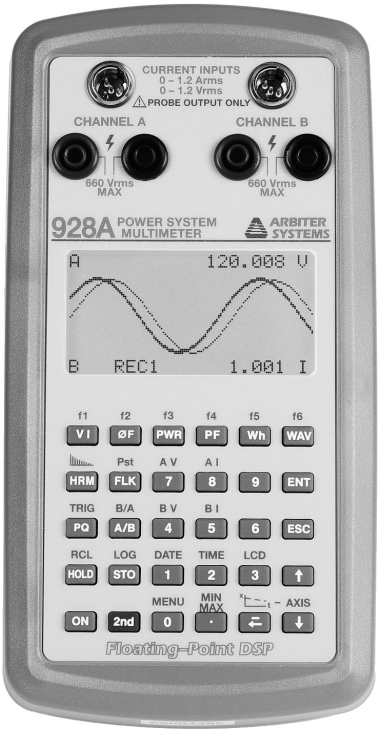
MODEL 928A USER'S MANUAL



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Notice

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2. If instrument return is authorized, forward prepaid to the manufacturer. If it is determined that the instrument is not covered by this warranty, an estimate will be made before the repair work begins, if requested.

See Contact Information on page ii.

Arbiter Systems, Inc.
Model 928A
Power System Multimeter™
User's Manual

PD0030900 Revision O

A pdf version of this manual is available for download at www.arbiter.com.

Contents

List of Figures

Introduction

Scope

Welcome to Arbiter Systems' Power System Multimeter with Floating Point DSP™! The Model 928A Power System Multimeter is filled with great features to help you measure electrical power. Whether you are a new or experienced user, you should find the Model 928A easy to use and accurate. Three power sources include alkaline or NiMH AA cells, and a +7 Vdc wall adapter for continuous use. The alkaline cells provide about 30 hours of use, and the NiMH should provide about 60 hours of use.

Features

- 128X64 graphic LCD display
- 30-key multi-function keypad
- Isolated USB serial interface
- 4 AA cells or a +7 Vdc plug-in power supply
- Flash memory for approximately 6500 records
- Accurate internal real time clock
- Mlink application software

Simple Measurement

To measure, simply set the inputs for voltage or current, connect the correct set of cables and press the desired function button.

Recording Data

Store data by pressing the STO button or using one of the Auto-Log features. The 928A also stores Sags and Swells, and standard Triggers in flash memory. 400 kB of flash memory provides enough space to store thousands of records.

Safety and Usage Information

Read the usage and safety information inside this manual. Dangerous voltages may be present at the terminals of the equipment you are measuring, so take precautions! Safety symbols are used throughout this manual to signify potential hazards to the equipment or to you, the user. Some of these are as follows.

"Warning" – identifies an action or a condition that poses a hazard to the user.
"Caution" – identifies a condition or action that may cause the incorrect operation or damage to the Model 928A.

Caution: Max CT Input Level

Never apply any signal directly to the CT inputs of Channel A or B greater than 1.2 Arms or 1.2 Vrms.

Apply voltage and current signals to two identical channels, labeled A and B. Prior to measuring, make

sure that the channels have been correctly configured for the signal type (whether they are voltage or current).

Caution: Direct Current Input

DO NOT connect a current signal directly to either Channel A or B. Always use a current-output or voltage-output CT when measuring current with the 928A.

Measuring Safety and Usage

Be sure to follow all precautions and safety information provided with any other equipment you are using.

Display

Using a 128x64 pixel display, the 928A can display all text and graphics necessary for operation. The LCD can be adjusted for contrast and backlighted operation.

The Instrument Case

Made from strong copolymer (similar to nylon), the 928A case is designed to protect it from certain mechanical and electrical hazards, however it is not waterproof. Water or other liquids can penetrate the case at a number of points, which can permanently damage the unit. Therefore, use care to protect it from rain, spills or condensing environments.

Caution: Water Damage

The case is not waterproof. Subjecting the 928A to rain or a wet environment will most likely damage it.

Caution: CT Probe Use

Please note that *the jaws of the CT probe must be fully closed to operate properly.* Some probes have a locking device, which must be fully engaged before the probe will operate correctly. When clamping any CT probe around conductors, always inspect the two jaws to make sure they are fully closed.

CT Characterization

While *the 928A Starter kit* includes a CT probe that has been characterized for accuracy, Arbiter also provides a service for users to have their own CT characterized for use with the 928A. Contact Arbiter Systems for more information on this service.

For more information on CT characterization files (called "Profiles"), see instructions under "CT Characterization Files" on page 31.

928A Standard

928A; AS0098400 – Operation Manual (includes Calibration Card); AS0093800 – Operation Manual; AP0009700 – Single-Phase Voltage Lead Set.

928A Starter Kit

AP0011200 – +7 Vdc Power Supply; AP0009700 – Single-Phase Voltage Lead Set; AP0012300 – 100:1 Clamp-On CT; 1.5 Volt AA Alkaline Battery (4); CA0026106 – USB Cable A-B 6 ft.; CA0027200 – CT Cable Voltage Output; HD0069800 – Soft Carrying Case; CTCAL01 – Calibration (100 mA – 100 A)*; AS0082900 – 928A Bail Assembly.

*Other CT characterization ranges available

Getting Started

Keyboard Operation

Most of the keys on your 928A perform one primary and one secondary function. The primary function of any key is indicated by the characters on the face of the key; for example, **ON**. The secondary functions are indicated above the key; for example, **RCL** above the **HOLD** key. See page 94 for key definitions.

Primary Function Keys

Primary keys need only to be pressed to function. For example, press [V I] to set the multimeter mode to read voltage and/or current for Channel A and B.

Secondary Function Keys – 2nd key

First press [2nd] followed by any key with symbol marked in blue above it.

Navigating Menus to Configure

1. To select a configure mode, press any function key, then **2nd** > **MENU**. For example, **PQ** > **2nd** > **MENU**, or **2nd** > **LOG** > **2nd** > **MENU**.

2. Scroll through fields using the ↑ or ↓ key and press **ENT** to move the cursor to the value field.
3. Press ↑, ↓ or number keys to change these values; press **ENT** to install and move to another value.
4. To save changes and exit, highlight <**STOre And Exit**> and press **ENT**. Alternatively, press **STO**.

Power Supply, On and Off

Press **ON** to power the 928A ON and OFF. To conserve power, the multimeter can be configured to automatically turn itself off after an adjustable period of inactivity.

For help on supplying inlet power, whether connecting the power source or installing batteries, see page 7ff.

Auto Power Shutdown

The 928A auto shutdown feature allows you to select whether you want the 928A to automatically shutdown or not. To automatically shut down and conserve batteries, use the the Auto Shutdown menu under the Main Menu. A number of different time intervals are available in which the 928A will automatically power down. See Auto Shutdown on page 17.

Battery Power Only

The Model 928A operates on four AA alkaline or Nickel-Metal Hydride batteries. In the event of a battery failure, always carry a spare set of fully-charged batteries.

Battery Replacement

1. Power off the 928A prior to removing the batteries.
2. Remove the battery cover retaining screw and remove the cover by pulling it upwards at the screw side. See Figure 1.
3. Replace the batteries. Note that battery orientation is indicated by polarity symbols.
4. Replace the battery cover and retaining screw and put back into service.

Figure 1: Battery Compartment

Caution: To optimize reliability, and reduce the possibility of corrosion between the contacts, keep all terminals as clean as possible. One method of cleaning the Model 928A battery terminals is to rub them periodically with a cotton-tipped swab moistened with denatured alcohol.

AC Power Adapter

Included in the Model 928A Starter Kit is a power adapter (Arbiter part no. AP0011200) that provides power to the 928A and is suitable for continuous use. The power adapter is not designed to charge batteries located in the battery compartment. For power adapter details and specifications, see "AC Power Adapter" on page 92.

Caution: The AC power adapter does not charge internal batteries. Batteries are disconnected when power adapter is connected to the Model 928A.

Operating with AC Adapter

The power adapter supplies power to the 928A for normal operation. While using the power adapter, any batteries installed in the 928A are disconnected. To operate the 928A with the accessory power adapter:

1. Attach the power supply to a line outlet from 90 to 264 Vac and 47 to 63 Hz.
2. Connect the 3.5 mm mini-plug into the 928A power receptacle.
3. Press **ON** to operate the 928A.

Bail Assembly

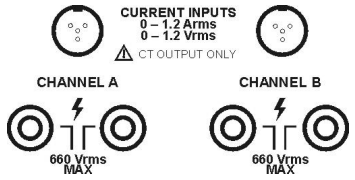
The Model 928A Starter Kit comes with a bail assembly for propping up the 928A and convenient viewing. Note that the plastic inserts on the ends of bail assembly slide into the pair of mounting holes on the top or bottom of the rear panel. See Figures 2 and 3 for details.

Figure 2: Bail Assembly attached to lower holes

Figure 3: Bail Assembly attached to upper holes

Measurement Terminals

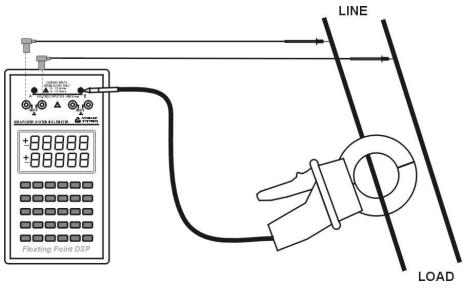
The Model 928A has two identical sets of measurement terminals, called Channel A and Channel B, that accept either a voltage or a current. To measure a current, select one of the current input connectors at the top of the instrument. To measure a voltage, select a set of voltage terminals found below the current input connectors.



Caution: Maximum Input, Current Terminals: 0 to 1.2 Arms or 0 to 1.2 Vrms. *See caution for CT probe use on page 4.*

Versatile Inputs

For basic measurements (voltage, current, frequency and phase angle) any combination of inputs may be used. For power and energy measurements (active power, apparent power, reactive power or power factor), use a combination of voltage and current inputs.



Voltage Terminals

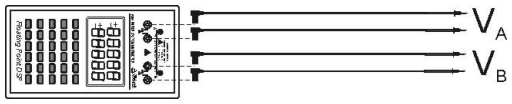
Two sets of voltage terminals allow you to apply voltages up to 660 Vrms, max. They may also be scaled for reading the primary voltage on a PT or transformer. These inputs are labeled "CHANNEL A" and "CHANNEL B."

Normally, a direct connection (e.g. 1:1) is the default selection for measuring voltages, however, you can configure almost any voltage ratio for PT measurement at the secondary. To configure voltage ratios other than 1:1, see Configuring Channels A and B starting on page 23.

Press **2nd** > **AV** to measure voltage at Channel A.

Press **2nd** > **BV** to measure voltage at Channel B.

Note: Voltage inputs are isolated by 1.2 Megohms to each other and have a maximum input rating of 660 Vrms.



Caution – Max Voltage Input Level: Never apply any signal to Channel A or B voltage input terminals which is greater than 660 Vrms.

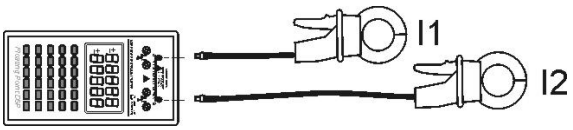
Current Terminals

Two sets of current terminals allow you to measure two currents simultaneously. The Current Input terminals for Channels A and B allow you to connect either a voltage-output CT or current-output CT to the 928A. A CT configuration screen allows you to setup CT values for both channels ahead of time.

CT configuration includes entering the CT Output Type (either voltage or current), CT Ratio and Phase Offset.

Press **2nd** > **AI** to measure current at Channel A.
Press **2nd** > **BI** to measure current at Channel B.

Note: Use care to select the correct probe type and scale factor to be able to measure accurately. Also, if using a characterized probe (by Arbiter Systems), be sure to select the correct characterization file (called a "Profile"). See CT Select, under Configuring Channels A and B on page 25.



Caution: No Direct Current Input – connect CT probe only. *See caution for CT probe use on page 4.*

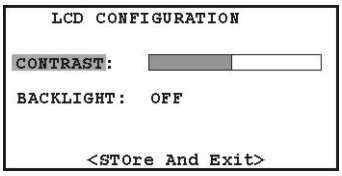
Caution: Maximum CT Input Level: Never apply any signal to Channel A or B current input terminals which is greater than 1.2 Arms or 1.2 Vrms.

Basic Functions and Keys

MIN/MAX – Range

Press the MIN/MAX key to cycle through various measurements, including the minimum, maximum, average and normal (active). To reset MIN/MAX values to zero, press and hold the backspace key for 3 seconds while in MIN/MAX function.

LCD – Display Control

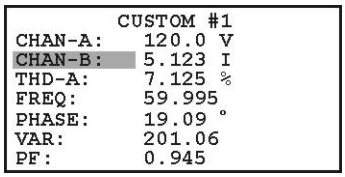


1. Press **2nd** > **LCD** to open the LCD configuration screen.
2. Press ↑ or ↓ to select LCD contrast or Backlight control.
3. Press **ENT** to select contrast slider bar or backlight condition.
4. Press ↑ or ↓ to adjust contrast, or select backlight ON or OFF and press **ENT**.
5. Highlight <**STOre And Exit**> with the cursor and press **ENT** to install new values and exit.

Function Keys, f1 – f6

f1 – Custom User Screen

Press **2nd** > **f1** to access either of two custom user screens. These screens are in tabular format and allow up to seven functional entries. Configure all user measurement functions through Mlink software; for more information see "Mlink Software Tutorial" starting on page 66.



f2,. . . ,f6 *There are currently no functions assigned to the secondary keys labeled f2 through f6.*

Splash Screen

When first powered on, the 928A will display an introductory message that describes the 928A. Press any of the main measurement keys (e.g. **VI**) to bypass the splash screen.

Up and Down Arrows

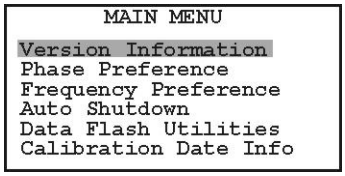
Press ↑ or ↓ to step through values in configuration menus or for choosing specific records held in memory.

MENU – Configuration and Settings

Use the MENU key to set up the functions, preferences and operating parameters of the 928A. Access these menus through the Main Menu, or in context.

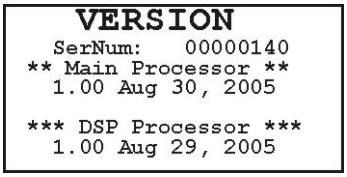
Main Menu

1. Press **2nd** > **MENU** > **2nd** > **MENU** to open the main menu.
2. Press **ESC** to backup to previous menus.



Firmware Version

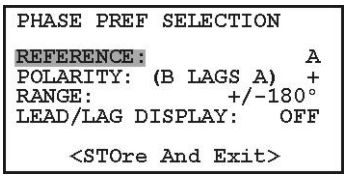
1. Open the main menu as shown above under Main Menu.
2. With the cursor highlight "Version Information" and press **ENT** and read the version information.



3. Press **ESC** to backup to previous menus.

Phase Preference

1. From the Main Menu, highlight "Phase Preference" with the cursor and press **ENT** to open the Phase Preference menu.



2. REFERENCE: Press **ENT** and ↑ or ↓ to set the Reference to Channel A or B. Press **ENT** to set it.

3. POLARITY: Press **ENT** and ↑ or ↓ to set POLARITY as positive (+) or negative (–) and **ENT** to set it.

   Note: Notation changes from "B LAGS A" to "A LAGS B" when switching REFERENCE from A to B.

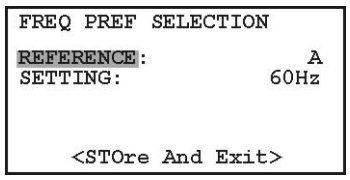
4. RANGE: Press **ENT** and ↑ or ↓ to select the range value (to either $\pm 180°$, or $0 - 360°$) and **ENT** to set it.

5. LEAD/LAG Display: Press **ENT** and ↑ or ↓ to switch the Lead/Lag display ON or OFF. When selecting ON, the words "LEAD" or "LAG" will be displayed in the **PF** (Apparent Power / Power Factor) function.

6. Highlight <**STOre And Exit**> and press **ENT** to install values.

Frequency Preference

1. From the Main Menu, highlight "Frequency Preference" and press **ENT** to open.



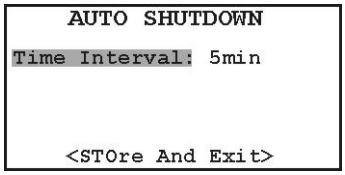
2. REFERENCE: Press **ENT** and ↑ or ↓ to access and change Reference value to A or B and **ENT**.

3. SETTING: Press **ENT** and ↑ or ↓ to access and change Frequency SETTING to either 50 Hz or 60 Hz, and **ENT** to set it.

4. Highlight <**STOre And Exit**> with the cursor and press **ENT** to install the new value(s).

Auto Shutdown

1. From the Main Menu, highlight "Auto Shutdown" and press **ENT** to open.

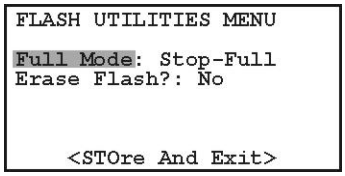


2. Press **ENT** and ↑ or ↓ to adjust the Auto Shutdown feature OFF or to one of the time intervals (OFF, 5min, . . . , 16hr), and **ENT** to set it.

3. Highlight <**STOre And Exit**> with the cursor and press **ENT** install the new setting.

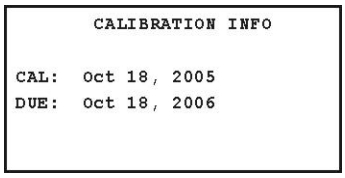
Flash Utilities Menu

Use the Flash Utilities Menu to manage 928A memory. Choose either "Stop-Full" or "Overwrite" in **Full Mode** to control storage with full memory condition. Choose "Yes" or "No" in **Erase Flash?** to do so.



Calibration Date Info

If your unit has a calibration certificate, highlight this selection and press **ENT** to view the calibration information. Without the certificate, the menu item will not appear.



Menus in Context

To access these menus, you will need to be viewing the specific function and press **2nd** > **MENU**. See specific function (e.g. **VI** or **PWR**) for complete information.

ENT – Enter or Move

Press **ENT** to open a menu selection, move between selections within a menu and to confirm a change to a new value.

ESC – Escape, Go Back

Press **ESC** to leave a specific menu or go back in keystrokes to the previous screen. For example, if you are viewing the Main Menu, press **ESC** to leave the Main Menu and view Channel Configuration.

STO – Store Value or Reading

Use **STO** to

1. Write to flash memory the current measured values at Channel A and B as shown on the display.

2. Save values during configuration of functions (e.g. a CT ratio or phase offset and moving to the next item). Use **STO** in lieu of highlighting <**STOre And Exit**> and pressing **ENT**.

When Recording Data

The Model 928A stores records according to the date and time running in the internal clock. Before measuring, check the clock for the correct time in the case that it has drifted or was inadvertently changed. See TIME and DATE, on pages 20 and 21, for more information on setting the time and date.

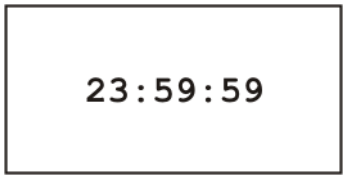
When Configuring Functions

To configure settings in the 928A, generally you will press **2nd** > **MENU** while in some measurement mode (e.g. **VI**). After changing any settings, press **STO** to install the new value(s) in memory and leave that menu. Also, highlight <**STOre And Exit**> then **ENT** to perform the same function as **STO**.

TIME – View or Set Time

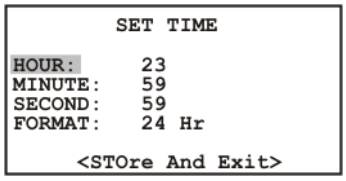
Viewing the Time

Press **2nd** > **TIME** to view the time.



Adjusting the Time

1. While viewing the time, press **2nd** > **MENU** to access the time adjust screen.

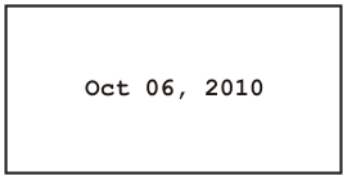


2. Press ↑ or ↓ to move between fields and **ENT** to enter the Time value field you want to change.
3. Using the ↑ or ↓, or number keys, adjust the desired time value, and press **ENT** to store. Make any additional changes.
4. When finished, highlight <**STOre And Exit**> and press **ENT** to install new values and return to viewing the time.
5. Press **ESC** to exit the time screen.

DATE – View or Set Date

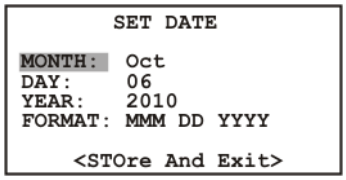
Viewing the Date

Press **2nd** > **DATE** to view the date.



Adjusting the Date

1. While viewing the date, press **2nd** > **MENU** to access the date adjust screen.



2. Press ↑ or ↓ to move between fields and highlight the value you want to change. Press **ENT** to enter date value.

3. Press ↑, ↓ or number keys to adjust the desired date value, and **ENT** to store.

4. When finished configuring the date, highlight <**STOre And Exit**> and press **ENT** to install new values and return to viewing the date.

5. Press **ESC** to exit the date screen.

Using the Input Channels

This page describes four steps in setting up and using channels A and B for voltage and/or current.

1. **Configure the Channels:** (see next page) In this step, you will set up *how* the channels measure. Configure Channels A and B scaling for reading any voltage or current signal. Once these are set up, you should be able to select the channel and begin measuring. Normally, you would not keep changing these values. However, if you change to a different CT, then you would need to configure this step again.

2. **Select the Channel:** In this step, you determine *what* each channel is measuring. Let's say you want to measure voltage on Channel A and current on Channel B. To set this up, press **2nd** > **AV** to set Channel A for voltage and press **2nd** > **BI** to set Channel B for current.

   If you want to set up both channels to measure current, then,press **2nd** > **AI** to set Channel A for current, press **2nd** > **BI** to set Channel B for current.

   Note: You must press the appropriate channel selection keys to correctly measure the desired function.

3. **Choose the Measurement Mode:** For example, press [VI] to display voltage and/or current values.

4. **Connect the Equipment:** To measure, connect the leads between the 928A and the circuit under test.

Configuring Channels A and B

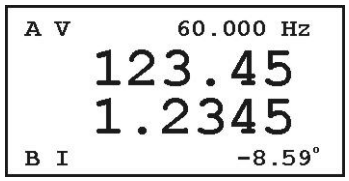
Configure Channels A and B, for both current and voltage through this menu. Four possibilities exist:

Ch-A V	Channel A measuring a voltage
Ch-A I	Channel A measuring a current
Ch-B V	Channel B measuring a voltage
Ch-B I	Channel B measuring a current

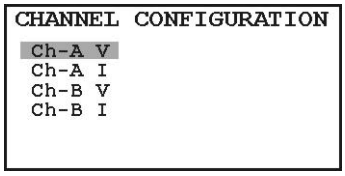
You can completely configure all these possibilities at one time from the Channel Configuration menu.

Voltage, Ch-A V

1. Press **VI** to open the measurement mode.

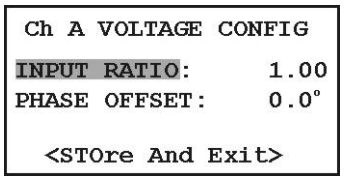


2. Press **2nd** > **MENU** to open the configuration screen for Channels A and B.



3. Press ↑ or ↓ to highlight the channel and **ENT** to open the specific Channel configuration screen. In this example, Ch-A V sets the voltage measurement parameters for Channel A.

4. The display should change to the "Ch A VOLTAGE CONFIG" screen. The configured items for voltage are Input Ratio and Phase Offset.



5. Press ↑ or ↓ to select desired field and **ENT** to select value to change.

Input Ratio

6. Enter the ratio values from the numeric keypad and press **ENT** to move to the next field. Note that all ratios are referenced to 1. For the example screen above, the Input Ratio is actually 1:1.

Phase Offset

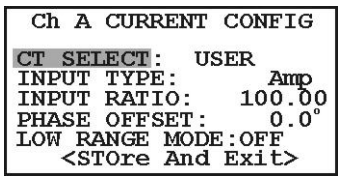
7. Enter the Phase Offset value from the numeric keypad and press **ENT** to move to the next field. In this example, the phase offset is 0.0°.

8. When finished configuring the channel, highlight <**STOre And Exit**> and press **ENT** to install any new values and return to the Channel Configuration menu. Press **ESC** to leave the Channel Configuration menu and return to the measurement mode.

Current, Ch-A I

Current Configuration includes five items: CT Select, Input Type, Input Ratio, Phase Offset and Low Range Mode.

1. Open the Ch A CURRENT CONFIG screen. Press **VI** > **2nd** > **MENU**, move the cursor to Ch-A I and press **ENT**. See also "Configuring Channel A and B" on Page 23.



2. Use ↑ or ↓, **ENT**, and the numeric keys to enter the CT Select, Input Type, Input Ratio, Phase Offset and Low Range Mode values as required.

CT Select

Selects either USER or M########, where:

- M######## – selects a characterized CT serial number (e.g. M00001234)
- USER – selects one user calibration constant

M######## selects a 12-point characterization set for the specified clamp-on CT, provided by Arbiter Systems. Calibration constants are obtained from Arbiter Systems and installed in the 928A using Mlink software. See "CT Profiles" in the Mlink Software Tutorial, on page 73 for information on uploading CT profiles.

3. Input Type, Input Ratio or Phase Offset for "M-type" CT SELECT values are protected from direct change in the 928A.

4. If choosing a CT SELECT value of USER, you can change any value in configuration screen.

5. When finished configuring, highlight <**STOre And Exit**> and press **ENT** to exit this menu.

Low Range Mode

For current measurements below 10 mA rms (i.e. into the 928A itself, not the CT) it may be advisable to switch the Low Range Mode ON. The Low Range Mode, multiplies the input signal by a factor of 20, and can improve accuracy and stability of the signal. Input signals above 10 mA rms may cause clipping.

Voltage Ch-B V

Change the Channel B voltage configuration in the same manner as for Ch-A V as described above. Remember that these settings only apply to Channel B when selecting the voltage function.

Current Ch-B I

Change the Channel B current configuration in the same manner as for Ch-A I as described above. Remember that these settings only apply to Channel B when selecting the current function.

Current Probe Configuration Examples

For secondary side measurements, you will need to set up the instrument scale factors so that you can cor-

rectly read the primary value. The example below shows how to configure a specific probe.

EXAMPLE: Current Probe Specification

AC Current Probe
AC Input: 75 Arms, maximum
AC Output: 10 mV/A rms
660 Vrms Working volts, max.

This probe produces 10 mV at the output terminals (to the 928A) for an input current of 1 Amp.

MAXIMUM OUTPUT VOLTAGE

= AC Input × AC Output Ratio
= 75 A × 10 mV/A
= 750 mV (or 0.75 Vrms)

It is safe to apply a current or voltage to either current input if it is less than or equal to the specified maximum of 1.2 Vrms, or 1.2 Arms. In this case it is safe to apply 0.75 Vrms being less than 1.2 Vrms. If using a current output CT, you would be able to apply up to 1.2 Arms to either current input.

Selecting a Channel Function

Press **2nd** > **AV** to select voltage at Channel A.

Press **2nd** > **AI** to select current at Channel A.

Press **2nd** > **BV** to select voltage at Channel B.

Press **2nd** > **BI** to select current at Channel B.

CT Probe Selection

ATTENTION: A CT profile, or characterization file, may be selected on only one channel at a time. For example, if the current probe profile is selected on channel B, you will need to deselect it from channel B before selecting it on channel A. If the profile (i.e. characterized CT) is selected for Channel B, it will not be available for selection on channel A.

See also caution for CT probe use on page 4.

No Direct Connection to Current Terminals

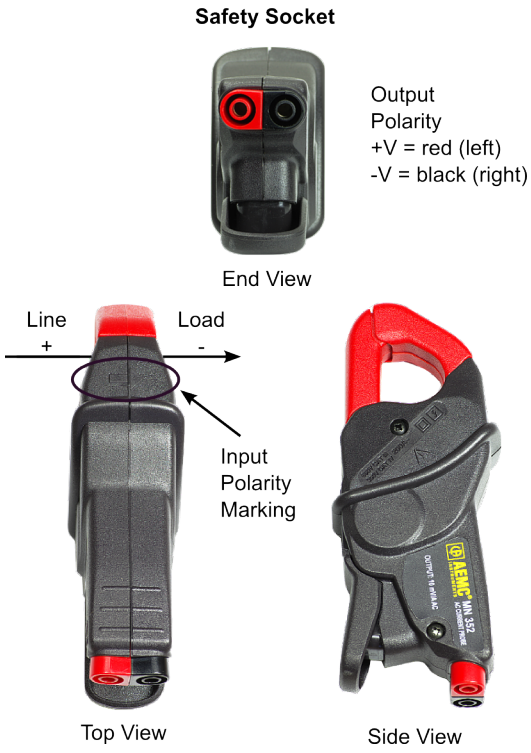
WARNING: CONNECT ONLY CT PROBE OUTPUT TO CURRENT TERMINALS ON 928A. Damage to the Model 928A current input may result if a current or voltage is connected directly to the 928A current terminals.

Maximum input to channel A or B current terminals is 1.2 Arms or 1.2 Vrms, depending on the type of current probe connected.

Using the MN352 Current Probe

Connect the CA0027200 accessory voltage-output CT cable between Channel A or B current input connector on the Model 928A and the safety sockets on MN352. Observe the polarity markings for correct reading.

WARNING: Always remove the clamp from the circuit under test before connecting/disconnecting the accessory cable at either end.



CT Cable Spring Clip

A circular spring clip has been added to the CT cable connector on the meter end to hold down the small locking button. It is easier to remove the connector from the meter with the spring clip in place. With the spring clip not in place, it is necessary to depress the button fully to extract the cable unit from the meter.

CT cables come with the spring clip pre-installed.

If desired, you may remove the spring clip so that the connector is locked into the meter. To remove the connector from the meter without the spring clip, press down the lock button with your finger and pull the connector straight out.

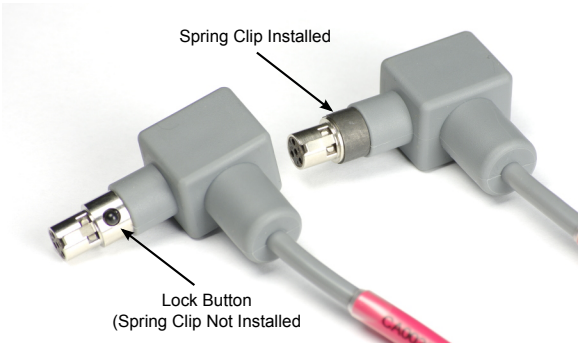


Figure 4: Spring Clip on Meter Side of CT Cable

Available, if your CT cable does not have a spring clip. Two spring clips and installation tool may be ordered for your CT cable set.

Part number AS0104000.

CT Characterization Files

With each CT probe, Arbiter Systems provides a characterization file (or "Profile") that improves the accuracy for current measurements by about 10 times. Before using the probe, the profile must be configured (see below) in the Model 928A. The Model 928A can store up to five different CT profiles.

To Obtain the CT File

1. Connect to the Arbiter Systems website at *www.arbiter.com*, navigate to the 928A product page and look under the "Key Features" tab.

You may also connect to the Arbiter home page and choose Service/Support, then Downloads, and finally Model 928A CT Characterization Files.

2. Type in the serial number that is located on your probe. The site will return a link to select for downloading. Select it and download the file to your pc.

To Upload the CT File

Go to "CT Profiles" on page 73 for instructions on installing and removing the CT file(s) on your Model 928A. Mlink provides you with tools for managing all of the CT files available for your Model 928A.

Configure CT File in the Model 928A

To choose a specific CT profile, you will need to go to the "Ch A (B) CURRENT CONFIG" menu in the Model 928A. See "CT Select" on page 25 for further details on choosing a specific CT profile.

Operation

Introduction

Information in this section provides specific details on configuring and using more advanced functions of the 928A.

Certain fundamental procedures are covered in the previous chapter, such as "Configuring Channels A and B" starting on page 23. If you have not previously reviewed them, it would be good to do so at this time.

Some of the more advanced features covered in this section include measuring:

Voltage and Current
Phase and Frequency
Power and Power Factor
Harmonics and Flicker
Power Quality
Triggering, AutoLogging and the Log Key
Recall of Data Stored in Flash Memory
Trending Data
Ratio Functions (A/B and B/A)

Making Measurements

VI – Voltage and Current

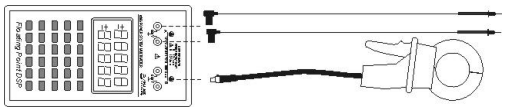
Choose either Channel A or Channel B to measure voltage and current. If necessary, refer to Configuring Input Channels in Getting Started. For example, if you wish to measure voltage using Channel A, then you would press **2nd** > **AV**.

CAUTION

Do Not Exceed the Maximum Ratings
Voltage Inputs: 660 Vrms
Current Inputs: 1.2 Arms or 1.2 Vrms

Setup

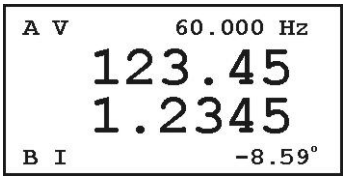
1. Verify that Channel A and Channel B are configured properly. If necessary, refer to Getting Started page 23, Configuring Channels A and B.



2. Press **VI** and connect the probe(s) between the 928A and the circuit elements.

3. Read values on the display.

Display Definitions



Display	Description
A V	Channel A with units in volts.
60.000 Hz	measured line frequency
123.45	measured channel A signal in volts
1.2345	measured channel B signal in amps
B I	Channel B with units in amps.
-8.59°	Phase angle of channel B signal relative, in degrees, to channel A.

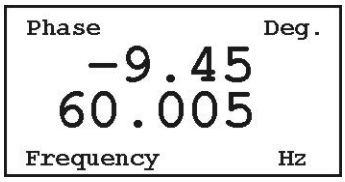
Caution: Please note that the jaws of the CT probe must be fully closed to operate properly. Some probes have a locking device, which must be fully engaged before the probe will operate correctly. When clamping any CT probe around conductors, always inspect the two jaws to make sure they are clean before fully closing.

ϕF – Phase and Frequency

To measure phase, you will need to connect two signals to the Model 928A: current-current, voltage-current or voltage-voltage. Frequency requires only one input.

Setup

1. Verify that Channel A and B are configured properly for the type of signals that you are measuring. If necessary, see page 23, Configuring Channels A and B.
2. Press ϕ**F** and connect the probes to the circuit elements.
3. Read the values on the display.



Phase Preferences

In this example, Channel B signal (current) is lagging Channel A (voltage) and is configured to report the phase as negative (-9.45°). If you want Channel B lagging Channel A to be reported as positive, you would need to open the Phase Preferences screen (under the Main Menu), and select as follows:

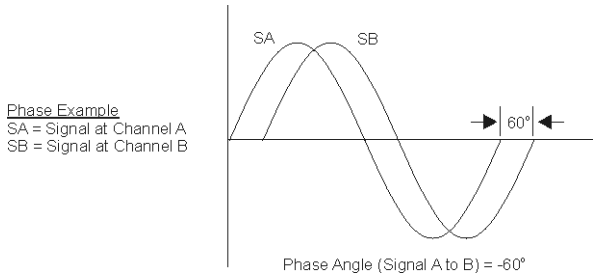
Polarity: (B lags A) +

Make sure the cursor covers the "+" sign and press one of the arrow keys to toggle it to the desired value and press **ENT**. For complete details on Main Menu Configuration, see page 16, under Phase Preference.

Note that the 928A is very flexible and always compares the signals at channels A and B for their phase relationship, regardless of the type of signal, whether voltage or current.

Phase Conventions

The following chart illustrates the standard phase conventions as used in the Model 928A. In this example, the inputs measured by the 928A may be either voltage or current signals.



SB is delayed from SA by 60 degrees, or approximately 2.8 milliseconds in time at 60 Hz. The phase is therefore referred to as lagging and given a *negative sign.*

If you prefer to see a lagging signal given a positive sign, then you should configure this in Phase Preferences in the Main Menu. See page 16, under Phase Preferences.

Example from the figure above: Suppose you are monitoring two signals, with a voltage connected at Channel A voltage terminals and a current at Channel B current input terminal. Then, the current would be lagging the voltage by 60 degrees.

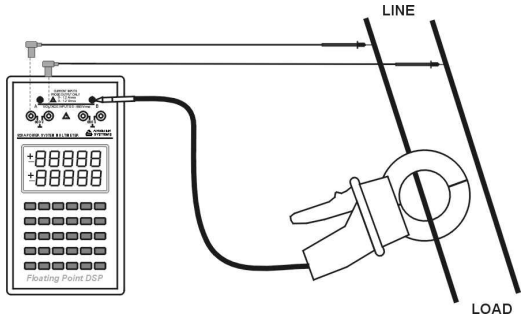
For additional details on phase conventions, please see page 100, Appendix C – Phase Conventions.

PWR – Active and Reactive Power

To use the power measurement function on the 928A, you must select one measurement channel for voltage and the other for current. In this example, Channel A is configured as voltage and Channel B as current.

Setup

1. Press **2nd** > **AV** to set Channel A to voltage and **2nd** > **BI** to set Channel B to current.

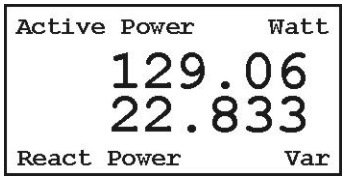


Note: in this figure, voltage probes are connected to Channel A and CT connected to Channel B.

2. Press **PWR** and connect the probes to the circuit elements.

3. Read the display.

Display Definitions



The display should indicate Active and Reactive power, showing the effective power to a load and wasted power returned to the line. The displayed units are Watts on the top and Vars on the bottom.

Determining Active Power

Active power is calculated from the real components of the current and the voltage.

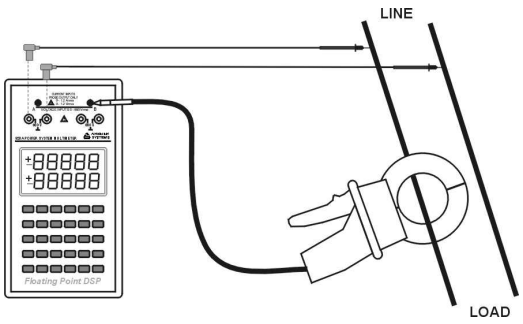
Caution: For current probe use, see "CT Probe Use" on page 4.

PF – Power Factor & Apparent Power

To use the Power Factor and Apparent Power function on the 928A, you will need to select one of the measurement channels for voltage and the other for current. In this example, Channel A is selected as voltage and Channel B as current.

Setup

1. Press **2nd** > **AV** to configure Channel A for voltage and press **2nd** > **BI** to configure Channel B for current.

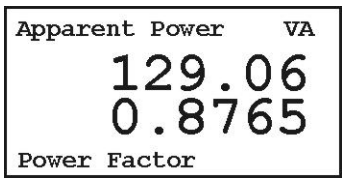


   Note: in this figure, voltage probes are connected to Channel A and CT connected to Channel B.

2. Press **PF** and connect the probes between the 928A and the circuit elements.

3. Read the display.

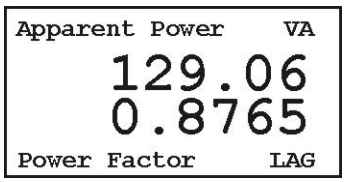
Display Definitions



The power factor displayed is determined from the reactive component of power.

Lead Lag Display

If you wish to know if the power factor is leading or lagging, configure this through the main menu, under Phase Preference. See page 16, under Phase Preference. The screen below shows a lagging power factor with the Lead/Lag indication turned ON.



Caution: For current probe use, see "CT Probe Use" on page 4.

Wh – Watt-hour

Use this mode to view the energy received and delivered.

To view or record any of the 10 energy values measured in the Model 928A, you must select one of the measurement channels for voltage and the other for current. Choose either channel for voltage or current. In this example however, Channel A is selected as voltage and Channel B as current.

Setup

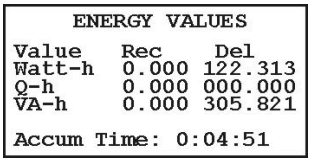
1. Check to see if the internal clock is displaying the correct date and time. See Time and Date on pages 20 and 21.

2. Press **2nd** > **AV** to configure Channel A for voltage.

   Press **2nd** > **BI** to configure Channel B for current.

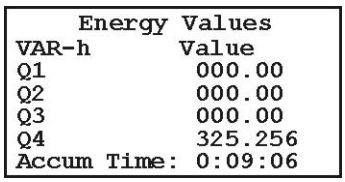
3. Connect the test probes between the 928A and the circuit or meter under test.

4. Press **Wh** to display the calculated Watt-hours.



Note: Del refers to the power delivered to the load, and **Rec** refers to the power delivered to the source.

5. Press **Wh** again to access the second set of energy values.



Important Note: Possible Data Loss – You will lose energy data if the 928A shuts down while measuring energy. Since energy values require time to accumulate, consider configuring the Auto Shutdown feature so that the 928A does not shut down during a measurement. Prior to collecting energy values, set the Auto Shutdown feature to OFF and use the external power supply. See Auto Shutdown on page 6.

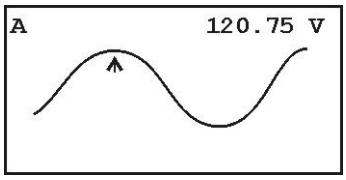
Caution: For current probe use, see "CT Probe Use" on page 4.

WAV - Waveform

To view or record signal waveforms on the 928A, select one or both of the measurement channels, for voltage and/or current. You can view up to two voltages, two currents or one voltage and one current. It does not matter which channel you select (A or B) to measure voltage or current.

Setup

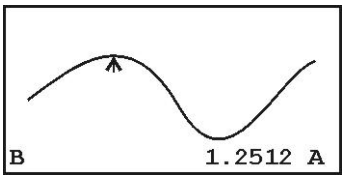
1. Make sure that Channel A and B are set up properly with at least one channel configured for voltage and/or current. If necessary, refer to Configuring Channels A and B on page 23.
2. Press the appropriate Signal Selection key in order to measure the signal properly - for example, press **2nd** > **AV** to select Channel A to measure voltage.
3. Connect the probe(s) between the 928A and the circuit under test.
4. Press **WAV** and read the Channel A graph on the display.



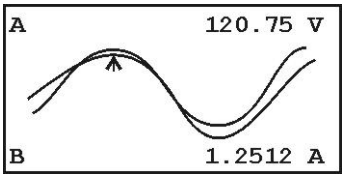
Channel A

5. Press **WAV** again to view the channel B graph on the display.
6. Press **WAV** a third time for a combined view of channels A and B on the display.

Channel B



Combined



Caution: For current probe use, see "CT Probe Use" on page 4.

HRM – Numerical Harmonics

To view or record harmonics on the 928A, you must select one or both of the measurement channels, for voltage and/or current. You can view up to two voltages, two currents or a voltage and current. It does not matter which channel you select (A or B) to measure voltage or current.

Setup

1. Make sure to select the correct signals for Channels A and B - for example press **2nd** > **AV** to measure voltage on channel A.
2. Press **HRM** and connect the meter probes between the 928A and the circuit under test.
3. Read the display; this example indicates channel A voltage magnitudes (fundamental through the 7th harmonic) and phase angle in degrees.

A	V	Phase
1	5.1000	-152.564
2	0.0100	21.010
3	0.0050	137.459
4	0.0004	-108.247
5	0.0039	49.934
6	0.0002	-5.094
7	0.0025	178.137

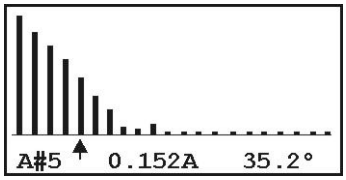
4. Press ↑ or ↓ to view the full range of tabulated harmonic values from the fundamental to the 50th harmonic. Press the arrow keys to move through the individual harmonic numbers and levels in groups of seven.
5. To read Channel B numerical harmonics, press **HRM**. Repeated pressing HRM toggles between Channel A and B numerical harmonic data.

Graphical Harmonics

To view a graphical representation of harmonics on the 928A, you must select one or both of the measurement channels, for voltage and/or current. The Model 928A allows you to view both voltages and currents, however it will allow you to view only one channel at a time. Each channel must be viewed separately due to the allowable space on the display.

Setup

1. Press the appropriate Signal Selection key in order to measure the signal properly – for example press **2nd** > **AI**.
2. Press **2nd** > and connect the meter probes between the 928A and the circuit under test. Read the display.



3. Press ↑ or ↓ to move the cursor to select the desired harmonic (e.g. in display above, cursor identifies 5th harmonic for channel A). Pressing the arrow keys, after reaching the last harmonic entry on the screen, will open the next (higher or lower) set of harmonics.
4. To read Channel B graphical harmonics, press **2nd** > . Repeatedly press **2nd** > to toggle between Channel A and B graphical harmonic data.

Flicker Information

In a sense, flicker is defined as a fluctuation of the line voltage. It is a very specific problem related to human perception and incandescent light bulbs, but not a general term for voltage variations.

The concept behind placing limits on voltage fluctuations is that they cause lights to flicker, which can be irritating and may cause discomfort. Voltage fluctuations are caused by loads on the power distribution system, which are located near lighting equipment (within the same building or powered by the same distribution transformer), and have changing power or current levels.

Based on groups of people tested for irritation from light fluctuations, most tend to be irritated when the light fluctuates at around 1000 changes/minute. Apparently above 1800 changes/minute light flicker is no longer perceived. Fluctuations in the rms voltage of only 0.25% are sufficient to cause noticeable flicker in light bulbs.

Some Definitions

Voltage Fluctuation: a series of voltage changes, or a continuous variation of the rms voltage.

Flicker: Impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time.

Short-Term Flicker Indicator, Pst: The flicker severity evaluated over a short period (10 minutes); Pst = 1.0 is the conventional threshold of irritability. A reasonable goal might be to limit Pst values to less than 1.0 for 95% of the time.

Long-Term Flicker Indicator, Plt: The flicker severity evaluated over a long period (over 2 hours) using successive Pst values. The Plt threshold is 0.8. Plt is not measured by the 928A.

FLK – Instantaneous Flicker

FLK flicker is defined as the instantaneous flicker that is updated each second. By simply pressing **FLK** the 928A will display instantaneous flicker based on the signals applied to channel A and/or B. To view flicker on the 928A, you must select voltage for measurement channels A and/or B.

1. Press **2nd** > **AV** and/or **2nd** > **BV**.
2. Press **FLK**, and read the instantaneous flicker.

FLK flicker values are measured at approximately 100 millisecond intervals and updated on the 928A display each second.

Pst – Short-Term Flicker

Pst flicker is defined as Short-Term Flicker and averages the flicker values over a ten minute time period, counting down in seconds. The display shows a countdown value as Pst is being processed. At the end of the countdown period, Pst is displayed based on the signals applied to channels A and/or B.

1. Press **2nd** > **AV** and/or **2nd** > **BV**.
2. Press **2nd** > **Pst**, and read the short-term flicker.

PQ – Power Quality, Sags and Swells

Method

The Model 928A measures sags, swells and power interruptions by using the **PQ** power quality triggering function. **PQ** follows the CBEMA method of measuring the signals at Channels A and B, comparing them to point limits over assigned time intervals. The rules used to measure the two input signals, including Point Limits, are called a Profile. An example of the CBEMA method used in the 928A is illustrated below.

Figure 5, drawn in a manner after the CBEMA method, models some sag/swell voltage limits and time intervals set in the 928A. Time intervals are normally configured as an integer multiple of a half cycle at the nominal frequency.

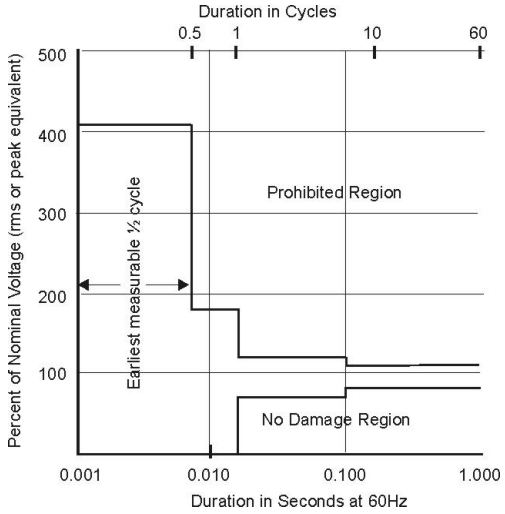


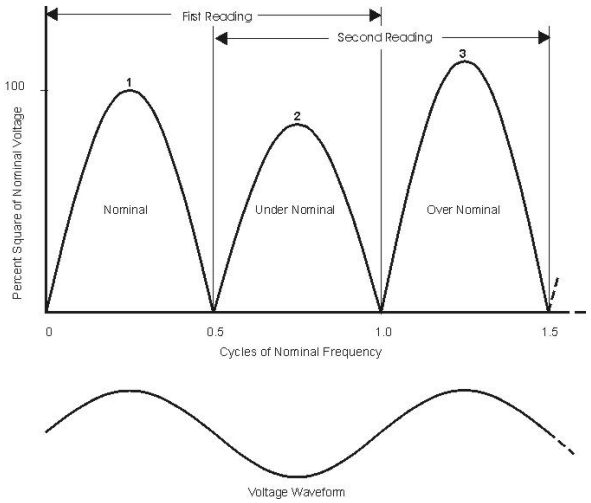
Figure 5: Point Limit Profile

The 928A stores power quality (PQ) records of sags and swells as a list of dates, times, maximums and minimums while the trigger is active. After the trigger becomes Inactive, it will display them on the 928A.

Any one profile may consist of up to 10 Point Limits, with each point defined over integer-multiples of half-cycles of the nominal frequency. Configuring point limits is straightforward, existing ones may be adjusted and more added at a later time.

Note: *the PQ function measures RMS values only.*

In the diagram below, notice that half-cycle voltage waveform elements have been squared, with each half-cycle having a different maximum compared to nominal. Also notice that these half-cycle elements are grouped in overlapping pairs. It is the rms value of two adjacent half-cycle elements that are compared to the profile limits.



PQ Profiles

The Model 928A can store up to 5 distinct PQ profiles that may be configured using Mlink software and uploaded into the 928A. Profiles are listed in the Model 928A as OFF, USER, PROF-1, . . . , PROF-5.

USER Profile

One profile, called USER, is available only from the 928A keypad. When you select USER, you can set up one point limit directly in the 928A. Records stored from USER profile are only available on the 928A itself and cannot be downloaded.

Profiles – OFF

Select OFF when not using PQ Triggering. Otherwise, PQ triggering could fill up the available memory. See "Selecting PQ Profiles" on following pages.

Working with PQ Profiles and Records

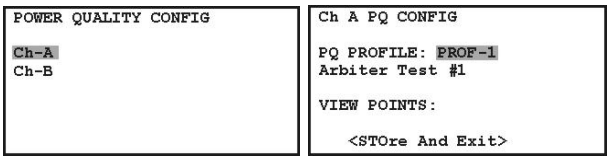
Internal flash memory will store all PQ event records until flash memory is full, overwritten or erased. View event records directly from flash on the 928A by pressing **PQ**. Changing the PQ profile will not disturb records already stored in flash memory.

NOTE: Make sure to download event records using Mlink software prior to deleting from flash in the 928A.

Selecting PQ Profiles

Except for one PQ profile named USER, all PQ Profiles are configured by using Mlink software. Configure the profile named USER only from the 928A keyboard.

Additionally, Channels A and Channel B may be configured independently.



1. To select a PQ Profile, press **PQ** > **2nd** > **MENU**. With the cursor, highlight either Channel A or B and press **ENT** to open the profile selection screen (seen in right screenshot).

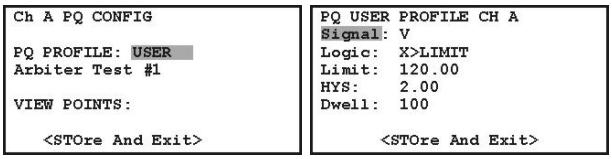
   There will be 7 available choices: 5 PQ Profiles, 1 USER Profile and OFF (to disable).

2. Press **ENT** to highlight the profile name (e.g. PROF-1), and ↑ or ↓ to select the desired PQ profile name. Press **ENT** to assign the profile name and to move to VIEW POINTS.

3. Press **ENT** (with cursor on VIEW POINTS) to open the Point Limit viewing screen, or highlight <**STOre And Exit**> and press **ENT**. Press **ESC** to exit.

USER Profile Setup

Select one USER profile in the same manner as for Profile 1 . . . 5 and OFF. From PQ Profile, select USER and press **ENT**. Select VIEW POINTS and press **ENT**. You should see the screen depicted on the right (below).



USER Profile Definitions

Signal: Select either V for voltage, or I for current.

Logic: Compares Signal (X) to Limit: select either X>LIMIT, or X<LIMIT.

Limit: Logically compares the signal to this value: select any floating point number up to 1,000,000.

HYS: Hysteresis: adds to the Limit value (±) to reduce unnecessary events; select any floating point number up to 1,000,000.

Dwell: Number of half cycles while Logic is true before trigger becomes Active; select any integer number up to 65535.

Tips on PQ Triggering

Here are some situations where you might not see any recorded events even though the measured parameter meets the required "Limit" conditions.

1. The parameter already meets the limiting condition when setting the trigger; it needs a transition from LO to HI or HI to LO before trigger becomes Active.
2. The parameter did not meet the dwell condition.
3. The parameter met the original limit conditions, however fell outside the sliding reference time constant (see IEC61000-4-30, par. 5.4.4.).

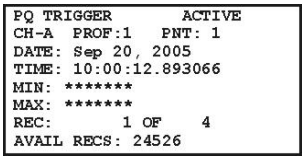
Accessing PQ Events

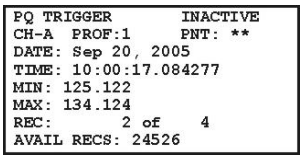
1. Press **PQ** to view power quality event records. Power Quality events are listed according to Record Number (RECS), Date and Time.

2. Scroll through the listed events by pressing ↑ or ↓ – shows MIN/MAX values when PQ Trigger is Inactive (right screen), no MIN/MAX values when Active (left screen).

3. Press any other function key to leave the PQ Event List.

4. Use Mlink software to download PQ records in CSV format to view in spreadsheet form.





NOTE: PQ profiles (PROF-1, . . . , PROF-5) must be configured through Mlink software, then uploaded to the Model 928A.

PQ Records

When the signals measured at either Channel A or B exceed any Point Limit, the Model 928A will record the following values:

- Start & Stop Times
- MAX & MIN values within Start and Stop Times

Press **PQ** to view recorded events by time and date. To view PQ data from Excel or other spreadsheet, use Mlink software to download records from 928A.

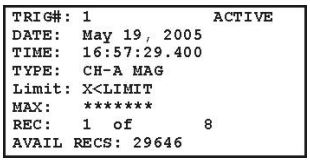
TRIG – Working with Triggers

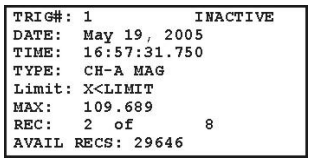
Use TRIG to test various input signal conditions such as voltage interruptions or frequency changes. When these conditions match the defined triggering limits, the 928A will record the start and stop times, and the maximum, or minimum signal value during the event (i.e. the date and time in which the trigger is active).

TRIG is very similar to PQ triggering as described in the previous section. However, TRIG is more general and flexible than PQ, and *does not* conform to IEC 61000-4-30, paragraph 5.4.4.

Viewing Triggers

Press **2nd** > **TRIG** to view the Trigger Events screen. Press ↑ or ↓ to move through the record list.





In the screen shots above, REC 1 of 8 indicates the date and time that TRIG #1 first became active (i.e. triggered); note that no input signal levels are recorded.

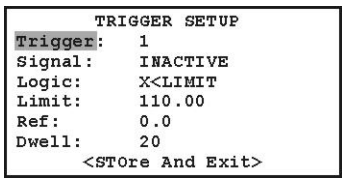
REC 2 of 8 shows the date and time TRIG #1 returned to normal limits, and became inactive (i.e. "non-triggered"). Notice that REC 2 of 8 also indicates a MAX (or MIN) value of the input signal during the time while the trigger was previously active.

In this example, the Limit was set to 110.00, and the lowest value recorded during this event was 109.689 volts at the date and time indicated.

Configuring Triggers

Note that you can only configure TRIG from the 928A itself, not in Mlink.

To configure TRIG, press **2nd** > **TRIG** > **2nd** > **MENU**. Once in this menu, step through each condition and view or edit any value. There are 8 individual triggers available.



1. Press **ENT** and ↑ or ↓ to select trigger.
2. Use **ENT** > ↑ and ↓, or the number keys to the configure triggering conditions.
3. Highlight <**Store And Exit**> and press **ENT** to store new values.
4. Press **ESC** to exit the configuration screens.

Trigger Setup Value Definitions

Trigger: 8 possible profiles available
Signal: Allowable input signal values: INACTIVE (means the trigger is not armed), CH-A MAG, CH-B MAG, WATTS, VA, VAR, PF and FREQ.
Logic: 4 conditionals: x < Limit; x > Limit; |x| > Limit; |x-ref| > Limit; x = input signal value
Limit: Numerical value compared to signal: floating point.
Ref: A nominal signal value (e.g. 60 Hz) used to compare to Limit: floating point
Dwell: The persistence in alarm condition before trigger becomes active, in 50 millisecond increments (e.g. 20 = 1 second): an integer.

A/B Function

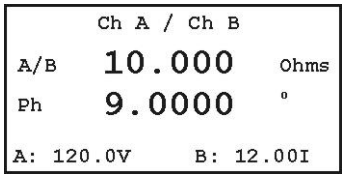
Use the A/B function to find the ratio of the two measured input signals to Channels A and B. If, for example, you wish to know the ratio of a voltage at channel A to a current a channel B, pressing the A/B button will display the results of dividing the voltage by the current giving resistance and phase offset of Channel B from Channel A.

Setup

1. Make sure that Channel A and B are set up properly with both channels configured for voltage and/or current; *you must use two channels to use A/B*. If necessary, see Configuring Channels A and B on page 23.

2. Press **A**/**B** and connect the measurement probes to the circuit under test.

3. Read the display.



NOTES: If you configure channel A as current and channel B as voltage, then the units will be in Mhos and degrees. If you choose two voltages or two currents, then the units will be a strict ratio (with no displayed units for A/B) and degrees.

B/A Function

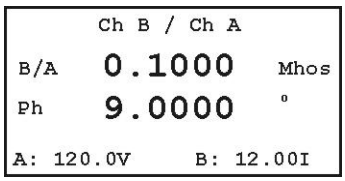
Use the B/A function in the same manner as you would with the A/B, only with the reverse response as with the A/B function and the same input signals.

Use the B/A function to find the ratio of the two measured input signals to Channels A and B. If, for example, you wish to know the ratio of a voltage at channel A to a current a channel B, pressing the B/A button will display the results of dividing the current by the voltage giving conductance, in Mhos, and phase offset of Channel A from Channel B, in degrees.

Setup

1. Press **B**/**A** and connect the measurement probes to the circuit under test.

2. Read the display.



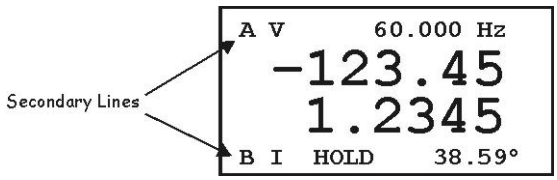
NOTES: If you configure channel A as current and channel B as voltage, the units will be in ohms and degrees. If you choose two voltages or two currents, then the units will be a strict ratio (with no displayed units for B/A) and degrees.

HOLD – Hold Metered Value

Press **HOLD** to leave the measurement mode and retain the last measured value on the display. Press **HOLD** again to return to the measurement mode.

The Hold function operates only with measurement functions, and not with setup screens or with Date and Time. To view and/or change the Date and Time, see DATE or TIME on pages 20 and 21.

When in the hold mode, you will see the word "HOLD" in the lower secondary line of the display, as illustrated below. When not in the measurement mode, the word "HOLD" will disappear.



Procedure

1. Set up the 928A to measure the values you wish to observe. If necessary, see Configuring Channels A and B on page 23.

2. Connect the measurement probes between the 928A and the circuit under test. Press **HOLD**. This puts the display in the hold mode.

3. Read the values.

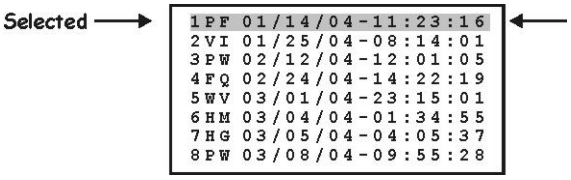
4. Press **HOLD** again to return to the measurement mode.

RCL – Recall Stored Values

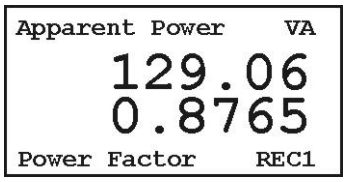
Press **2nd** > **RCL** to open the list of records stored from pressing **STO**. Records are replaced when storing a new record over the old record location. The Model 928A can store up to eight records using **STO**, and numbered from 1 to 8.

Records are stored according to number, type, date and time as shown in the example below.

Viewing Procedure



1. Press **2nd** > **RCL** to view the Recall Stored Data screen.
2. Use ↑ or ↓ to select the record for viewing.
3. Press **ENT** to view the selected record data. Note the word"REC1", for Record #1, in the lower right of the display below.



4. Press **ESC** to return to the Recall Data screen and select a new record. Press **ESC** again to leave the Recall Stored Values list.

Integration Key

Purpose

Use the Integration function to view a plot of the selected signal over time. Signals include voltage, current, frequency, phase and power factor. Configure the signal sampling interval from 1 to 65535 seconds. The vertical range scales according to the upper and lower limits that you configure.

Press **2nd** > **AXIS** to scale the plotted values to the desired viewing range. This includes the upper and lower limits, the last measured value, a vertical graticule and the units of the measured signal. See next page for setup details.

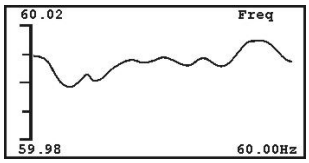
Procedure

1. Press **2nd** > ⌐‾ to plot and view the configured signal.

2. Press ← and hold for three seconds to restart the plot.

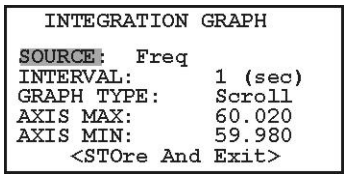
Example

In the example below, the plotted signal (i.e. Source) is frequency, the upper and lower limits (Axis Max and Axis Min) are 60.020 and 59.980 Hz, and the last measured value is 60.00 Hz. Since the Graph Type chosen is Scroll, previously plotted data moves left.



AXIS Key

Use the AXIS key to configure how the Integration function plots the signal source. There are five categories to set up in this menu.



Graph Definitions

Source	Chan-A, Chan-B, freq, phase, PF Actpwr
Interval	From 1 to 65535, in seconds
Graph Type	Scroll or Fixed
Axis Max	Maximum plotted value on display
Axis Min	Minimum plotted value on display

Procedure

1. Press **2nd** > **AXIS** to open the Integration Key configuration screen.
2. Press ↑ or ↓ to locate the desired field and **ENT** to enter the variable field.
3. Press ↑, ↓ or number keypad to change the required values(s) and press **ENT** to store value.
4. Finally, highlight <**STOre And Exit**> with the cursor and press **ENT** to save any changes and exit this menu.
5. Press **ESC** at any time to quit the menu function.

LOG Key

Purpose

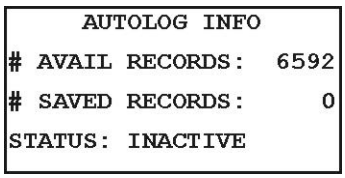
Use the LOG key to automatically record basic electrical data to the 928A flash memory over a specified time interval. This function, also called AUTOLOG, makes it convenient to record measured electrical quantities while the equipment is unattended.

Logging Features

- Basic Data only (see list at end of section).
- Logging interval in seconds
- Stores up to 6592 records, maximum

Viewing Autolog Information

To view Autolog information, press **2nd** > **LOG**, and the screen will display some basic information about the data logging features.



In order to operate, the Autolog function needs start and stop times and dates and a logging interval in seconds. Set up these features while in the AUTOLOG INFO menu by pressing **2nd** > **MENU**.

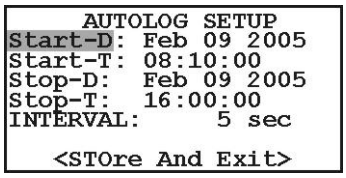
Viewing Autolog Data

Use Mlink software (see page 81) to download Autolog records to computer and view in spreadsheet format. They cannot be viewed on the 928A itself.

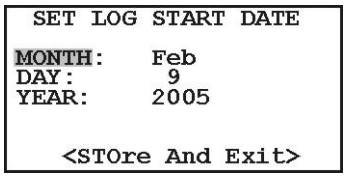
Autolog Setup

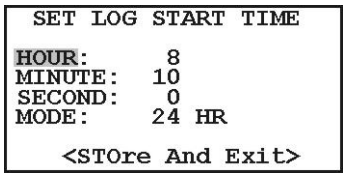
Always make sure to verify the time a date in the 928A before using the Autolog feature. See pages 20 and 21.

1. From the Autolog Info screen, press **2nd** > **MENU**. The Autolog Setup screen should appear.



2. Use the arrow keys to locate the field you wish to alter, and press **ENT** to open the field value. Both screens below show the start date and time. *Stop date and time screens are very similar. Be sure to configure them both.*





3. *Adjustment procedure:* Use the arrow keys to locate the desired field value and press **ENT** to

enter the value. Use the numeric keypad, ↑ or ↓, to enter the desired parameters and press **ENT** to store.

4. When you have finished adjusting any parameters, always move the cursor to <**STOre And Exit**> and press **ENT**.

5. When finished adjusting the 928A clock features, or to quit for any reason, press **ESC** to leave the Autolog setup.

Autolog Time Mode

The Autolog Time Mode is set when you set up the Time features. See Time Adjustment. **Note:** check the 928A Time and Date for accuracy prior to starting the Autologging. To adjust time and date, see pages 20 and 21.

Basic Data List

- Channel A magnitude
- Channel B magnitude
- Power Factor
- Q
- VA
- VAR
- Watt
- Relative Phase (B to A)
- Frequency
- Frequency Deviation
- Frequency Rate
- Channel A Flicker
- Channel B Flicker

Mlink Software Tutorial

Introduction

This tutorial was written to assist you in using Mlink, application software written specifically for the Model 928A. Mlink application software provides you with the following functions:

- Uploading CT Profiles*
- Configuring Power Quality Triggers
- Downloading Data Records
- Configuring Custom User Screens
- Uploading New 928A Firmware

* CT Profiles are current probe characterization files stored in the Model 928A that improve their accuracy.

Download Mlink

Download the latest version of Mlink from the Arbiter website under Downloads, Software, or if necessary contact Arbiter Systems at the information listed on page ii.

Drivers for Windows Vista, 7 and 8

Mlink is compatible with Windows Vista, Windows 7 Pro in 64-bit mode and Windows 8.

To install drivers on any of these versions of Windows, make sure that the 928A is connected to your computer via the USB cable and make sure your computer is connected to the Internet. The operating system should search for the drivers and load them. This may take some time so be patient. Check the Arbiter website for additional information.

For additional support on Windows Vista and Windows 7 check the Arbiter website under Service/Support.

Installing Mlink USB Driver on Windows XP

Before using Mlink, you will need to load USB/Virtual COM Port drivers on your pc. USB drivers for Windows XP are available from the Arbiter website under Downloads, Software.

After you have acquired the drivers, you should load them on your system.

1. Unzip the downloaded file to a directory.

2. Connect the 928A to your computer via the included USB cable. Make sure that the 928A is powered on.

3. Windows XP™ should give you a "Found New Hardware" message (small bubble message at task bar). It may also open a window that indicates that it is searching for a driver.

4. At the conclusion, the Windows new driver installation window should allow you to choose a driver. Pick from specific location and point to the unzipped directory.

5. Click "Finish."

6. A message should appear, "Found USB Serial Port" (small bubble message at task bar).

7. Choose specific location, from the search window.

8. Click "Finish," and it should be ready to use.

Tips for Installing Drivers on XP

1. During the install you must see the DOS prompt indicating it is installing. If not, run the install again: make sure to watch for the DOS prompt indicating it is installing.

Installing Mlink

Load the Mlink installation file on your computer, and either double-click on the file or select Start > Run and browse to locate the Mlink self installation file. Select the Mlink self-installing program and begin the installation. See Figure 6.

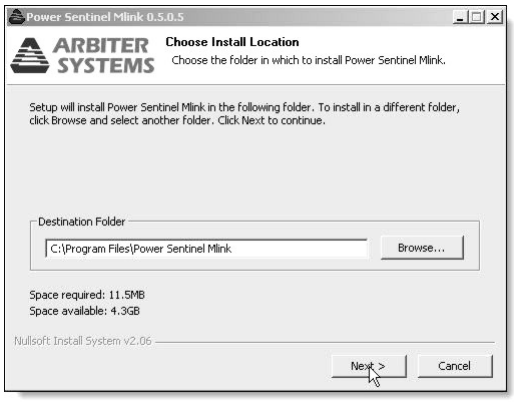


Figure 6: Mlink Installation Screen

Connecting to the 928A

Prior to starting Mlink, make sure that:

1. The 928A is powered ON
2. The USB cable is connected between the pc and the 928A.

Startup - USB Connection

When starting Mlink for the first time, you may be greeted with the connection window shown in Figure 7, and an opportunity to select a COM port. This selec-

tion is necessary, even though it is a USB port, since the 928A uses an RS-232-to-USB Bridge technology to create a virtual COM port. Otherwise, you should only see the Mlink main window (next page) with a green connection light. Normally, after you have first seen the connection window in Figure 7, you will not see this window again.

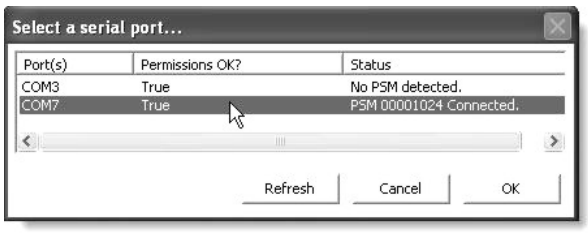


Figure 7: Mlink Connection Window

Connecting

1. To connect, select the desired COM port number and click the OK button. A short delay may occur for the OK button to become available.
2. If the port number does not appear, click the Refresh button; another port should appear (e.g. COM3). It may take a few seconds to appear. Then, repeat step 1.
3. Under the Status column, it should indicate if the 928A (PSM) is detected or not. The unit serial number should appear - e.g. "PSM 00001109 Connected."

   NOTE: If you do not see the correct COM port in the connection window, you may need to do the following:

4. Close Mlink and power cycle the 928A.

5. Restart Mlink and check for your COM port as per steps 1 – 3 above.
6. If the previous step does not work, then you may want to check which COM port Windows is using.
7. To check this, you will need to go to My Computer > Manage > Device Manager > Ports (COM & LPT) > USB Serial Port (COM X) > (Right Click) > Properties > Port Settings (tab) > Advanced (button) > COM Port Number > select an available port up to 9. See Figure 8.

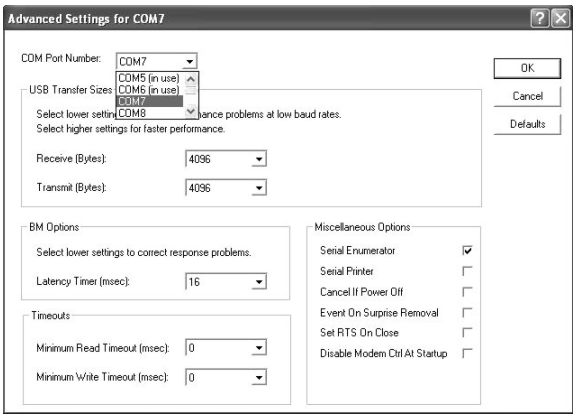


Figure 8: Windows XP COM Port Assignment

Mlink Main Window

Located on the main screen are six basic function buttons as indicated in Figure 9. There are also several important functions found under one menu item called "Main". On the lower-right of the status bar there is a connection light that strobes, notifying you of the connection status. When finished, close Mlink by clicking the Exit button.

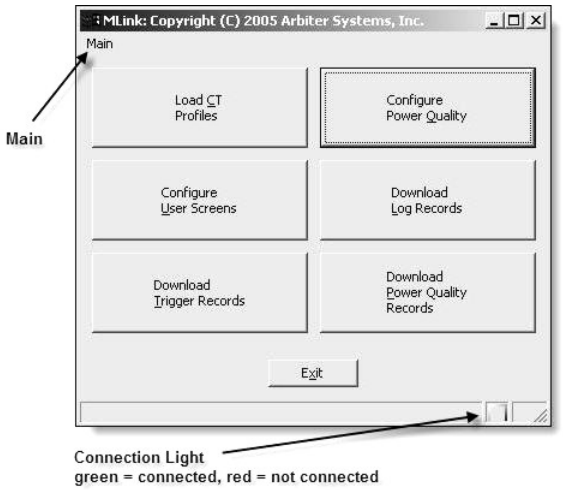


Figure 9: Mlink Main Window

Available Functions

From the Mlink main window, you have the following functions: Load CT Profiles, Configure User Screens, Download Trigger Records, Configure Power Quality, Download Log Records and Download Power Quality Records. Besides these, you can select the Main menu to select select a port or upload new firmware.

CT Profiles

Improve the accuracy of the 928A by installing CT profile (CT Characterization File) for the specific CT probes you use. In Mlink software, this characterization file is called a Profile. The 928A can store up to 5 separate profiles for different probes or different characterizations for the same probe.

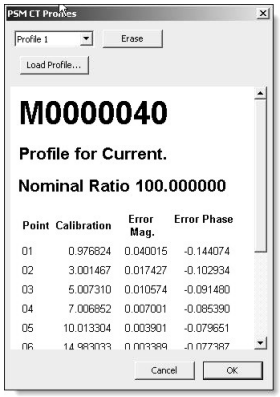


Figure 10: Load CT Profiles Window: includes – Probe Title, Nominal Ratio, 12 Current Points, Error Magnitudes, Error Phases

To Install Profiles

1. Download CT profile from Arbiter website – go to Service/Support > Downloads > Model 928A CT Characterization Files. On CT Characterization page, type in entire CT serial number after the **M**.
2. Power on the 928A and connect the USB cable between the 928A and the computer.
3. Start Mlink and check for a green connection light! If red, go back to "Startup – USB Connection."
4. From the main screen, click the "Load CT Profiles" button.

5. Select the Profile number that you wish to install - e.g. Profile 1 (this includes any of the five filenames).
6. Click the Load Profiles button to browse for the CT profile file for uploading. Select the file and click OPEN. Profile data should immediately appear in the Load CT Profiles window.
7. Click OK to close the Upload CT Profile window.

To Erase Profiles

1. Select one profile number you wish to erase – e.g. Profile 1, . . . , Profile 5 and click the Erase button. The profile data will be erased and replaced with zeros.
2. Click OK close the CT Profile window.

NOTE: To apply profiles in the 928A, see "Current Ch-AI" on page 25.

Configure User Screens

Two user screens are available for you to customize the 928A display. See page 14. Once configured you can toggle between the two screens by pressing **2nd** > **f1** successively. If your requirements change, you can run Mlink again to change the order or type of functions listed in the 928A User Screens.

1. Power on the 928A and connect the USB cable between the 928A and the computer.
2. Start Mlink and check for a green connection light! If red, go back to "Startup – USB Connection."

3. Click the “Configure User Screens” button.
4. To add new fields, select the desired fields in the Possible Fields box and click the right arrows.

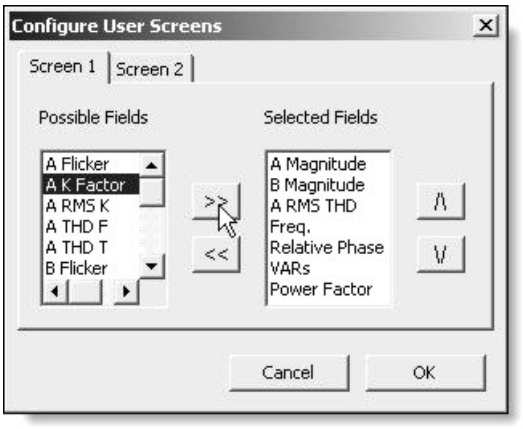


Figure 11: Configure User Screens Window

NOTE: Each user screen allows a maximum of seven items – the maximum number of lines on the 928A display.

5. To remove fields, select the desired fields in the Selected Fields box and click the left arrow.
6. To change the order in the Selected Fields window, select the desired field in the Selected Fields box and click either the Up or Down arrow to change the order.
7. Click OK to close the Configure window.

Download Trigger Records

The 928A allows you to quickly move event-triggered records to your pc using Mlink. Triggers must first be defined and activated in the 928A – see "TRIG – Working with Triggers" on page 55.

Figure 12: Download Triggers Window

1. Power on the 928A and connect the USB cable between the 928A and the computer.
2. Start Mlink and check for a green connection light! If red, go back to "Startup – USB Connection."
3. Click the "Download Trigger Records" button.
4. If the 928A has Trigger Records to download, a Save Log As window should appear with supplied filename for the data. Click the Save button, or type in another filename and click Save.
5. A Download records window should display the progress or will say, "Nothing to Download."
6. Wait for the download to finish and click OK to close the Download Triggers window.

Configure Power Quality

Use this section to assist you in configuring the 928A to detect sags and swells by using Point Limits similar to a CBEMA method. Make sure to review the section entitled "Power Quality – Sags and Swells" on page 49. Figure 5 illustrates how progressive limits over specified time intervals can be applied to detecting sags and swells.

There are two separate setup screens in Mlink for configuring Power Quality triggering in the 928A: the first screen is tabbed "Settings" and the second is tabbed "Point Limits". These are depicted in Figures 13 and 14.

The Settings screen sets up some basic things about the measured signal and how the point limits are compared to it. Check through the values listed in the screen shot illustrated in Figure 13 and compare them with the definitions on the following pages.

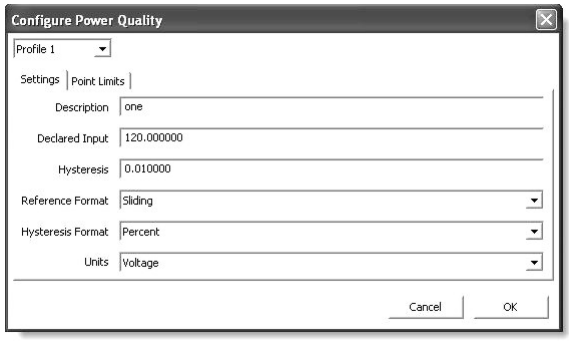


Figure 13: Power Quality Settings

Power Quality Settings

1. Press **ON** to start the 928A and connect the USB cable between the 928A and the computer.
2. Start Mlink and check for a green connection light! If red, go back to "Startup – USB Connection."
3. Click the "Configure Power Quality" button and check to see if the Settings tab is on top.

Settings Definitions

Profile: Select the Profile number (1 – 5) in the drop-down window at the top, and type in a profile name for "Description."

Declared Input: This is the same as the nominal value being measured. For example, 120 (i.e. Vrms). It is also used as the initial condition for a sliding reference.

Hysteresis: Select a value (for Units, Voltage or Current) that represents the allowable Hysteresis (e.g. 5.000000 in Figure 13).

Reference Format: Select either Absolute or Sliding. Choose "Absolute" if you want the Limit to be fixed (for Limit Format as either absolute or percent). Choose "Sliding" as the Reference Format if choosing any the Limit Format as Percent and want the Limit to change gradually. Sliding Reference is defined with a 1-minute time constant.

Hysteresis Format: Select Absolute or Percent.

Units: Select the appropriate input signal, either Voltage or Current.

Configure Point Limits

Mlink allows you to set up ten point limits for each of the five profiles. Point Limits allow you to setup different stages of triggering tailored to monitor voltage (or current) sags and swells. Set up each point limit in the same manner, and place them in any order. This makes setting them up very flexible.

In the example below (Figure 14) there are three separate point limits defined. All of the limit functions are X>Limit; two limit formats are absolute and one is percent. The limits are defined in decreasing voltages as 150, 140 and 120 with the first two fixed limits and one as a sliding reference. Each point is assigned a different dwell time: 1, 4 and 12 half-cycles respectively.

Use a sliding reference, for example, to provide a *gradually changing* limit to account for a line voltage that changes slowly throughout the day. The sliding reference uses the method described in IEC-61000-4-30, paragraph 5.4.4, and should eliminate needless triggers during normal operation. Hard limits could be used for extreme voltage swings.

Point Limit Definitions

Point: denotes the number of the Point Limit (1 – 10). You can define up to 10 different points to measure the selected value (e.g. voltage or current).

Limit Function: set to OFF, X < Limit, X > Limit.

Limit Format: set to Absolute or Percent.
Absolute refers to the the actual measured value (e.g. X (voltage) > 130 Vrms). Percent refers to a percent of the measured value (e.g. 105 percent of the measured value, entered as 1.05).

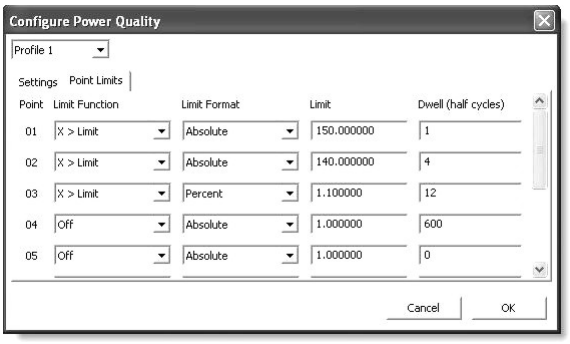


Figure 14: Power Quality Point Limits

Limit: sets the numerical value against which the measured signal is compared: a floating point value. For example, absolute: Limit = 132 volts; percent: 110% of 120 volts = 132, in the Point Limits screen, $1.1 \times 120 = 132$).

Dwell: during trigger condition, sets the number of input signal half-cycles that must occur before recording begins: an integer number.

Click OK to install PQ Profiles in the 928A, or Cancel to quit without making any changes.

User Profile

One selection named USER is available with one Point Limit that is only accessible from the 928A keypad. See "Selecting PQ Profiles" on page 51, for information on setting up the USER profile.

OFF – Deactivate PQ Trigger

When not recording, select OFF for Channels A and B PQ Config to deactivate the PQ Event Recording. Otherwise, trigger records may fill up the available flash memory module. See "PQ Event Storage and Viewing" on page 54.

NOTE: The PQ function triggers on the RMS values of voltages and currents that exceed the specified Point Limits. The RMS value must exceed the Limit for the duration specified as Dwell.

Download Log Records

The 928A is designed to transfer AutoLogged records (using the LOG key) to your pc. To configure Autologging see "LOG Key" on pages 63ff.

To transfer records from the 928A to the pc, you will need to have some records already stored in the 928A flash memory module. Logging is based on start and stop times and dates. In order to use this feature effectively make sure to set the correct time and date. See TIME and DATE on pages 20 and 21.

1. Power on the 928A and connect the USB cable between the 928A and the computer.
2. Start Mlink and check for a green connection light! If red, go back to "Startup – USB Connection."
3. Click the Download Log Records button.
4. If you have records to download, a Save Log As window should appear with supplied filename. Click the Save button, or type in another filename and click Save.

5. A Download records window should indicate the number of records downloaded and say, "Download Complete," or will say, "Nothing to Download" if there are no records to download.
6. Click OK to finish and close the Download progress window.

Download Power Quality Records

Use this feature to transfer power quality records from your 928A to your pc. Downloading is very much the same as for Standard Log Records or for Trigger Records, and requires that records be stored in the 928A flash memory module.

1. Power on the 928A and connect the USB cable between the 928A and the computer.
2. Start Mlink and check for a green connection light! If red, go back to "Startup – USB Connection."
3. Click the Download Power Quality Records button.
4. If you have records to download, a SaveAs window should appear with supplied filename. Click the Save button, or type in another filename and click Save.
5. A Download records window should indicate the number of records downloaded and say, "Download Complete," or will say, "Nothing to Download" if there are no records to download.
6. Click OK to finish.

NOTE: PQ records take more time to download, so do not close the progress window if you do not see immediate progress.

Uploading New Firmware

Mlink provides a convenient method for uploading new firmware to the 928A, and optimizing performance. When new firmware versions become available, obtain them from the Arbiter web site or by contacting Arbiter Systems technical support.

1. Start Mlink and select Main > Upload Firmware. The firmware file is in a zipped format and Mlink automatically unzips it.
2. Select the file and click OPEN and you should see the progress as shown in Figure 15. The 928A displays "FLASH PROGRAM IN PROGRESS" during the installation. Click OK when finished.

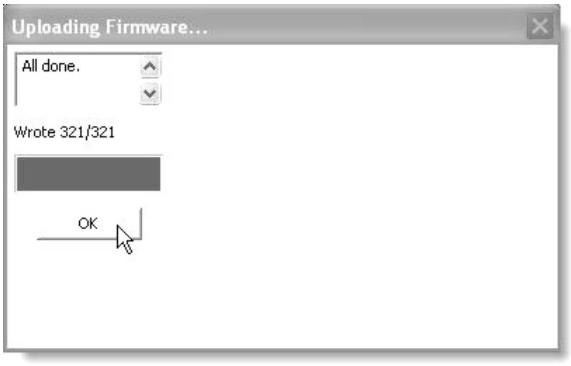


Figure 15: Upload Firmware Window

Functional Description

Introduction

The Model 928A is a two-channel, AC power measurement instrument, providing 0.1% accuracy in a handheld package. Besides voltage, current and power quantities, it measures power quality, including harmonics, flicker, sags, surges and interruptions. Also, it includes a graphical display, internal clock, approximately 400 KB of flash for data storage, and full-time battery operation using common AA-size NiMH or Alkaline cells.

User Interface

The user interface consists of a 128 x 64 graphic LCD with backlight, and 30-key silicone keypad. Also included is a USB serial interface for configuring and data retrieval.

Details

Input Sections

Two identical input channels (A and B) allow users to connect to voltage sources (0 to 660 Vrms) and to current sources (0 to 1.2 Arms or 0 to 1.2 Vrms), designed to work with a CT up to approximately 1000 A. To allow accurate measurements at low current levels (< 10 A) there will be a $\times 20$ 'booster' amplifier available to extend the input current range downwards to about 10 – 100 mA (with a 1000:1 external CT) for full accuracy and lower with somewhat reduced performance. Current Inputs are connected to the upper connectors and allow for a voltage output or current output CT. The current input section has a 1000:1 CT giving an output current of 0 to 1 mA, which is then converted to a voltage. The voltage input section uses medium-power, low TC resistors that accept up to 660 Vrms with a 1 Vrms signal to the ADC.

The current input sections are able to accept either 1.2 Arms or 1.2 Vrms max input. This will accommodate either current or voltage output probes.

MUX and ADC

The ADC is a 24-bit Texas Instruments ADS1251 sigma delta converter running at 10240 samples-per-second. There are two multiplexers being used: a 74HC4053 and a 74HC4052. The '4053' is being used to switch between the voltage and current channel inputs, and the '4052' switches the source for current channels: either a current CT (maximum input 1.2 Arms), voltage CT (maximum input of 1.2 Vrms) or gain of 20.

DSP

The DSP is a Texas Instruments TMS320VC33-120 and runs from 1.8 to 3.3 V power supplies. The TMS320 will perform all of the DSP and control processing, reducing the parts count and power requirement.

Power Supplies

The 928A will operate from four-AA cells, which can be either NiMH or Alkaline. Rechargeable batteries may be recharged from a third-party NiMH recharger, available at many consumer outlets. Also available is accessory Kit power adapter AP0011200.

Accessories

Arbiter Systems recommends the use of the following accessories for use with the Model 928A.

Current Measurement

Current Output CT Lead Set

CA0027100 (current output): This accessory current lead set connects directly between a Model AP0009800 CT, or similar current output CT, and the Model 928A current terminals using safety banana connectors. It is constructed of high-quality silicone-insulated, fine-stranded wire for durability and safety.

Voltage Output CT Lead Set

CA0027200 (voltage output): This accessory current lead set connects directly between a Model AP0012300 CT, or similar voltage-output CT, and the Model 928A

using safety banana connectors. It is constructed of high-quality silicone-insulated, fine-stranded wire for durability and safety.

Standard CT

AP0012300, 100:1 clamp-on CT: 150 A, 10 mV/A; standard banana connectors.

Optional CT

AP0001300 clamp-on CT (AEMC SR601) 1000:1, 1000 Arms, 660 Vrms, 1 mA/A; shrouded banana connectors. Requires CT cable assembly, CA0027100.

Voltage Measurement

For voltage measurement, use the AP0009700 voltage lead set. This lead set includes Arbiter's professional lead set material and voltage probe kit accessories for connecting to a variety of circuit connections.

Soft Carrying Case

For carrying the Model 928A and some accessories, choose the HD0065200. Made from rugged polyester, it provides two compartments for clamp-on CT, lead sets and manual.

USB Data Cable

Use CA0026106 USB cable when connecting the Model 928A to a computer. For configuring the Model 928A or downloading data from the flash memory module, use Mlink software.

Specifications

Input

Input Configuration

The Model 928A has two identical measurement channels, Channel A and Channel B. Each input channel has a voltage input and a current input. Current inputs are intended for use with external CT having a nominal output of 0-1 Arms or 0-1 Vrms. For basic measurements (voltage, current, frequency, phase angle) any combination of inputs may be used. For power and energy measurements (active power, apparent power, reactive power and power factor), select one voltage input channel and one current input channel.

Voltage

Input Range:	1 to 660 Vrms
Impedance:	1.2 megohm, differential

Current

Input Range (I):	0.01 to 1.2 Arms (underrange* to < 1 mA)
Input Range (V):	0.01 to 1.2 Vrms (underrange* to < 1 mV)
Burden:	0.01 Ohm max. or 100 kilohms, min.

*For underrange, turn Low Range mode ON.

Interface

Operator Interface

Display:	128X64 graphic LCD
Keyboard:	30 key keyboard
Serial:	USB 1.1
Memory:	512 KB Flash
Data:	User Setups Real Time Clock Approx. 400 KB measurement data

Power Supply Requirements

Batteries

Type:	4-AA Cells, alkaline or NiMH
Operation:	30 hours typical with alkaline cells 60 hours typical with NiMH

External Power Supply

Part number: AP0011200.
Type: +7 Vdc, regulated; 5 W

Measurements

Voltage and Current

Method:	True rms, 3 kHz Bandwidth
Accuracy:	0.1% of reading (voltage) or ±5 mV, whichever is greater
	0.1% of reading (current) + CT errors
	1% of reading + CT errors (low range)

Phase Angle, A to B

Range:	0 to 360 or ±180°
Accuracy:	0.1°
underrange:	< 1°, typical

Frequency

Range:	50 or 60 Hz ±5 Hz
Accuracy:	0.005% of reading

Harmonics

Input:	Channel A and B, simultaneous
Range:	2nd to 50th (50 or 60 Hz fund.)
Accuracy:	0.1% THD + 5% reading

Harmonics, continued

Display:	THD; K-factor; Amplitude bar graph; and individual harmonic magnitude and phase (simultaneous).

Waveform

Display:	Channel A and/or Channel B

Power and Energy Quantities

Range:	0 to 99999 MVA or MVAh ±99999 MVAR or MVARh ±99999 MW or MWh ±1.0000 PF, lead or lag
Accuracy:	0.1% of VA, for VA, VAR, and W 0.001 PF

General

Physical

Size:	200.0 x 104.2 x 37.4 mm (7.9 x 4.1 x 1.5 in.)
Weight:	18 oz (928A only, with batteries)

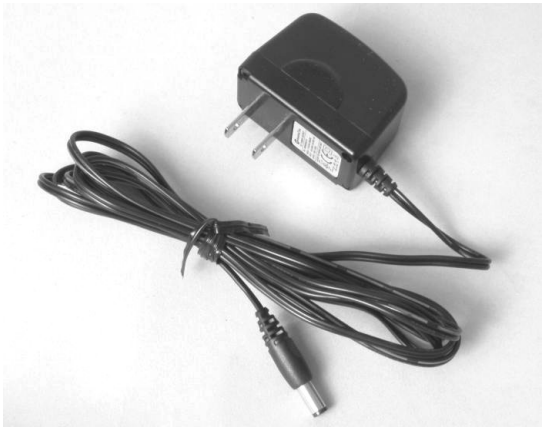
Environmental

Temperature:	Operating: -10° to +50°C Nonoperating: -40° to +75°C
Humidity:	Noncondensing

AC Power Adapter

Part number AP0011200. For benchtop or continuous use with available line power, use the AP0011200, AC Power Adapter. It provides a regulated +7 Vdc at up to 800 mA to the 928A.

Input Connector:	5.5 × 2.0 mm, center pos.
Input Voltage:	90 Vac to 264 Vac
Input Current:	<0.5 Arms at 90 Vac Input
Input Frequency:	47 to 63 Hz
Output Voltage:	+7 Vdc at 800 mA
EMI:	FCC Part 15 Class B when tested with a resistive load, both conducted and radiated.
MTBF:	50,000 hours or greater at 25°C
Operating Temp:	0° to +70°C
Storage Temp:	-40° to +80°C
Humidity:	0 to 90% Relative Humidity
Weight:	90 g MAX



MN352 Current Probe

Part number, AP0012300 (voltage output). For up to 120 Arms, use the MN352, 100:1 socket output current probe with the Model 928A, Power System Multimeter. Using the latest transformer technology, the MN352 can measure currents from 0.1 to 120 Arms over a frequency range of 40 to 10 kHz.

Probe Specifications

Electrical

Nominal Range:	0.1 to 150 Arms
Measurement Range:	0.1 to 120 Arms*
Output Sensitivity:	10 mV/A
Accuracy:	2% (uncompensated)
Phase Shift (1 – 20 Arms):	3.0°
Frequency Range:	40 to 10kHz
Limiting Oper. Cond.:	200A perm. to 1 kHz
Crest Factor:	3 @ 150 A peak
Working Voltage:	600 Vrms

General

Maximum Conductor Size:	20mm
Output Connection:	4mm safety sockets
Operating Temp. Range:	-10 to +55°C
Storage Temp. Range:	-40 to +70°C
Operating Humidity:	85% (10 – 35°C)
Weight:	180g (6.5 oz)

*1.2 Vrms is the input limit on the 928A (current input). *BEFORE USING PROBE: Please read section entitled "Caution: CT Probe Use" on page 4.*

Keypad Definitions

This appendix lists all of the keys on the Model 928A keypad, for both the primary and secondary purposes. For Primary keys, press only the key itself. For secondary keys, press [2nd] and then the key with blue label above the key button of choice.

Primary Keys

[0] . . . [9] **Numeric keys** – including decimal point; press to enter any necessary value during configuration menus.

[2nd] **Secondary key** – press [2nd] to access any of the blue secondary keys (located above the nomenclature printed on the key itself).

[ØF] **Phase/Frequency key** – press to view the phase and frequency at channels A and B. Phase requires two signals and frequency only one signal (frequency channel is selectable).

[A/B] **Channel A/B ratio key** – press to divide channel A by channel B. Results are in Ohms, Mhos, or unit-less (depending on input choice) and degrees.

[ENT] **Enter key** – press to open a hidden menu, or install a configuration value.

[ESC] **Escape key** – press to return to a previous screen or to leave a specific menu.

[FLK] **Instantaneous Flicker** – press to view the instantaneous flicker, updated once per second.

[HOLD] **Hold key** – press to hold the reading of the signals at channels A and B; press again to return to the measurement mode. Works with any of the specific measurement functions.

[HRM] **Numerical Harmonics key** – press to view the harmonics of the signals at channels A and B, from the 2nd to the 50th, in tabular form.

[ON] **ON key** – press to switch the 928A on and off.

[PF] **Power Factor & Apparent Power key** – press to display the Power Factor and Apparent Power in Volt-Amps.

[PQ] **Power Quality key** – press to review power quality data records: sags and swells, interruptions. Download records using Mlink.

[PWR] **Active & Reactive Power key** – press to display the power in Watts and Vars.

[STO] **Store key** – press to: (1) to write current measurements to the flash memory card, or (2) to assign values during configuration – same as highlighting <STOre And Exit> and pressing [ENT].

[V I] **Voltage/Current key** – press to view the voltage and/or current signals at channels A and B.

[WAV] **Waveform key** – press to view the signal waveforms at channels A and B (as A and B, A or B).

[Wh] **Watt-hours key** – press once to view the cur-

rent energy values; press again to view Q-hours.

[←] **Backspace key** – press to move left in any configuration screen, to erase any numerical value, or to restart a process (e.g. the Integration graph). Also, press to enter a negative number during configuration.

[↑], [↓] **Up and Down arrow keys** – press to browse through values in menus, browse through function values (e.g. harmonics) or for choosing specific records held in memory.

Secondary Keys

[A I] **Channel A current selection** – press to select channel A for current measurement.

[A V] **Channel A voltage selection** – press to select channel A for voltage measurement.

[AXIS] **Axis key** – press to set up the axes for the Integration function.

[B/A] **Channel B/A ratio key** – press to divide channel B by channel A. Results are in Ohms, Mhos, or unit-less (depending on input choice) and degrees.

[B I] **Channel B current selection** – press to select channel B for current measurement.

[B V] **Channel B voltage selection** – press to select channel B for voltage measurement.

[DATE] **Date key** – press to view or adjust the date on the Real Time Clock.

[f1] . . . [f6] **Multi-function keys** (soft keys) – f1 is a custom user screen. f2 to f6 are currently unused.

[LCD] **LCD Display adjust key** – press to access the display configuration menu. Allows control of both contrast and backlighting.

[LOG] **Log key** – press [2nd] > [LOG] to display auto log data based on start and stop time and date. Use Download Log Records in Mlink to retrieve records to computer.

[MENU] **Menu key** – press [2nd] > [MENU] to access the various 928A systems configuration screens.

[MIN MAX] **MIN/MAX key** – press [2nd] > [MIN MAX] to cycle through the four different measurement modes: minimum, maximum, average and normal (measurement mode).

[Pst] **Short-term flicker** – press to display Pst; flicker for a 10-minute average.

[RCL] **Recall Data key** – press to list data saved in flash memory when using the [STO] key.

[TIME] **Time key** – press to view or adjust the time on the Real Time Clock.

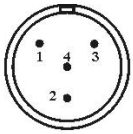
 **Integration key** – press to view a progressive plot of the signal SOURCE, defined by pressing **2nd** > **AXIS** and changing the input signal defined under SOURCE. Scaled by sample time, upper and lower limits.

 **Graphical Harmonics** – press to display harmonics in graphical form. Press [↓], or [↑] to peruse the list of graphical harmonics.

CT Input Connector

928A Current Input Connector

The 928A Channel A and B Current Inputs allow two types of output signals from the CT: voltage or current. These CT output signals are limited to 1.2 Vrms and 1.2 Arms. Pin locations and their descriptions for these two connectors are given in the drawings and photos that follow.



Pin Designations (names reflect the signal source)

1	CT Output Current (Dot Side)
2	CT Output Voltage - referenced to Pin 4
3	CT Output Current (No Dot)
4	CT Output Voltage; Connected to cable shield on current cable – Ca0027100

Figure 16: 928A Current Connector Layout

CT Cable Connector

A small black colored button on the connector releases the connector from the 928A current input. To release the cable from the 928A you must depress the button and pull the connector straight out. Do not twist the connector. To defeat the locking device on the connector, Arbiter is now supplying a spring clip to depress the button. See page 30 for detail on the spring clip.

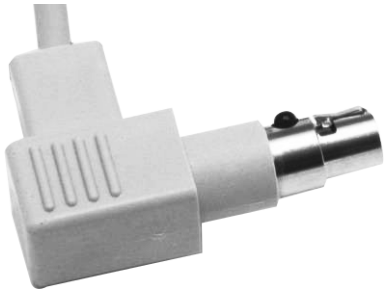


Figure 17: CT Cable Connector – side view

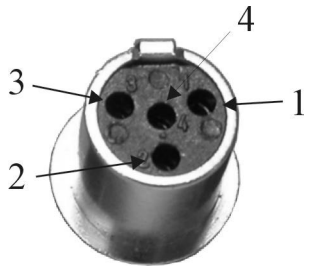
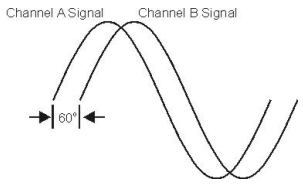


Figure 18: CT Connector End View

Phase Conventions

This appendix contains supplemental material for determining how the Model 928A responds to the various settings contained in the Phase/Freq Preferences menu.

The 928A allows you to select the reference channel, lag polarity, range (±180° or 0 to 360°), lead-lag display ON or OFF, frequency source (A or B) and frequency (50 or 60 Hz). The items below provide interpretation for these settings. Switching Phase Preference to B effectively reverses the polarity.



Range Setting	Polarity Setting	Resultant Reading
± 180°	(–) for Chan B lagging Chan A	-60°
± 180°	(+) for Chan B lagging Chan A	+60°
0 – 360°	(–) for Chan B Lagging Chan A	300°
0 – 360°	(+) for Chan B lagging Chan A	60°

For "A Lagging B", ±180° polarities switch. For 0 – 360°, (-) = –60° and (+) = 300°

CE Mark Certification

Declaration of Conformity with European Union Directives

Date of Issue: June 11, 2008

Directives: 89/336/EEC Electromagnetic Compatibility
73/23/ EEC Low Voltage Safety

Model Number(s): 928A Power System Multimeter

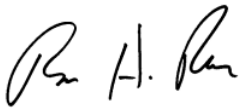
Manufacturer: Arbiter Systems, Inc.
1324 Vendels Circle, Suite 121
Paso Robles, CA 93446 − USA

Harmonized Standard Referenced:

EN55011 Class A, Radiated and Conducted Emissions

EN50082-1 Generic Immunity, Part 1 Residential, Commercial and Light Industrial environments

EN61010-1 Safety requirements of Electrical Equipment for Measurement, Control and Laboratory Use.



Signed: _____

Signatory: Bruce H. Roeder

This certificate declares that the described equipment conforms to the applicable requirements of the directives on Electromagnetic Compatibility 89/339/EEC, Safety 73/23/EEC, and amendments by 93/68/EEC adopted by the European Union.

Index