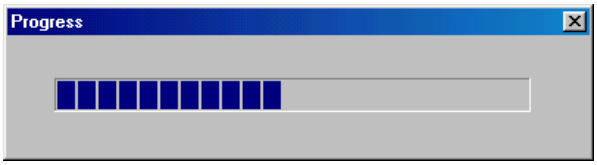


To preset a register value, highlight a specific line in the list, then click the Edit Setting button (or simply double click on the line). The Edit Register Setting window will appear, showing the properties of the selected register. The only editable field is the Setting. Enter the new value in the red (Settings) field and click OK.

Read Meter Configuration

This selection will read the meter's existing configuration and display it as the currently open configuration file. If you have not already entered the meter's password, you will be prompted to enter it now. Click OK when finished.

During the read, you will see a Progress indicator on your screen.



When the progress indicator is finished, you will see the configuration file name at the bottom of the screen change to "Untitled.cfg". The data is not saved until you initiate the "File | Save As" command and save the data as a configuration (.cfg) file.

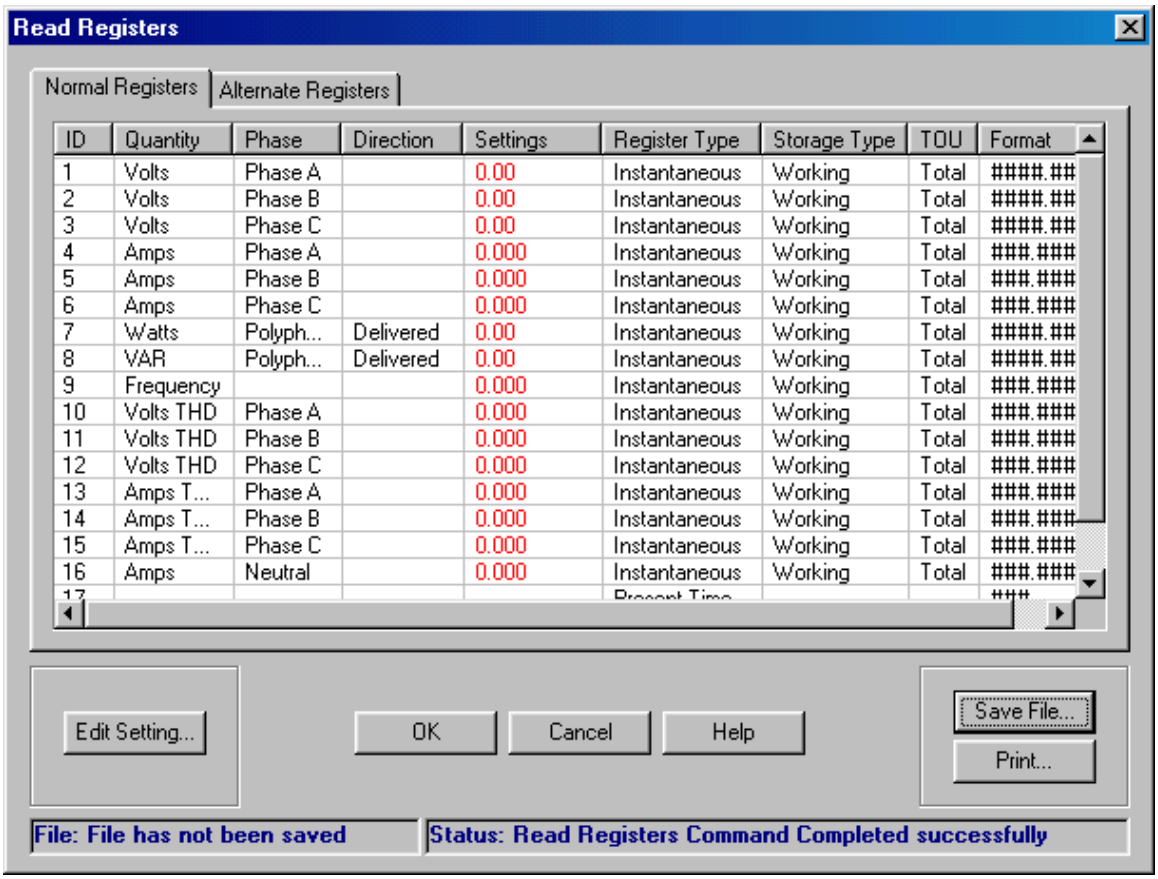
NOTE: You may use the latest version of JEMWare to open a configuration file saved with a prior version, or to read the configuration from a meter that was programmed with a prior version. If you do this, however, you must verify all settings in the configuration before saving it or programming it into a meter. Verify the settings by opening each item in the Meter Settings menu and reviewing the settings. This allows you to be confident that the correct settings are in place and also allows JEMWare to insert appropriate default settings for features that may not have been present in the older version of JEMWare.

Disconnect

This choice will end the communications connection between the PC and meter.

Read Registers

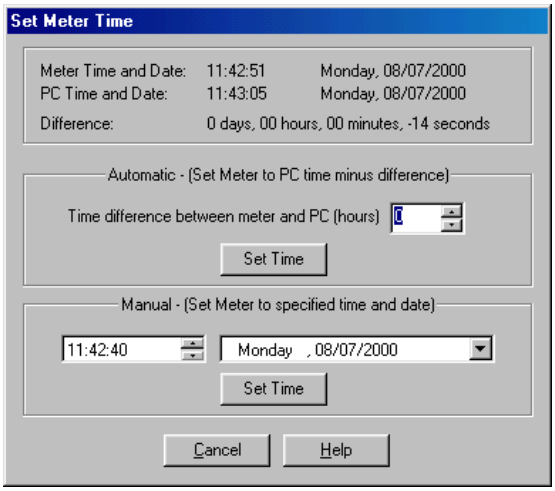
Use this menu for a convenient method of viewing all active Normal and Alternate registers in a meter, and their current settings. You can also save these settings as a Preset (.pre) file, which can later be used to load registers on a new meter with these values.



To change a register value, highlight a specific line in the list, then click the Edit Setting button. Enter the new value in the red (Settings) field and click OK. Click the Save File button to save the data as a .pre (preset) file for later use.

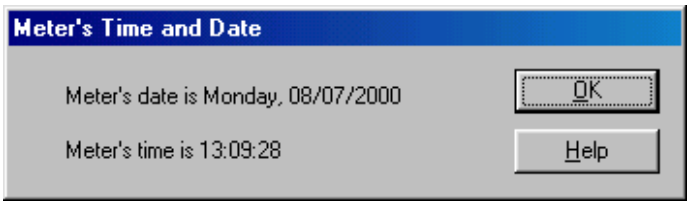
Set Meter Time

Use this command to set the clock inside the meter. You can either set the time to automatically match the PC clock, or manually set it to any specific time that you enter via the keyboard.
Click “Set Time” to actually change the meter’s time/date.



Get Meter Time

This menu item will read the clock time from the meter and display it on the PC. It will not change the time, nor can it be edited from this screen. To change the time, go to the Set Meter Time menu.



Activate Cellular Modem

This will turn on the cellular modem

Get Cellular Modem Info

This will retrieve information about the cellular modem:

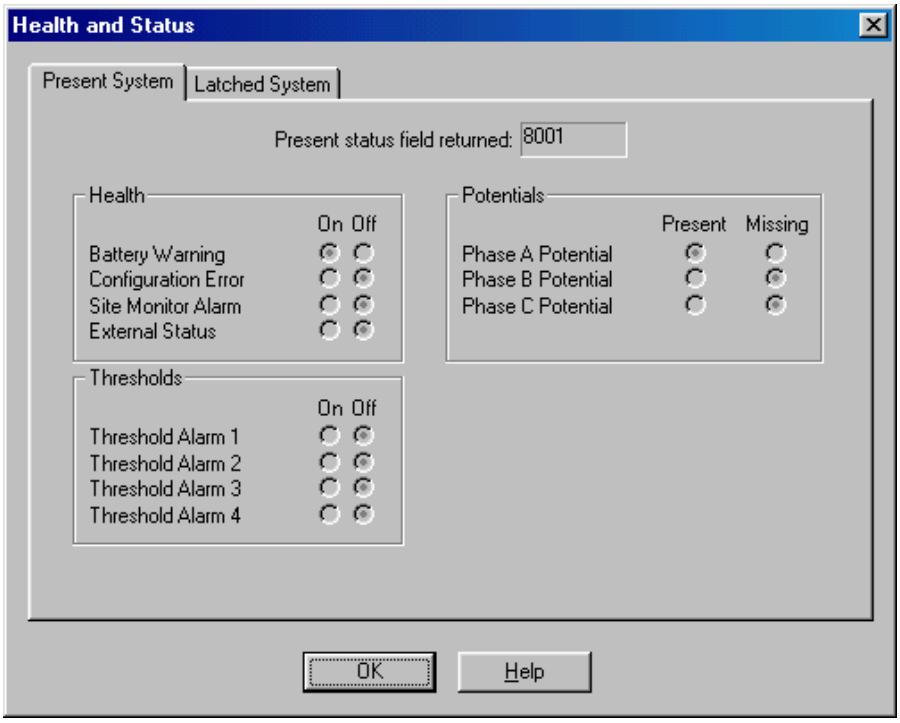
Signal strength
Registration Status
IP Address
Phone No
ESN
Carrier ID
Firmware Version

Freeze

Click this menu choice to perform a register freeze.

Health Check

This feature will read and display the meter's Health Status and Threshold Alarms from the connected meter. Also the Phase A, B, and C Potential Annunciators are reported.

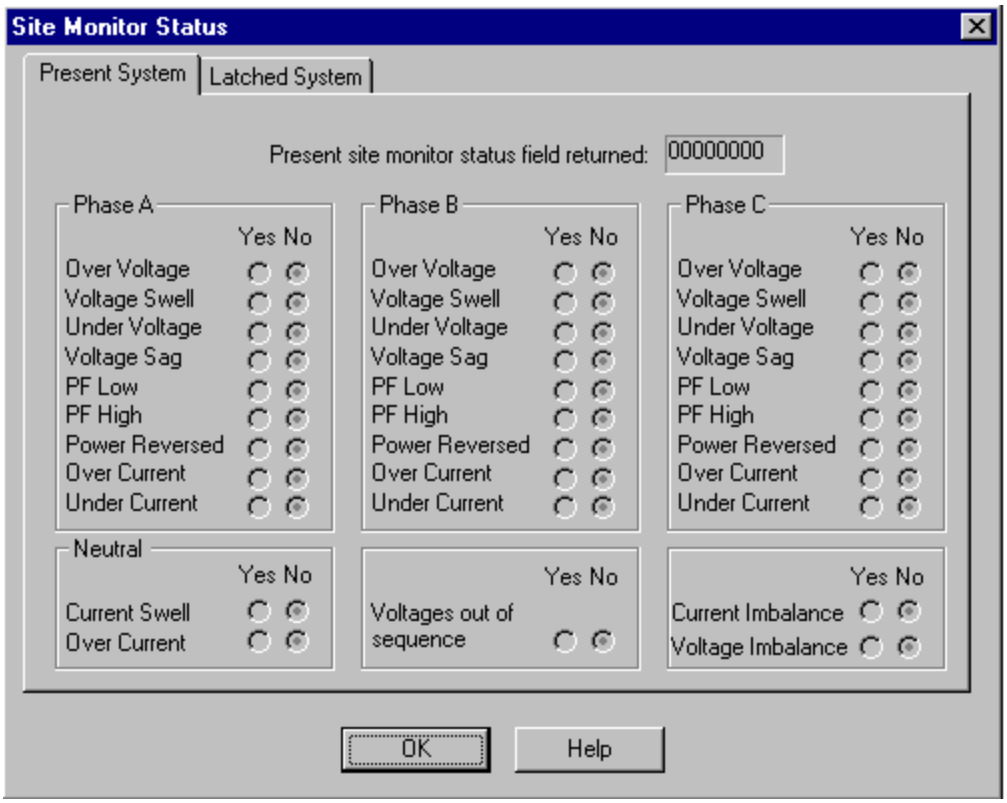


The **Present System** page is the status of the meter at the time of the last Freeze. Note that you must perform a Freeze to update the current status.

The **Latched System** page shows all indicators that have been on alarm since the last meter Reset, regardless of whether they are still in the alarm condition or not.

Site Monitor Status

This feature will read and display the meter's Site Monitor Alarms from the connected meter.

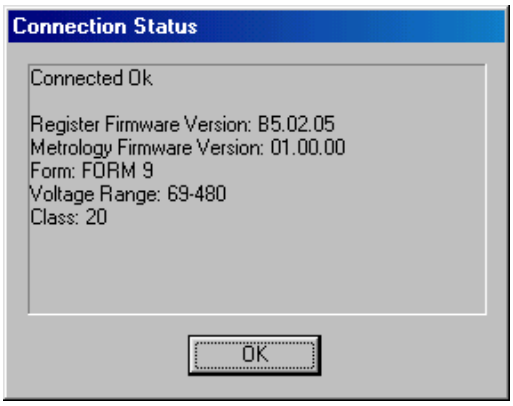


- The **Present System** page is the status of the meter at the time of the last Freeze. Note that you must perform a Freeze to update the current status.
- The **Latched System** page shows all indicators that have been on alarm since the last meter Reset, regardless of whether they are still in the alarm condition or not.

The site monitor status field at the top of each page displays a hexadecimal number that represents the condition (Yes/No) of all the monitored status bits. Refer to the JEMStar Command Set manual 1083-603 or Ci20 Command Set manual 1086-684 for a definition of this number.

Status Query

Select this menu choice to interrogate the connected meter and report the meter's firmware version and basic operating type.



Diagnostics

The Diagnostics feature graphically displays power flow in the connected meter and shows real time operating details. This can be important to the meter installer or service technician who wants to diagnose a meter malfunction or improper meter installation.

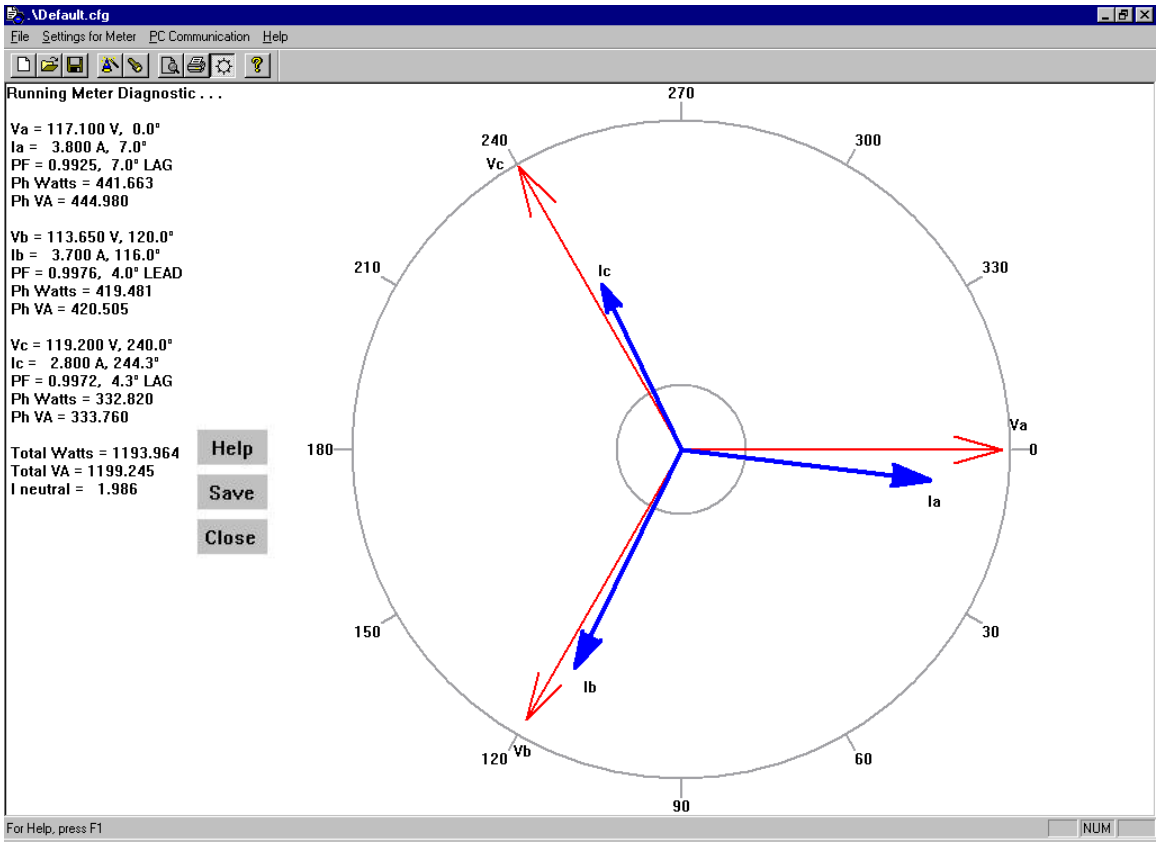
The diagnostic display is a polar coordinate diagram showing the three phase voltages and three phase currents.

The formats of the vectors are arranged to industry standards:

- The zero axes point straight out to the right
- Ninety degrees is straight down

Each voltage phase vector is colored red (thin line arrows above); its angle indicates the voltage phase angle and its length indicates the voltage magnitude. Each current phase vector is colored blue (thick line arrows above); its angle indicates the current phase angle and its length indicates the current magnitude. The color and attributes of the vectors are arranged such that both current and voltage vectors are visible at all times, regardless of overlap.

For each vector, the phase label, phase angle and magnitude are displayed as text.



In addition to the graphics, the Diagnostics menu also displays the following text information:

- Phase Volts (for 3 phases), Magnitude and Angle (0-359 deg)
- Phase Amps (for 3 phases) , Magnitude and Angle (0-359 deg)
- Total Watts
- Total VA
- Neutral Current

The meter being diagnosed can be connected through any of the conventional means: direct cable connection, optical port, or modem. The diagnostic display information can be captured into a special file as a record of installation condition, and may be viewed or printed at any later time.

You can save the diagnostic view by hitting the save button and storing off as a jpg to use in the future.

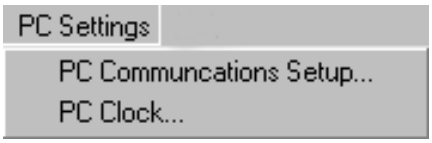
Interpreting the Diagnostics Display

You can use the Diagnostic Display to troubleshoot installation problems such as wrong phase connections or missing phases. The visual display provides an instant identification of the problem.

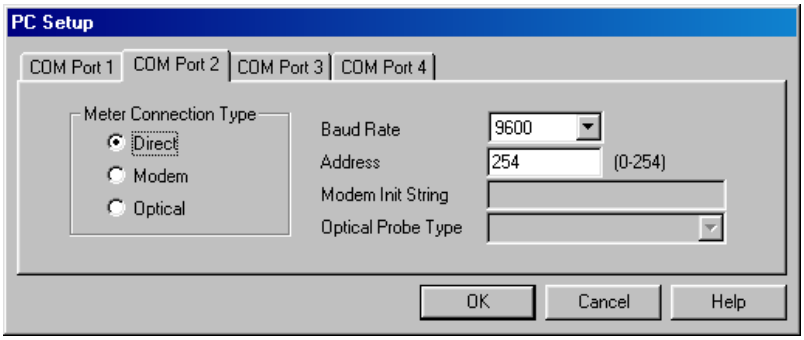
To close the Diagnostic display, click the Diagnostics icon  in the toolbar, and you will return to the Main Menu.

PC SETTINGS

PC Communications Setup



This screen is used for setting up parameters that are specific to the Personal Computer; it does not affect any meter settings. Once this has been set up, the program will remember your COM port settings for future use.



You can configure up to four separate serial communication ports. Each COM port can be arranged for a different connection type, based on your specific requirements. The IRQ and port address are set and managed by Windows; JEMWare does not override the standard Windows settings.

To configure, first determine a valid COM port number available on your computer (1 through 4), and select the corresponding tab at the top of the screen. Next, select the Meter Connection Type for the method you are using to connect the communications hardware.

Meter Connection Type:

Direct COM Port

Use this setting if you are connecting with a standard RS-232 serial communications cable. The signals are available on the meter's pigtail cable and should be terminated with an appropriate connector for your application. Refer to the *JEMStar* User Manual 1083-600 or the *Ci20* User Manual 1086-381 for the cable color code and signal functions.

Modem

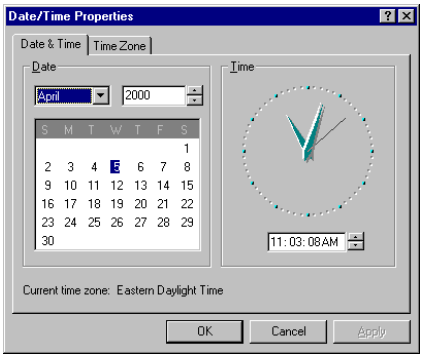
Use this setting if you are connecting through a dial-up modem. *JEMWare* supports the generic Hayes command set, and will accept a Modem Initialization String of up to 100 Characters. The default init string "ATZ" is provided, and may be all you need. Consult your modem's instruction manual for further information on initialization strings.

Optical

Use this setting if you are connecting with an optical probe such as the Scientific Columbus™ Model 5282 or GE Smart Coupler™. These pickups use a quick-connect magnetic attachment to the front of the meter, and the globe can remain attached (or be removed) during communications. Consult the manuals provided with these devices for operating instructions.

PC Clock

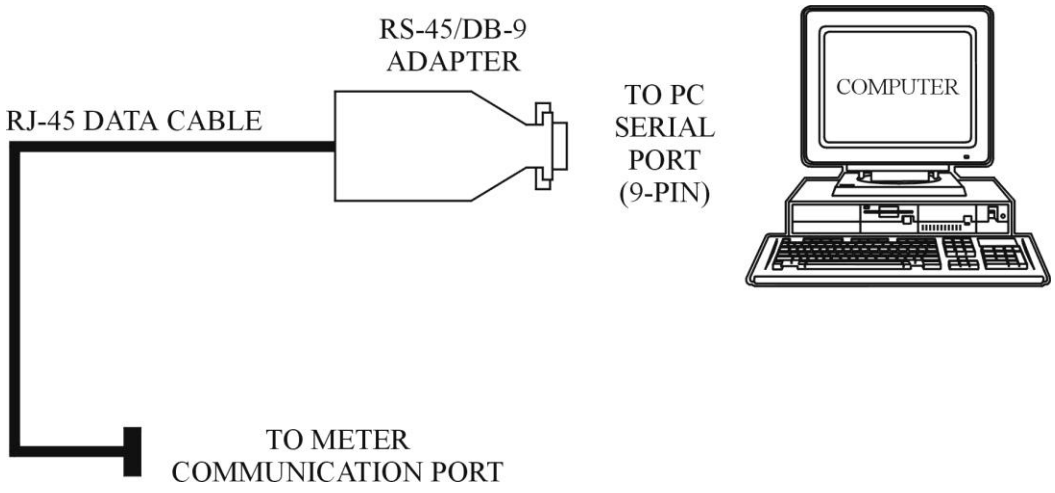
This selection displays the current Date and Time that is running on the computer, and simply mimics the standard Windows display. You can change the PC time and date from this screen. To set the meter time and date, go to the "Set Meter Time" menu.



CONNECTING TO A METER

Step 1: Connect the Hardware
You can connect a meter to your computer using any of the following methods.

- **Direct Connection** uses your computer's RS-232 COM port wired directly to the RS-232 port on the meter. This is the simplest method, but limits the distance to about 50 ft.



  You can also create an RS-485 network to connect one or more meters to your computer at a time, which will increase the maximum cable distance to about 4000 ft. To use RS-485 communications, you must install an RS-232 to RS-485 converter at your computer's COM port. If you do not already have this device, AMETEK offers all the necessary hardware. Plug the RS-232/485 converter box into your PC serial port. Connect the RJ-45 phone cable between COM1 on the meter and the back of the converter.

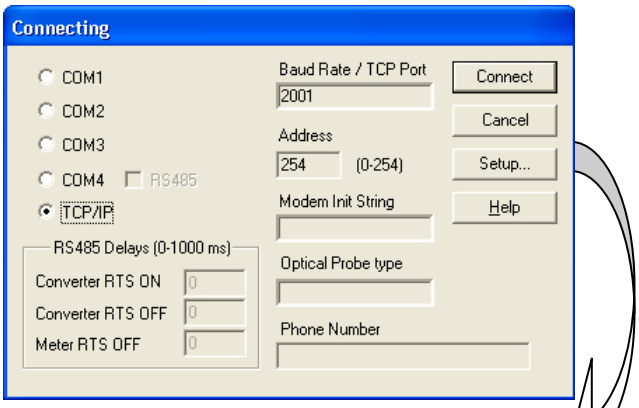
  If you are creating your own serial cable, refer to the JEMStar User Manual 1083-600 or Ci20 User Manual 1086-381 for the required connector types and pinout arrangements.

- **Optical connection**: Each meter has provisions to attach an optical sensor to the front of the meter. The optical sensor will provide an RS-232 output that is used exactly the same as the Direct Connection style.

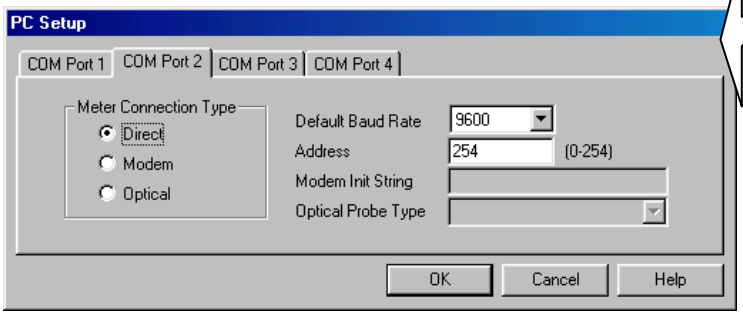
- **Modem Connection** can be used if your meter has an internal modem. *JEMWare* will dial up the phone number associated with the meter and allow meter communications over any distance.

Step 2: Set up the communication parameters

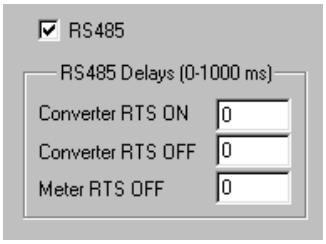
Open the *JEMWare* application by double-clicking the icon on your desktop. The Main Screen will appear. If this is a first-time use, go to the menu labeled "Meter Communication | Connect", and set the COM port number (1 – 4) that your PC is using.



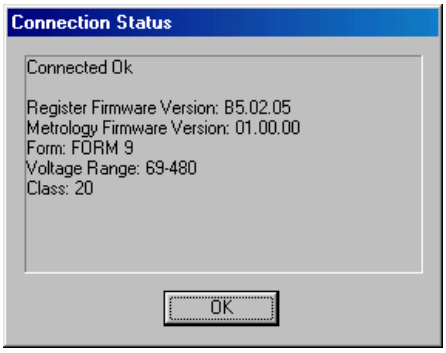
Now click on the Setup button and proceed to the PC Setup screen. You must select whether your communication is Direct Connect, Optical, or via a modem. If a modem is used, you must enter an initialization string to direct the modem to connect properly (the standard Hayes "ATZ" string is provided as the default). If this is an optical probe connection, be sure to select the proper type from the pull-down box.
Enter the appropriate information for your meter connection type and click OK to close the setup screen.



If you are employing RS-485 communications, select the RS485 check box. You will need to enter RTS (Request To Send) time delays in mS that are specific to the RS232 - RS485 converter you are using. Typically, 5 to 10 mS ON and OFF is sufficient for the Black Box™ converter (available from AMETEK), but you may need to experiment with the numbers if you are using a different converter. The Meter RTS OFF number should match your entry under Meter Settings | Serial Communication screen.



Click the Connect button on the "Connecting" screen to link your PC to the meter. If successful, you will see be notified of a proper connection and the meter type that is connected. The connect status screen will also reveal all options enabled in the meter. *Note: when equipped with the Ethernet/Serial option, it will always indicate RS-232 regardless of how the hardware is configured. Refer to the hardware manual for details to identify whether the Ethernet Option board is jumpered for RS-232 or RS-485.



Step 3: Configure the Meter
Once you are connected to the meter, you have several options.

1. You can read the existing configuration in the meter, make changes as necessary in JEMWare, and then write the new configuration back to the meter.
2. You can write a previously saved JEMWare configuration to the meter.
3. You can also make minor changes to the meter's configuration such as setting the time, or perform a Health Check, etc. without going through the main setup process.

Be sure to save all new configurations in *JEMWare* for future reference.

CHANGING METER CONFIGURATIONS

Certain features of the meter are forced to be re-initialized when portions of the meter's configuration are changed. This section summarizes the changes that will force a re-initialization. Note that when a new configuration is loaded into a meter, the meter determines individually if each section has changed from the currently stored configuration. These features are re-initialized ONLY if the particular configuration sections are different. Re-initialization means that the data in that particular register is set to zero.

Display Registers
The Display Registers feature includes the following parts of the JEMStar:
• Registers in the Normal, Alternate and Test display list
• Self Read registers
• Register Thresholds
• Site Monitor alarms
• Totalization registers
The following configuration sections, if modified, will cause the Display Registers feature to be reinitialized, erasing all previous data:
• Normal display list
• Alternate display list
• Test display list
• Demand settings
• Self Read settings
• Primary Scaling settings
• Register Threshold settings
• Demand, Load Profile Interval Timing settings
• Totalization channel setup
• Timekeeping and DST Changes

Load Profile
The Load Profile features (which does not include individual Event Logs) will be erased and reinitialized if these configuration sections are modified:
• Demand, Load Profile Interval Timing settings
• Load Profile channel assignments
• Primary Scaling settings
• Totalization channels

Energy Pulses
The Energy Pulse feature will be re-initialized if these configuration sections are changed:
• Energy pulse channel assignments

APPENDIX A – DNP SERIAL COMMUNICATIONS

INTRODUCTION

Distributed Network Protocol (DNP 3.0) is an industry standard protocol for SCADA communications between Master Stations, Host computers, Remote Terminal Units, and Intelligent Electronics Devices (such as the meter). It is a public domain, non-proprietary protocol based on the IEC-870 standards, and is intended primarily for use in SCADA-like systems.

DNP as a protocol provides efficient, robust data communications through a system of 32-bit data link CRCs (Cyclical Redundancy Checks) and confirmation messages. However, DNP is much more than an error-detection-and-correction scheme. A DNP-compliant device, from the protocol's point of view, is considered a group of data "objects", each of which contains one or more "points". The DNP protocol specification defines the allowable object types and what constitutes a "point" for that object type.

DNP is *not* intended to be a general-purpose two-way communications link. Rather, it is highly optimized for SCADA and automation applications involving relatively small amounts of near-real-time data that is often read by the DNP master every few seconds. In the case of the meters, it is *not* used as a means of controlling or reconfiguring the meter.

DNP V3.00 DEVICE PROFILE

The purpose of this document is to describe the specific implementation of the **D**istributed **N**etwork **P**rotocol (DNP) 3.0 within the meter. This document, in conjunction with the DNP 3.0 Basic 4 Document Set, and the DNP Subset Definitions Document, provides complete information on how to communicate with the meter via the DNP 3.0 protocol.

The meter uses the Triangle MicroWorks™, Inc. DNP 3.0 Slave Source Code Library Version 2.19. This implementation of DNP 3.0 is fully compliant with DNP 3.0 Subset Definition Level 2, contains many Subset Level 3 features, and contains some functionality even beyond Subset Level 3.

The following sections, in conjunction with the Device Profile Document, provide a complete interoperability/configuration guide for the meter:

- the Implementation Table
- the Point List Tables
- Configuration methods

DNP V3.00

DEVICE PROFILE DOCUMENT

Vendor Name: **AMETEK Power Instruments**	
Device Name: **JEMStar, using the Triangle MicroWorks, Inc. DNP 3.0 Slave Source Code Library, Ver 2.19**	
Highest DNP Level Supported: For Requests: **Level 2** For Responses: **Level 2**	Device Function: ☐ Master ☒ **Slave**
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): **For static (non-change-event) object requests, request qualifier codes 00 and 01 (start-stop), 07 and 08 (limited quantity), and 17 and 28 (index) are supported in addition to request qualifier code 06 (no range – or all points). Static object requests received with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. Static object requests received with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event object requests, qualifiers 17 or 28 are always responded.** **The read and write function code for Object 50 (Time and Date), variation 1, is supported.**	
Maximum Data Link Frame Size (octets): Transmitted: **292** Received **292**	Maximum Application Fragment Size (octets): Transmitted: **2048** Received: **2048**
Maximum Data Link Re-tries: **Configurable from 0 to 255 – Via JEMWare**	Maximum Application Layer Re-tries: **None**
Requires Data Link Layer Confirmation: **Configurable as: Never, Only for multi-frame messages, or Always via JEMWare**	
Requires Application Layer Confirmation: **When sending multi-fragment responses** **Sometimes**	
Timeouts while waiting for: Data Link Confirm: **Configurable via JEMWare** Complete Appl. Fragment: **None** Application Confirm: **Configurable via JEMWare** Complete Appl. Response: **None** Others: Transmission Delay: **Configurable, via JEMWare** Inter-character Timeout: **1 sec.** Need Time Delay: **Configurable, via JEMWare** Frozen Counter Event scanning period: **FIXED AT 5 seconds**	

DNP V3.00

DEVICE PROFILE DOCUMENT

Sends/Executes Control Operations:

WRITE Binary Outputs	**Never**
SELECT/OPERATE	**Never**
DIRECT OPERATE	**Never**
DIRECT OPERATE – NO ACK	**Never**
Count > 1	**Never**
Pulse On	**Never**
Pulse Off	**Never**
Latch On	**Never**
Latch Off	**Never**
Queue	**Never**
Clear Queue	**Never**

Reports Binary Input Change Events when no specific variation requested: **Never**	Reports time-tagged Binary Input Change Events when no specific variation requested: **Never**
Sends Unsolicited Responses: **Never**	Sends Static Data in Unsolicited Responses: **Never** No other options are permitted.
Default Counter Object/Variation: **Default Object: 20** **Default Variation: 5** **Point-by-point list attached**	Counters Roll Over at: **32 Bits** **Other Value: 999,999,999** **Point-by-point list attached**

Sends Multi-Fragment Responses:

Yes

THE METER IMPLEMENTATION

The Meter DNP implementation conforms to the standard for a Level II slave device, with some additions. Implementation consists of the following **static** objects:

- (38) Single-bit Binary Input without flag (Object 1 Variation 1)
- (50) Analog Inputs, configurable with JEMWare for either 32-bit analog input without flag points (Object 30 Variation 3), or 16-bit analog input without flag points (Object 30 Variation 4)
- A configurable number (up to 64) of 32-bit counters (Object 20 Variation 5) that can be assigned to any register in the Normal or alternate display set
- A corresponding number of 32-bit frozen counter without flag (Object 21 variation 5) that represent the values of the counter points at the time of the last meter freeze

IMPLEMENTATION TABLE

The following table identifies the variations, function codes, and qualifiers supported by the meter in both request messages and in response messages.

For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

In the table below text shaded as Subset Level 3 indicates Subset Level 3 functionality (beyond Subset Level 2), and text shaded as beyond Subset Level 3 indicates functionality beyond Subset Level 3.

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	**Variation Number**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
1	0	Binary Input (Variation 0 is used to request default variation)	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 28 (index)		
1	1	Binary Input	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01(start-stop) 17, 28 (index – see note 2)
20	0	Binary Counter (Variation 0 is used to request default variation)	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 28 (index)		
20	5	32-Bit Binary Counter without Flag	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01(start-stop) 17, 28 (index – see note 2)
21	0	Frozen Counter (Variation 0 is used to request default variation)	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 28 (index)		
21	9	32-Bit Frozen Counter without Flag	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01(start-stop) 17, 28 (index – see note 2)

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	**Variation Number**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
23	0	Frozen Counter Event (Variation 0 is used to request default variation)	1 (read)	06(no range, or all) 07, 08(limited qty)		
23	5	32-Bit Frozen Counter Event with Time	1 (read)	06(no range, or all) 07, 08(limited qty)	129 (response)	17, 28 (index)
30	0	Analog Input (Variation 0 is used to request default variation)	(read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 28 (index)		
30	3	32-Bit Analog Input without Flag	(read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01(start-stop) 17, 28 (index – see note 2)
30	5	short floating point	(read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01(start-stop) 17, 28 (index – see note 2)
50	0	Time and Date	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01(start-stop) 17, 28 (index – see note 2)
50	1	Time and Date	1 (read) 2 (write)	00, 01(start-stop) 06(no range, or all) 07 (limited qty=1) 08 (limited qty) 17, 28 (index)	129 (response)	00, 01(start-stop) 17, 28 (index – see note 2)
52	2	Time Delay Fine			129 (response)	07 (limited qty) (qty = 1)
60	0	Class 0, 1, 2, and 3 Data	1 (read)	06(no range, or all)		
60	1	Class 0 Data	1 (read)	06(no range, or all)		
60	2	Class 1 Data	1 (read)	06(no range, or all) 07, 08(limited qty)		
60	3	Class 2 Data	1 (read)	06(no range, or all) 07, 08(limited qty)		
60	4	Class 3 Data	1 (read)	06(no range, or all) 07, 08(limited qty)		
80	1	Internal Indications	2 (write)	00 (start-stop) (index must =7)		
No Object (function code only) –See Note 3			13(cold restart)			
No Object (function code only)			14(warm restart)			
No Object (function code only)			23(delay meas.)			

Note 1: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. (For change-event objects, qualifiers 17 or 28 are always responded.)

Note 2: A cold restart is implemented as a warm restart – the meter is not restarted, but the DNP process is restarted.

Point List

The tables in the following sections identify all the individual data points provided by the implementation of DNP 3.0 in the meter.

Binary Input Points

The Binary input points represent such things as:

- Contact input status
- Threshold alarm conditions
- Site monitor alarm conditions
- Phase potential status

A meter may be configured with up to 40 Binary Input Points in DNP. You may assign any of the following Binary Inputs to any Binary Input Point:

- Contact Input 1 status
- Contact Input 2 status
- Voltages out of sequence alarm
- Neutral over current alarm
- Neutral current swell alarm
- Phase C under current alarm
- Phase C over current alarm
- Phase C power reversed alarm
- Phase C PF high alarm
- Phase C PF low alarm
- Phase C voltage sag alarm
- Phase C under voltage alarm
- Phase C voltage swell alarm
- Phase C over voltage alarm
- Phase B under current alarm
- Phase B over current alarm
- Phase B power reversed alarm
- Phase B PF high alarm
- Phase B PF low alarm
- Phase B voltage sag alarm
- Phase B under voltage alarm
- Phase B voltage swell alarm
- Phase B over voltage alarm
- Phase A under current alarm
- Phase A over current alarm
- Phase A power reversed alarm
- Phase A PF high alarm
- Phase A PF low alarm
- Phase A voltage sag alarm
- Phase A under voltage alarm
- Phase A voltage swell alarm
- Phase A over voltage alarm
- Threshold Alarm 1
- Threshold alarm 2
- Threshold alarm 3
- Threshold alarm 4
- Phase A potential status
- Phase B potential status
- Phase C potential status
- Loss of Phase Potential
- End of Demand Interval
- Fatal Error
- Non-fatal Error

A meter's default configuration is to have these Binary Input Points assigned:

Point Index	Binary Input Name/Description
0	Contact Input 1 status
1	Contact Input 2 status
2	Voltages out of sequence alarm
3	Neutral over current alarm
4	Neutral current swell alarm
5	Phase C under current alarm
6	Phase C over current alarm
7	Phase C power reversed alarm
8	Phase C PF high alarm
9	Phase C PF low alarm
10	Phase C voltage sag alarm
11	Phase C under voltage alarm
12	Phase C voltage swell alarm
13	Phase C over voltage alarm
14	Phase B under current alarm
15	Phase B over current alarm
16	Phase B power reversed alarm
17	Phase B PF high alarm
18	Phase B PF low alarm
19	Phase B voltage sag alarm
20	Phase B under voltage alarm
21	Phase B voltage swell alarm
22	Phase B over voltage alarm
23	Phase A under current alarm
24	Phase A over current alarm
25	Phase A power reversed alarm
26	Phase A PF high alarm
27	Phase A PF low alarm
28	Phase A voltage sag alarm
29	Phase A under voltage alarm
30	Phase A voltage swell alarm
31	Phase A over voltage alarm
32	Threshold Alarm 1
33	Threshold alarm 2
34	Threshold alarm 3
35	Threshold alarm 4
36	Phase A potential status
37	Phase B potential status
38	Phase C potential status

Counters

Counters are implemented as 32-bit counter without flag (Object 20 Var 5). For the counter point list, the user may select any Normal, Alternate, or Internal (not Test) display register to map to each point in the counter list. Note that display registers may contain demand or instantaneous readings as well as consumption totals. This list can be configured to contain up to 64 counter points. In addition to the Normal and Alternate register set, the meter has an internal register list consisting of 49 various measurements. Using JEMWare, the counter point list can be configured to be any mix of Normal, Alternate or Internal registers (up to a total of 64 points). Each numeric counter point value is represented as the corresponding register value times a user-selected scaling factor.

Registers in the Normal and Alternate display lists are set by the user. The Internal list contains these registers:

- Watthours Delivered
- Watthours Received
- VARhours Delivered
- VARhours Received
- VAhours Delivered
- VAhours Received
- Qhours Delivered
- Qhours Received
- Amphours
- Volt Squared hours
- Amp Squared hours
- Average PF Delivered Phase A
- Average PF Delivered Phase B
- Average PF Delivered Phase C
- Average PF Delivered Polyphase
- Average PF Received Phase A
- Watt Delivered Past Interval Demand
- VAR Delivered Past Interval Demand
- VA Delivered Past Interval Demand
- Amp Phase A Past Interval Demand
- Amp Phase B Past Interval Demand
- Amp Phase C Past Interval Demand
- Neutral Amp Past Interval Demand
- Peak Demand Watt Delivered
- Peak Demand VAR Delivered
- Peak Demand VA Delivered
- Peak Demand Amp Phase A
- Peak Demand Amp Phase B
- Peak Demand Amp Phase C
- Peak Demand Neutral Amp
- Peak Demand Watt Delivered at last BPR
- Peak Demand VAR Delivered at last BPR
- Peak Demand VA Delivered at last BPR
- Time of Peak Demand Watt Delivered
- Time of Peak Demand VAR Delivered
- Time of Peak Demand VA Delivered
- Time of Peak Demand Amp Phase A
- Time of Peak Demand Amp Phase B
- Time of Peak Demand Amp Phase C
- Time of Peak Demand Neutral Amp
- Time of Peak Watt Delivered at last BPR
- Time of Peak VAR Delivered at last BPR
- Time of Peak VA Delivered at last BPR
- PF at Peak Watt Delivered at last BPR
- PF at Peak VAR Delivered at last BPR
- PF at Peak VA Delivered at last BPR
- Watt Delivered Predicted Demand
- VAR Delivered Predicted Demand
- VA Delivered Predicted Demand

Other data formats that may be assigned to display registers include:

- Time and Date registers are represented as seconds since midnight 1/1/70
- Diagnostic and String register types will be represented as 0
- Status registers will be represented as a direct 32-bit mask value.

The corresponding frozen counter object is implemented as Object 21 Variation 9. The values of the points in this object represent the values of the corresponding counter points at the time of the last register freeze.

In the meter, all static data is permanently assigned to Class 0.

A meter register configured as a DNP Counter point may contain a value as large as 999,999,999 (nine digits). Some DNP master devices cannot accept counter values this large. You may configure a meter to restrict the reported value of counter points to 3, 4, 5, 6, 7, or 8 digits, or allow the full 9-digit precision to be reported. Restricting the number of digits reported affects only DNP counter points, not the actual display registers.

A meter's default configuration is to have these Counter Points assigned:

Point Index	Counter Name/Description
0	Internal – system Watthrs delivered x selected scale
1	Internal – system Watthrs received x selected scale
2	Internal – system VARhrs delivered x selected scale
3	Internal – system VARhrs received x selected scale
4	Internal – system VAhours delivered x selected scale
5	Internal – system VAhours received x selected scale
6	Internal – system Qhrs delivered x selected scale
7	Internal – system Qhrs received x selected scale
8	Internal – system Amphrs x selected scale
9	Internal – system V2h x selected scale
10	Internal – system A2H x selected scale

Analog Inputs

Analog Inputs are implemented as 32-bit analog input without flag (object 30 Var 5) points, or 16-bit analog input without flag (object 30 Var 4) points. A total of up to 140 points are supported, which represent such things as:

- Instantaneous Per phase Watts, VARs, VA, Volts, Amps, and Power Factor
- Line frequency
- Per-phase THD for volts and Amps
- Per-phase V^2 and A^2
- Bi-directional Watts and VARs

32-Bit Inputs

These inputs are represented in SECONDARY units, and up to 3 decimal places of precision may be obtained by entering a scale value of 1000. For conversion to primary units, the point value should be multiplied by the appropriate PT and/or CT ratio.

A meter's default configuration is to have these Analog Input Points assigned:

Point Index	Analog Input Name/Description	Scaling
0	Instantaneous Watts, Phase A, Del	x1000
1	Instantaneous Watts, Phase A, Rec	x1000
2	Instantaneous Watts, Phase B, Del	x1000
3	Instantaneous Watts, Phase B, Rec	x1000
4	Instantaneous Watts, Phase C, Del	x1000
5	Instantaneous Watts, Phase C, Rec	x1000
6	Instantaneous Watts, Poly, Del	x1000
7	Instantaneous Watts, Poly, Rec	x1000
8	Instantaneous VARs, Phase A, Del	x1000
9	Instantaneous VARs, Phase A, Rec	x1000
10	Instantaneous VARs, Phase B, Del	x1000
11	Instantaneous VARs, Phase B, Rec	x1000
12	Instantaneous VARs, Phase C, Del	x1000
13	Instantaneous VARs, Phase C, Rec	x1000
14	Instantaneous VARs, Poly, Del	x1000
15	Instantaneous VARs, Poly, Rec	x1000
16	Instantaneous VA, Phase A, Del	x1000
17	Instantaneous VA, Phase A, Rec	x1000
18	Instantaneous VA, Phase B, Del	x1000
19	Instantaneous VA, Phase B, Rec	x1000
20	Instantaneous VA, Phase C, Del	x1000
21	Instantaneous VA, Phase C, Rec	x1000
22	Instantaneous VA, Poly, Del	x1000
23	Instantaneous VA, Poly, Rec	x1000
24	Instantaneous Amps, Phase A	x1000
25	Instantaneous Amps, Phase B	x1000
26	Instantaneous Amps, Phase C	x1000
27	Instantaneous Amps, Neutral	x1000
28	Instantaneous Volts, Phase A	x1000
29	Instantaneous Volts, Phase B	x1000

Point Index	Analog Input Name/Description	Scaling
30	Instantaneous Volts, Phase C	x1000
31	Frequency	x1000
32	Instantaneous PF, Phase A, Del	x1000
33	Instantaneous PF, Phase A, Rec	x1000
34	Instantaneous PF, Phase B, Del	x1000
35	Instantaneous PF, Phase B, Rec	x1000
36	Instantaneous PF, Phase C, Del	x1000
37	Instantaneous PF, Phase C, Rec	x1000
38	Instantaneous PF, Poly, Del	x1000
39	Instantaneous PF, Poly, Rec	x1000
40	Volts THD, Phase A	x1000
41	Volts THD, Phase B	x1000
42	Volts THD, Phase C	x1000
43	Amps THD, Phase A	x1000
44	Amps THD, Phase B	x1000
45	Amps THD, Phase C	x1000
46	$Volts^2$ Phase A	x1000
47	$Volts^2$ Phase B	x1000
48	$Volts^2$ Phase C	x1000
49	$Amps^2$ Phase A	x1000
50	$Amps^2$ Phase B	x1000
51	$Amps^2$ Phase C	x1000
52	$Amps^2$ Poly	x1000
53	Instantaneous Watts, Phase A, Bidirectional	x1000
54	Instantaneous Watts, Phase B, Bidirectional	x1000
55	Instantaneous Watts, Phase C, Bidirectional	x1000
56	Instantaneous Watts, Polyphase, Bidirectional	x1000
57	Instantaneous VARs, Phase A, Bidirectional	x1000
58	Instantaneous VARs, Phase B, Bidirectional	x1000
59	Instantaneous VARs, Phase C, Bidirectional	x1000
60	Instantaneous VARs, Polyphase, Bidirectional	x1000
61	Instantaneous Uncompensated Watts, Phase A, Del	x1000
62	Instantaneous Uncompensated Watts, Phase A, Rec	x1000
63	Instantaneous Uncompensated Watts, Phase B, Del	x1000
64	Instantaneous Uncompensated Watts, Phase B, Rec	x1000
65	Instantaneous Uncompensated Watts, Phase C, Del	x1000
66	Instantaneous Uncompensated Watts, Phase C, Rec	x1000
67	Instantaneous Uncompensated Watts, Poly, Del	x1000
68	Instantaneous Uncompensated Watts, Poly, Rec	x1000
69	Instantaneous Uncompensated VARs, Phase A, Del	x1000
70	Instantaneous Uncompensated VARs, Phase A, Rec	x1000
71	Instantaneous Uncompensated VARs, Phase B, Del	x1000

Point Index	Analog Input Name/Description	Scaling
72	Instantaneous Uncompensated VARs, Phase B, Rec	x1000
73	Instantaneous Uncompensated VARs, Phase C, Del	x1000
74	Instantaneous Uncompensated VARs, Phase C, Rec	x1000
75	Instantaneous Uncompensated VARs, Poly, Del	x1000
76	Instantaneous Uncompensated VARs, Poly, Rec	x1000
77	Instantaneous Uncompensated VA, Phase A, Del	x1000
78	Instantaneous Uncompensated VA, Phase A, Rec	x1000
79	Instantaneous Uncompensated VA, Phase B, Del	x1000
80	Instantaneous Uncompensated VA, Phase B, Rec	x1000
81	Instantaneous Uncompensated VA, Phase C, Del	x1000
82	Instantaneous Uncompensated VA, Phase C, Rec	x1000
83	Instantaneous Uncompensated VA, Poly, Del	x1000
84	Instantaneous Uncompensated VA, Poly, Rec	x1000
85	Instantaneous Uncompensated PF, Phase A, Del	x1000
86	Instantaneous Uncompensated PF, Phase A, Rec	x1000
87	Instantaneous Uncompensated PF, Phase B, Del	x1000
88	Instantaneous Uncompensated PF, Phase B, Rec	x1000
89	Instantaneous Uncompensated PF, Phase C, Del	x1000
90	Instantaneous Uncompensated PF, Phase C, Rec	x1000
91	Instantaneous Uncompensated PF, Poly, Del	x1000
92	Instantaneous Uncompensated PF, Poly, Rec	x1000
93	Instantaneous Uncompensated Watts, Phase A, Bidirectional	x1000
94	Instantaneous Uncompensated Watts, Phase B, Bidirectional	x1000
95	Instantaneous Uncompensated Watts, Phase C, Bidirectional	x1000
96	Instantaneous Uncompensated Watts, Polyphase, Bidirectional	x1000
97	Instantaneous Uncompensated VARs, Phase A, Bidirectional	x1000
98	Instantaneous Uncompensated VARs, Phase B, Bidirectional	x1000
99	Instantaneous Uncompensated VARs, Phase C, Bidirectional	x1000
100	Instantaneous Uncompensated VARs, Polyphase, Bidirectional	x1000

16-Bit Inputs

These inputs are represented in SECONDARY units and scaled so that the meter's full-scale value is represented by 32767. The list is the same as that configured for the 32-bit Analog Input points, but the user-entered scale values are not used.

Example:
At 60 Hz, the raw value represented for frequency may be 19640. Dividing by 32767 and then multiplying by the full-scale engineering units value (see the following table), gives the following reading:

$$\frac{19640}{32767} \times 100.0 = 59.94 Hz$$

To obtain primary units, multiply by the appropriate PT and/or CT ratios.

A meter's default configuration is to have these Binary Input Points assigned:

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
0	Instantaneous Watts, Phase A, Del	0 – 10600 W	0 - 32767
1	Instantaneous Watts, Phase A, Rec	0 – 10600 W	0 - 32767
2	Instantaneous Watts, Phase B, Del	0 – 10600 W	0 - 32767
3	Instantaneous Watts, Phase B, Rec	0 – 10600 W	0 - 32767
4	Instantaneous Watts, Phase C, Del	0 – 10600 W	0 - 32767
5	Instantaneous Watts, Phase C, Rec	0 – 10600 W	0 - 32767
6	Instantaneous Watts, Poly, Del	0 – 31800 W	0 - 32767
7	Instantaneous Watts, Poly, Rec	0 – 31800 W	0 - 32767
8	Instantaneous VARs, Phase A, Del	0 – 10600 VAR	0 - 32767
9	Instantaneous VARs, Phase A, Rec	0 – 10600 VAR	0 - 32767
10	Instantaneous VARs, Phase B, Del	0 – 10600 VAR	0 - 32767
11	Instantaneous VARs, Phase B, Rec	0 – 10600 VAR	0 - 32767
12	Instantaneous VARs, Phase C, Del	0 – 10600 VAR	0 - 32767
13	Instantaneous VARs, Phase C, Rec	0 – 10600 VAR	0 - 32767
14	Instantaneous VARs, Poly, Del	0 – 31800 VAR	0 - 32767
15	Instantaneous VARs, Poly, Rec	0 – 31800 VAR	0 - 32767
16	Instantaneous VA, Phase A, Del	0 – 10600 VA	0 - 32767
17	Instantaneous VA, Phase A, Rec	0 – 10600 VA	0 - 32767
18	Instantaneous VA, Phase B, Del	0 – 10600 VA	0 - 32767
19	Instantaneous VA, Phase B, Rec	0 – 10600 VA	0 - 32767
20	Instantaneous VA, Phase C, Del	0 – 10600 VA	0 - 32767
21	Instantaneous VA, Phase C, Rec	0 – 10600 VA	0 - 32767
22	Instantaneous VA, Poly, Del	0 – 31800 VA	0 - 32767
23	Instantaneous VA, Poly, Rec	0 – 31800 VA	0 - 32767
24	Instantaneous Amps, Phase A	0 –20 A	0 - 32767
25	Instantaneous Amps, Phase B	0 –20 A	0 - 32767
26	Instantaneous Amps, Phase C	0 –20 A	0 - 32767
27	Instantaneous Amps, Neutral	0 –20 A	0 - 32767
28	Instantaneous Volts, Phase A	0 – 530 V	0 - 32767
29	Instantaneous Volts, Phase B	0 – 530 V	0 - 32767
30	Instantaneous Volts, Phase C	0 – 530 V	0 - 32767
31	Frequency	0 – 100 Hz	0 - 32767
32	Instantaneous PF, Phase A, Del	0 – 1.00	0 - 32767
33	Instantaneous PF, Phase A, Rec	0 – 1.00	0 - 32767

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
34	Instantaneous PF, Phase B, Del	0 – 1.00	0 - 32767
35	Instantaneous PF, Phase B, Rec	0 – 1.00	0 - 32767
36	Instantaneous PF, Phase C, Del	0 – 1.00	0 - 32767
37	Instantaneous PF, Phase C, Rec	0 – 1.00	0 - 32767
38	Instantaneous PF, Poly, Del	0 – 1.00	0 - 32767
39	Instantaneous PF, Poly, Rec	0 – 1.00	0 - 32767
40	Volts THD, Phase A	0 – 100 %	0 - 32767
41	Volts THD, Phase B	0 – 100 %	0 - 32767
42	Volts THD, Phase C	0 – 100 %	0 - 32767
43	Amps THD, Phase A	0 – 100 %	0 - 32767
44	Amps THD, Phase B	0 – 100 %	0 - 32767
45	Amps THD, Phase C	0 – 100 %	0 - 32767
46	$Volts^2$ Phase A	0 – 280900 V^2	0 - 32767
47	$Volts^2$ Phase B	0 – 280900 V^2	0 - 32767
48	$Volts^2$ Phase C	0 – 280900 V^2	0 - 32767
49	$Amps^2$ Phase A	0 – 400 A^2	0 - 32767
50	$Amps^2$ Phase B	0 – 400 A^2	0 - 32767
51	$Amps^2$ Phase C	0 – 400 A^2	0 - 32767
52	$Amps^2$ Poly	0 – 1200 A^2	0 - 32767
53	Instantaneous Watts, Phase A, Bidirectional	-10600 to +10600 W	-32768 to +32767
54	Instantaneous Watts, Phase B, Bidirectional	-10600 to +10600 W	-32768 to +32767
55	Instantaneous Watts, Phase C, Bidirectional	-10600 to +10600 W	-32768 to +32767
56	Instantaneous Watts, Polyphase, Bidirectional	-31800 to +31800 W	-32768 to +32767
57	Instantaneous VARs, Phase A, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
58	Instantaneous VARs, Phase B, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
59	Instantaneous VARs, Phase C, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
60	Instantaneous VARs, Polyphase, Bidirectional	-31800 to +31800 VAR	-32768 to +32767
61	Instantaneous Uncompensated Watts, Phase A, Del	0 – 10600 W	0 - 32767
62	Instantaneous Uncompensated Watts, Phase A, Rec	0 – 10600 W	0 - 32767
63	Instantaneous Uncompensated Watts, Phase B, Del	0 – 10600 W	0 - 32767
64	Instantaneous Uncompensated Watts, Phase B, Rec	0 – 10600 W	0 - 32767
65	Instantaneous Uncompensated Watts, Phase C, Del	0 – 10600 W	0 - 32767
66	Instantaneous Uncompensated Watts, Phase C, Rec	0 – 10600 W	0 - 32767
67	Instantaneous Uncompensated Watts, Poly, Del	0 – 31800 W	0 - 32767
68	Instantaneous Uncompensated Watts, Poly, Rec	0 – 31800 W	0 - 32767
69	Instantaneous Uncompensated VARs, Phase A, Del	0 – 10600 VAR	0 - 32767
70	Instantaneous Uncompensated VARs, Phase A, Rec	0 – 10600 VAR	0 - 32767
71	Instantaneous Uncompensated VARs, Phase B, Del	0 – 10600 VAR	0 - 32767
72	Instantaneous Uncompensated VARs, Phase B, Rec	0 – 10600 VAR	0 - 32767
73	Instantaneous Uncompensated VARs, Phase C, Del	0 – 10600 VAR	0 - 32767

Point Index	Analog Input Name/Description	Engineering Units Range	Scaled Range
74	Instantaneous Uncompensated VARs, Phase C, Rec	0 – 10600 VAR	0 - 32767
75	Instantaneous Uncompensated VARs, Poly, Del	0 – 31800 VAR	0 - 32767
76	Instantaneous Uncompensated VARs, Poly, Rec	0 – 31800 VAR	0 - 32767
77	Instantaneous Uncompensated VA, Phase A, Del	0 – 10600 VA	0 - 32767
78	Instantaneous Uncompensated VA, Phase A, Rec	0 – 10600 VA	0 - 32767
79	Instantaneous Uncompensated VA, Phase B, Del	0 – 10600 VA	0 - 32767
80	Instantaneous Uncompensated VA, Phase B, Rec	0 – 10600 VA	0 - 32767
81	Instantaneous Uncompensated VA, Phase C, Del	0 – 10600 VA	0 - 32767
82	Instantaneous Uncompensated VA, Phase C, Rec	0 – 10600 VA	0 - 32767
83	Instantaneous Uncompensated VA, Poly, Del	0 – 31800 VA	0 - 32767
84	Instantaneous Uncompensated VA, Poly, Rec	0 – 31800 VA	0 - 32767
85	Instantaneous Uncompensated PF, Phase A, Del	0 – 1.00	0 - 32767
86	Instantaneous Uncompensated PF, Phase A, Rec	0 – 1.00	0 - 32767
87	Instantaneous Uncompensated PF, Phase B, Del	0 – 1.00	0 - 32767
88	Instantaneous Uncompensated PF, Phase B, Rec	0 – 1.00	0 - 32767
89	Instantaneous Uncompensated PF, Phase C, Del	0 – 1.00	0 - 32767
90	Instantaneous Uncompensated PF, Phase C, Rec	0 – 1.00	0 - 32767
91	Instantaneous Uncompensated PF, Poly, Del	0 – 1.00	0 - 32767
92	Instantaneous Uncompensated PF, Poly, Rec	0 – 1.00	0 - 32767
93	Instantaneous Uncompensated Watts, Phase A, Bidirectional	-10600 to +10600 W	-32768 to +32767
94	Instantaneous Uncompensated Watts, Phase B, Bidirectional	-10600 to +10600 W	-32768 to +32767
95	Instantaneous Uncompensated Watts, Phase C, Bidirectional	-10600 to +10600 W	-32768 to +32767
96	Instantaneous Uncompensated Watts, Polyphase, Bidirectional	-31800 to +31800 W	-32768 to +32767
97	Instantaneous Uncompensated VARs, Phase A, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
98	Instantaneous Uncompensated VARs, Phase B, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
99	Instantaneous Uncompensated VARs, Phase C, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
100	Instantaneous Uncompensated VARs, Polyphase, Bidirectional	-31800 to +31800 VAR	-32768 to +32767

Events

The meter DNP implementation includes frozen counter event objects. These are implemented as Object 23 Var 5, 32-Bit frozen counter with time. These provide a time-stamped snapshot of the corresponding counters at the time of freeze. The meter has storage for 5 frozen event objects when all 64 points are configured (possibly more if less points are used). An event is generated at each register freeze. Each event includes all corresponding registers at the time the freeze occurred.

If event data is not desired, the generation of events can be disabled using JEMWare.

In the meter, all event data is permanently assigned to Class 1.

Time and Date

Time and Date (object 50) is supported both for read and write. Using JEMWare, you can configure the "Write Time Interval", which is the interval after which the meter will set the "Need Time" bit in the Internal Indications.

Configuration

JEMWare software must be used to set up the configurable parameters that relate to DNP 3.0 in the meter, as well as configurable point assignments for Object 20. Please refer to the section in this manual titled “Protocols” for detailed procedures.

APPENDIX B – MODBUS COMMUNICATIONS

INTRODUCTION

The MODBUS protocol defines a message structure that electronic communications equipment will recognize and use, regardless of the type of networks over which they communicate. It describes the procedure a host piece of equipment called the MASTER uses to request access to another device called the SLAVE, how it will respond to requests from other devices, and how errors will be detected and reported. A common format is defined for the layout and contents of message fields.

The MODBUS protocol has two distinct forms, RTU mode and ASCII mode. RTU mode essentially means binary mode, where each byte of information is transmitted as an actual 8-bit binary byte. ASCII mode packages each byte in two ASCII coded hexadecimal characters. In addition, the two modes use different methods to calculate their checksums and message packet boundaries. These methods are detailed later in this section.

Further information concerning MODBUS implementation standards can be found at the following website:

www.modicon.com/techpubs/toc7.html

The MODBUS Device Address, timeout, and communications parameters are configured via the *JEMWare* software. **The meter will always be a MODBUS slave device.**

COMMUNICATIONS

The following MODBUS communications parameters are configurable via *JEMWare:*

- ASCII or RTU mode
- 7 or 8 bit mode (ASCII only)
- Parity (Even/Odd/None)
- Baud Rate (1200,9600,19200,38400)
- RS-232 (full duplex) or RS-485 (half duplex) signal levels

SERIAL PORT CONNECTIONS

MODBUS Point-to-Point Connection Using RS232

This method is used for connecting the meter MODBUS directly to a MODBUS Master device. The transmit and receive data pins on the MODBUS host system may vary between pin 2 and pin 3 according to the type of equipment used. In applications where

an IBM compatible PC with a 9-pin D-Type connector is used, TXD is pin 3 and RXD is pin 2.

MODBUS Master	Direction	JEMStar I/O cable
DTE RXD or DCE TXD	←	BLUE/GREEN
DTE TXD or DCE RXD	→	BLUE/RED
Comm GND	—	PURPLE/WHITE

MODBUS Multidrop Connection Using RS485 (differential)

MODBUS Master	Direction	JemStar I/O cable
XMT/RCV -	↔	BLUE/RED
XMT/RCV+	↔	BLUE/GREEN

Notes:

- The meter does not implement hardware handshaking signals with RS-232 or RS-485 serial data.
- The MODBUS port is connected via a pigtail I/O cable for S-base and A-Base meters (wire colors shown above). See the section labeled "Serial Communications" for wiring details of Switchboard meters (terminal block connections). Refer to the section "Dual Communications Option" for connections if your meter has this feature.

DATA TRANSFERS USING MODBUS (RTU OR ASCII)

The meter MODBUS implementation will fully support all data transfers with the following commands:

Read Output Status (Function code 01)
Read Input Status (Function code 02)
Read Holding Registers (Function code 03)
Read Input Registers (Function code 04)
Force Single Coil (Function code 05)
Force Multiple Coils (Function code 15)
Preset Multiple Registers (Function code 16)

As implied by the **Read Holding Registers** command, all meter available data will be stored in 16-bit Holding Registers. However, these registers will either hold the High Order or Low Order 16 bits (word) of a 32-bit quantity. Whenever a 32-bit quantity is accessed, the registers containing both the High Order & Low Order words must be included in the request, or the command will be rejected.

The meter MODBUS interface can access data in either RTU or ASCII mode. The supported Register Sets and the MODBUS Function Codes (FC) used to retrieve the data are as follows.

Function Code (FC)	Register Set
01	Read Discrete Outputs
02	Read Discrete Inputs
03	Read Holding Registers (native data types)
04	Read Input Registers (Scaled and Cascaded)
05	Force Single Discrete Outputs
15	Force Multiple Discrete Outputs
16	Preset Multiple Holding Registers

LRC Calculation (ASCII mode)

When the meter MODBUS interface operates in ASCII mode, it uses LRC for error checking. The LRC value is one byte, contained in two ASCII characters. The LRC consists of the 2's complement of the byte sum of all the binary byte values (after each pair of ASCII coded hex characters are converted to a byte) of the Device Address through the last Data byte. Neither the Start of Message colon (':') nor the carriage return – line feed pair is included in the LRC calculation.

The LRC value is calculated by the transmitting device that appends the LRC to the message. The receiving device recalculates the LRC and compares it to the value in the message. If the values are not the same, the receiver ignores the message.

CRC Calculation (RTU mode)

The MODBUS interface also operates in RTU mode and uses CRC for error checking. The CRC value is two bytes, containing a 16 bit binary value. The CRC value is calculated by the transmitting device that appends the CRC to the message. The receiving device recalculates the CRC and compares it to the value in the message. If the values are not the same, the receiver will not process the message.
The CRC value is calculated according to the following procedure.

1. Initialize a 16 bit *CRC register* to 0xFFFF
2. Place the first 8 bit character from the message and place it into a *test register.*
3. Exclusive OR the *test character* with the *CRC register*, leaving the result in the *CRC register*.
4. The *CRC register* is shifted one bit toward the least significant bit, the least significant bit is saved into a *carry register*, and the most significant bit is zero filled.
5. If the old least significant bit was zero, go to step 6, if it was one, the *CRC register* is exclusive Ored with 0xa001.
6. Repeat steps 4 and 5, seven times.
7. Using each successive character in the message, repeat steps 3 through 6.
8. The CRC is the value in the CRC register.
9. The CRC value is placed into the message in hexadecimal format with the most significant byte going into the first CRC byte and the least significant byte going into the last CRC byte.

RTU MESSAGE FRAMING

In RTU mode, messages start with a silence interval of at least 3.5 character times. If the SLAVE device can monitor the network bus continuously, this silence interval can be used to identify the beginning of a new message, with the first field of a new message being the Device Address. Devices that use the silence interval to detect a new message expect the entire message frame to be transmitted continuously, and do not allow a silent interval of more than 1.5 characters to occur before completion of the entire message.

The meter MODBUS implementation does not monitor the network bus continuously, and thus will not detect any silence interval. Consequently, the strict rules about silence intervals will not be enforced. The start of a new message will be detected using a synchronization algorithm.

Typical meter RTU Queries:

Query Field	**Read Holding Regs**	**Force Single Coil**
Device Address	05	05
Function	03	05
Register Address	00 04	00 01
# Regs/Preset Value	00 06	FF 00
Error Check (CRC)	XX XX	XX XX

ASCII MESSAGE FRAMING

In ASCII mode, messages start with a 'colon' (:) character (ASCII 3A hex) and end with a 'carriage return – line feed' pair (ASCII 0D & 0A hex). The carriage return – line feed pair is optional.

The allowable characters transmitted for all other fields are hexadecimal 0-9 and A-F. SLAVE Devices monitor the network bus continuously for the colon character. When one is received, each device decodes the next field (the address field) to determine if the query is directed at it.

Intervals of up to one second can elapse between characters within the message. If a greater interval occurs, the receiving device assumes that an error has occurred.

Typical meter ASCII Queries:

Query Field	**Read Holding Regs**	**Force Single Coil**
Start character	**':'**	**':'**
Device Address	'0' '5'	'0' '5'
Function	'0' '3'	'0' '5'
Register Address	'0' '0' '0' '4'	'0' '0' '0' '1'
# Regs/Preset Value	'0' '0' '0' '6'	'F' 'F' '0' '0'
Error Check (LRC)	'X' 'X'	'X' 'X'
End characters	**CR LF**	**CR LF**

Communication Errors

Communication errors, consisting of an illegal character in ASCII mode, a Parity, LRC or CRC error, will result in the message causing the error to be ignored by the meter. The MASTER Device will timeout and retransmit the message.

Exception Responses

The meter MODBUS implementation can produce 1 of 3 possible exceptions:

- **Illegal Function** (Exception Code 01)
- **Illegal Data Address** (Exception Code 02)
- **Illegal Data Value** (Exception Code 03)

An **Illegal Function** is self-explanatory. If the meter receives a MODBUS query that contains a function that it does not support (anything other than 01, 02 03, 04, 05, 15 or 16), an Illegal Function (Exception 01) will be returned.

The **Data Address** is the *Holding Register* or *Input Register* address. For example, an Illegal Data Address for a Function 03 command would be either a register value greater that 0xE7 or a register value that begins at the second word (Lo Order Word) of a 32-bit quantity. An Illegal Data Address for a Function 06 command would be any register other that 0x16.

The meaning of the **Data Value** depends upon the command. The Data Value for a Function 03 command is the number of Holding registers requested, starting with the first (Data Address) register. If the sum of the first register and the number of registers is either greater that 0x3F, or results in the request of only one word of any 32-bit quantity, an Illegal Data Value exception is generated.

An Exception Response is the meter's Device Address, the function value with the High Order Bit set to 1, and the Exception Code followed by either the LRC (ASCII mode) or the CRC (RTU mode). For example, in RTU mode an **Illegal Data Address** exception to a function 03 request would be:

Exception Byte	Contents	Example
1	Meter Device Address	5
2	Marked Function Code	83
3	Exception Code	02
4	High Order Byte CRC	XX
5	Low Order Byte CRC	XX

TIMEOUTS

RTU Mode

The timeout period from the reception of a matching Device Address until that message is completed is software assignable using *JEMWare* software. If a timeout occurs, the portion of the message already processed is discarded and the meter will again look for a matching Device Address. The default timeout is 1 second, but can be configured for 100 to 65000 mS.

ASCII Mode

In ASCII mode, the timeout is meaningless to the meter since it is always the SLAVE Device. Whenever a colon (**':'**) character is encountered, the MODBUS logic automatically interprets it as the start of a new message and discards any portion of the previous message. Similarly, if a timeout were to occur, any portion of the previous message would be discarded and the logic would wait for the next colon (**':'**) character, which essentially accomplishes the same purpose.

However, since the Carriage Return – Line Feed pair is optional at the end of a query message, a 1 second timer is automatically started at the end of the CRC to allow for these optional characters. If the Carriage Return – Line Feed pair is not received at the end of this 1 second timeout, the logic proceeds with processing the message.

REGISTER PRESETS

In the meter Modbus implementation, meter registers (Normal and Alternate) may be cleared or set to a given value with the Preset Multiple Registers command (Function Code 16). Note that the start register specified in the command must be the Hi-order register number of the appropriate register pair, and there cannot be more than 120 registers per request. In addition, **Allow Register Presets** must be specifically enabled in the meter with JEMWare (Go to menu Meter Settings/Protocols/Modbus). If not enabled, Modbus exception 01 (illegal function) will be returned if register presets are attempted.

Digital Output Control

The meter digital outputs may be forced to a high or low state via MODBUS using either the Force Single coil (Func 05) or Force Multiple Coils (Func 15) command. To use this feature, **Allow Digital Outputs Control** must be enabled in the meter with JemWare. If not enabled, Modbus Exception 01 (Illegal Function) will be returned when this is attempted.

MODBUS REGISTER MAPS

The meter contains 4 Discrete Output registers, 39 Discrete Input Registers, 232 Holding registers, and 53 Input registers. All Holding Registers contain 32-bit data values in consecutive pairs. Thus, the individual Holding Registers 40001 through 40232 will contain either the High Order Word or the Low Order Word of a 32-bit data type.

The Input Registers of the meter are stored as signed and unsigned 16-bit integers. These integers represent a value in some Engineering Unit, with a 'Scale Factor' of some number of decimal places.

The meter register values are visible via MODBUS as MODBUS Holding Registers. The 32-bit register values are mapped as two consecutive MODBUS registers, with the High Order 16-bit segment first. Any or all of these MODBUS Registers can be accessed via the MODBUS Read Holding Registers (03) command, however each request must be limited to 120 Modbus registers maximum.

The following pages show the MODBUS memory map in table form.

Read Output (Coil) Status (function 01) Point list

MODBUS Address	PLC Address	Register Contents
REG 00	10001	Digital Output 1
REG 01	10002	Digital Output 2
REG 03	10003	Digital Output 3
REG 04	10004	Digital Output 4

Read Input Status (function 02) Point List

MODBUS Address	PLC Address	Register Contents
REG 00	20001	Contact Input 1 status
REG 01	20002	Contact Input 2 status
REG 02	20003	Voltages out of sequence alarm
REG 03	20004	Neutral over current alarm
REG 04	20005	Neutral current swell alarm
REG 05	20006	Phase C under current alarm
REG 06	20007	Phase C over current alarm
REG 07	20008	Phase C power reversed alarm
REG 08	20009	Phase C PF high alarm
REG 09	20010	Phase C PF low alarm
REG 0A	20011	Phase C voltage sag alarm
REG 0B	20012	Phase C under voltage alarm
REG 0C	20013	Phase C voltage swell alarm
REG 0D	20014	Phase C over voltage alarm
REG 0E	20015	Phase B under current alarm
REG 0F	20016	Phase B over current alarm
REG 10	20017	Phase B power reversed alarm
REG 11	20018	Phase B PF high alarm
REG 12	20019	Phase B PF low alarm
REG 13	20020	Phase B voltage sag alarm
REG 14	20021	Phase B under voltage alarm
REG 15	20022	Phase B voltage swell alarm
REG 16	20023	Phase B over voltage alarm
REG 17	20024	Phase A under current alarm
REG 18	20025	Phase A over current alarm
REG 19	20026	Phase A power reversed alarm
REG 1A	20027	Phase A PF high alarm
REG 1B	20028	Phase A PF low alarm
REG 1C	20029	Phase A voltage sag alarm
REG 1D	20030	Phase A under voltage alarm
REG 1E	20031	Phase A voltage swell alarm
REG 1F	20032	Phase A over voltage alarm
REG 20	20033	Threshold alarm 1
REG 21	20034	Threshold alarm 2
REG 22	20035	Threshold alarm 3
REG 23	20036	Threshold alarm 4
REG 24	20037	Phase A potential status
REG 25	20038	Phase B potential status
REG 26	20039	Phase C potential status

Read Holding Registers (function 03) Point List

MODBUS Address	PLC Address	Signed/ Unsigned	Scale Factor	Register Contents
REG 00	40001	S	1000	PT Ratio Hi
REG 01	40002	S	1000	PT Ratio Lo
REG 02	40003	S	1000	CT Ratio Hi
REG 03	40004	S	1000	CT Ratio Lo
REG 04	40005			Reserved
REG 05	40006			Reserved
REG 06	40007			Reserved
REG 07	40008			Reserved
REG 08	40009			Reserved
REG 09	40010			Reserved
REG 0A	40011	S	1000	Normal Reg 0 Hi
REG 0B	40012	S	1000	Normal Reg 0 Lo
REG 0C	40013	S	1000	Normal Reg 1 Hi
REG 0D	40014	S	1000	Normal Reg 1 Lo
REG 0E	40015	S	1000	Normal Reg 2 Hi
REG 0F	40016	S	1000	Normal Reg 2 Lo
REG 10	40017	S	1000	Normal Reg 3 Hi
REG 11	40018	S	1000	Normal Reg 3 Lo
REG 12	40019	S	1000	Normal Reg 4 Hi
REG 13	40020	S	1000	Normal Reg 4 Lo
REG 14	40021	S	1000	Normal Reg 5 Hi
REG 15	40022	S	1000	Normal Reg 5 Lo
REG 16	40023	S	1000	Normal Reg 6 Hi
REG 17	40024	S	1000	Normal Reg 6 Lo
REG 18	40025	S	1000	Normal Reg 7 Hi
REG 19	40026	S	1000	Normal Reg 7 Lo
REG 1A	40027	S	1000	Normal Reg 8 Hi
REG 1B	40028	S	1000	Normal Reg 8 Lo
REG 1C	40029	S	1000	Normal Reg 9 Hi
REG 1D	40030	S	1000	Normal Reg 9 Lo
REG 1E	40031	S	1000	Normal Reg 10 Hi
REG 1F	40032	S	1000	Normal Reg 10 Lo
REG 20	40033	S	1000	Normal Reg 11 Hi
REG 21	40034	S	1000	Normal Reg 11 Lo
REG 22	40035	S	1000	Normal Reg 12 Hi
REG 23	40036	S	1000	Normal Reg 12 Lo
REG 24	40037	S	1000	Normal Reg 13 Hi
REG 25	40038	S	1000	Normal Reg 13 Lo
REG 26	40039	S	1000	Normal Reg 14 Hi
REG 27	40040	S	1000	Normal Reg 14 Lo
REG 28	40041	S	1000	Normal Reg 15 Hi
REG 29	40042	S	1000	Normal Reg 15 Lo
REG 2A	40043	S	1000	Normal Reg 16 Hi
REG 2B	40044	S	1000	Normal Reg 16 Lo

MODBUS Address	PLC Address	Signed/ Unsigned	Scale Factor	Register Contents
REG 2C	40045	S	1000	Normal Reg 17 Hi
REG 2D	40046	S	1000	Normal Reg 17 Lo
REG 2E	40047	S	1000	Normal Reg 18 Hi
REG 2F	40048	S	1000	Normal Reg 18 Lo
REG 30	40049	S	1000	Normal Reg 19 Hi
REG 31	40050	S	1000	Normal Reg 19 Lo
REG 32	40051	S	1000	Normal Reg 20 Hi
REG 33	40052	S	1000	Normal Reg 20 Lo
REG 34	40053	S	1000	Normal Reg 21 Hi
REG 35	40054	S	1000	Normal Reg 21 Lo
REG 36	40055	S	1000	Normal Reg 22 Hi
REG 37	40056	S	1000	Normal Reg 22 Lo
REG 38	40057	S	1000	Normal Reg 23 Hi
REG 39	40058	S	1000	Normal Reg 23 Lo
REG 3A	40059	S	1000	Normal Reg 24 Hi
REG 3B	40060	S	1000	Normal Reg 24 Lo
REG 3C	40061	S	1000	Normal Reg 25 Hi
REG 3D	40062	S	1000	Normal Reg 25 Lo
REG 3E	40063	S	1000	Normal Reg 26 Hi
REG 3F	40064	S	1000	Normal Reg 26 Lo
REG 40	40065	S	1000	Normal Reg 27 Hi
REG 41	40066	S	1000	Normal Reg 27 Lo
REG 42	40067	S	1000	Normal Reg 28 Hi
REG 43	40068	S	1000	Normal Reg 28 Lo
REG 44	40069	S	1000	Normal Reg 29 Hi
REG 45	40070	S	1000	Normal Reg 29 Lo
REG 46	40071	S	1000	Normal Reg 30 Hi
REG 47	40072	S	1000	Normal Reg 30 Lo
REG 48	40073	S	1000	Normal Reg 31 Hi
REG 49	40074	S	1000	Normal Reg 31 Lo
REG 4A	40075	S	1000	Normal Reg 32 Hi
REG 4B	40076	S	1000	Normal Reg 32 Lo
REG 4C	40077	S	1000	Normal Reg 33 Hi
REG 4D	40078	S	1000	Normal Reg 33 Lo
REG 4E	40079	S	1000	Normal Reg 34 Hi
REG 4F	40080	S	1000	Normal Reg 34 Lo
REG 50	40081	S	1000	Normal Reg 35 Hi
REG 51	40082	S	1000	Normal Reg 35 Lo
REG 52	40083	S	1000	Normal Reg 36 Hi
REG 53	40084	S	1000	Normal Reg 36 Lo
REG 54	40085	S	1000	Normal Reg 37 Hi
REG 55	40086	S	1000	Normal Reg 37 Lo
REG 56	40087	S	1000	Normal Reg 38 Hi
REG 57	40088	S	1000	Normal Reg 38 Lo
REG 58	40089	S	1000	Normal Reg 39 Hi
REG 59	40090	S	1000	Normal Reg 39 Lo

MODBUS Address	PLC Address	Signed/ Unsigned	Scale Factor	Register Contents
REG 5A	40091	S	1000	Normal Reg 40 Hi
REG 5B	40092	S	1000	Normal Reg 40 Lo
REG 5C	40093	S	1000	Normal Reg 41 Hi
REG 5D	40094	S	1000	Normal Reg 41 Lo
REG 5E	40095	S	1000	Normal Reg 42 Hi
REG 5F	40096	S	1000	Normal Reg 42 Lo
REG 60	40097	S	1000	Normal Reg 43 Hi
REG 61	40098	S	1000	Normal Reg 43 Lo
REG 62	40099	S	1000	Normal Reg 44 Hi
REG 63	40100	S	1000	Normal Reg 44 Lo
REG 64	40101	S	1000	Normal Reg 45 Hi
REG 65	40102	S	1000	Normal Reg 45 Lo
REG 66	40103	S	1000	Normal Reg 46 Hi
REG 67	40104	S	1000	Normal Reg 46 Lo
REG 68	40105	S	1000	Normal Reg 47 Hi
REG 69	40106	S	1000	Normal Reg 47 Lo
REG 6A	40107	S	1000	Normal Reg 48 Hi
REG 6B	40108	S	1000	Normal Reg 48 Lo
REG 6C	40109	S	1000	Normal Reg 49 Hi
REG 6D	40110	S	1000	Normal Reg 49 Lo
REG 6E	40111	S	1000	Alternate Reg 0 Hi
REG 6F	40112	S	1000	Alternate Reg 0 Lo
REG 70	40113	S	1000	Alternate Reg 1 Hi
REG 71	40114	S	1000	Alternate Reg 1 Lo
REG 72	40115	S	1000	Alternate Reg 2 Hi
REG 73	40116	S	1000	Alternate Reg 2 Lo
REG 74	40117	S	1000	Alternate Reg 3 Hi
REG 75	40118	S	1000	Alternate Reg 3 Lo
REG 76	40119	S	1000	Alternate Reg 4 Hi
REG 77	40120	S	1000	Alternate Reg 4 Lo
REG 78	40121	S	1000	Alternate Reg 5 Hi
REG 79	40122	S	1000	Alternate Reg 5 Lo
REG 7A	40123	S	1000	Alternate Reg 6 Hi
REG 7B	40124	S	1000	Alternate Reg 6 Lo
REG 7C	40125	S	1000	Alternate Reg 7 Hi
REG 7D	40126	S	1000	Alternate Reg 7 Lo
REG 7E	40127	S	1000	Alternate Reg 8 Hi
REG 7F	40128	S	1000	Alternate Reg 8 Lo
REG 80	40129	S	1000	Alternate Reg 9 Hi
REG 81	40130	S	1000	Alternate Reg 9 Lo
REG 82	40131	S	1000	Alternate Reg 10 Hi
REG 83	40132	S	1000	Alternate Reg 10 Lo
REG 84	40133	S	1000	Alternate Reg 11 Hi
REG 85	40134	S	1000	Alternate Reg 11 Lo
REG 86	40135	S	1000	Alternate Reg 12 Hi
REG 87	40136	S	1000	Alternate Reg 12 Lo

MODBUS Address	PLC Address	Signed/ Unsigned	Scale Factor	Register Contents
REG 88	40137	S	1000	Alternate Reg 13 Hi
REG 89	40138	S	1000	Alternate Reg 13 Lo
REG 8A	40139	S	1000	Alternate Reg 14 Hi
REG 8B	40140	S	1000	Alternate Reg 14 Lo
REG 8C	40141	S	1000	Alternate Reg 15 Hi
REG 8D	40142	S	1000	Alternate Reg 15 Lo
REG 8E	40143	S	1000	Alternate Reg 16 Hi
REG 8F	40144	S	1000	Alternate Reg 16 Lo
REG 90	40145	S	1000	Alternate Reg 17 Hi
REG 91	40146	S	1000	Alternate Reg 17 Lo
REG 92	40147	S	1000	Alternate Reg 18 Hi
REG 93	40148	S	1000	Alternate Reg 18 Lo
REG 94	40149	S	1000	Alternate Reg 19 Hi
REG 95	40150	S	1000	Alternate Reg 19 Lo
REG 96	40151	S	1000	Alternate Reg 20 Hi
REG 97	40152	S	1000	Alternate Reg 20 Lo
REG 98	40153	S	1000	Alternate Reg 21 Hi
REG 99	40154	S	1000	Alternate Reg 21 Lo
REG 9A	40155	S	1000	Alternate Reg 22 Hi
REG 9B	40156	S	1000	Alternate Reg 22 Lo
REG 9C	40157	S	1000	Alternate Reg 23 Hi
REG 9D	40158	S	1000	Alternate Reg 23 Lo
REG 9E	40159	S	1000	Alternate Reg 24 Hi
REG 9F	40160	S	1000	Alternate Reg 24 Lo
REG A0	40161	S	1000	Alternate Reg 25 Hi
REG A1	40162	S	1000	Alternate Reg 25 Lo
REG A2	40163	S	1000	Alternate Reg 26 Hi
REG A3	40164	S	1000	Alternate Reg 26 Lo
REG A4	40165	S	1000	Alternate Reg 27 Hi
REG A5	40166	S	1000	Alternate Reg 27 Lo
REG A6	40167	S	1000	Alternate Reg 28 Hi
REG A7	40168	S	1000	Alternate Reg 28 Lo
REG A8	40169	S	1000	Alternate Reg 29 Hi
REG A9	40170	S	1000	Alternate Reg 29 Lo
REG AA	40171	S	1000	Alternate Reg 30 Hi
REG AB	40172	S	1000	Alternate Reg 30 Lo
REG AC	40173	S	1000	Alternate Reg 31 Hi
REG AD	40174	S	1000	Alternate Reg 31 Lo
REG AE	40175	S	1000	Alternate Reg 32 Hi
REG AF	40176	S	1000	Alternate Reg 32 Lo
REG B0	40177	S	1000	Alternate Reg 33 Hi
REG B1	40178	S	1000	Alternate Reg 33 Lo
REG B2	40179	S	1000	Alternate Reg 34 Hi
REG B3	40180	S	1000	Alternate Reg 34 Lo
REG B4	40181	S	1000	Alternate Reg 35 Hi
REG B5	40182	S	1000	Alternate Reg 35 Lo

MODBUS Address	PLC Address	Signed/ Unsigned	Scale Factor	Register Contents
REG B6	40183	S	1000	Alternate Reg 36 Hi
REG B7	40184	S	1000	Alternate Reg 36 Lo
REG B8	40185	S	1000	Alternate Reg 37 Hi
REG B9	40186	S	1000	Alternate Reg 37 Lo
REG BA	40187	S	1000	Alternate Reg 38 Hi
REG BB	40188	S	1000	Alternate Reg 38 Lo
REG BC	40189	S	1000	Alternate Reg 39 Hi
REG BD	40190	S	1000	Alternate Reg 39 Lo
REG BE	40191	S	1000	Alternate Reg 40 Hi
REG BF	40192	S	1000	Alternate Reg 40 Lo
REG C0	40193	S	1000	Alternate Reg 41 Hi
REG C1	40194	S	1000	Alternate Reg 41 Lo
REG C2	40195	S	1000	Alternate Reg 42 Hi
REG C3	40196	S	1000	Alternate Reg 42 Lo
REG C4	40197	S	1000	Alternate Reg 43 Hi
REG C5	40198	S	1000	Alternate Reg 43 Lo
REG C6	40199	S	1000	Alternate Reg 44 Hi
REG C7	40200	S	1000	Alternate Reg 44 Lo
REG C8	40201	S	1000	Alternate Reg 45 Hi
REG C9	40202	S	1000	Alternate Reg 45 Lo
REG CA	40203	S	1000	Alternate Reg 46 Hi
REG CB	40204	S	1000	Alternate Reg 46 Lo
REG CC	40205	S	1000	Alternate Reg 47 Hi
REG CD	40206	S	1000	Alternate Reg 47 Lo
REG CE	40207	S	1000	Alternate Reg 48 Hi
REG CF	40208	S	1000	Alternate Reg 48 Lo
REG D0	40209	S	1000	Alternate Reg 49 Hi
REG D1	40210	S	1000	Alternate Reg 49 Lo
REG D2	40211	U	1000	Sys Wh Del Hi
REG D3	40212	U	1000	Sys Wh Del Lo
REG D4	40213	U	1000	Sys Wh Rec Hi
REG D5	40214	U	1000	Sys Wh Rec Lo
REG D6	40215	U	1000	Sys VARh Del Hi
REG D7	40216	U	1000	Sys VARh Del Lo
REG D8	40217	U	1000	Sys VARh Rec Hi
REG D9	40218	U	1000	Sys VARh Rec Lo
REG DA	40219	U	1000	Sys VAh Del Hi
REG DB	40220	U	1000	Sys VAh Del Lo
REG DC	40221	U	1000	Sys VAh Rec Hi
REG DD	40222	U	1000	Sys VAh Rec Lo
REG DE	40223	U	1000	Sys Qh Del Hi
REG DF	40224	U	1000	Sys Qh Del Lo
REG E0	40225	U	1000	Sys Qh Rec Hi
REG E1	40226	U	1000	Sys Qh Rec Lo
REG E2	40227	U	1000	Sys Amph Hi
REG E3	40228	U	1000	Sys Amph Lo

MODBUS Address	PLC Address	Signed/ Unsigned	Scale Factor	Register Contents
REG E4	40229	U	1000	Sys V2H Hi
REG E5	40230	U	1000	Sys V2H Lo
REG E6	40231	U	1000	Sys A2H Hi
REG E7	40232	U	1000	Sys A2H Lo

Read Input Registers (function 04) Point List

MODBUS Address	PLC Address	Register Contents	Engineering Units Range	Scaled Range
REG 00	30001	Instantaneous Watts, Phase A, Del	0 – 10600 W	0 - 32767
REG 01	30002	Instantaneous Watts, Phase A, Rec	0 – 10600 W	0 - 32767
REG 02	30003	Instantaneous Watts, Phase B, Del	0 – 10600 W	0 - 32767
REG 03	30004	Instantaneous Watts, Phase B, Rec	0 – 10600 W	0 - 32767
REG 04	30005	Instantaneous Watts, Phase C, Del	0 – 10600 W	0 - 32767
REG 05	30006	Instantaneous Watts, Phase C, Rec	0 – 10600 W	0 - 32767
REG 06	30007	Instantaneous Watts, Poly, Del	0 – 31800 W	0 - 32767
REG 07	30008	Instantaneous Watts, Poly, Rec	0 – 31800 W	0 - 32767
REG 08	30009	Instantaneous VARs, Phase A, Del	0 – 10600 VAR	0 - 32767
REG 09	30010	Instantaneous VARs, Phase A, Rec	0 – 10600 VAR	0 - 32767
REG 0A	30011	Instantaneous VARs, Phase B, Del	0 – 10600 VAR	0 - 32767
REG 0B	30012	Instantaneous VARs, Phase B, Rec	0 – 10600 VAR	0 - 32767
REG 0C	30013	Instantaneous VARs, Phase C, Del	0 – 10600 VAR	0 - 32767
REG 0D	30014	Instantaneous VARs, Phase C, Rec	0 – 10600 VAR	0 - 32767
REG 0E	30015	Instantaneous VARs, Poly, Del	0 – 31800 VAR	0 - 32767
REG 0F	30016	Instantaneous VARs, Poly, Rec	0 – 31800 VAR	0 - 32767
REG 10	30017	Instantaneous VA, Phase A, Del	0 – 10600 VA	0 - 32767
REG 11	30018	Instantaneous VA, Phase A, Rec	0 – 10600 VA	0 - 32767
REG 12	30019	Instantaneous VA, Phase B, Del	0 – 10600 VA	0 - 32767
REG 13	30020	Instantaneous VA, Phase B, Rec	0 – 10600 VA	0 - 32767
REG 14	30021	Instantaneous VA, Phase C, Del	0 – 10600 VA	0 - 32767
REG 15	30022	Instantaneous VA, Phase C, Rec	0 – 10600 VA	0 - 32767
REG 16	30023	Instantaneous VA, Poly, Del	0 – 31800 VA	0 - 32767
REG 17	30024	Instantaneous VA, Poly, Rec	0 – 31800 VA	0 - 32767
REG 18	30025	Instantaneous Amps, Phase A	0 –20 A	0 - 32767
REG 19	30026	Instantaneous Amps, Phase B	0 –20 A	0 - 32767
REG 1A	30027	Instantaneous Amps, Phase C	0 –20 A	0 - 32767
REG 1B	30028	Instantaneous Amps, Neutral	0 –20 A	0 - 32767
REG 1C	30029	Instantaneous Volts, Phase A	0 – 530 V	0 - 32767
REG 1D	30030	Instantaneous Volts, Phase B	0 – 530 V	0 - 32767
REG 1E	30031	Instantaneous Volts, Phase C	0 – 530 V	0 - 32767
REG 1F	30032	Frequency	0 – 100 Hz	0 - 32767
REG 20	30033	Instantaneous PF, Phase A, Del	0 – 1.00	0 - 32767
REG 21	30034	Instantaneous PF, Phase A, Rec	0 – 1.00	0 - 32767
REG 22	30035	Instantaneous PF, Phase B, Del	0 – 1.00	0 - 32767
REG 23	30036	Instantaneous PF, Phase B, Rec	0 – 1.00	0 - 32767
REG 24	30037	Instantaneous PF, Phase C, Del	0 – 1.00	0 - 32767
REG 25	30038	Instantaneous PF, Phase C, Rec	0 – 1.00	0 - 32767
REG 26	30039	Instantaneous PF, Poly, Del	0 – 1.00	0 - 32767
REG 27	30040	Instantaneous PF, Poly, Rec	0 – 1.00	0 - 32767
REG 28	30041	Volts THD, Phase A	0 – 100 %	0 - 32767
REG 29	30042	Volts THD, Phase B	0 – 100 %	0 - 32767
REG 2A	30043	Volts THD, Phase C	0 – 100 %	0 - 32767

MODBUS Address	PLC Address	Register Contents	Engineering Units Range	Scaled Range
REG 2B	30044	Amps THD, Phase A	0 – 100 %	0 - 32767
REG 2C	30045	Amps THD, Phase B	0 – 100 %	0 - 32767
REG 2D	30046	Amps THD, Phase C	0 – 100 %	0 - 32767
REG 2E	30047	$Volts^2$ Phase A	0 – 280900 V^2	0 - 32767
REG 2F	30048	$Volts^2$ Phase B	0 – 280900 V^2	0 - 32767
REG 30	30049	$Volts^2$ Phase C	0 – 280900 V^2	0 - 32767
REG 31	30050	$Amps^2$ Phase A	0 – 400 A^2	0 - 32767
REG 32	30051	$Amps^2$ Phase B	0 – 400 A^2	0 - 32767
REG 33	30052	$Amps^2$ Phase C	0 – 400 A^2	0 - 32767
REG 34	30053	$Amps^2$ Poly	0 – 1200 A^2	0 - 32767
REG 35	30054	Instantaneous Watts, Phase A, Bidirectional	-10600 to +10600W	-32768 to +32767
REG 36	30055	Instantaneous Watts, Phase B, Bidirectional	-10600 to +10600 W	-32768 to +32767
REG 37	30056	Instantaneous Watts, Phase C, Bidirectional	-10600 to +10600 W	-32768 to +32767
REG 38	30057	Instantaneous Watts, Polyphase, Bidirectional	-31800 to +31800 W	-32768 to +32767
REG 39	30058	Instantaneous VARs, Phase A, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
REG 3A	30059	Instantaneous VARs, Phase B, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
REG 3B	30060	Instantaneous VARs, Phase C, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
REG 3C	30061	Instantaneous VARs, Polyphase, Bidirectional	-31800 to +31800 VAR	-32768 to +32767
REG 3D	30062	Instantaneous Uncompensated Watts, Phase A, Del	0 – 10600 W	0 - 32767
REG 3E	30063	Instantaneous Uncompensated Watts, Phase A, Rec	0 – 10600 W	0 - 32767
REG 3F	30064	Instantaneous Uncompensated Watts, Phase B, Del	0 – 10600 W	0 - 32767
REG 40	30065	Instantaneous Uncompensated Watts, Phase B, Rec	0 – 10600 W	0 - 32767
REG 41	30066	Instantaneous Uncompensated Watts, Phase C, Del	0 – 10600 W	0 - 32767
REG 42	30067	Instantaneous Uncompensated Watts, Phase C, Rec	0 – 10600 W	0 - 32767
REG 43	30068	Instantaneous Uncompensated Watts, Poly, Del	0 – 31800 W	0 - 32767
REG 44	30069	Instantaneous Uncompensated Watts, Poly, Rec	0 – 31800 W	0 - 32767
REG 45	30070	Instantaneous Uncompensated VARs, Phase A, Del	0 – 10600 VAR	0 - 32767
REG 46	30071	Instantaneous Uncompensated VARs, Phase A, Rec	0 – 10600 VAR	0 - 32767
REG 47	30072	Instantaneous Uncompensated VARs, Phase B, Del	0 – 10600 VAR	0 - 32767
REG 48	30073	Instantaneous Uncompensated VARs, Phase B, Rec	0 – 10600 VAR	0 - 32767

MODBUS Address	PLC Address	Register Contents	Engineering Units Range	Scaled Range
REG 49	30074	Instantaneous Uncompensated VARs, Phase C, Del	0 – 10600 VAR	0 - 32767
REG 4A	30075	Instantaneous Uncompensated VARs, Phase C, Rec	0 – 10600 VAR	0 - 32767
REG 4B	30076	Instantaneous Uncompensated VARs, Poly, Del	0 – 31800 VAR	0 - 32767
REG 4C	30077	Instantaneous Uncompensated VARs, Poly, Rec	0 – 31800 VAR	0 - 32767
REG 4D	30078	Instantaneous Uncompensated VA, Phase A, Del	0 – 10600 VA	0 - 32767
REG 4E	30079	Instantaneous Uncompensated VA, Phase A, Rec	0 – 10600 VA	0 - 32767
REG 4F	30080	Instantaneous Uncompensated VA, Phase B, Del	0 – 10600 VA	0 - 32767
REG 50	30081	Instantaneous Uncompensated VA, Phase B, Rec	0 – 10600 VA	0 - 32767
REG 51	30082	Instantaneous Uncompensated VA, Phase C, Del	0 – 10600 VA	0 - 32767
REG 52	30083	Instantaneous Uncompensated VA, Phase C, Rec	0 – 10600 VA	0 - 32767
REG 53	30084	Instantaneous Uncompensated VA, Poly, Del	0 – 31800 VA	0 - 32767
REG 54	30085	Instantaneous Uncompensated VA, Poly, Rec	0 – 31800 VA	0 - 32767
REG 55	30086	Instantaneous Uncompensated PF, Phase A, Del	0 – 1.00	0 - 32767
REG 56	30087	Instantaneous Uncompensated PF, Phase A, Rec	0 – 1.00	0 - 32767
REG 57	30088	Instantaneous Uncompensated PF, Phase B, Del	0 – 1.00	0 - 32767
REG 58	30089	Instantaneous Uncompensated PF, Phase B, Rec	0 – 1.00	0 - 32767
REG 59	30090	Instantaneous Uncompensated PF, Phase C, Del	0 – 1.00	0 - 32767
REG 5A	30091	Instantaneous Uncompensated PF, Phase C, Rec	0 – 1.00	0 - 32767
REG 5B	30092	Instantaneous Uncompensated PF, Poly, Del	0 – 1.00	0 - 32767
REG 5C	30093	Instantaneous Uncompensated PF, Poly, Rec	0 – 1.00	0 - 32767
REG 5D	30094	Instantaneous Uncompensated Watts, Phase A, Bidirectional	-10600 to +10600W	-32768 to +32767
REG 5E	30095	Instantaneous Uncompensated Watts, Phase B, Bidirectional	-10600 to +10600 W	-32768 to +32767
REG 5F	30096	Instantaneous Uncompensated Watts, Phase C, Bidirectional	-10600 to +10600 W	-32768 to +32767
REG 60	30097	Instantaneous Uncompensated Watts, Polyphase, Bidirectional	-31800 to +31800 W	-32768 to +32767
REG 61	30098	Instantaneous Uncompensated VARs, Phase A, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
REG 62	30099	Instantaneous Uncompensated VARs, Phase B, Bidirectional	-10600 to +10600 VAR	-32768 to +32767
REG 63	30100	Instantaneous Uncompensated VARs,	-10600 to	-32768 to

MODBUS Address	PLC Address	Register Contents	Engineering Units Range	Scaled Range
		Phase C, Bidirectional	+10600 VAR	+32767
REG 64	30101	Instantaneous Uncompensated VARs, Polyphase, Bidirectional	-31800 to +31800 VAR	-32768 to +32767

Extended Holding Registers (function 03)

The meter contains a number of Holding Registers that facilitate its use in energy monitoring and management systems and to provide limited access to Load Profile data. This section describes those registers and their interpretation. They are read using Function Code 03, the same as the basic Holding Registers.

MODBUS Register	Meter Parameter	Units	Format	Number of Registers
	Instantaneous			
1000	Amps, phase A	Primary milli-amps	Long	2
1002	Amps, phase B	Primary milli-amps	Long	2
1004	Amps, phase C	Primary milli-amps	Long	2
1006	Amps, phase N	Primary milli-amps	Long	2
1008	Amps polyphase	Primary milli-amps	Long	2
1010	Volts, L-L, phase A-B	Primary milli-amps	Long	2
1012	Volts, L-L, phase B-C	Primary milli-volts	Long	2
1014	Volts, L-L, phase C-A	Primary milli-volts	Long	2
1016	Volts, L-L, polyphase	Primary milli-volts	Long	2
1018	Volts, L-N, phase A-N	Primary milli-volts	Long	2
1020	Volts, L-N, phase B-N	Primary milli-volts	Long	2
1022	Volts, L-N, phase C-N	Primary milli-volts	Long	2
1024	Volts, L-N, polyphase	Primary milli-volts	Long	2
1026	Frequency	HZ.hundredths	Int	1
1027	PF Delivered, phase A	PF.milli	Int	1
1028	PF Delivered, phase B	PF.milli	Int	1
1029	PF Delivered, phase C	PF.milli	Int	1
1030	PF Delivered, polyphase	PF.milli	Int	1
1031	PF Received, phase A	PF.milli	Int	1
1032	PF Received, phase B	PF.milli	Int	1
1033	PF Received, phase C	PF.milli	Int	1
1034	PF Received, polyphase	PF.milli	Int	1
1035	THD, Amps, phase A	percent. milli	Long	2

1037	THD, Amps, phase B	percent. milli	Long	2
1039	THD, Amps, phase C	percent. milli	Long	2
1041	THD, Volts, phase A-N	percent. milli	Long	2
1043	THD, Volts, phase B-N	percent. milli	Long	2
1045	THD, Volts, phase C-N	percent. milli	Long	2
1047	THD, Volts, phase A-B	percent. milli	Long	2
1049	THD, Volts, phase B-C	percent. milli	Long	2
1051	THD, Volts, phase C-A	percent. milli	Long	2
1053	W Delivered, phase A	Primary xW.milli	Long	2
1055	W Delivered, phase B	Primary xW.milli	Long	2
1057	W Delivered, phase C	Primary xW.milli	Long	2
1059	W Delivered, polyphase	Primary xW.milli	Long	2
1061	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1062	VAR Delivered, phase A	Pri xVAR. milli	Long	2
1064	VAR Delivered, phase B	Pri xVAR. milli	Long	2
1066	VAR Delivered, phase C	Pri xVAR. milli	Long	2
1068	VAR Delivered, polyphase	Pri xVAR. milli	Long	2
1070	Reactive/Q Power UOM to Kilo Conversion Factor	power of ten	Int	1
1071	VA Delivered, phase A	Pri xVA. milli	Long	2
1073	VA Delivered, phase B	Pri xVA. milli	Long	2
1075	VA Delivered, phase C	Pri xVA. milli	Long	2
1077	VA Delivered, polyphase	Pri xVA. milli	Long	2
1079	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1080	W Received, phase A	Primary xW.milli	Long	2
1082	W Received, phase B	Primary xW.milli	Long	2
1084	W Received, phase C	Primary xW.milli	Long	2
1086	W Received, polyphase	Primary xW.milli	Long	2
1088	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1089	VAR Received, phase A	Pri xVAR. milli	Long	2
1091	VAR Received, phase B	Pri xVAR. milli	Long	2
1093	VAR Received, phase C	Pri xVAR. milli	Long	2
1095	VAR Received, polyphase	Pri xVAR. milli	Long	2
1097	Reactive/Q Power UOM to Kilo Conversion Factor	power of ten	Int	1
1098	VA Received, phase A	Pri xVA. milli	Long	2
1100	VA Received, phase B	Pri xVA. milli	Long	2
1102	VA Received, phase C	Pri xVA. milli	Long	2
1104	VA Received, polyphase	Pri xVA. milli	Long	2
1106	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1

1107	Watts, bi-directional, phase A	Primary xW.milli	Long	2
1109	Watts, bi-directional, phase B	Primary xW.milli	Long	2
1111	Watts, bi-directional, phase C	Primary xW.milli	Long	2
1113	Watts, polyphase, bi-directional	Primary xW.milli	Long	2
1115	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1116	VARs, bi-directional, phase A	Pri xVAR. milli	Long	2
1118	VARs, bi-directional, phase B	Pri xVAR. milli	Long	2
1120	VARs, bi-directional, phase C	Pri xVAR. milli	Long	2
1122	VAR polyphase, bi-directional	Pri xVAR. milli	Long	2
1124	Reactive/Q Power UOM to Kilo Conversion Factor	power of ten	Int	1
	Average Power Factors			
1200	PF Delivered, phase A	pf.milli	Int	1
1201	PF Delivered, phase B	pf.milli	Int	1
1202	PF Delivered, phase C	pf.milli	Int	1
1203	PF Delivered, polyphase	pf.milli	Int	1
1204	PF Received, polyphase	pf.milli	Int	1
	Consumption			
1205	Wh Delivered	pri xWh.milli	Mod 10 x 3	3
1208	Wh Received	pri xWh.milli	Mod 10 x 3	3
1211	Real/Apparent Energy UOM to Kilo conversion factor	power of ten	Int	1
1212	VARh Delivered	pri xVARh.milli	Mod 10 x 3	3
1215	VARh Received	pri xVARh.milli	Mod 10 x 3	3
1218	Reactive/Q Energy UOM to Kilo Conversion Factor	power of ten	Int	1
1219	VAh Delivered	pri xVAh.milli	Mod 10 x 3	3
1222	VAh Received	pri xVAh.milli	Mod 10 x 3	3
1225	Real/Apparent Energy UOM to Kilo conversion factor	power of ten	Int	1
1226	Qh Delivered	pri xQh.milli	Mod 10 x 3	3
1229	Qh Received	pri xQh.milli	Mod 10 x 3	3
1232	Reactive/Q Energy UOM to Kilo Conversion Factor	power of ten	Int	1
1233	Amphours	pri Ah.milli-UOM	Mod 10 x 3	3
1236	Amp^2hours	pri kAh.milli-UOM	Mod 10 x 3	3
1239	$Amps/Amp^2$ UOM to Kilo conversion factor	power of ten	Int	1
1240	$Volt^2hours$	pri kAh.milli-UOM	Mod 10 x 3	3
1243	$Volts^2$ UOM to Kilo conversion factor	power of ten	Int	1
	Demand			

1244	Demand - W Delivered	Primary xW.milli	Long	2
1246	Peak Demand - W Delivered	Primary xW.milli	Long	2
1248	Prev Billing Period Peak Demand - W Delivered	Primary xW.milli	Long	2
1250	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1251	Demand - VAR Delivered	Primary xVAR.milli	Long	2
1253	Peak Demand - VAR Delivered	Primary xVAR.milli	Long	2
1255	Prev Billing Period Peak Demand - VAR Delivered	Primary xVAR.milli	Long	2
1257	Reactive/Q Power UOM to Kilo Conversion Factor	power of ten	Int	1
1258	Demand - VA Delivered	Primary xVA.milli	Long	2
1260	Peak Demand - VA Delivered	Primary xVA.milli	Long	2
1262	Prev Billing Period Peak Demand - VA Delivered	Primary xVA.milli	Long	2
1264	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
	Demand Prediction			
1265	Predicted Demand - W Delivered, polyphase	Primary xW.milli	Long	2
1267	Predicted Demand - VAR Delivered, polyphase	Primary xVAR.milli	Long	2
1269	Predicted Demand - VA Delivered, polyphase	Primary xVA.milli	Long	2
1271	Real/Apparent Power UOM to Kilo conversion factor	power of ten	Int	1
1272	Reactive/Q Power UOM to Kilo Conversion Factor	power of ten	Int	1
	Demand Current			
1273	Demand Current Phase A	Primary milli-amps	Long	2
1275	Demand Current Phase B	Primary milli-amps	Long	2
1277	Demand Current Phase C	Primary milli-amps	Long	2
1279	Demand Current Phase N	Primary milli-amps	Long	2
1281	Peak Demand Current Phase A	Primary milli-amps	Long	2
1283	Peak Demand Current Phase B	Primary milli-amps	Long	2
1285	Peak Demand Current Phase C	Primary milli-amps	Long	2
1287	Peak Demand Current Phase N	Primary milli-amps	Long	2
	Time of Peak Demand			
1289	W Delivered, polyphase		Time	3
1292	VAR Delivered, polyphase		Time	3
1295	VA Delivered, polyphase		Time	3
1298	Demand Current Phase A		Time	3

1301	Demand Current Phase B		Time	3
1304	Demand Current Phase C		Time	3
1307	Demand Current Phase N		Time	3
1310	Prev Billing Period Peak W Delivered		Time	3
1313	Prev Billing Period Peak VAR Delivered		Time	3
1316	Prev Billing Period Peak VA Delivered		Time	3
	Coincident Power Factor			
1319	when W Delivered was peak last billing period	PF.milli	Int	1
1320	when VAR Delivered was peak last billing period	PF.milli	Int	1
1321	when VA Delivered was peak last billing period	PF.milli	Int	1
	Pulse Inputs			
1400	Input 1		Int	1
1401	Input 2		Int	1
	Scratchpad (WRITABLE)			
1600 - 1619	20 registers writable by system		Int	1 ea
	Configuration			
1700	Meter ID or Type (unique for each Model)		Int	1
1702 - 1704	Date / Time		Time	3
1705 - 1707	Register Firmware Version		Int	3
1708	Class		Int	1
1709	Health Status		Int	1
1710	VT Ratio (x:1)		Long	2
1712	CT Ratio (x:1)		Long	2
1714	W/ VA/ Wh/ VAh Primary Unit of Measure	power of ten	Int	1
1715	VAR/ Q/ VARh/ Qh Primary Unit of Measure	power of ten	Int	1
1716	Volt Primary Unit of Measure	power of ten	Int	1
1717	Amp Primary Unit of Measure	power of ten	Int	1
1718	Volt Primary Squared Unit of Measure	power of ten	Int	1
1719	Amp Primary Squared Unit of Measure	power of ten	Int	1
1720	Connection Type		Int	1
1721	Demand Method		Int	1
1722	Demand Interval		Int	1
1723	Demand Subinterval		Int	1
1724	Configured number of display items in Normal Display List (See MODBUS registers 1800 - 1999, 12000 - 12749)		Int	1
1725	Configured number of display items in Alternate Display List (See MODBUS registers 2000 - 2199, 13000 - 13749)		Int	1
1726	Configured number of display items in Internal Display List (See MODBUS registers 14000 - 14749)		Int	1
1727	Configured number of Load Profile channels (See MODBUS registers 15000 - 15179)		Int	1
	Display Registers			
1800-1999	Normal Display List Registers (up to 50 entries)		Display	4 ea

2000 - 2199	Alternate Display List Registers (up to 50 entries)		Display	4 ea
	Load Profile			
2900 - 2919	Data Log Header		Int	22
2950 - 2985	Data Log Table of Contents (36 scratchpad registers writable by system)		Int	36
3000 - 10799	Load Profile data		LP Record	200 records
	Display Register and Load Profile Channel Descriptions			
12000 - 12749	Normal Display List Register Map / Index (50 entries)		Reg Desc	15 ea
13000 - 13749	Alternate Display List Register Map / Index (50 entries)		Reg Desc	15 ea
14000 - 14749	Internal Display List Register Map / Index (50 entries)		Reg Desc	15 ea
15000 - 15179	Load Profile Channel Map / Index (12 entries)		Reg Desc	15 ea

Scaling Factors

Note: These MODBUS registers are scaling factors expressed as powers of ten that, when multiplied by the appropriate power or energy registers, give readings in primary kilo-units (e.g. kilowatts, kilowatthours).

MODBUS Register(s)	Measurement Type
1061, 1079, 1088, 1106, 1115, 1211, 1225, 1250, 1264, 1271	Watt, Watthour, VA, VAhour
1070, 1097, 1124, 1218, 1232, 1257, 1272,	VAR, VARhour, Q, Qhour
1239	Amp, Amp^2, Amphour, Amp^2hour
1243	$Volt^2$, $Volt^2$hour

Special Data Formats

These Registers have special or unusual formatting:

- Pulse Input 1(MODBUS register 1400): Reads 0 if meter Contact Input 1 is off, 1 if on.
- Pulse Input 2 (MODBUS register 1401): Reads 0 if meter Contact Input 2 is off, 1 if on.
- Meter ID (MODBUS register 1700): and unique identification number assigned by Square-D. Meter returns 15220.
- Register Firmware Version (MODBUS registers 1705 - 1701): Three MODBUS registers, each containing 2 digits of the meter Register Firmware version number. Display each register's contents as a 2-digit hexadecimal number, and separate the registers with periods. (E.g. "B3.00.12")
- Health Status (MODBUS register 1709): A series of bits giving the present health status of the meter:

  (MSB)-> 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 <-(LSB)

Bit	Meaning
16	1 = Battery Warning. Cumulative time on battery exceeds 2 years.
15	1 = Configuration error - using default configuration
14	1 = Site Monitor alarm condition is present
13	1 = External status input is ON
12	1 = Threshold 1 alarm condition is present
11	1 = Threshold 2 alarm condition is present
10	1 = Threshold 3 alarm condition is present
9	1 = Threshold 4 alarm condition is present
8	1 = (reserved)
7	1 = (reserved)
6	1 = (reserved)
5	1 = (reserved)
4	1 = (reserved)
3	1 = Phase C voltage active
2	1 = Phase B voltage active
1	1 = Phase A voltage active

- VT Ratio (MODBUS registers 1710 - 1711): The meter's configured external Voltage Transformer ratio multiplied by 1000.
- CT Ratio (MODBUS registers 1712 - 1713): The meter's configured external Current Transformer ratio multiplied by 1000.
- W/ VA/ Wh/ VAh Primary Unit of Measure (MODBUS register 1714): A power of ten showing the configured Unit of Measure for Real and Apparent power and energy measurements:

  0 = units (watts, VA)
  3 = kilo units
  6 = mega units

9 = giga units

- VAR/ Q/ VARh/ Qh Primary Unit of Measure (MODBUS register 1715): A power of ten showing the configured Unit of Measure for Reactive and Q power and energy measurements:
  0 = units (VAR, Q)
  3 = kilo units
  6 = mega units
  9 = giga units
- Volt Primary Unit of Measure (MODBUS register 1716): A power of ten showing the configured Unit of Measure for Volt measurements:
  0 = units (volts)
  3 = kilo units
  6 = mega units
- Amp Primary Unit of Measure (MODBUS register 1717): A power of ten showing the configured Unit of Measure for Amp measurements:
  0 = units (amps)
  3 = kilo units
  6 = mega units
- Volt Primary Squared Unit of Measure (MODBUS register 1718): A power of ten showing the configured Unit of Measure for Volts Squared measurements:
  0 = units (volts squared)
  3 = kilo units
  6 = mega units
- Amp Primary Squared Unit of Measure (MODBUS register 1719): A power of ten showing the configured Unit of Measure for Amp Squared measurements:
  0 = units (amps squared)
  3 = kilo units
  6 = mega units
- Connection Type (MODBUS register 1720): The meter service connection type. A 3-wire Delta connection returns 30, while a 4-wire Wye returns 40.
- Demand Method (MODBUS register 1721): A bit field indicating the demand methods configured in the meter.
  (MSB)-> 0 0 0 0 0 0 0 0 0 0 0 0 0 0 E S <-(LSB)
  Where: E is the External Demand Interval Sync Enabled bit (1 = external demand sync, 0 = internal sync).
  S is the Sliding Window Demand indicator (1 = sliding window, 0 = fixed window)
- Demand Interval (MODBUS register 1722): The meter's demand interval length in minutes.
- Demand Subinterval (MODBUS register 1723): The meter's demand subinterval length in minutes.
- Number of Normal Display Registers (MODBUS register 1724): The number of display registers (max. 50) currently configured in the Normal display list.
- Number of Alternate Display Registers (MODBUS register 1725): The number of display registers (max. 50) currently configured in the Alternate display list.
- Number of Internal Display Registers (MODBUS register 1726): The number of display registers (max. 50) currently configured in the Internal display list.
- Number of Load Profile Channels (MODBUS register 1727): The number of Load Profile pulse channels (max. 12) currently configured in the meter.

MODBUS Register Formats

These extended MODBUS holding registers come in a variety of formats. These formats are described here.

Int

The Int type is a signed 16-bit integer number. It is the basic MODBUS register.

Long

The Long is two MODBUS registers sent consecutively to form a 32-bit value. The first register contains the sign bit and the 15 most significant bits of the value. The second register contains the remaining 16 least significant bits.

Time

The Time format is three MODBUS registers sent consecutively to form a date-time group encoded thus:

	Upper 8 bits	Lower 8 bits
First register	Month (1 - 12)	Day (1 - 31)
Second register	Year (0 - 199)	Hour (0 - 23)
Third register	Minute (0 - 59)	Second (0 - 59)

Mod10 x 3

The Mod10 x 3 format is three MODBUS registers sent consecutively to form a 12-digit decimal value encoded thus:

First register:	4 least significant (of 12) digits of complete value, in binary (0 - 9999)
Second register:	4 middle (of 12) digits of complete value, in binary (0 - 9999)
Third register:	4 most significant (of 12) digits of complete value, in binary (0 - 9999)

Therefore, the complete value is (R3 * 10^8) + (R2 & 10^4) + R1. This format can accommodate values from 0 to 999,999,999,999 decimal.

Display

The Display format varies depending on the exact definition of a given display item by the user. Meter Displays can contain a numeric value expressed as a Long or a Mod x 3 format with a primary scaling factor, a Long format without scaling, or a Time format. Each Display has a corresponding Register Description (see Reg Desc below) that contains, among other things, a "Format Type" field that explains how to interpret that Display's data.

LP Record

The Load Profile Record contains the Load Profile data for a single interval. This format consists of a time stamp (in the Time format described here) followed by 1 to 12 pulse

channels depending on the meter's configuration. Each pulse channel is three MODBUS registers in the format R1 * R2 * 10^R3. The first register is a pulse count, the second register is a pulse weight (in, for example, Watthours per pulse), and the third register is a power of ten. The complete interval's accumulation for that channel is found by multiplying the first register by the second register, then multiplying the result by 10 raised to the power in the third register.

LP Header

The Load Profile Header is a data structure that describes the meter's implementation of Load Profile for MODBUS retrieval:

Register Offset	Register Name	Register Description	Notes
0	Table of Contents	Beginning register of record which lists the register numbers that are being logged for this data log. (0 specifies that the data log is not being used)	This is a pointer to the block where the 1-12 channels are defined by listing the first register corresponding to the value logged in that register. Meter reads Register 2950
1	File Type	Specifies the file type, i.e., data log, waveform capture, etc. (Set to 1 for Data Log)	Meter reads 1
2	File Size	The file size in records, max = 32000	Meter reads 200
3	Record Size	Record size in registers, max 39 including date/time stamp. Table of contents will hold (Record Size - 3) registers	Calculated by Meter based on Recorder Contents
4	File Mode	0 = FIFO, 1 = Fill and Hold	Always 0 for the Meter
5	Record Entry Enable / Disable	Record entry enable (FFFF)/disable(0000) for data log files	Meter is FFFF by default
6	Entry Update Interval	Entry update interval (in minutes) for data log files synchronized to entry interval offset time	Meter's configured Load Profile interval length, in minutes.
7	Entry Interval Offset Time	Time (in minutes) past midnight to synchronize record entry update intervals to	Always 0 for Meter
8	Current # Records in File	Current number of records in the file	Managed by Meter. Maximum 200
9	Current first record sequence	Current first (oldest) record sequence number in the file	Managed by Meter. Ranges from 1 to 32000
10	Current last record sequence	Current last (newest) record sequence number in the file	Managed by Meter. Ranges from 1 to 32000
11	Date/Time of last file reset/clear	Date/Time of last file reset/clear in 3 register format	Date & Time at which Meter Load Profile was reinitialized (reconfigured).
14	Allocated File Size	File size allocated during last file resize, in records	(same as Offset 2)
15	Allocated Record Size	Record size (in registers) allocated during the last file resize, including the date/time stamp	(same as Offset 3)

16	File Status	Status of the file based on actual and allocated file size and record size	Meter always reads 0 (OK)
17	File Location	Starting register number for file	Meter always reads 3000
18	Cont. WFC Segment Delay	Continuous WFC segment limit may be set in range 1-5	N/A = -32768
19	Cont. WFC Trigger Delay	Number of Pre-Trigger Cycles to obtain when a continuous WFC occurs. Applicable only to the Cont. WFC File Only. Reserved for all others.	N/A = -32768
20	Oldest Record	Register number at start of oldest record in file.	Location of record corresponding to sequence number stored at Offset 9.
21	Newest Record	Register number at start of newest record in file.	Location of record corresponding to sequence number stored at Offset 10.

Reg Desc

Each meter Display Register and Load Profile Channel has a corresponding "Register Description" (Reg Desc) that tells the host system how to interpret its data.
Every Register Description contains 15 MODBUS registers that fully describes the Display or Load Profile Channel. Four of these registers contain bit fields that detail the operation of the Display or Channel.

Offset	Name	Contents
0	Reg Type	Describes the Type (Numeric, Time, Status, ID, or Totalization) of Display Register or Load Profile channel
1	Quantity Type (Used only if Reg Type is Numeric or Totalization, otherwise contains zero)	Describes the measurement quantity of a Numeric or Totalization Display Register or Load Profile channel
2	Demand Quantity Type (Used only if Reg Type is Numeric Coincident Demand to indicate quantity of associated Peak demand. Otherwise contains zero)	If this Display Register is a Coincident Demand, this describes the measurement quantity of the Peak Demand associated with it.
3	Reg Format	This describes how the Display Register or Load Profile channel data is to be interpreted and formatted for display.
4	Reg ID Number	The Identification number assigned by the user to this Display Register, or the Load Profile Channel Number.
5 - 14	Text Description	20 bytes of text, padded with nulls, that the user assigned to be displayed with this Display Register. This will contain all nulls for Load Profile channels.

Reg Type

The Reg Type register contains a number of bit fields that describe the basic type of the Display Register or Load Profile channel.
Reg Type: (MSB)-> t t t a a a l l d d d n n n n n <-(LSB)
Where:
t t t is the Register Type:

0 = Numeric (Power) Display Register or Channel
1 = Time Display Register
2 = Status Display Register
3 = ID Display Register
4 = Unused Register
5 = Totalization Display Register or Channel

a a a is the Display Register or Channel Algorithm:

0 = Demand
1 = Consumption
2 = Average PF
3 = Peak Demand
4 = Instantaneous
5 = Thermal
6 = Peak Thermal
7 = Demand Prediction

l l is the Demand Algorithm, and is used only for Demand, Peak Demand, or Peak Thermal Registers or Channels:

For Demand Registers or Channels:
0 = Unused
1 = Past Interval Demand
2 = Present Interval Demand

For Peak Demand Registers:
0 = Peak Demand
1 = Time of Peak Demand
2 = Coincident Demand
3 = Date of Peak Demand

For Peak Thermal Registers:
0 = Peak Thermal
1 = Time of Peak Thermal
2 = Unused
3 = Date of Peak Thermal

d d d is the Display Update:

0 = Working (value updates at any time)
1 = Freeze (value updates on communications Freeze)
2 = Season (value updates on TOU Season Change)
3 = Billing Period Reset (value updates on BPR)
4 = Cumulative (Peak Demand value accumulates on BPR)
5 = Continuous Cumulative (Peak Demand value accumulates on BPR and Demand Interval)

n n n n n is a Selection Number that defines which Status, ID, or Time value, or Totalization channel, this Display Register contains:

For Time Registers:
0 = Present Time - present value of the meter clock
1 = Last BPR Time - time of the last Billing Period Reset
2 = Last Freeze Time - time of the last communications Freeze
3 = Last Season Time - time of last Time of Use season change
4 = Next DST Time - time of next Daylight Saving Time change
5 = Present Date - present value of the meter clock
6 = Last BPR Date - date of the last Billing Period Reset
7 = Last Freeze Date - date of the last Register Freeze

8 = Last Season Date - date of the last Time of Use season change
9 = Next DST Date - date of the next Daylight Saving Time change
10 = Test Time Remaining - time remaining in meter Test Mode
11 = Demand Time Remaining - time remaining in present Demand Interval
12 = Days On Battery - number of days meter has used backup battery power (i.e. cumulative outage time)

For Status Registers:

0 = Present Status - present System Status Word.
1 = Latched Status Word - "sticky" System Status Word. Shows conditions that have set a Status bit in the System Status Word but have since gone away.
2 = Last BPR Status - System Status Word at last Billing Period Reset
3 = Last Freeze Status - System Status Word at last communications Freeze
4 = Last Season Status - System Status Word at last Time of Use season change
5 = Register Firmware Version - Meter register firmware version (no numeric value)
6 = Metrology Firmware Version - Meter metrology firmware version (no numeric value)
7 = Blank - blank display (no numeric value)
8 = Segment Check - all display segments active (no numeric value)
9 = Phasor V - 2- or 3-phase voltage vector display (no numeric value)
10 = Phasor A - 2- or 3-phase current vector display (no numeric value)
11 = Phasor VaIa - Phase A voltage and current vector display (no numeric value)
12 = Phasor VbIb - Phase B voltage and current vector display (no numeric value)
13 = Phasor VcIc - Phase C voltage and current vector display (no numeric value)
14 = BPR Count - cumulative number of Billing Period Resets that have occurred
15 = Outage Count - cumulative number of power outages that have occurred

For ID Registers:

0 = Label 1 - User-defined label 1 (default "Meter Name")
1 = String 1
2 = Label 2 - User-defined label 1 (default "Administrator")
3 = String 2
4 = Label 3 - User-defined label 1 (default "Location")
5 = String 3
6 = Label 4 - User-defined label 1 (default "Configuration ID")
7 = String 4
8 = Label 5 - User-defined label 1 (default "Account Number")
9 = String 5 (Selector value 9)

For Totalization registers, the Selection Number contains the number of the Totalization Channel (1 - 12) that is being displayed.

Quantity Type

The Quantity Type register describes the basic quantity being measured by the Display Register or Load Profile channel. Quantity Type is valid only if the associated Reg Type indicates this is a Numeric or Totalization Register.
(MSB)-> q q q q e e e d d d r r r r c i <-(LSB)
Where:
q q q q is the base electrical Measurement Quantity:

- 0 = Watts (Watthours)
- 1 = VAR (VARhours)
- 2 = VA (VAhours)
- 3 = Amps (Amphours)
- 4 = Q (Qhours)
- 5 = PF
- 6 = Volts
- 7 = Frequency
- 8 = Volts THD
- 9 = Amps THD
- 10 = External Count (Load Profile only)
- 11 = External Status (Load Profile only)
- 12 = Amps Squared (Amp Squared hours)
- 13 = Volts Squared (Volt Squared hours)

e e e is the Element or Phase on which the measurement is taken:

- 0 = No element - Not applicable to any element or line phase. (Frequency only)
- 1 = Polyphase - Sum or net of all phases. (If Channel Quantity is Volts or Volts Squared, Polyphase means an average of all phases.)
- 2 = Phase A - Measured on Phase A.
- 3 = Phase B - Measured on Phase B.
- 4 = Phase C - Measured on Phase C.
- 5 = Neutral - Measured on Neutral line. (Amps only)
- 6 = Phase Average - Average of all phases. (Amps or Amps Squared only)

d d d is the Direction of the measured quantity

- 0 = No direction - Directionless quantities such as volts or amps.
- 1 = Delivered - Power flowing from the line side of the meter to the load.
- 2 = Received - Power flowing from the load side of the meter to the line.
- 3 = Quadrant 1 - Delivered watts, lagging VARs. (VARs only)
- 4 = Quadrant 2 - Received watts, leading VARs. (VARs only)
- 5 = Quadrant 3 - Received watts, lagging VARs. (VARs only)
- 6 = Quadrant 4 - Delivered watts, leading VARs. (VARs only)

r r r r is the Time of Use Rate during which the quantity is measured.

- 0 = Total - Register is always active.
- 1 = Rate A - Register measures only during TOU Rate A.
- 2 = Rate B - Register measures only during TOU Rate B.
- 3 = Rate C - Register measures only during TOU Rate C.
- 4 = Rate D - Register measures only during TOU Rate D.
- 5 = Rate E - Register measures only during TOU Rate E.
- 6 = Rate F - Register measures only during TOU Rate F.
- 7 = Rate G - Register measures only during TOU Rate G.
- 8 = Rate H - Register measures only during TOU Rate H.

c is the Compensation flag:

0 = Value has Transformer Loss Compensation applied (if applicable)
1 = Value is not compensated.

i is the Integrated Quantity flag:
0 = Quantity is instantaneous or average (i.e. Demand, Instantaneous, Thermal, etc.)
1 = Quantity is integrated (i.e. Consumption, Totalization)

Demand Quantity Type

The Demand Quantity Type register describes the basic quantity being measured by an associated Peak Demand Display Register. It uses the same bit assignments as Quantity Type described above. It is valid only if the associated Reg Type indicates this is a Coincident Demand Display Register.

Reg Format

The Reg Format register identifies the MODBUS data format used by the associated Display Register or Load Profile channel.
(MSB)-> 0 0 0 0 f f f f d d d d c c c c <-(LSB)
Where:
f f f f is the Register Format identifier:
0 = No value - Register or Channel contains no displayable information
1 = Int - Display contains a single MODBUS register, remaining 3 registers are not used. (Display Registers only)
2 = Long - Display contains a Long (2 MODBUS registers), remaining 2 registers are not used. (Display Registers only)
3 = Time - Display contains a Time (3 MODBUS registers), last register is not used. (Display Registers only)
4 = Long + scale - Display contains a Long (2 MODBUS registers), 1 unused register, and the last register is a Scale (power of 10). (Display Registers only)
5 = Mod x 3 + scale - Display contains a Mod x 3 (3 MODBUS registers) and the last register is a Scale (power of 10). (Display Registers only)
6 = Load Profile channel - Display contains one Value (1 MODBUS register), one Multiplier (1 MODBUS register), and a Scale (power of 10). (Load Profile channels occupy only 3 MODBUS registers.) (Load Profile channels only)

d d d d is the total number of digits of the value to be displayed. (Only for Numeric or Totalization Display Registers.)
c c c c is the number of decimal places of the value to be displayed, and is part of the total number of digits displayed. (Only for Numeric or Totalization Display Registers.)

Reg ID Number

The Identification number assigned by the user to this Display Register, or the Load Profile Channel Number. The decimal value of this number is displayed with the Display Register.

Text Description

20 bytes of text, padded with nulls, that the user assigned to be displayed with this Display Register. This will contain all nulls for Load Profile channels.

APPENDIX C – ANSI TABLES COMMUNICATION

INTRODUCTION

The utility metering industry – utility companies, equipment vendors, government and standards agencies – has created a standardized method of retrieving meter data. The ANSI Standard C12.19 -1997 "Utility Industry End Device Data Tables" (or "ANSI Tables") describes a set of data tables that are used to represent all types of metering data. The specification defines the data structures used to represent data involved in the configuration, control, and reading of utility meters. This does not define any process or behavior – it is strictly intended for data structure (table) definitions.

It is recommended that you review the Standard before operating the meter with ANSI Tables Protocol. Note that the Standard does not require the entire set of Data Tables to be implemented.

A complete ANSI Tables Protocol Technical Reference Manual is available from AMETEK that describes all meter-specific communication parameters. Refer to document 1083-609.

TABLE ORGANIZATION

ANSI Data Tables are numbered and grouped into "Decades" that are associated with a particular metering function. For example, Decade 0 (Tables 00 - 09) describes the end device (meter) configuration, identification, and procedural capabilities. Decade 1 (Tables 10 - 19) describes data sources such as device inputs, units of measure, etc. Individual tables are built from basic data types that are also defined in ANSI C12.19. These basic types include Boolean, integer, character, and floating-point representations of various sizes. Basic types are collected into arrays, and combinations of singles and arrays are collected into tables.

COMMUNICATION METHODS

Three related ANSI Standards define the protocols for transmitting ANSI Tables over various communication channels. The meter is fully compliant with all communication types.

- ANSI C12.18-1996, "Protocol Specification for ANSI Type 2 Optical Port"
- ANSI C12.21-1999, "Protocol Specification for Telephone MODEM Communication"
- ANSI C12.22, "Protocol Specification for Interfacing to Data Communication Networks" (unapproved draft)

ANSI Type 2 Optical Port Protocol (C12.18)

ANSI C12.18 defines the physical structure and dynamic processes required to send and receive ANSI Data Tables via an optical communications interface. The Optical Port Protocol describes how to establish a connection with the meter, negotiate communication parameters, establish user identity and privileges perform various functions, and send and receive data tables. Since the Optical Port cannot support multiple end devices on a single connection, it makes no provision for unique device addresses.

ANSI Telephone Modem Protocol (C12.21)

ANSI C12.21 defines the dynamic processes required to send and receive ANSI Data Tables via a dial-up modem connection. C12.21 does not define the process for establishing a modem connection – it picks up responsibility for communication after the modem connection is established.
The Telephone Modem Protocol describes how to negotiate communication parameters, establish user identity and privileges, perform various functions, and send and receive data tables. Since a single modem may serve multiple meters, the Telephone Modem Protocol provides for individual end device addressing on a multidrop connection.

ANSI Network Protocol (C12.22)

ANSI C12.22 defines the dynamic processes required to send and receive ANSI Data Tables via a network connection. C12.22 is not an approved standard, but is mentioned here for future reference. At this time, there is no meter implementation specifically related to C12.22.

ANSI TABLES IMPLEMENTATION IN A METER

ANSI Tables protocol is available on all meter serial communication interfaces, standard or optional. You can configure a serial interface either via JEMWare configuration software or though the meter front-panel menu system. ANSI Tables protocol can be operated on one or more of the meter's serial interfaces. Using ANSI Tables on one serial port does not interfere with the use of ANSI Tables (or a different protocol) on any other port.

Optical Port

If a meter is configured for ANSI Tables on the Optical port, it will automatically use the C12.18 Optical Port protocol. For connecting an Optical Adapter to the meter, refer to the section titled "Communication Ports" in Chapter 2 of this manual.

Modem Port

If a meter is configured for ANSI Tables on the Modem port, it will automatically use the C12.21 Telephone Modem protocol. For connection details, refer to the section titled "Communication Ports" in Chapter 2 of this manual.

Direct-connect (RS-232 or RS-485) Port

If a meter is configured for ANSI Tables on an RS-232 or RS-485 port, it will automatically use the C12.21 Telephone Modem protocol. For connection details, refer to the section titled "Communication Ports" in Chapter 2 of this manual.

SUPPORTED DATA TABLES

Only the following Tables are supported in the meter. Rows shaded in gray are either undefined by the ANSI C12.19 Standard, or not supported by the meter.

Decade 0

Decade 0 – Device Configuration, Identification, and Procedure Tables			
Table No.	**Title**	**Description**	**Read / Write**
00.	General config	General info on end device configuration, data formats	R
01.	Manufacturer ID	Manufacturer, HW and FW revision numbers	R
02.	Device Nameplate	Nameplate data (form, class, voltage, freq, etc.)	R
03.	ED_MODE Status	Present operating mode, present error / warning status	R
04.	Pending Status	Indicates pending status of tables in the meter	
05.	Device Identification	Device serial number	R
06.	Utility Information	Utility and installation identification	R
07.	Procedure Initiate	Activate device procedures (BPR, etc.) *	W
08.	Procedure Response	Results of previous Procedure Initiate (Table 07) write	R
09.	(undefined)		

*Supported Procedures in Table 07 (Procedure Initiate)

Procedure Number	**Procedure Name**	**Description**
3	Clear Data	Erase Registers & Load Profile, retain Configuration, try to retain Event Logs
6	Change End Device Mode	Enter or Exit Test Mode
7	Clear Standard Status Flags	Clear Health Check and other status flags
9	Remote Reset	Billing Period Reset (Self Read, Season Change, and new Season not supported in this procedure)
10	Set Date and/or Time	Set Time and Date
18	Log In	Establish a user session
19	Log Out	End a user session

Decade 1

Decade 1 – Data Source Tables			
Table No.	**Title**	**Description**	**Read / Write**
10.	Dimension Sources Limiting	Maximum dimensions and end device capabilities	
11.	Actual Sources Limiting	Actual parameters configured in device	R
12.	Unit of Measure	Units of Measure, calculation methods (VA, etc)	R
13.	Demand Control	Demand interval, subinterval, and related info	R
14.	Data Control	Data source selections (?)	R?
15.	Constants	?	R?
16.	Source Definition	Available data sources selectable by other tables (such as Table 14)	
17.	(undefined)		
18.	(undefined)		
19.	(undefined)		

Decade 2

Decade 2 – Register Tables			
Table No.	**Title**	**Description**	**Read / Write**
20.	Dimension Register Limiting	Maximum dimensions of measured data registers	
21.	Actual Register	Actual function values for registers	R
22.	Data Selection	Grouped lists of source indices into Table 16.	
23.	Current Register Data	Current Register Data	R
24.	Previous Season Data	Register Data as of most recent Season Change	R
25.	Previous Demand Reset Data	Register Data as of most recent Demand Reset	R
26.	Self Read Data	Register Data as of most recent Self Read event	R
27.	Present Register Selection	Lists of source indices into Table 16.	
28.	Present Register Data	Present demand and values selected by Table 27	
29.	(undefined)		

Decade 3

Decade 3 – Local Display Tables			
Table No.	**Title**	**Description**	**Read / Write**
30.	Dimension Display Limiting	Maximum dimensional values for local display operation	
31.	Actual Display	Actual dimensional values for local display operation	R
32.	Display Source	Select source data for local display	R?
33.	Primary Display List	Configuration of Primary display list (data, timing, scroll, etc.)	
34.	Secondary Display List	Configuration of Secondary display list (data, timing, scroll, etc.)	
35.	(undefined)		
36.	(undefined)		
37.	(undefined)		
38.	(undefined)		
39.	(undefined)		

Decade 4

Decade 4 – Security Tables			
Table No.	**Title**	**Description**	**Read / Write**
40.	Dimension Security Limiting	Maximum number of passwords and security access levels in end device	
41.	Actual Security Limiting	Actual number of passwords and security access levels in end device	R
42.	Security	Passwords; Read, Write, and Execute permission flags	R?
43.	Default Access Control	Default table and procedure access permissions (for tables not included in Table 44)	R?
44.	Access Control	Table and procedure access permissions for tables not using default access control	R?
45.	Key	Authentication and / or encryption keys	R?
46.	(undefined)		
47.	(undefined)		
48.	(undefined)		
49.	(undefined)		

Decade 5

Decade 5 – Time and TOU Tables			
Table No.	**Title**	**Description**	**Read / Write**
50.	Dimension Limiting Time and Time of Use	Maximum capabilities for Date & Time and TOU control	
51.	Actual Time and TOU Limiting	Actual capabilities for Time & Date and TOU control	R
52.	Clock	Real time clock	R
53.	Time Offset	Time zone offset and DST information	R
54.	Calendar	Schedule definition table for TOU	
55.	Clock State	Real time clock information	R?
56.	Time Remaining	Predictive time quantities	
57.	(undefined)		
58.	(undefined)		
59.	(undefined)		

Decade 6

Decade 6 – Load Profile Tables			
Table No.	**Title**	**Description**	**Read / Write**
60.	Dimension Limiting Load Profile	Maximum capabilities of Load Profile	
61.	Actual Load Profile Limiting	Actual Load Profile capabilities	R
62.	Load Profile Control	Data sources and formats used In Load Profile	R
63.	Load Profile Status	Status of each Load Profile data set	R?
64.	Load Profile Data Set 1	Load Profile data information, set 1	R
65.	Load Profile Data Set 2	Load Profile data information, set 2	
66.	Load Profile Data Set 3	Load Profile data information, set 3	
67.	Load Profile Data Set 4	Load Profile data information, set 4	
68.	(undefined)		
69.	(undefined)		

Decade 7

Decade 7 – History and Event Logs			
Table No.	**Title**	**Description**	**Read / Write**
70.	Limiting Log Dimensions	Maximum size and capabilities of History and Event Logs	
71.	Actual Log Dimensions	Actual size and capabilities of History and Event Logs.	
72.	Event Identification	Events supported by end device	
73.	History Log Control	Defines History Log codes to be written to History Log.	
74.	History Log Data	The History Log contents	
75.	Event Log Control	Defines Event Log codes to be written to the Event Log.	
76.	Event Log Data	The Event Log contents	
77.	(undefined)		
78.	(undefined)		
79.	(undefined)		

Decade 8

Decade 8 – User Defined Tables			
Table No.	**Title**	**Description**	**Read / Write**
80.	Dimension Function Limiting	Maximum values and control parameters for user-defined tables.	
81.	Actual Function Limiting	Actual values and control parameters for user-defined tables.	
82.	List	Data elements used in the generation of user defined tables.	
83.	Selection	Selects data elements used in user-defined tables.	
84.	First User Defined	User defined table 1	
85.	Second User Defined	User defined table 2	
86.	Third User Defined	User defined table 3	
87.	Fourth User Defined	User defined table 4	
88.	Fifth User Defined	User defined table 5	
89.	Sixth User Defined	User defined table 6	

Decade 9

Decade 9 – Telephone Control			
Table No.	**Title**	**Description**	**Read / Write**
90.	Dimension Telephone Limiting	Maximum dimensions for telephone control data	
91.	Actual Telephone Limiting	Actual dimensions for telephone control data	
92.	Global Parameters	General parameters for call answer and originate	
93.	Originate Communication Parameters	Call originate parameters	
94.	Originate Schedule	Call out schedule	
95.	Answer Communication Parameters	Call answer parameters	
96.	Call Purpose	Reason for most recent call out	R
97.	Call status	Progress of most recent calls to each phone number	
98.	(undefined)		
99.	(undefined)		

GLOSSARY

Apparent Power
The product of the applied voltage and current in an ac circuit. Apparent power, or volt-amperes, is not the real power of the circuit because the power factor is not considered in the calculation. A meter calculates Apparent Power = $\sqrt{Watts^2 + VARs^2}$

ARO
At Rated Output

Average Power Factor
The ratio of kilowatt-hour pulses to computed equivalent kVAh pulses for the billing period.

Billing Period
The period of time (commonly a month) between readings of a meter, when those readings are used for billing a power customer. Also, the period of time between two consecutive demand resets.

Billing Period Reset
A task commonly associated with the Billing Read is the Billing Period Reset. The Reset causes a "snapshot" of register readings to be copied to storage as well as clearing Peak Demand readings and updating Cumulative and Continuous Cumulative readings. You must break a seal to perform a Billing Period Reset on the front panel. The Reset is recorded in the Billing Period Reset event buffer.

Billing Read
A Billing Read is the task of reading billing information from the meter front panel. If the billing information is required to be available to anyone, it can be programmed into the Normal display list (See "Casual" Read).

Burden
Load imposed by a device on an input circuit, expressed in ohms or VA.

"Casual" Read
A "casual" read is the ability to see measurements on a sealed, functioning meter without breaking a seal or otherwise violating the meter's security. The type and amount of information available during a casual read can be selected by the meter setup programmer using JEMWare.

Any non-secure readings may be placed in the Normal display list. If nothing is to be displayed to unauthorized users, the programmer may place the Blank or Segment Check display items in the Normal list. Consult the JEMWare user’s manual for full configuration details.

Class; Class Amps
The maximum current for which a meter is specified to operate within its accuracy rating.

Coincident Demand Register
A *Coincident* register is one that the user can set to capture data at the same time as any Peak Demand Register. The Coincident register is linked to a Peak Demand register through JEMWare software. One or more registers can be set to "coincide" with a single Peak Demand register.

Cold Start
A procedure that will return the meter to factory default settings and *erase all stored data in the meter registers*. To perform a Cold Start in the meter:

1. Remove power from the meter.
2. Simultaneously press the UP and DOWN arrow buttons while applying power to the meter, until the meter logo is displayed.

Continuous Cumulative Demand Register
A *Continuous Cumulative* register will sum the selected quantity read at BPR plus the quantity from the Working register. The sum is continuously updated.

Cumulative Demand Register
A *Cumulative* register will store the selected quantity when a BPR occurs. The quantity in the register is saved until the next BPR command, at which time the quantity is added to the existing quantity. The sum accumulates until it is manually cleared.

Daily Schedule
The daily schedule is an array of times and rates, and it determines the moment at which a TOU period changes.

Demand
The average of some measurement over a defined period of time, traditionally calculated by accumulating the integrated measurement over the defined period (the "demand interval") and dividing by the time.

Demand Deferral
A period immediately following a power outage during which demands are not calculated. It is determined by the number of demand-interval closures following the power outage.

Demand Reset
A scheduled or user-initiated event that causes maximum demands to be zeroed and certain other calculations to occur.

DNP
Distributed Network Protocol: a serial communication protocol used in instrument networking.

Element
A voltage and current input pair to a meter or transducer, typically from the same phase. A half element takes advantage of mathematical relationships present in a three phase power system to eliminate the need for one voltage measurement.

Energy Constant
A number used to represent a fixed electrical quantity in the meter. A meter uses the following constants to report various energy quantities:
Km = Load Profile pulse weight
Ke = Energy Pulse weight, Secondary side
pKe = Energy Pulse weight, Primary side
Kt = Test Pulse weight
Kh = # Watthours per each rotation (of a mechanical disk meter); Kh is still used as a constant in digital meters.

Full Scale
A reference condition corresponding to the highest rated value of a given measurement. For watts, this condition occurs at the user's input voltage, class current rating, and unity power factor. For VARs, full scale is at the user's input voltage, class current, and zero power factor.

Health / Status Read
A Health and Status Read is concerned with evaluating the correct operation of the meter and its installation, not its billing data. Health and Status display items may be programmed into either Normal or Alternate display lists at the user's discretion.

Holiday
For TOU purposes, a holiday is a date contained in the holiday schedule.

Holiday Schedule
A holiday schedule is an array of dates (in seconds time format at midnight) within the TOU schedule that enables the meter to identify holidays.

Instantaneous Quantities
Instantaneous quantities are short-term average or RMS measurements of electrical characteristics in a circuit. Instantaneous quantities are suitable for developing Instantaneous Register, Thermal Demand, or analog outputs.

Integrated Quantities
Integrated quantities are power measurement quantities that are integrated over time, and which may be accumulated. Integrated quantities are used for developing Consumption, Fixed or Sliding Window Demand (Peak or Coincident), Load Profile, or pulse outputs.

Interval
A period over which a demand is calculated consisting of one or more subintervals.

IRLED
Infrared light-emitting diode, such as the optical port on the meter.

Ke, Kh, Km, Kt
See Energy Constant

KYZ
A meter output that indicates energy by toggling a Form-C contact output at a frequency proportional to power flow. Each transition represents some constant amount of energy (typically referred to as Ke, "energy constant") that has been consumed. A meter mimics this function by allowing the user to configure two solid-state contact outputs into a similar arrangement.

LLC
Line Loss Compensation: the ability of an instrument to measure or calculate the power lost in an imperfect conductor and to use that figure to modify its power or energy readings.

Liquid Crystal Display (LCD)
Display area on the meter face that contains alpha-numeric characters for data readout.

Load Linearity
Specifies the maximum deviation of performance in percent registration over a range of current (load) assuming all other conditions at nominal reference conditions.

Load Profile
A record of energy consumption stored periodically (typically every 1 to 60 minutes) and sequentially. Each stored "interval" (one record) contains one or more "channels" (a single integrated quantity accumulated during the interval just ended).

(Load Profile) Periodic Special Event
The meter stores pulses accumulated since the time of the previous LP interval closure.

Load Profile Interval
An LP interval is the period between two consecutive LP interval closures.

Load Profile Record
An LP record is the data in a segment of load-profile memory where the accumulated pulses from a single LP interval are stored.

Loss Compensation
A generic term used to include both TLC and LLC.

Measurement Quantity
A single measurable characteristic of power flow in a circuit, or a commonly used combination of measurement quantities. E.g. Volts Phase A, Watthours Delivered Total.

MODBUS™
A standard serial communication protocol used by programmable controllers.

Null Modem
Cable that emulates a modem to enable the connection of two DTE (data terminal equipment) devices such as any two devices that would communicate with a modem (DCE) device.

Partial Load Profile Count
The total accumulated counts within an interval after the last special event or load- profile interval closure.

Past Interval Demand
The demand for the most recently ended demand interval.

Peak Demand
(a.k.a. Maximum Demand) The highest demand reading in a Billing Period.

Phase
The timing relationship between two signals of the same frequency, expressed as an angle. E.g. the delay between voltage and current waveforms in an AC circuit, or between voltage waveforms in different circuits.
One of (usually) three circuits in a polyphase power distribution system. Each phase may be treated as an individual power source that is synchronized to the other phases in the system.

Polyphase
The sum, average, or combination (as appropriate) of measurements from all phases input to a meter.

Power Factor (PF)
The ratio of the real power (watts) to the apparent power (volt-amperes). PF is equal to the cosine of the phase angle between voltage and current.

Present TOU Period
The one Time Of Use period that the meter determines to be active at the present time. This is determined by the present date and time of the meter and the TOU schedule.

Preset Register Value
A numerical value other than zero or the standard default value, that can be saved on a PC for future use. Presets are typically used as a method of saving specific register settings from a removed meter for installation in a replacement meter. The preset file is saved using a .PRE suffix.

Pulse
A state change in either direction of a binary metering signal.

Register
Used to refer to specific quantities to be displayed or retrieved.

Register Assembly
The term used to refer to the hardware implementation of the display or control of the I/O functions of the meter.

Register Freeze
A command that can be issued by the user to move recorded data into storage registers for the purpose of downloading or retrieving the information at a certain instant. The meter will continue to record data without interruption.

RMS
Root Mean Square: the equivalent DC value of a periodic (AC) signal. 5 amps RMS delivers the same amount of power to a given load as 5 amps DC.

Rolling Interval/Sliding Window
A demand measurement consisting of the summation of values calculated over multiple consecutive subintervals. A calculation is updated at the completion of each subinterval, but includes a defined number of previous subintervals.

Season
A season is a range of dates whose start date is contained in the season schedule in seconds time format.

Season Schedule
A season schedule is an array of dates within the TOU schedule that enables the meter to identify the seasons.

Seconds Time Format
A 32-bit number in units of seconds referenced from January 1, 1990.

Special Event
An event stored in load-profile data such as a register freeze, power fail, time set, etc.

Storage Register
A copy of a quantity which could be a displayable register and is saved when triggered by a demand reset.

Subinterval
The increment of time in which demand calculations are updated.

THD
Total Harmonic Distortion: a measure of the amount of harmonic content in a periodic signal, expressed as a percentage. A pure sine wave at the fundamental frequency has 0% THD.

Thermal Demand
A measurement filtered through a time delay such that step changes in the measurement are reflected slowly in the output. Commonly used to simulate the effects of current heating on power distribution equipment.

Thermal Time Characteristic

The time required for a Thermal Demand Register to reflect 90% of a step change in input. Similar to the time characteristic of mechanical thermal demand meters.

Time
Time indicates hours, minutes, and seconds.

TLC
Transformer Loss Compensation: the ability of an instrument to measure or calculate the power lost in an imperfect transformer and to use that figure to modify its power or energy readings.

Total Registers
Those meter registers that are not TOU registers are called total registers. The total registers always are active.

TOU Period
A selected duration of time during which the consumption, demand, and other information are assigned to a set of Time Of Use registers.

TOU Rate Indicator Output
A display segment that indicates the present TOU rate in effect.

TOU Register
A TOU register is a register of the meter that, for a designated TOU period, accumulates and may display amounts of electrical energy, demand, or other quantities measured or calculated.

TOU Schedule
The TOU schedule is a static, externally configured database within the meter. The data base contains information that allows the meter to determine the present TOU period based upon the real date and time of the meter.

VA
Volt Amperes or Volt Amps: the product of voltage and current in a circuit regardless of phase. Typically expressed in RMS units, this is also called "apparent" power. A meter calculates VA = $\sqrt{Watts^2 + VARs^2}$

VAh
VA hour: VA integrated over time to produce a measurement that may be accumulated.

VAR
Volt Amps Reactive: the product of voltage and current in a circuit, times the sine of the phase shift between the two. Typically expressed in RMS units. The unit of "reactive" or "imaginary" power.

VARh
VAR hour: VAR integrated over time to produce a measurement that may be accumulated.

W

Watt: the product of voltage and current in a circuit, times the cosine of the phase shift between the two. Typically expressed in RMS units. The unit of "real" power.

Wh

Watt hour: W integrated over time to produce a measurement that may be accumulated.

PROCEDURES FOR FACTORY REPAIR AND RETURN

A. Obtain a Returned Material Authorization (RMA) number by calling the AMETEK Repair Department and giving the following information:

1. ***Model*** and ***Serial Number*** of the equipment.
2. Failure Symptom - **Be Specific**
3. Approximate date of installation.
4. The site name and address of the failed equipment.
5. Complete shipping information for the return of the equipment if other than the operating site.
6. Name and telephone number of person to contact if questions arise.

B. Enclose the information with the equipment and pack in a commercially accepted shipping container with sufficient packing material to insure that no shipping damage will occur. Mark the outside of the container with the RMA number.

Ship to the appropriate location:

Attention: Repair Department

AMETEK Power Instruments
255 North Union Street
Rochester, New York 14605 USA
Telephone: (585) 263-7700
Fax: (585) 262-4777

C. Your equipment will be tested, repaired, and inspected at the factory. Normal factory turn-around is ten working days or less (excluding shipping time).

WARRANTY — AMETEK warrants equipment of its own manufacture to be free from defects in material and workmanship, under normal conditions of use and service. AMETEK will replace any component found to be defective, upon its return, transportation charges prepaid, within five years of its original purchase. AMETEK will extend the same warranty protection on accessories, which is extended to AMETEK by the original manufacturer. AMETEK assumes no responsibility, expressed or implied, beyond its obligation to replace any component involved. Such warranty is in lieu of all other warranties expressed or implied.