

**-DISCONTINUED PRODUCT-**



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**Model 918B  
Phase Angle Multimeter**

**Operation Manual**

**Arbiter Systems, Inc.  
Paso Robles, California  
U.S.A.**

Printed in U.S.A.

This manual is issued for reference only at the convenience of Arbiter Systems. Arbiter Systems has made reasonable effort to verify that all diagrams, to the best of our knowledge, are accurate as of September 5, 2001. However, due to production changes and availability of parts, these diagrams are subject to revisions and modifications. Check with Arbiter Systems at the address below for any revisions made since this publish date.

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**Model 918B**  
**PHASE ANGLE MULTIMETER**

**Operation Manual**

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PD0010600C



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## 1.0 Introduction

This manual provides operating instructions and specifications for the Arbiter Systems Model 918B Phase Angle Multimeter.

### 1.1 Features

The Model 918B Phase Angle Multimeter is a compact, microprocessor-controlled instrument capable of ten functions, which have been optimized for use in applications involving AC power transmission and distribution.

The following parameters are measured directly by the 918B:

DC Volts:	0.2 V to 1 kV
AC rms Volts:	0.2 V to 1 kV
AC rms Amperes:	0.02 A to 20 A (0.002 A to 1000 A*)
Frequency:	45 Hz to 500 Hz
Phase Angle:	0 to 360 degrees

The following parameters are calculated, based on measured values:

Watts:	$V_{rms} \times I_{rms} \times \cos \Theta$	0.004 W to 20 kW (1000 kW*)
Volt-Amps:	$V_{rms} \times I_{rms}$	0.004 VA to 20 kVA (1000 kVA*)
VA Reactive:	$V_{rms} \times I_{rms} \times \cos (-\Theta)$	0.004 VAR to 20 kVAR (1000kVAR*)
Power Factor:	$\cos \Theta$	-1.0 to +1.0, lead or lag
Watt-Hours		0 to 9999 kWh

\*With optional accessories.

The 918B accepts inputs via two pairs of front panel jacks; one pair for voltage, and one pair for current (optional adapters allow voltage-to-voltage phase measurements). The voltage connections are made directly to the circuit under test, using leads included with the instrument. The current input is voltage-isolated from the circuit under test by means of a clamp-on current probe (also included), which offers the added advantage of allowing measurement of current without opening the circuit.

A 16-character supertwist liquid crystal display provides a clear indication of the parameter being tested, and the value measured. Selection of functions and ranges is accomplished via a user-friendly front panel interface, consisting of eight pushbuttons. Auto-ranging simplifies operation by minimizing user keystrokes, or the ranges can be set manually.

A "Hold" function allows the user to "freeze" the values for all parameters at the press of a button. A "Minimum/Maximum" function permits recording of the individual minimum and maximum values that occur for each function, within a time frame that is controlled by the user.

A unique feature of the 918B is the "Delta Phase" mode, which allows measurement of the phase angle between two voltages (or currents), using any synchronous current (or voltage) as a reference. This allows, for example, comparison of all of the phase angles in a three-phase system, without requiring simultaneous connection to all of the phases.

The ability to operate from either the internal nickel-cadmium rechargeable battery, or from the ac line (with supplied plug-in transformer) makes the unit suitable for both hand-held and benchtop applications.



**1.2 Accessories Included**

The following accessories are included with the 918B Phase Angle Multimeter:

- Test probe kit, with screw-on adapters; part no. AP0002000A
- Battery charger, 120 vac/60 Hz; part no. AP0001100A (see "International Power" below for other line voltages and frequencies)
- 1000:1 Clamp-on Current transformer, part no. 09111A
- Current transformer cable, part no. CA0014300A
- 918B bail, part no. HD0033800A
- Soft carrying case, part no. HD0033600A
- Operation manual, part no. PD0010600B

**1.3 Accessories Available**

The following accessories are available from Arbiter Systems, for use with the 918B Phase Angle Multimeter:

- Maintenance and Calibration Manual, part no. PD0011100A
- Auxiliary voltage adapter, 10-750 V (for direct voltage-to-voltage phase angle measurements), Model 09184A
- Plug-in CT/adapter, 0.002-2.0 A direct input, Model 09182A.
- Plug-in CT/adapter, 0.02 - 20 A direct input, Model 09182B.
- 1000 Amp Clamp-on Current Transformer, Model 09113A (must be used with Model 09182A)

**1.4 International Power**

Battery chargers for international operation are currently available. Contact Arbiter Systems for more information about these chargers.

If operation on a different line voltage becomes necessary, any power supply capable of generating 15 volts dc at 150 mA minimum may be used for charging. A 3.5mm (1/8") miniature phone plug, tip

positive and sleeve negative, will allow such a power supply to be used to operate and charge the 918B.

### **1.5 Safety Precautions**

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards for the design and intended use of the instrument. Arbiter Systems, Inc. assumes no liability for the user's failure to comply with these requirements.

#### **Beware of Hazardous Voltages**

The 918B Phase Angle Multimeter is capable of measuring voltages up to 1000 volts. Use extreme caution when working around high voltages. Failure to do so could result in personal injury or death.

#### **Do Not Connect (-) Input Terminal to Voltages in Excess of $\pm 25$ Volts From Earth Ground.**

The 918B was designed for use with the (-) input connected to ground or circuit neutral. Application of more than  $\pm 25$  volts with respect to earth ground may result in the potential for electric shock or damage to the instrument. This precaution is of particular importance when the charger is connected to the instrument.

#### **Do Not Make Current Connections Directly to the 918B Current Input.**

The current inputs of the Model 918B are designed to accept only the output of a current transformer. The transformer is necessary to provide voltage isolation, and to convert the measured current to a value that can be safely applied to the current inputs of the instrument. Never connect the current to be measured directly to the

current input; damage to the instrument and/or hazardous conditions may result. Always use the supplied current transformer or one of the other current transformers or adapters available from the factory (see "Accessories Available", section 1.3).

**Replace Fuses with the Proper Size and Type.**

A pair of ¼ amp, 250 volt, 2AG type fast-blow fuses protect the current inputs of the 918B (Arbiter Systems part number FU0001603A). Replace only with fuses of the same type and rating.

**Do Not Substitute Parts or Modify Instrument**

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to Arbiter Systems for service and repair to ensure that the safety features are maintained.

The preceding safety precautions may appear in other sections of this manual, where appropriate for the specific operations being described.

**1.6 Factory Service**

Should the instrument need to be returned for factory service, please contact the Arbiter Systems Service Department to obtain a Return Material Authorization (RMA) number. You must provide the serial number of the instrument in order to obtain an RMA number. If your instrument is covered by warranty, see our "Limited Warranty" description at the end of this manual. If your instrument is not covered by warranty, we will provide a copy of our current service policy and price list. If return of an instrument is authorized, forward the instrument prepaid to Arbiter Systems.

**Extended Warranty**

Arbiter Systems also offers an extended warranty available in one year increments. You may purchase the extended warranty at any time before your standard one year warranty expires. Please contact our sales department for more information about our extended warranty.

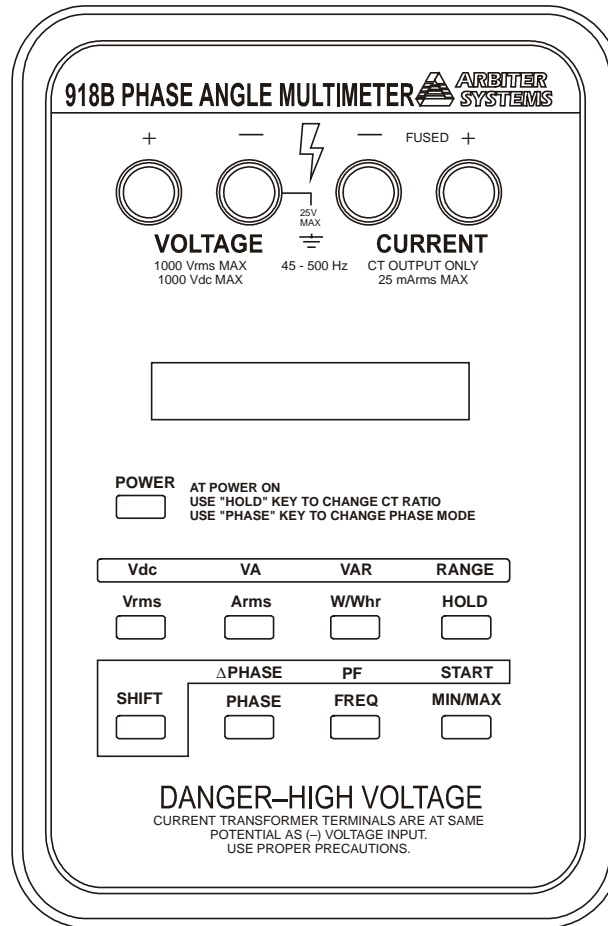


Figure 1 – 918B Front Panel



## 2.0 Operation

This section provides detailed instructions for the individual operating modes and features of the 918B Phase Angle Multimeter. Figure 1 provides a reference for front panel controls and input jacks. Also, abbreviated descriptions of the main features are printed on the rear panel of the instrument, for quick reference.

Be certain to observe safety precautions, where noted.

### 2.1 Instrument Power

#### 2.1.1 Operation from the AC Line

The 918B Phase Angle Multimeter may be operated for an indefinite period of time from the ac line, using the included external power supply. All measurement functions can be performed while the instrument is connected in this manner. To operate the 918B from the ac line, connect the 3.5mm (1/8") mini plug into the power jack on the rear panel, and plug the power supply into an ac line socket.

**Caution** Do not exceed  $\pm 25$  volts peak, with respect to earth ground on the (-) voltage input. The 918B is designed to operate with the (-) input connected to earth ground or circuit neutral.

**NOTE** Characters will always be present on the display when the power pack is connected and plugged into the ac line. When the unit is turned on, the displays associated with normal operation will be present. After the "Power" key is pressed to turn the unit off, or after auto power-off occurs (see section 2.1.5), the display will indicate the battery charging status.

### **2.1.2 Operation from the Internal Battery**

The 918B Phase Angle Multimeter features an internal 9.6 volt nickel-cadmium rechargeable battery, which will permit operation of the instrument for a minimum of 25 hours between charges.

### **2.1.3 Battery Test**

At initial power-up the instrument will automatically perform a battery voltage measurement. If the battery voltage is above 11 volts, the instrument will recheck the voltage once per hour. When the measured voltage falls below 11 volts, the frequency of the battery voltage test will increase to once every fifteen minutes.

When the battery voltage falls below approximately 9.2 volts, the display will indicate "LoBat". At this point, the charger should be connected.

Whenever the momentary battery test is being performed, the display will change briefly to read, "Battery Test".

### **2.1.4 Charging the Internal Battery**

To charge the 918B internal batteries, connect the power pack to the ac line and the power inlet jack on the rear panel. Internal power management circuitry will automatically evaluate the charge state of the battery, and select one of two charging rates. A high charging rate is applied initially, until the battery is near full capacity. After this, a lower, "trickle" charge rate is used, allowing the 918B to be connected to the ac line indefinitely without danger of overcharging. When the unit is turned off during charging, the front panel display will indicate which of the charge rates is being used, and the voltage of the battery. This display is updated every 15 minutes.

A completely discharged battery will require approximately 6-8 hours to reach full charge. To maximize the operational life of the battery, it is advisable to allow full discharge prior to recharging.



### 2.1.5 Auto Power-Off

To increase battery life, the 918B includes an automatic power-off circuit. In order for the unit to turn itself off, all of the following conditions must be met continuously for a period of 20 minutes:

- No keystrokes;
- Voltage level of less than 1 volt at the voltage input;
- Current level of less than 20 milliamperes at the current input.

After auto power-off has occurred, normal operation may be resumed by pressing the "Power" key.

If the power pack is connected when auto power-off occurs, the unit will switch to the battery charge mode, and give a continuous display of charging status (see section 2.1.4, "Charging the Internal Battery"). When the instrument is turned back on, it will return to the same set of operating conditions that were present when auto power-off occurred, provided the power pack remained connected the entire time that the unit was off.

## 2.2 Power On

To begin operation of the 918B, first verify that any voltage and/or current connections to the inputs are in compliance with the limits shown on the front panel. Press the front panel button labeled "POWER". The display will provide a momentary indication of the selected current transformer, then a momentary indication of the selected phase convention.

### 2.2.1 Initial Configuration

The default values for some of the 918B configuration settings may be modified to accommodate special test circumstances or external equipment options. These changes can be made at initial power-up, using the following instructions.

### 2.2.1.1 Changing the CT Configuration

The current input of the Model 918B Phase Angle Multimeter is designed for operation with a current transformer, which reduces the measured current to a level that can be accommodated by the instrument. The standard clamp-on current transformer included with the 918B has a ratio of 1000:1. The step-down ratio of other current transformers to be used in conjunction with the 918B is dependent on the range of currents to be measured. *The 918B accepts 20 milliamperes maximum.*

**NOTE** The Model 918B Phase Angle Multimeter incorporates special circuitry to compensate for impedance characteristics of Arbiter Systems' current transformers. Use of current transformers from other manufacturers can result in instability and/or unsatisfactory operation.

The 918B includes a provision for changing the current transformer configuration, should this become necessary. One possible scenario necessitating this type of change would be as follows:

#### **Example: Measuring 1000 Amps**

In order to measure currents of up to 1000 Arms, one could use an Arbiter Systems Model 09113A 1000:1 clamp-on current transformer, which must be used in conjunction with a Model 09182A 100:1 current transformer. The resultant combined current step-down ratio would be 100,000:1. With this combination, the user would have to reconfigure the 918B from the 1000:1 standard ratio to the 100,000:1 required by the new combination.

#### **Procedure**

1. To change the current transformer configuration, first turn the unit off.
2. Switch the 918B power ON. There will be a momentary display of the present ratio setting. The initial default display is "CT: 20A CLAMP-ON".

3. During the time this display is present, press the "HOLD" key. The next selection will appear, which is "CT: 2A DIRECT". If this is the desired selection, do nothing; the new value will be incorporated, and the unit will be ready for use.
4. If another value is desired, press "HOLD" again while the CT selection display is still present.
5. This key sequence can be continued, as necessary, to scroll through all of the choices, which are available.

A standard Model 918B is equipped to use the following current transformers:

#### **20A CLAMP-ON, Standard CT**

Calibrated for the standard (Model 09111A) clamp-on 1000:1 20A current transformer. Note: The calibration constants for this configuration apply specifically to the 20A clamp-on CT supplied with, and having the same serial number as the 918B. Use of other CTs may result in reduced accuracy.

#### **2A DIRECT, Accessory CT**

Calibrated for the Arbiter Systems 09182A 100:1 2.0A plug-in current transformer.

#### **20A DIRECT, Accessory CT**

Calibrated for the Arbiter Systems 09182B 1000:1 20A plug-in current transformer.

#### **1000A CLAMP, Accessory CT**

Calibrated for the combination of an Arbiter Systems Model 09113A and Model 09182A. This combination provides clamp-on measurement capability for currents of up to 1000A.

**NOTE** When a Model 918B Phase Angle Multimeter is ordered and shipped from the factory with additional current transformers, a

calibration is performed on the instrument for each of the additional transformers. When the user selects the appropriate configuration, the factory-stored calibration constants are automatically applied. If a current transformer other than one supplied with the unit is used, a calibration error or performance problem may result. For best results, always use current transformers supplied by Arbiter Systems.

### **Voltage-to-Voltage Measurements**

In addition to the current transformer choices, the display will also indicate "10-750 V ADAPTER". This selection is to be used in conjunction with the Arbiter Systems Model 09184A Auxiliary Voltage Adapter, to allow the 918B to perform voltage-to-voltage phase angle measurements. Refer to Section 3.5 for further information.

#### **2.2.1.2 Changing the Phase Convention**

When used for measurement of the phase angle between a voltage and current, the 918B will display a value, which is dependent upon the phase convention that is being employed. There are four selections available for phase convention.

##### **Lead; 0 – 360**

This is the default setting. The displayed value will be a positive number between 0 and 360, corresponding to the number of degrees by which the current leads the voltage.

##### **Lag; 0 – 360**

The displayed value will be a positive number between 0 and 360, corresponding to the number of degrees by which the current lags the voltage.

**Lead;  $\pm 180$** 

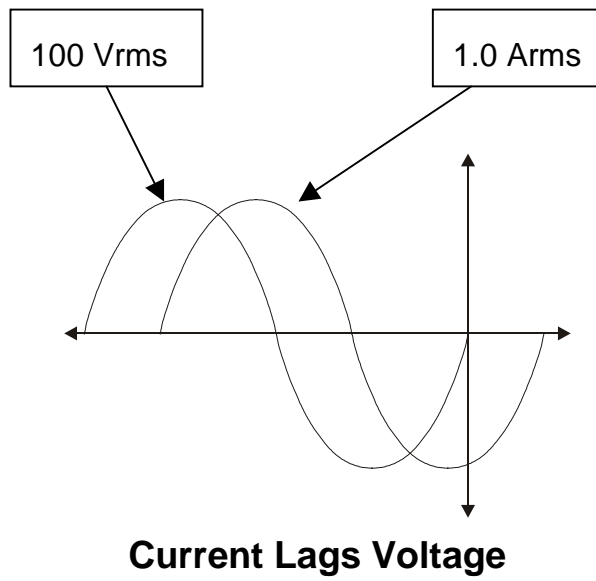
The value displayed is the number of degrees by which the current leads the voltage. The reading will be between +180 degrees and -180 degrees. For negative readings, interpret them as having the current lagging the voltage by the displayed number of degrees.

**Lag;  $\pm 180$** 

The value displayed is the number of degrees by which the current lags the voltage. The reading will be between +180 degrees and -180 degrees. For negative readings, interpret them as having the current leading the voltage by the displayed number of degrees.

**Example: Phase Convention, Lead; 0 – 360**

A measurement example using the standard 918B phase convention is illustrated in Figure 2 of this manual, and also, for reference, on the back panel of the instrument. This diagram shows the values for different measurement modes which will be displayed when 100 Vrms and 1.0 Arms signals are applied to the voltage and current inputs, with the current lagging the voltage by 60 degrees.



**Example:**

<b>Phase</b>	<b>300</b>	<b>DEG</b>
<b>PF</b>	<b>0.500</b>	<b>LAG</b>
<b>VA</b>	<b>100</b>	<b>VA</b>
<b>W</b>	<b>50.0</b>	<b>W</b>
<b>VAR</b>	<b>86.6</b>	<b>VAR</b>

**Figure 2 – Phase Convention, Lead 0 - 360°**

In the phase mode, with the default phase-convention setting, the instrument interprets and displays the phase angle as 300 degrees.

The phase convention can easily be changed to one of the other three configurations. It is important to note, however, that the only factor that will be affected is the actual display of phase angle. All other measurement modes will continue to display data in the same manner as they did before any changes were made.

### **Changing the Phase Convention**

To change the phase convention, use the following procedure:

1. Turn the 918B off.
2. Turn the 918B back on. A two-second display will occur showing the selected current transformer configuration. Immediately following this, another display will occur showing one of the four phase convention settings from above, depending on which one had been previously selected and stored.
3. During the two-second display, pressing the "PHASE" button will cause the instrument to show the next available choice for phase convention. Repeated pressing of the "PHASE" button will cause the display to scroll through the phase convention selections in the same order that they are presented above.
4. Pausing for more than two seconds will cause the currently displayed setting to be accepted as the new phase convention.

Once a phase convention has been selected, it will be held in the instrument memory, even when the unit is turned off. Every time the instrument is turned back on, a two-second display will occur, showing the selected phase convention.

### 2.3 Measurement of DC Volts

The 918B can measure dc voltages of between 0.2 and 1000 volts. For measurement of dc voltage, the current input is not used.

**CAUTION** Do not exceed  $\pm 25$  volts peak, with respect to earth ground, on the (-) voltage input. The 918B is designed to operate with the (-) input connected to earth ground or circuit neutral.

#### Procedure

1. Switch the unit into the dc voltage mode by first pressing the "SHIFT" key, then pressing "Vdc".
2. Plug the supplied test probes into the voltage input terminals, with the red wire connected to the (+) terminal and the black wire connected to the (-) terminal.
3. Connect the black lead to the circuit neutral or ground, or the point to be used as the reference for the measurement.
4. Connect the red test lead to the voltage to be measured. The voltage present between the two test leads will be indicated on the front panel display.

#### Voltage Ranges

For the voltage input, the 918B has four different operating ranges. Depending on the level of voltage applied to the input, the instrument may automatically switch between ranges. This range switching is internal, and may or may not be evident in the display. Automatic range switching can be defeated, using range hold. Refer to section 3.1, "Automatic and Manual Range Selection", for a description of the internal ranges, the display ranges, auto-ranging operation, and range hold operation.



### Hold Mode

When making measurements using any of the operating modes of the 918B, you can "freeze" the values for all measured parameters by simply pressing the "HOLD" button. You can then switch between all of the different modes and determine their respective values at the time "HOLD" was pressed. Pressing "HOLD" a second time restores the instrument to normal operation.

### Min / Max Readings

Recording of minimum and maximum values is suspended for any period of time that the hold function is active. However, all previously recorded values are retained. Refer to section 3.2 for more information on minimum and maximum value recording.

### 2.4 Measurement of AC Volts

The 918B Phase Angle Multimeter is capable of rms voltage measurements of between 0.2 and 1000 volts, over a frequency range of 45 to 500 hertz. Because an rms-to-dc converter is employed, the value displayed will be the true rms value of the voltage measured. For measurement of ac voltage, the current input is not used.

**CAUTION** Do not exceed  $\pm 25$  volts peak, with respect to earth ground on the (-) voltage input. The 918B is designed to operate with the (-) input connected to earth ground or circuit neutral.

### Procedure

1. Switch the unit into the ac voltage mode by pressing the key labeled "Vrms".
2. Plug the supplied test probes into the voltage input terminals, with the red wire connected to the (+) terminal and the black wire connected to the (-) terminal.
3. Connect the black lead to the circuit neutral or ground, or the point to be used as the reference for the measurement.

4. Connect the red test lead to the voltage to be measured. The voltage present between the two test leads will be indicated on the front panel display.

### **Voltage Ranges**

For the voltage input, the 918B has four different operating ranges. Depending on the level of voltage applied to the input, the instrument may automatically switch between ranges. This range switching is internal, and may or may not be evident in the display. Automatic range switching can be defeated, using range hold. Refer to section 3.1, "Automatic and Manual Range Selection", for a description of the internal ranges, the display ranges, auto-ranging operation, and range hold operation.

### **Hold Mode**

When making measurements using any of the operating modes of the 918B, you can "freeze" the values for all measured parameters by simply pressing the "HOLD" button. You can then switch between all of the different modes and determine their respective values at the time "HOLD" was pressed. Pressing "HOLD" a second time restores the instrument to normal operation.

### **Min / Max Readings**

Recording of minimum and maximum values is suspended for any period of time that the hold function is active. However, all previously recorded values are retained. Refer to section 3.2 for more information on minimum and maximum value recording.

## **2.5 Measurement of AC Amperes**

Using the supplied 1000:1 clamp-on current transformer, the 918B Phase Angle Multimeter is capable of rms current measurements of between 0.02 and 20 amperes, over a frequency range of 45 to 500 hertz. For instructions on using other current transformers with different ratios, refer to section 2.2.1.1. Because an rms-to-dc

converter is employed, the value displayed will be true rms. For measurement of rms ac current, the voltage input is not used.

**Procedure**

1. Switch the unit into the rms ac current mode by pressing the front panel button labeled "Arms".
2. Connect the output of the clamp-on current transformer (CT) to the current input of the 918B, using the supplied cable. Be sure that the (+) and (-) terminals on the CT correspond directly to the (+) and (-) terminals of the 918B current input.
3. Clamp the CT around the wire carrying the current to be measured, making certain that the jaws close completely. Note the (+) and (-) symbols near the jaw opening, indicating the phase relationship between the CT input and the CT output.
4. Although not critical for current-only indication, this will be of particular importance for measurement of parameters involving phase angle, such as power factor, watts, and vars, which will be covered in subsequent sections of this manual.
5. After the connections are made, the display will indicate the ac current flowing in the circuit.

**Current Ranges**

For the current input, the 918B has three different operating ranges. Depending on the level of current applied to the input, the instrument may automatically switch between ranges. This range switching is internal, and may or may not be evident in the display. Automatic range switching can be defeated, using range hold. Refer to section 3.1, "Automatic and Manual Range Selection", for a description of the internal ranges, the display ranges, auto-ranging operation, and range hold operation.

### Hold Mode

When making measurements using any of the operating modes of the 918B, you can "freeze" the values for all measured parameters by simply pressing the "HOLD" button. You can then switch between all of the different modes and determine their respective values at the time "HOLD" was pressed. Pressing "HOLD" a second time restores the instrument to normal operation.

### Min / Max Readings

Recording of minimum and maximum values is suspended for any period of time that the hold function is active. However, all previously recorded values are retained. Refer to section 3.2 for more information on minimum and maximum value recording.

### 2.6 Measurement of Volt Amps (Apparent Power)

The value of volt amps (VA) is defined as the product of the rms voltage and the rms current, without regard to the phase angle. Using the supplied 1000:1 current transformer, the 918B is capable of measuring volt-amp values of up to 20,000. (For instructions on using other current transformers with different ratios, refer to section 2.2.1.1). For volt-amp measurement with the 918B, both the voltage and the current inputs are utilized.

**CAUTION** Do not exceed  $\pm 25$  volts peak, with respect to earth ground, on the (-) voltage input. The 918B is designed to operate with the (-) input connected to earth ground or circuit neutral.

### Procedure

1. To perform VA measurements with the 918B, switch the instrument to the VA mode by first pressing "SHIFT", then pressing "VA".
2. Connect the output of the clamp-on current transformer (CT) to the current input of the 918B, using the supplied cable. Be sure

that the (+) and (-) terminals on the CT correspond directly to the (+) and (-) terminals of the 918B current input.

3. Clamp the CT around the wire carrying the current to be measured, making certain that the jaws close completely. Note the (+) and (-) symbols, indicating the phase relationship between the CT input and the CT output.
4. Although not critical for volt-amp indication, this will be of particular importance for measurement of parameters involving phase angle, such as power factor, watts, and vars, which will be covered in subsequent sections of this manual.
5. Plug the supplied test probes into the voltage input terminals, with the red wire connected to the (+) terminal and the black wire connected to the (-) terminal.
6. Connect the black lead to the circuit neutral or ground, or the point to be used as the reference for the measurement.
7. Connect the red test lead to the voltage to be measured. The value displayed will be the product of the rms voltage and the rms current in the circuit.

### **Operating Ranges**

For voltage inputs, the 918B has four different operating ranges. For current inputs, the 918B has three different operating ranges. Depending on the levels of voltage and current applied to the inputs, the instrument may automatically switch between ranges. This range switching is internal, and may or may not be evident in the display. Automatic range switching can be defeated, using range hold. Refer to section 3.1, "Automatic and Manual Range Selection", for a description of the internal ranges, the display ranges, auto ranging operation, and range hold operation.

### **Flashing Display – Input Low**

For the VA mode, minimum values of voltage and current must be present at the inputs to maintain accuracy. The 918B display will

indicate when the voltage and/or current fall below their minimum values. If an input value falls below the bottom of the lowest range in auto-range mode, or below the bottom of a held range, the display will begin to flash. Measurements can still be made, but the input is outside of its specified range and accuracy cannot be guaranteed. If the input falls to a value too low to actually permit a measurement, the display will indicate "Input Low".

When making measurements using any of the operating modes of the 918B, you can "freeze" the values for all measured parameters by simply pressing the "HOLD" button. You can then switch between all of the different modes and determine their respective values at the time "HOLD" was pressed. Pressing "HOLD" a second time restores the instrument to normal operation.

Recording of minimum and maximum values is suspended for any period of time that the hold function is active. However, all previously recorded values are retained. Refer to section 3.2 for more information on minimum and maximum value recording.

### **2.7 Measurement of Volt Amps Reactive (Reactive Power)**

Volt-amps-reactive is a parameter that is similar to volt amps, but which takes into account the phase angle between the voltage and current. Volt-amps-reactive is defined as the product of the rms voltage, the rms current, and the sine of the phase angle between them. The basic unit for volt-amps-reactive is the var. Using the supplied 1000:1 current transformer, the 918B is capable of measuring var values of up to 20,000. (For instructions on using other current transformers with different ratios, refer to section 2.2.1.1). For measurement of vars with the 918B, both the voltage and the current inputs are used.

<p><b>CAUTION</b> Do not exceed <math>\pm 25</math> volts peak, with respect to earth ground, on the (-) voltage input. The 918B is designed to operate with the (-) input connected to earth ground or circuit neutral.</p>
--

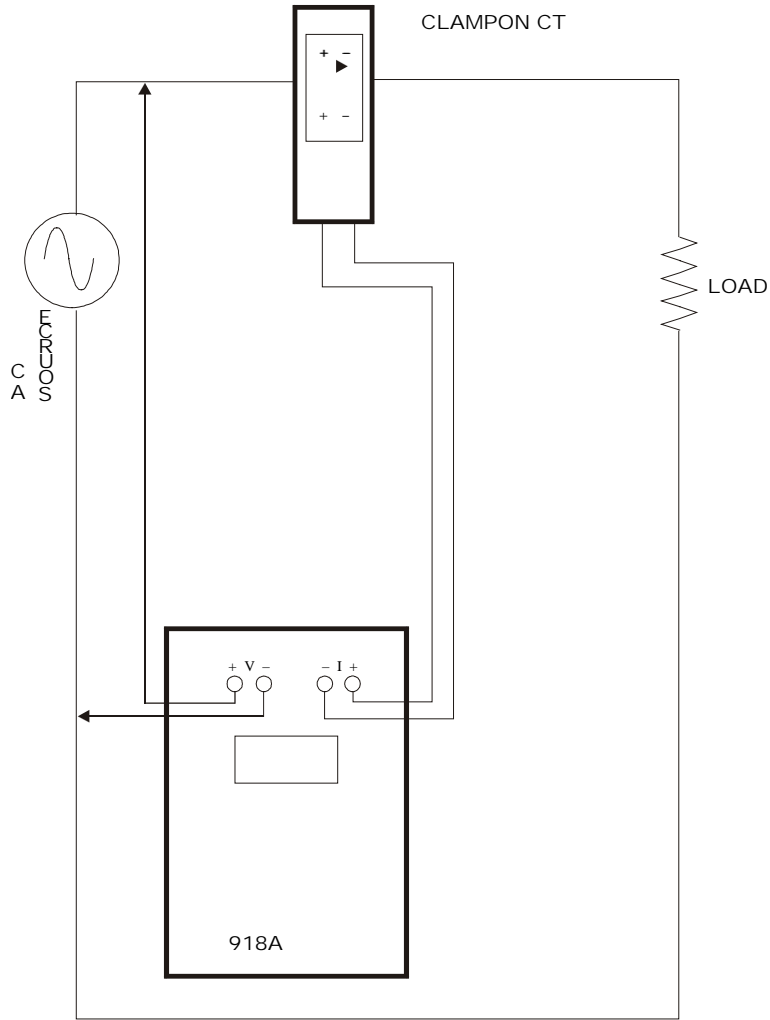
1. To perform var measurements with the 918B, switch the instrument to the var mode by first pressing "SHIFT", then pressing "VAR".
2. Connect the output of the clamp-on current transformer (CT) to the current input of the 918B, using the supplied cable. Be sure that the (+) and (-) terminals on the CT correspond directly to the (+) and (-) terminals of the 918B current input.
3. Clamp the CT around the wire carrying the current to be measured, making certain that the jaws close completely. Note the (+) and (-) symbols and the arrow, indicating the phase relationship between the CT input and the CT output.
4. If a current flowing in the same direction as the arrow is exactly in phase with a voltage present on the (+) voltage lead (with respect to the (-) voltage lead), the var value displayed on the 918B will be zero. Figure 3 illustrates the relationship between voltage lead polarity and current transformer orientation.
5. Plug the supplied test probes into the voltage input terminals, with the red wire connected to the (+) terminal and the black wire connected to the (-) terminal.
6. Connect the black lead to the circuit neutral or ground, or the point to be used as the reference for the measurement.
7. Connect the red lead to the voltage to be measured. The value displayed will be the volt amps reactive for the circuit under test.

**Operating Ranges**

For voltage inputs, the 918B has four different operating ranges. For current inputs, the 918B has three different operating ranges. Depending on the levels of voltage and current applied to the inputs, the instrument may automatically switch between ranges. This range switching is internal, and may or may not be evident in the display. Automatic range switching can be defeated, using range hold. Refer to section 3.1, "Automatic and Manual Range Selection", for a

description of the internal ranges, the display ranges, auto-ranging operation, and range hold operation.

For the circuit below, with a phase angle of zero between voltage and current, the 918B will indicate zero degrees phase.



**Figure 3 – Current Transformer Orientation**



### **Flashing Display – Input Low**

In var mode, minimum values of voltage and current must be present at the inputs to maintain accuracy. The 918B display will indicate when the voltage and/or current fall below their minimum values. If an input value falls below the bottom of the lowest range in auto-range mode, or below the bottom of a held range, the display will begin to flash. Measurements can still be made, but the input is outside of its specified range and accuracy cannot be guaranteed. If the input falls to a value too low to actually permit a measurement, the display will indicate "Input Low".

### **Hold Mode**

When making measurements using any of the operating modes of the 918B, you can "freeze" the values for all measured parameters by simply pressing the "HOLD" button. You can then switch between all of the different modes and determine their respective values at the time "HOLD" was pressed. Pressing "HOLD" a second time restores the instrument to normal operation.

### **Min / Max Readings**

Recording of minimum and maximum values is suspended for any period of time that the hold function is active. However, all previously recorded values are retained. Refer to section 3.2 for more information on minimum and maximum value recording.

## **2.8 Measurement of Watts (Active Power)**

The active power in an ac circuit is measured in watts, and is defined as the product of the rms voltage, the rms current, and the cosine of the phase angle between the two. Using the supplied 1000:1 current transformer, the 918B is capable of measuring active power values of up to 20,000 watts. (For instructions on using other current transformers with different ratios, refer to section 2.2.1.1).

For active power measurements with the 918B, both the voltage and current inputs are used.

**CAUTION** Do not exceed  $\pm 25$  volts peak, with respect to earth ground, on the (-) voltage input. The 918B is designed to operate with the (-) input connected to earth ground or circuit neutral.

### Procedure

1. To perform watt measurements with the 918B, switch the instrument to the watts (power) mode by pressing "W".
2. Connect the output of the clamp-on current transformer (CT) to the current input of the 918B, using the supplied cable. Be sure that the (+) and (-) terminals on the CT correspond directly to the (+) and (-) terminals of the 918B current input.
3. Clamp the CT around the wire carrying the current to be measured, making certain that the jaws close completely. Note the (+) and (-) symbols and the arrow, indicating the phase relationship between the CT input and the CT output.
4. If a current flowing in the same direction as the arrow is exactly in phase with a voltage present on the (+) voltage lead (with respect to the (-) voltage lead), the watts value displayed on the 918B will be maximum. Figure 3 illustrates the relationship between voltage lead polarity and current transformer orientation.
5. Plug the supplied test probes into the voltage input terminals, with the red wire connected to the (+) terminal and the black wire connected to the (-) terminal.
6. Connect the black lead to the circuit neutral or ground, or the point to be used as the reference for the measurement.
7. Connect the red test lead to the voltage to be measured. The value displayed is the active power in the circuit, in watts.

### Operating Ranges

For voltage inputs, the 918B has four different operating ranges. For current inputs, the 918B has three different operating ranges. Depending on the levels of voltage and current applied to the inputs, the instrument may automatically switch between ranges. This range switching is internal, and may or may not be evident in the display. Automatic range switching can be defeated, using range hold. Refer to section 3.1, "Automatic and Manual Range Selection", for a description of the internal ranges, the display ranges, auto-ranging operation, and range hold operation.

In the "watts" mode, minimum values of voltage and current must be present at the inputs to maintain accuracy. The 918B display will indicate when the voltage and/or current fall below their minimum values. If an input value falls below the bottom of the lowest range in auto-range mode, or below the bottom of a held range, the display will begin to flash. Measurements can still be made, but the input is outside of its specified range and accuracy cannot be guaranteed. If the input falls to a value too low to actually permit a measurement, the display will indicate "Input Low".

### Hold Mode

When making measurements using any of the operating modes of the 918B, you can "freeze" the values for all measured parameters by simply pressing the "HOLD" button. You can then switch between all of the different modes and determine their respective values at the time "HOLD" was pressed. Pressing "HOLD" a second time restores the instrument to normal operation.

### Min / Max Readings

Recording of minimum and maximum values is suspended for any period of time that the hold function is active. However, all previously recorded values are retained. Refer to section 3.2 for more information on minimum and maximum value recording.

### 2.9 Measurement of Power Factor

The power factor in a circuit is the ratio of the active power (watts) to the apparent power (volt amps). If all of the apparent power is being delivered to the load, then active power equals apparent power, and the power factor is 1. However, if only 75% of the apparent power is being delivered to the load, the power factor is 0.75.

In any ac circuit, only two parameters affect power factor: The phase angle between the voltage and current, and the relative quality of the waveshapes of each. In typical ac transmission and distribution systems, the quality of the sinewave is good enough to cause the phase angle to become the dominant factor. When only the phase angle is considered, power factor will be equal to the cosine of the phase angle.

The 918B is capable of displaying any power factor value between +1 and -1. For measurement of power factor with the 918B, both the voltage and the current inputs are used.

**CAUTION** Do not exceed  $\pm 25$  volts peak, with respect to earth ground, on the (-) voltage input. The 918B is designed to operate with the (-) input connected to earth ground or circuit neutral.

#### Procedure

1. To perform power factor measurements with the 918B, switch the instrument to the power factor mode by first pressing "SHIFT", followed by "PF".
2. Connect the output of the clamp-on current transformer (CT) to the current input of the 918B, using the supplied cable. Be sure that the (+) and (-) terminals on the CT correspond directly to the (+) and (-) terminals of the 918B current input.
3. Clamp the CT around the wire carrying the current to be measured, making certain that the jaws close completely. Note

the (+) and (-) symbols and the arrow, indicating the phase relationship between the CT input and the CT output.

4. If a current flowing in the same direction as the arrow is exactly in phase with a voltage present on the (+) voltage lead (with respect to the (-) voltage lead), the power factor value displayed on the 918B will be +1.000. Figure 3 illustrates the relationship between voltage lead polarity and current transformer orientation.
5. Plug the supplied test probes into the voltage input terminals, with the red wire connected to the (+) terminal and the black wire connected to the (-) terminal. Connect the black lead to the circuit neutral or ground, or the point to be used as the reference for the measurement.
6. Connect the red test lead to the voltage to be measured. The value displayed will be the power factor for the circuit, and will have a value between -1.0 and 1.0. The display will also indicate "LEAD", or "LAG" depending on whether the current is leading or lagging the voltage in phase.

### Operating Ranges

For voltage inputs, the 918B has four different operating ranges. For current inputs, the 918B has three different operating ranges. Depending on the levels of voltage and current applied to the inputs, the instrument may automatically switch between ranges. This range switching is internal, and may or may not be evident in the display. Automatic range switching can be defeated, using range hold. Refer to section 3.1, "Automatic and Manual Range Selection", for a description of the internal ranges, the display ranges, auto-ranging operation, and range hold operation.

### Flashing Display – Input Low

In power factor mode, minimum values of voltage and current must be present at the inputs to maintain accuracy. The 918B display will indicate when the voltage and/or current fall below their minimum

values. If an input value falls below the bottom of the lowest range in auto-range mode, or below the bottom of a held range, the display will begin to flash. Measurements can still be made, but the input is outside of its specified range and accuracy cannot be guaranteed. If the input falls to a value too low to actually permit a measurement, the display will indicate "Input Low".

### **Hold Mode**

When making measurements using any of the operating modes of the 918B, you can "freeze" the values for all measured parameters by simply pressing the "HOLD" button. You can then switch between all of the different modes and determine their respective values at the time "HOLD" was pressed. Pressing "HOLD" a second time restores the instrument to normal operation.

### **Min / Max Readings**

Recording of minimum and maximum values is suspended for any period of time that the hold function is active. However, all previously recorded values are retained. Refer to section 3.2 for more information on minimum and maximum value recording.

### **2.10 Measurement of Frequency**

The 918B is capable of displaying any frequency between 45 and 500 Hz. Make frequency measurements with the 918B by using either the voltage or the current inputs individually. However, if both have signals present, the instrument will default to reading the frequency of the voltage input.

<p><b>CAUTION</b> Do not exceed <math>\pm 25</math> volts peak, with respect to earth ground, on the (-) voltage input. The 918B is designed to operate with the (-) input connected to earth ground or circuit neutral.</p>
--

**Procedure**

To measure frequency with the 918B, first switch the instrument to the frequency mode by pressing "FREQ".

If the frequency of the current in a circuit is desired, use the following connection procedure:

1. Connect the output of the clamp-on current transformer (CT) to the current input of the 918B, using the supplied cable.
2. Be sure that the (+) and (-) terminals on the CT correspond directly to the (+) and (-) terminals of the 918B current input. Clamp the CT around the wire carrying the current to be measured, making certain that the jaws close completely.
3. Note the (+) and (-) symbols, indicating the phase relationship between the CT input and the CT output.

If the frequency of the voltage in a circuit is desired, use the following connection procedure:

1. Plug the supplied test probes into the voltage input terminals, with the red wire connected to the (+) terminal and the black wire connected to the (-) terminal.
2. Connect the black lead to the circuit neutral or ground, or the point to be used as the reference for the measurement.
3. Connect the red test lead to the voltage to be measured. The value displayed will be the frequency of the voltage or current in the circuit under test.

As stated above, if both the voltage and current inputs are used, and signals are present at both, the instrument will default to displaying the frequency of the voltage.

**Flashing Display – Input Low**

For the frequency mode, a minimum value of voltage or current must be present at one of the inputs to maintain accuracy. The 918B display will indicate when the voltage and/or current fall below their

minimum values. If an input value falls below the bottom of the lowest range in auto-range mode, or below the bottom of a held range, the display will begin to flash. Measurements can still be made, but the input is outside of its specified range and accuracy cannot be guaranteed. If the input falls to a value too low to actually permit a measurement, the display will indicate "Input Low".

### Hold Mode

When making measurements using any of the operating modes of the 918B, you can "freeze" the values for all measured parameters by simply pressing the "HOLD" button. You can then switch between all of the different modes and determine their respective values at the time "HOLD" was pressed. Pressing "HOLD" a second time restores the instrument to normal operation.

### Min / Max Readings

Recording of minimum and maximum values is suspended for any period of time that the hold function is active. However, all previously recorded values are retained. Refer to section 3.2 for more information on minimum and maximum value recording.

### 2.11 Measurement of Phase Angle

The 918B is capable of measuring the phase angle, in degrees, between the voltage input and the current input. The range for this function is dependent on which phase convention has been selected (refer to Section 2.2.1.2, "Changing the Phase Convention"). To perform phase measurements with the 918B, both the voltage and current inputs are used.

<p><b>CAUTION</b> Do not exceed <math>\pm 25</math> volts peak, with respect to earth ground, on the (-) voltage input. The 918B is designed to operate with the (-) input connected to earth ground or circuit neutral.</p>
--



**Procedure**

1. Switch the instrument to the phase mode by pressing "PHASE". Connect the output of the clamp-on current transformer (CT) to the current input of the 918B, using the supplied cable.
2. Be sure that the (+) and (-) terminals on the CT correspond directly to the (+) and (-) terminals of the 918B current input. Clamp the CT around the wire carrying the current to be measured, making certain that the jaws close completely.
3. Note the (+) and (-) symbols and the arrow, indicating the phase relationship between the CT input and the CT output. If a current flowing in the same direction as the arrow is exactly in phase with a voltage present on the (+) voltage lead (with respect to the (-) voltage lead), the phase value displayed on the 918B will be zero. Figure 3 illustrates the relationship between voltage lead polarity and current transformer orientation.
4. Plug the supplied test probes into the voltage input terminals, with the red wire connected to the (+) terminal and the black wire connected to the (-) terminal.
5. Connect the black lead to the circuit neutral or ground, or the point to be used as the reference for the measurement.
6. Connect the red test lead to the voltage to be measured. The value of the phase angle between the voltage and current in the circuit under test will be displayed, in accordance with the selected phase convention.

**Flashing Display – Input Low**

For the phase angle mode, minimum values of voltage and current must be present at the inputs to maintain accuracy. The 918B display will indicate when the voltage and/or current fall below their minimum values. If an input value falls below the bottom of the lowest range in auto-range mode, or below the bottom of a held range, the display will begin to flash. Measurements can still be made, but the input is outside of its specified range and accuracy

cannot be guaranteed. If the input falls to a value too low to actually permit a measurement, the display will indicate "Input Low".

**Hold Mode**

When making measurements using any of the operating modes of the 918B, you can "freeze" the values for all measured parameters by simply pressing the "HOLD" button. You can then switch between all of the different modes and determine their respective values at the time "HOLD" was pressed. Pressing "HOLD" a second time restores the instrument to normal operation.

**Min / Max Readings**

Recording of minimum and maximum values is suspended for any period of time that the hold function is active. However, all previously recorded values are retained. Refer to section 3.2 for more information on minimum and maximum value recording.

### 3.0 Special Functions and Features

The Model 918B Phase Angle Multimeter has a number of functions and features, which allow performance of specialized measurement tasks, some which would not even be possible with an ordinary single-phase meter. This section describes how to utilize the special capabilities of the 918B.

#### 3.1 Automatic and Manual Range Selection

##### 3.1.1 Description of Ranges

In order to accommodate a wide variation of values, the 918B divides the voltages and currents applied to the inputs into several different ranges. The table that follows illustrates the relationship between the value applied to the voltage or current input and the resultant range that is utilized. The table also shows which of the eight digits will be used to display a given value.

##### 100:1 Current Transformer (09182A):

	Range	Low	High	Display Digits									
				1	2	3	4	5	6	7	8		
A	1	0.002	0.02A			X	.	X	X	X	X		
M													
P	2	0.02A	0.2A			X	.	X	X	X			
S													
	3	0.2A	2.0A			X	.	X	X	X			

**1000:1 Current Transformer (09111A, 09182B):**

	Range	Low	High	Display Digits									
				1	2	3	4	5	6	7	8		
A M P S	1	0.02A	0.2A		X	.	X	X	X				
	2	0.2A	2A		X	.	X	X	X				
	3	2A	20A	(<10A)	X	.	X	X	X				
				(≥10A)	X	X	.	X	X				

**10,000:1 Current Transformer (09113A with 09182A):**

	Range	Low	High	Display Digits									
				1	2	3	4	5	6	7	8		
A M P S	1	2A	20A	(<10A)	X	.	X	X	X				
				(≥10A)	X	X	.	X	X				
	2	20A	200A	(<100A)	X	X	.	X	X				
				(≥100A)	X	X	X	.	X				
3	200A	1000	(<	X	X	X	.	X					
			(≥	X	X	X	X						

**Voltage:**

	Range	Low	High	Display Digits									
				1	2	3	4	5	6	7	8		
VOLTS	1	0.2V	2V		±	X	.	X	X	X			
	2	2V	20V	(<10V)	±	X	.	X	X	X			
				(≥10V)	±	X	X	.	X	X			
	3	20V	200V	(<100V)	±	X	X	.	X	X			
				(≥100V)	±	X	X	X	.	X			
	4	200V	2000V	(<	±	X	X	X	.	X			
				(≥	±	X	X	X	X				

\*Maximum specified input voltage is 1000V, rms or dc.

**3.1.2 Automatic Range Selection**

When the instrument is first turned on, it will default to automatic range selection. The operating ranges are selected automatically, depending on the levels of voltage and current present on the inputs. During the transition from one range to the next, the display will momentarily blank, indicating that a range change is taking place.

**3.1.3 Manual Range Selection**

The 918B has a provision for manually selecting and holding a particular measurement range. This can be done for either the voltage or current mode, or both.

**Procedure**

1. To select and hold a range, first switch the instrument into the desired mode (i.e. voltage or current).

2. Select the range by pressing the "SHIFT" key, followed by "RANGE". If no input is present, the lowest range will be held. The character "Θ" will appear on the display during any time that a range is held.
3. Repeatedly pressing the "SHIFT" and "RANGE" keys again in sequence will cause the unit to change to the next highest range, continuing until the highest range is reached.
4. Pressing "SHIFT" and "RANGE" one more time will cause the unit to go back to automatic range selection, where the cycle can be repeated.

If there is an input signal present and a value is being displayed in a particular range, the "SHIFT"/"RANGE" key sequence will cause the present range to be held. It will be impossible to select or hold a range lower than the one being used.

### **OVLD – Out of Range Indication**

If a range is held, and the upper limit of the range is exceeded by more than approximately 10%, the 918B will indicate an out-of-range condition by displaying the message "OVLD!"

When the instrument is operated in one of the modes which utilize both the voltage and the current inputs, and a voltage and/or current range is held, the display will indicate when either of the inputs falls below an acceptable level. The measurement modes, which are subject to Out-of-Range, are volt-amperes, volt-amperes reactive, watts, power factor, and phase angle.

### **Input Low**

While in one of the above modes, if an input level falls below the lower end of a held range, the display will begin to flash. If an input value falls below 50% of the lower end value of a held range, the display will read "Input Low".

### 3.2 Minimum and Maximum Value Storage

The Minimum/Maximum function of the 918B allows continuous monitoring of all operating modes, with automatic recording of the lowest and highest values for each. Regardless of the particular mode that the instrument is in, recording of min/max values for all modes will be taking place.

#### Procedure

1. Stored minimum and maximum values for a given measurement mode can be recalled by first entering the desired mode, then successively pressing the "MIN/MAX" key.
2. The first keystroke will return the minimum value, the second will return the maximum value, and the third will restore the unit to normal operation.

When reading the minimum or the maximum values, you can switch to other modes to determine their respective minimum or maximum values.

#### Hold Mode

The instrument will continue to record values while displaying minimum or maximum values. If a new input level appears which is beyond either of the previous minimum or maximum values, it will automatically overwrite the existing stored value and update the display. If you do not wish this to happen, press "HOLD" to discontinue recording of new minimum and maximum values while the existing ones are being reviewed.

The minimum and maximum values, which are stored for dc volts, ac volts, ac amperes, frequency, and phase are the actual values recorded on the inputs. Values, which are recorded for the other modes, correspond to minimum and maximum *calculated* values. *The calculation takes place at the time the values are stored, rather than at the time they are recalled.*

### Clearing Min / Max Values

Recording of all values begins automatically as soon as the instrument is turned on. To clear all of the stored values and begin a new recording period,

1. Press the "SHIFT" key, followed by the "START" key. There is no limit to the amount of time for which min/max recording can continue.

Recording of minimum and maximum values is suspended for any period of time that the instrument is in the hold mode. All values recorded prior to going into the hold mode are preserved, and recording will continue normally after the unit is removed from the hold mode.

### 3.3 Using Delta Phase for Phase Comparison Measurements

The 918B features a Delta Phase function, which allows phase comparisons between two signals at the same frequency, using a third synchronous signal as a reference. This permits measurement of the phase relationship between, for example, all of the phases in a three-phase system.

A typical application of the Delta Phase function would be measuring the phase angle between the "A" and "B" phase voltages in a three-phase system, using the "C" phase current as a reference. The procedure to follow for this measurement example would be as follows:

#### Procedure

1. Switch the instrument to the Phase mode by pressing the "PHASE" key.
2. Clamp the current transformer around the "C" phase wire.
3. Connect the black voltage test lead to circuit neutral.



4. Connect the red voltage test lead to the "A" phase wire. The phase angle indicated is the phase angle between the "A" phase voltage and the "C" phase current.
5. Press "SHIFT", then " $\Delta$ PHASE". The display will indicate zero.
6. Move the red voltage test lead to the "B" phase wire. The new value displayed will be the phase angle between the "A" phase voltage and the "B" phase voltage.

### **3.3.1 Using Fixed Offsets in Delta Phase Mode**

Operating with one of three preset phase angle offsets can enhance the basic capabilities of the Delta Phase mode. In addition to normal Delta Phase operation, the operator has the choice of entering offset values of 30, 60, or 90 degrees lag (current lagging voltage).

After selecting the offset value, the 918B will indicate zero because the phase angle at the inputs is equal to the offset value.

All of the 918B measurement functions, which involve phase (W, PF, vars, and phase) will account for the entered offset. For example, if the offset entered is 30 degrees lag, and the instrument is used to measure a circuit in which the current lags the voltage by 30 degrees, then the power factor indicated would be 1.0.

#### **Procedure**

1. To enter an offset value, first set the unit to the Phase mode by pressing "PHASE".
2. Press "SHIFT" then " $\Delta$ PHASE" to switch to the Delta Phase mode. Pressing the "SHIFT"/" $\Delta$ PHASE" key sequence again will cause the display to momentarily indicate " $\Delta$ Ph = 30 Deg LAG", and will select this value as the offset.
3. Repeating the "SHIFT"/" $\Delta$ PHASE" sequence will select 60 degrees, then 90 degrees offset, then will finally disable the Delta Phase mode.

**NOTE** It is important to note that regardless of which phase convention is selected (refer to section 2.2.1.2 of the Operation Manual), the only offsets that can be entered are 30, 60, and 90 degrees lag.

If an offset value is entered and then an operating mode other than phase is selected, pressing "SHIFT" then " $\Delta$ PHASE" will provide a momentary display of the entered offset, but will not change the offset value.

### Clearing an Offset Value

1. To clear a selected offset and return to normal operation, first set the unit to the phase mode (if it is not already set to the phase mode) by pressing "PHASE".
2. Once the unit is in the phase mode, pressing "PHASE" again will clear the offset value, and return the instrument to normal phase mode operation.

### 3.4 Watt-Hour Measurement

The Model 918B has a provision for measurement of watt-hours. Watt-hour recording begins as soon as the instrument is turned on.

#### Procedure

1. To review watt-hours as they are accumulated, press the "W" button twice.
2. After the first press of the "W" button, the unit will display power.
3. When the button is pressed again, the unit will display watt-hours.
4. If both voltage and current are present when in the watt-hour display mode, the display will increment upward or downward, depending on the direction of power transfer.

**Resetting Watt-Hours**

1. To reset watt-hours to zero and begin a new recording cycle, press the "SHIFT" key, followed by "START".
2. Recording of new data begins immediately upon pressing "START".
3. If the unit is in the watt-hour mode and is switched to another mode, pressing the "W" key once returns the unit to the watt-hour mode, not the power mode as may be expected.
4. It is necessary to press the "W" key twice in order to return to the power measurement mode.

**3.5 Making Voltage-to-Voltage Phase Angle Measurements**

Continuous phase angle measurements between two voltage sources can be performed with the 918B, using an optional Auxiliary Voltage Adapter (Arbiter Systems Model 09184A). The adapter is plugged into the current input and a single test lead is used to connect to the second voltage source. The negative (-) test lead from the front-panel voltage input is used as the common ground for both inputs.



## 4.0 Specifications

### 4.1 Measured Parameters:

#### **Voltage (RMS and DC):**

Ranges (automatic or manual selection):

Range 1: 0.2 to 2 V

Range 2: 2 to 20 V

Range 3: 20 to 200 V

Range 4: 200 to 1000 V

Accuracy:  $\pm 0.2\%$  of reading  $\pm 0.05$  of full scale typical.  
 $\pm (1\% \text{ of reading} + 1 \text{ digit})$  maximum

#### **Current (RMS, with Supplied 1000:1 Current Transformer**

Note These specifications apply to operation using the 20A clamp-on CT supplied with, and having the same serial number as the 918B. Use of other CTs may result in reduced accuracy.

Ranges (automatic or manual selection)

Range 1: 0.02 to 0.2 A

Range 2: 0.2 to 2 A

Range 3: 2 to 20 A

Accuracy:  $\pm 0.2\%$  of reading  $\pm 0.05$  of full scale typical.  
 $\pm (1\% \text{ of reading} + 1 \text{ digit})$  maximum

**Phase**

Range: 0 to 360 degrees

Resolution: 0.1°

Accuracy: ±0.5 degrees typical

±1.0° maximum, with supplied clamp-on CT and current greater than 0.1 Arms and voltage greater than 1 Vrms

**Frequency**

Range: 45 to 500 Hz

Accuracy: ±(0.01% of reading + 1 digit)

Resolution: 0.01 Hz for frequencies less than 100 Hz

0.1 Hz for frequencies of 100 Hz or more.

## 4.2 Calculated Parameters

### Volt-Amps

Calculated as the product of the rms voltage and the rms current.

Range: 0.004 VA to 20 kVA (with supplied 1000:1 current transformer)

Accuracy: Derived from the individual uncertainties of the voltage and current measurements.

$\pm 1.5\%$  of reading, max.

### Volt-Amps Reactance

Calculated as the product of the rms voltage, the rms current, and the sine of the phase angle between the two.

Range: 0.004 var to 20 kvar (with supplied 1000:1 current transformer)

Accuracy: Derived from the individual uncertainties of the voltage, current, and phase measurements

$\pm 1.5\%$  of VA, max.

### Power

Calculated as the product of the rms voltage, the rms current, and the cosine of the phase angle between the two.

Range: 0.004 W to 20 kW (with supplied 1000:1 current transformer)

Accuracy: Derived from the individual uncertainties of the voltage, current, and phase measurements

$\pm 1.5\%$  of VA, max.

**Power Factor**

Range: -1.0 to +1.0, lead or lag

Accuracy: Derived from the uncertainty of the phase angle measurement

$\pm 0.01$  max.

**Watt Hours**

Calculated from power sampled at a rate of once per second.

Range: 0 to  $\pm 9999$  kWh

Accuracy: Derived from the individual uncertainties of the voltage, current, and phase measurements.

$\pm 0.6\%$  of reading at 1 Arms, 120 Vrms, and  $0^\circ$ , typical.

**4.3 General Specifications****Supply Power**

Battery: Internal 9.6V/0.5Ah nickel cadmium rechargeable. 25 hours, minimum operating time with full charge.

AC Line/ Plug-in transformer, 15V/150mA output, 120V,

Charging 60Hz, 5 W input. Unit can be operated with charger connected.



**Physical Characteristics**

Outline

Dimensions: 182mm H x 122mm W x 43 mm D  
(7.2" x 4.8" x 1.7")

Weight: Instrument: 1 kg (2.2 lbs)

Shipping: 2.3 kg (5 lbs)

**Environmental**

Temperature: Operating range: 0° to 50°C

Operating, typical.: 25°C

Storage range: -40° to +75°C

Humidity: Non-condensing.



## Warranty

Arbiter Systems makes no warranty, expressed or implied, on any product manufactured or sold by Arbiter Systems except for the following limited warranty against defects in materials and workmanship on products manufactured by Arbiter Systems.

Products manufactured by Arbiter Systems are guaranteed against defective materials and workmanship under normal use and service for one year from date of delivery. The responsibility of Arbiter Systems under this warranty is limited to repair or replacement, at Arbiter Systems' option, of any product found to be defective. Arbiter Systems shall have no liability under this warranty unless it receives written notice of any claimed defect within the earlier of thirty days of discovery by Buyer or one year from the date of delivery. For warranty service or repair, products must be returned to a service facility designated by Arbiter Systems. Buyer shall prepay all shipping charges to Arbiter Systems and Arbiter Systems shall pay shipping charges and return the product to Buyer. However, Buyer shall pay all shipping charges, duties and taxes for products returned to Buyer in a country other than the United States of America.

THE WARRANTY SET FORTH HEREIN CONSTITUTES THE ONLY WARRANTY OBLIGATIONS OF ARBITER SYSTEMS, EXPRESSED OR IMPLIED, STATUTORY, BY OPERATION OF LAW, OR OTHERWISE. ARBITER SYSTEMS DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND BUYER EXPRESSLY WAIVES ALL OTHER WARRANTIES.

This limited warranty does not extend to any product which has been subject to (i) improper use or application, misuse, or abuse, or operation beyond its rated capacity, or contrary to the instructions in the operation and maintenance manuals, if any (ii) accident (iii) repair or maintenance, except in accordance with the operation and maintenance manuals, if any, and any special instructions of Arbiter Systems, or (iv) modification without the prior written authorization of Arbiter Systems (whether by the substitution of non approved parts or otherwise).

The remedies provided herein are Buyer's sole and exclusive remedies. In no event shall Arbiter Systems be liable for direct, indirect, incidental or consequential damages (including loss of profits), whether based on contract, tort, or other legal theory.

FOR THE FASTEST POSSIBLE SERVICE, SHOULD FAULT UNDER THIS WARRANTY DEVELOP, PLEASE PROCEED AS FOLLOWS:

- 1) Notify Arbiter Systems, Inc., specifying the instrument model number and serial number and giving full details of the difficulty. Service data or instrument return authorization will be provided upon receipt of this information.
- 2) If instrument return is authorized, forward prepaid to the manufacturer. If the instrument is not covered by this warranty, an estimate will be made before the repair work begins, if requested.

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