Megger®

User Manual

Model PMM-1

POWER MULTIMETER®

It is essential that this instruction book be read thoroughly before putting the equipment in service!

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REVISIONS HISTORY

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IMPORTANT

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The recipient, if a Government agency, acknowledges that this instruction book and the equipment described were procured with "Limited Rights" to technical data as described in ASPR 9-203 (b).

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1 OPERATOR SAFETY

ATTENTION: READ THIS MANUAL BEFORE PROCEEDING WITH INSTALLATION AND OPERATING THE INSTRUMENT.

1.1 DESCRIPTION

This instrument must be operated, used and serviced ONLY by trained, qualified personnel. Misuse of electrical instruments can result in personal injury and damage to the apparatus under test. **Obey all applicable safety rules and regulations at all times.**

Refer to the following sections of this manual for operating specifications and procedures.

1.2 EXPLANATION OF SAFETY SYMBOLS

Megger uses, where applicable, the following IEC 417 symbols on its instruments:

This symbol indicates that the operator of the instrument must refer to the instruction manual for further explanation and clarification.

Safety Ground Terminal. This terminal **must** be connected to an earth ground before making other connections to the instrument and prior to operating it!!!

This red symbol indicates that high voltage (i.e., any voltage equal or greater than 1000 Volts) is present on the terminal. Use extreme care.

This is the symbol for a sinusoidal AC voltage or current.

AC or DC voltage.

1.3 GROUNDING

Where a ground binding post or a grounding lead is provided on the instrument, it must be connected to an earth ground **PRIOR** to making any other connections.

WARNING: To avoid electric shock do not interrupt the connection to the protective safety ground.

1.4 POWER CORD AND FUSES

The power cord must be connected to a grounded supply system with proper electrical ratings, as indicated on the instrument.

In the case of detachable power cords, only the cord supplied or specified by Megger should be used.

WARNING: TO AVOID ELECTRIC SHOCK ALWAYS DISCONNECT THE POWER CORD FROM THE SUPPLY CIRCUIT BEFORE SERVICING THE INSTRUMENT OR WHEN REPLACING A FUSE.

WARNING: ALL FUSES MUST BE REPLACED WITH THE SAME TYPE AND CURRENT AND VOLTAGE RATINGS. SHORT-CIRCUITING THE FUSEHOLDER IS PROHIBITED.

2 GENERAL INFORMATION

2.1 DESCRIPTION

The Megger POWER MULTIMETER (Model PMM-1) is a next generation portable battery/line operated multifunction instrument for measuring AC or DC voltage, AC primary and secondary current, power, reactive power, phase angle and frequency of a single or three phase electrical system. POWER MULTIMETER is easily configured to measure the amplitude and phase angle between any two voltage and current inputs. All measured quantities are displayed simultaneously on an easy-to-read graphic display.

The unique firmware in the POWER MULTIMETER, combined with a built-in microprocessor-based timer, is specifically designed to ease testing and commissioning of protective relay systems, including induction unit pick-up and timing tests. The internal timer responds to a variety of start and stop gates, including the application of AC or DC voltage, and opening or closing of dry contacts.

POWER MULTIMETER is a menu driven instrument equipped with data-retention and TIMED data-logging capabilities. Automatically stores measured data at user defined intervals. Transmit them to a PC on a pre-programmed time interval or save data directly to NOV RAM memory.

Other important features include accurate phase angle measurement at very low current levels, max hold and the high speed measurement modes.

2.2 APPLICATIONS

POWER MULTIMETER is an ideal instrument for use in general electrical systems maintenance, in electrical machine repairs, in protective relay testing, or in monitoring power at the electrical service entrance.

In the protective relay application area, POWER MULTIMETER is designed to perform fast, accurate checking and testing of protective relay and meter installations, during their commissioning and in routine maintenance.

Also, combined with a source of voltage and/or current, POWER MULTIMETER becomes an excellent tool for testing and calibrating various types of protective relays.

2.3 FEATURES

- Battery and line operated, with an automatic built-in charger.
- Rugged, ergonomic and light plastic enclosure.

- 3 independent voltage and current channels, with a built-in timer.
- Specifically designed to ease testing and commissioning of protective relay systems.
- Simultaneously measures and displays voltage, current, phase angle, power, reactive power, power factor, and frequency of single or three phase systems.
- Wide current and voltage operating ranges.
- High speed measurement mode, with up to 1200 sets of readings in single phase mode and up to 400 sets of readings in three phase mode.
- Accurate phase angle measurement at very low current levels.
- Timer mode, phase angle between the voltage and current is measured and displayed.
- Auto-ranging to reduce test time, with manual over-ride.
- RS232 data and parallel printer output ports.
- Large, easy-to-read, high-resolution LCD display.
- Menu driven, easy to operate.
- Data storage for saving measured values.
- Programmable Time Data Logging to Memory.
- Customize C.T. ratio inputs up to a ratio of 9999:1 or 9999:5.
- Customize P.T. ratio inputs up to a ratio of 9999:1 or 9999:5.
- Megger Power DB Lite software to recover and print data.
- Harmonic measurement of any selected voltage or current – up to the 49^{th} harmonic.

2.4 ELECTRICAL SPECIFICATIONS

* SPECIFICATIONS	
Input:	Line: 90-253 V, 50/60 Hz, 30 VA
Battery:	Internal, sealed lead-acid, rechargeable battery with an internal automatic charger. Safety features include Internal battery over-charging and charge exhaustion protection. Operation Time: 10-Hour continuous on full charge.
Voltage:	0 - 650 Volts (AC/DC) in 8 ranges, with 0.1% resolution. Accuracy at 50/60 Hz: ±0.05% of reading, from 3-650 AC Volts. (21° - 25°C) ±0.1% of reading, from 3-650 AC Volts. (0° - 50°C) ±0.1% of reading, from 3-650 DC Volts. Input impedance: 1 MΩ. Max input: 1000 Volts, from inputs to the chassis or between inputs.
Current:	0 - 100 Amperes (AC) in 10 ranges, with 0.1% resolution. Accuracy at 50/60 Hz: ±0.05% of reading, from 0.10-10 Amperes (21° - 25°C). ±0.1% of reading > 10 amperes. Burden at 5A: 0.1VA.
Phase Angle:	± 0 - 180.0° and 0 - 360° lead or lag, with 0.01° resolution. Accuracy at 50/60 Hz: ±0.05° for input levels above 30 Volts and 1 Amps[1], ±0.5° for input levels above 3 Volts and 0.02 Amps ± 2° input levels below 3 Volts and 0.02 Amps.
Power:	± 0 - 100 KW, with 0.1% resolution. Accuracy at 50/60 Hz: ±0.1% of VA.
Reactive Power:	± 0 - 100 KVAR with 0.1% resolution. Accuracy at 50/60 Hz: ±0.1% of VA.
Operating Frequency:	45 - 65 Hz, with 0.01 Hz resolution. Accuracy: ± 0.03 Hz.
Time:.	0.000 to 999.999 Seconds. Accuracy: ±0.005% of reading or LSD whichever is greater. 0.000 to 9999.9 Cycles. Accuracy: ±0.5 Cycle when initiated by dry contact or potential above 5 Volts DC or 115 Volts AC.
Start/Stop Inputs:	5 - 300 Volts AC, DC, or dry contacts closure or opening. Input resistance: 1000 Ω Minimum.
Response Time:	Regular single-phase mode: 1 reading per second High Speed Mode: 20 readings per second/60 seconds max. Three-phase mode: 1 set of readings every second.

* Specifications subject to change.

[1] When using current as reference, using voltage as reference the accuracy changes to ±0.1°

2.5 SAFETY, MECHANICAL AND ENVIRONMENTAL SPECIFICATIONS

Safety:	IEC 61010-1, Overvoltage CAT II
Case Material:	
Dimensions:	344W x 242H x 242D millimetres (13.5W x 9H x 9D inches)
Weight:	6.0 Kg (13.4 Lbs), approximately
Operating Temperature:	-15°C to 55°C (5°F to 131°F)
Storage Temperature:	-30°C to 75°C (-22°F to 167°F)
Relative Humidity:	10 to 95%, NON-CONDENSING

2.6 ORDERING INFORMATION

	Cat. No.
POWER MULTIMETER	PMM-1
The instrument is shipped complete with:	
Line cord, three wire, 120V	6828
Instruction Manual	17357
(2) Fuses 1.0 A 250 V, 5 x 20 mm	MC7797
Accessory Pouch External Mount Portable Case	17355
PMM1- Power DBLite software	DB0001
The following optional accessories are available:	
Standard Potential Leads [set of 4, 2m]	835312
Fused Potential Leads [set of 4, 2m]	830213
20-Amps Current Leads, States Plugs [set of 3, 1m]	835313
20-Amp Current Leads, clips [set of 3, 1m]	835314
100-Amp Current Leads [set of 3, 1m]	835315
1000:1 Clamp-On Current Transformer	830312
1000:5 Clamp-On Current Transformer	835318
3000:1 Clamp-On Current Transformer	835319
3000:5 Clamp-On Current Transformer	835320
200:1 Minature Clamp-On Current Transformer	50611
Soft Carrying Case	50775

2.7 CHANGES

Please note that this instrument is subject to continuous development and improvement. This instrument may therefore incorporate minor changes in detail from the information contained herein.

2.8 WARRANTY

Megger warrants the equipment, sold by us or our authorized agents, to be free from defects in material and workmanship, reasonable wear and tear excluded, for a period of 12 months from date of shipment.
Warranty service will be performed on the equipment at the **Megger** factory (unless the return of only a subassembly is authorized by **Megger**) or, at **Megger**'s discretion, in the field. The customer shall prepay shipping charges for units returned to **Megger**, and **Megger** shall pay for the return of the required or replaced unit to the customer, repair or replace (at **Megger**'s option) the unit or subassembly provided that the Instrument has not been altered, modified or repaired by unauthorized personnel, and that our examination discloses to our satisfaction that any improper operation or failure was not the result of improper use, negligence or accident, exceeding environmental limits, or connecting the Instrument to incompatible equipment. The customer is asked to obtain return authorization from **Megger** PRIOR TO returning a unit for service.

This warranty covers the cost of repairing or replacing faulty components at **Megger**'s option, but not the cost of travel and living expenses of service personnel for work completed in the field. Any field service trips will be subject to inspection of the **Megger** service representative. If it is determined upon arrival that the repair is not covered by the Warranty, the customer must be prepared to cover the standard rates of the **Megger** service representative(s) in addition to the cost of travel and living expenses of the service personnel. The invoice for the full amount of the non-warranty repair will be submitted by the **Megger** office upon the return of the service representative. The customer must remit the required payment immediately for all service work performed.

Products manufactured by **Megger** to customer's specifications are warranted to be free from defects in material and workmanship and to conform to those specifications made a part of **Megger**'s quotation, or of a customer's Contract or Purchase Order. Inspection and acceptance shall be conclusive as to fulfilling this warranty, except as to fraud or such gross mistakes as to amount to fraud.

Since **Megger** has no control over conditions of use, no warranty is made or implied as to suitability for customer's intended use beyond such performance specifications as are made a part of **Megger**'s quotation, or of a customer's contract or purchase order which has been approved and acknowledged by **Megger**. No other warranty is either expressed or implied. **Megger** shall not be liable for consequential damages.

3 INSTALLATION

3.1 UNPACKING AND INSPECTION

Prior to shipment this instrument was electrically tested and mechanically inspected to meet specifications and be free of mechanical defects.

After unpacking the instrument, visually inspect the instrument and accessories for damage. If evidence of damage is present, **YOU** must contact the carrier who transported the unit and file a claim in writing. The shipping container and packing material should be retained for inspection by the carrier's agent. Electrical operation per section 4 should be checked as soon as possible after shipment.

3.2 PREPARATION FOR USE

THIS INSTRUMENT IS DESIGNED TO BE USED TO MEASURE POTENTIALLY LETHAL VOLTAGE AND CURRENT. It is highly recommended that the user familiarize himself with the controls, functions and features detailed in section 4 prior to use. ***ALL SAFETY PROCEDURES AND PRECAUTIONS MUST BE FOLLOWED WHEN OPERATING ON LINE WITH LETHAL VOLTAGES OF HIGH CAPACITY!!!***

3.3 REPACKING AND SHIPMENT

To insure proper shipment of this instrument, it is recommended that the original reusable container and packing material be retained. If being returned for calibration or service, please attach a card to the instrument specifying the owner, model and serial number and service required.

4 OPERATING INSTRUCTIONS

4.1 PANEL CONTROLS AND OPERATING FUNCTIONS

Refer to FIGURE 4-1. for the following panel controls.

1. **LINE INPUT SOCKET**: This is the main input for the POWER MULTIMETER, and should be connected to a suitable line receptacle, using the provided line cord. The input socket also contains the protection fuse. Replace with type GDC, 1 Amp, 250 Volts only.

2. **MAIN POWER SWITCH:** Bring the switch to the right position to activate the instrument.

3. **AC LINE INDICATOR:** This LED will illuminate when the input plug is connected to a live line power.

4. **BATTERY CHARGED INDICATOR**: This LED will illuminate when the internal battery is charging to its full capacity or has degraded to 20% of its full capacity.

5. **PROTECTIVE GROUND TERMINAL:** The safety protective chassis ground connection for the instrument. This terminal is internally connected to the U ground.
   NOTE: The protective ground terminal must be connected to an earth ground before making other connections to the instrument and prior to operating it!!!

6. **DISPLAY:** The display is a high-resolution graphic LCD.

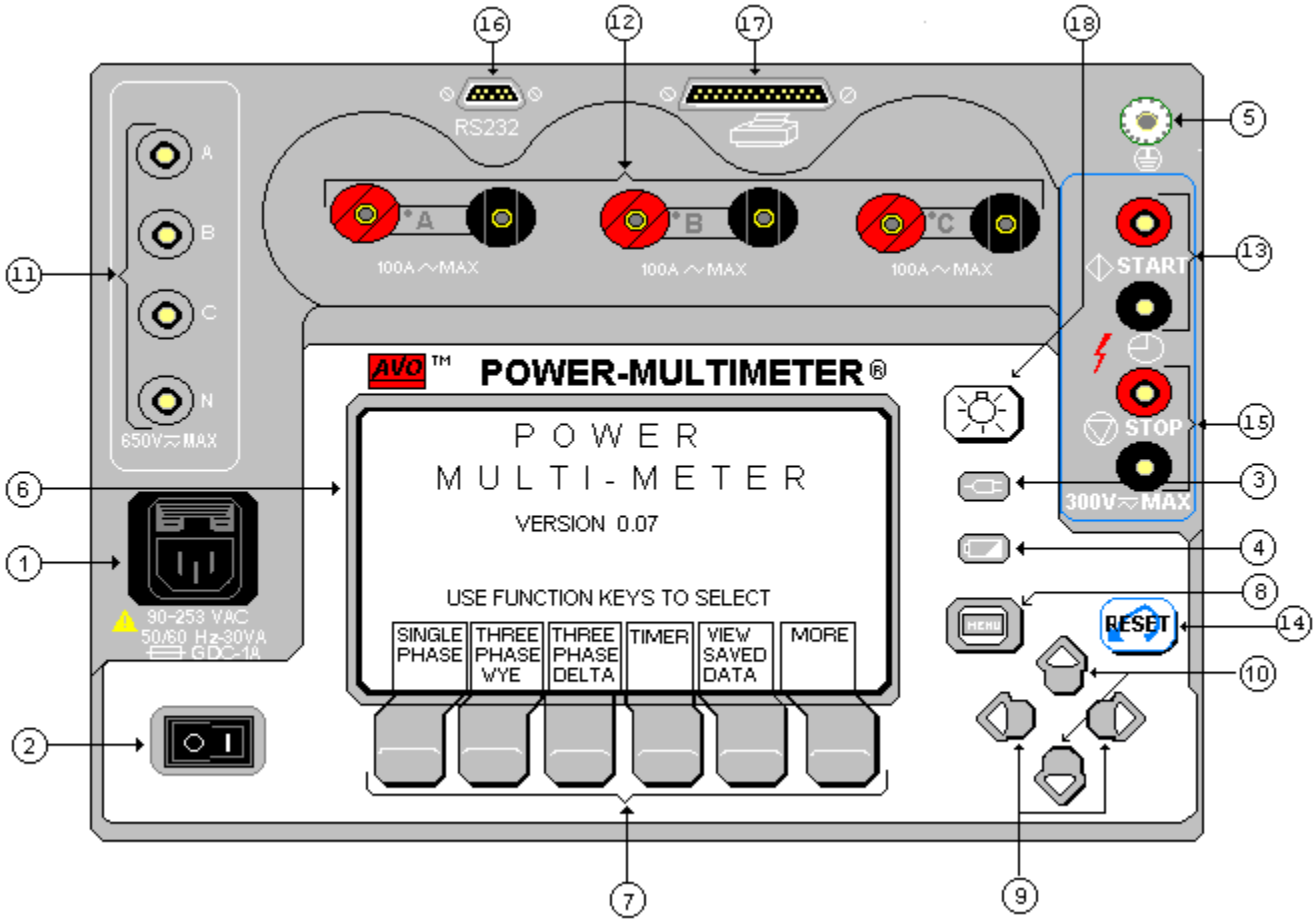
7. **FUNCTION KEYS**: These pushbuttons are operated in conjunction with the display. The display provides indication of key function. Function of each key varies with each screen.

8. **MENU KEY:** When depressed, the POWER MULTIMETER will return to the Main Menu.

9. **LEFT/RIGHT CURSOR KEYS:** The cursor keys allow the operator to move, in the left and right directions, to different fields on the screen.

10. **UP/DOWN CURSOR KEYS:** The cursor keys allow the operator to move, in the up and down directions, to different fields on the screen.

FIGURE 4-1 FRONT PANEL OF THE POWER MULTIMETER



11. **VOLTAGE INPUTS:** The single or polyphase voltages are connected to these binding posts, as labelled.

12. **CURRENT INPUTS:** Three independent current circuits may be connected to these binding posts. The correct polarity, for the phase angle measurement purposes, is indicated by the red terminal and a grey dot.

13. **START INPUTS:** Interval timer start binding post connections.

14. **RESET KEY:** This key is used to reset the meter in certain measuring screens.

15. **STOP INPUTS:** Interval timer stop binding post connections.

16. **RS232 OUTPUT PORT:** This port is provided for transmitting and receiving the data results to and from an external PC or a data terminal.

17. **PARALLEL PRINTER PORT:** The printer port can be connected to a Dot Matrix compatible parallel printer, for printing the test results.

18. **DISPLAY BACK-LIGHT SWITCH:** This switch controls the display back-light. In low ambient light conditions, the back-light allows the operator to see the display. If not needed, the back-light should be turned off to preserve the battery.

4.2 SAFETY CONSIDERATIONS

The measuring terminals of this instrument can be connected to lethal voltages and hazardous current circuits. Professional organizations using this instrument will normally have safety procedures covering such installations and users will be trained to follow them. Not withstanding these conditions, certain precautions should be followed when using this instrument.

1. The chassis ground connection should **always** be firmly attached to the system ground bus, even when an AC line cord is used.

2. Connections should be established to the potential and current terminals before the measuring circuit is energized.

3. The use of potential leads containing high rupture fuses is recommended in high KVA circuits.

4. All current terminals should be tightly fastened, to avoid dangerous terminal voltages and preclude ohmic heating at high currents.

4.3 USING THE INTERNAL BATTERY

NOTE: If the PMM-1 has been in transient for more than a week, it is very important that the unit be given a full charge before being used in the battery operation mode.

The internal charger will automatically charge the battery when the line power is applied to the instrument. When the battery is charging, the `battery charged' LED illuminates. The instrument can be used while the battery is being charged.

The BATTERY Charge LED also acts as low-battery indicator. This LED will flash at a constant rate, once the battery charge drops below 25%.

In order to prolong the life of the battery and ensure optimum performance, the following procedure should be observed:

1. Charge the battery overnight after using the instrument for a short time or after a whole day.

2. Charge the instrument at least once a month, if it is stored unused, store it connected to a power line.

3. If the battery condition has been allowed to deteriorate due to lack of attention, charge it for a period of up to 12 hours to allow the charger to recover the condition of the battery.

4.4 GENERAL OPERATING INSTRUCTIONS

The following is a general procedure for operating the POWER MULTIMETER.

1. **NOTE:** Due to the sensitivity of the Power Multimeter to very low levels of voltage and current, it is highly recommended that the protective ground terminal be connected to an earth ground and jumpered to the voltage input neutral post before making any measurements!!! This is recommended even if the AC power cord is used.

2. If the AC power is used, connect the provided AC power cord to a suitable supply. The POWER MULTIMETER is equipped with a wide input range power supply and therefore can be operated from 90 to 253 Volts (AC), 50 or 60 Hertz.

3. Turn on the instrument by toggling the power switch to its ON - position. The instrument should display the Main Menu.
   NOTE: To adjust the screen contrast, press the MORE function key and use the LESS or MORE contrast function keys to set the screen contrast.

4. The Power Multimeter is shipped with default settings. Timer Horn: **Disabled**, measuring mode: **60 Hz**, and Phase Angles: **0 - 360° Lag**. To make changes to the settings, press the More function key, then select **SetUp Page2**. In the SetUp Page2 screen complete the desired changes, then press the OK or Menu key to initialize the changes.

   Note: The unit saves the selections/changes made in the SetUp Page2 screen. Turning the unit OFF and ON will not restore the default settings.

5. Make the proper connections to the voltage and/or current channel inputs. Connections should be established to the potential and current terminals before the measuring circuit is energized!!!

6. Proceed with the actual test as described in the following sections.

4.5 SINGLE-PHASE OPERATION

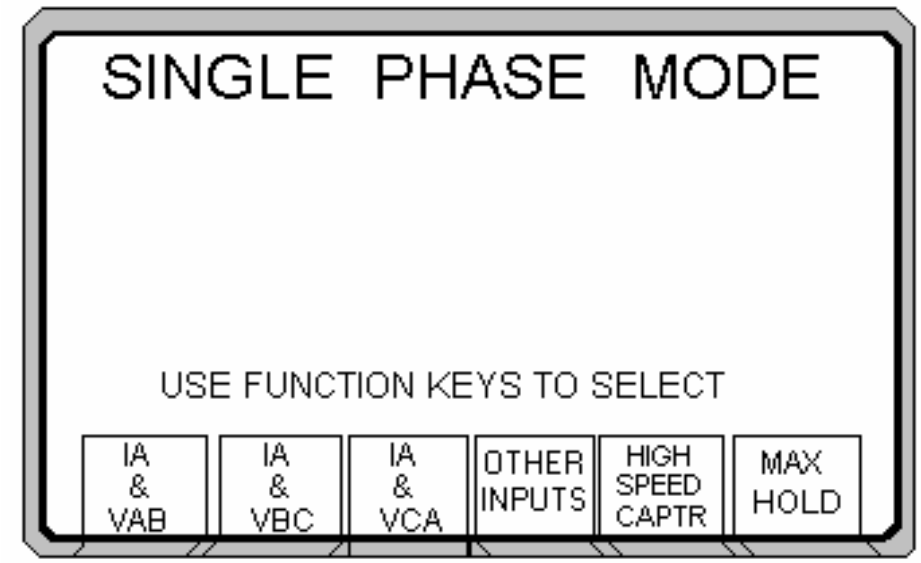
The single-phase operation mode is intended for measuring a single voltage and current, two voltages or two currents. This mode features a quick input selection menu, which enables the operator to measure various quantities in a single- or poly-phase installation.

Note: **Lag** ; displayed phase angles lags the reference in the Lag mode. **Lead** ; displayed phase angles leads the reference in the Lead mode.

4.5.1 SELECTING THE INPUT CHANNELS

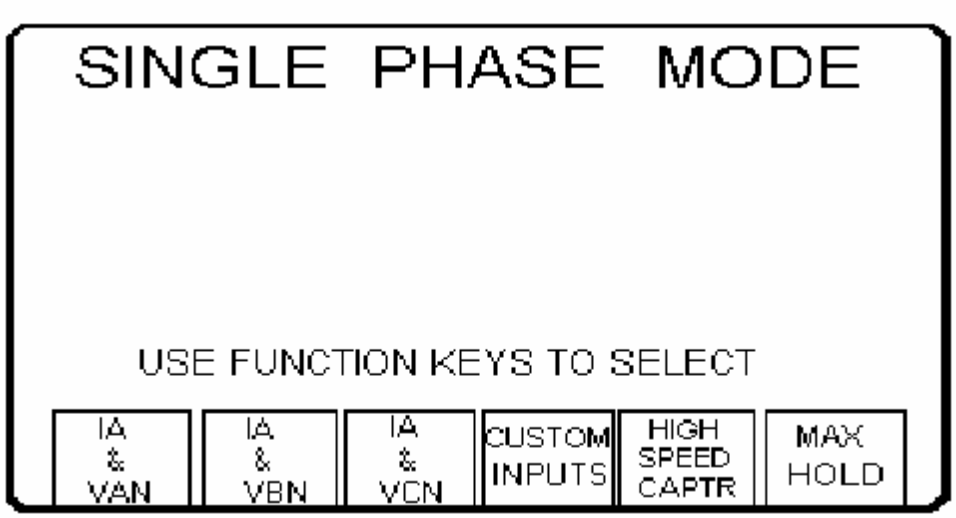
1. From the Main Menu, press the **SINGLE PHASE** function key. The following should appear on the display.

2. From the single-phase screen, select the input channels required. The following quick selections are provided for convenience:

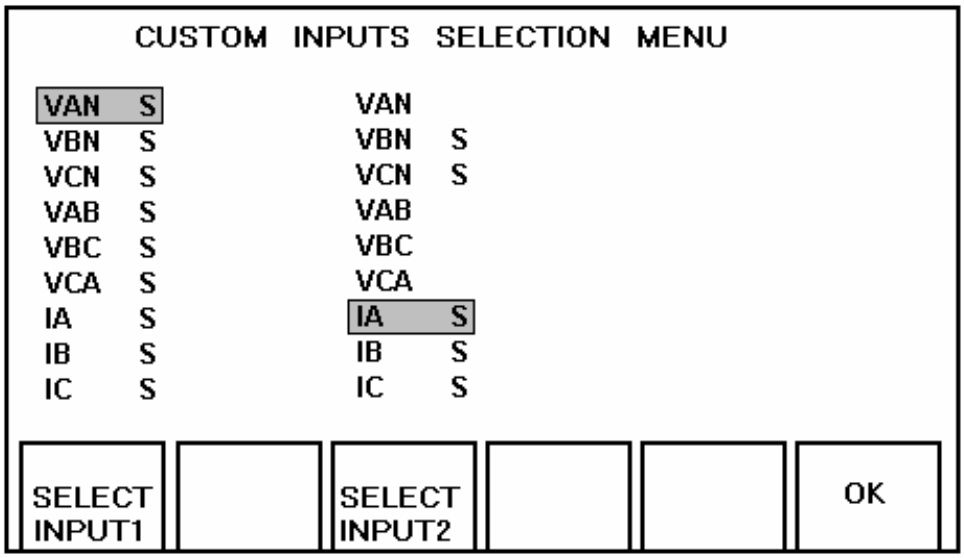


- **Ia & Vab** For one-current and two voltage measurements. The current is applied to A current terminals, and the voltage is applied between the A and B voltage terminals.
- **Ia & Vbc** For one current and two voltage measurements. The current is applied to A current terminals, and the voltage is applied between the B and C voltage terminals.
- **Ia & Vca** For one current and two voltage measurements. The current is applied to A current terminals, and the voltage is applied between the C and A voltage terminals.

Press the corresponding function key to activate the measurement on any of the above selections. Pressing OTHER INPUTS results in the following,



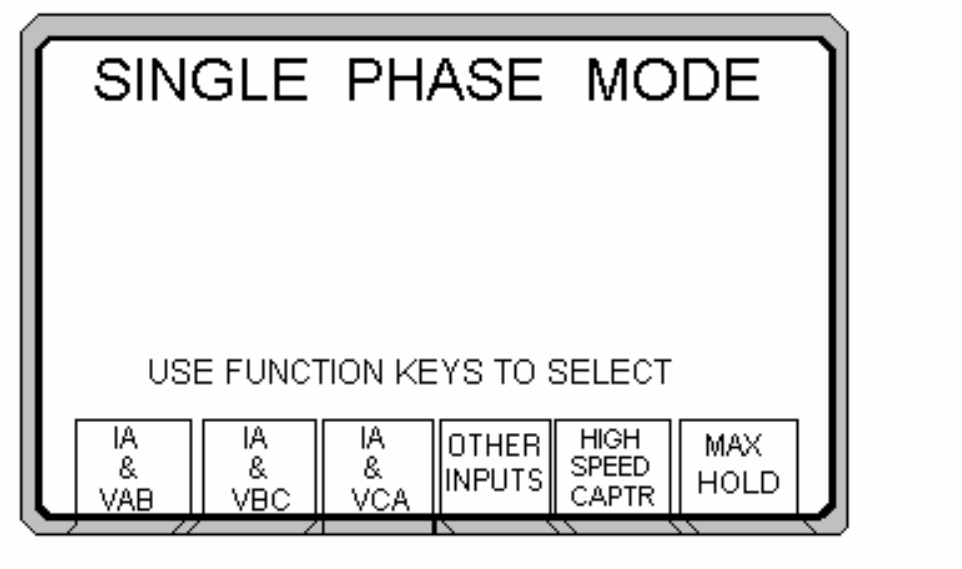
If inputs other than the ones listed above are required, press the **CUSTOM INPUTS** function key. The instrument will display the following:



3. Use the **SELECT INPUT 1** and **SELECT INPUT 2** function keys to configure the measurements. Note that certain combinations of input 1 and 2 are not possible. The instrument automatically disables these combinations.

4. Press the OK function key to activate the measurement.

4.5.2 THE MEASURING FUNCTIONS



1. Anytime during the course of measurement, the serial and/or parallel (i.e., printer) transmission can be activated.

   In order to activate the transmission, make the appropriate connection to the PRINTER or RS232 device. Refer to section 4.13. for more details.

   Press the **PRINT** function key to initiate the transmission. If the instrument establishes proper communication with the external device (i.e., printer), **DATA** will be printed.

   Improper communication will prompt an error message!

2. If the timed data transmission has been activated, measured data will be sent to the external device at the set time interval. Please refer to section 4.11. for information on timed data transmission.

3. The **START** or **STOP** inputs respond to a change of state. This change may be a dry contact opening or closure, or the initial application/removal of an AC or DC voltage. The input terminals are isolated from the chassis ground and are independent of signal polarity.

4. To save the measurements, simply press the **SAVE** function key.

   Pressing this key will TAG NUMBER the sub-screen. This number is tagged to the saved data, for future reference. All saved data are time and date stamped.

5. The instrument automatically defaults to true **RMS** measurement. To change the measurement mode to **AVERAGE**, press the Volt function key to toggle from **RMS** to **AVG**.

   NOTE: When measuring DC volts, the instrument must be in the RMS measurement mode only and positive polarity connected to V_A, V_B, or V_C!

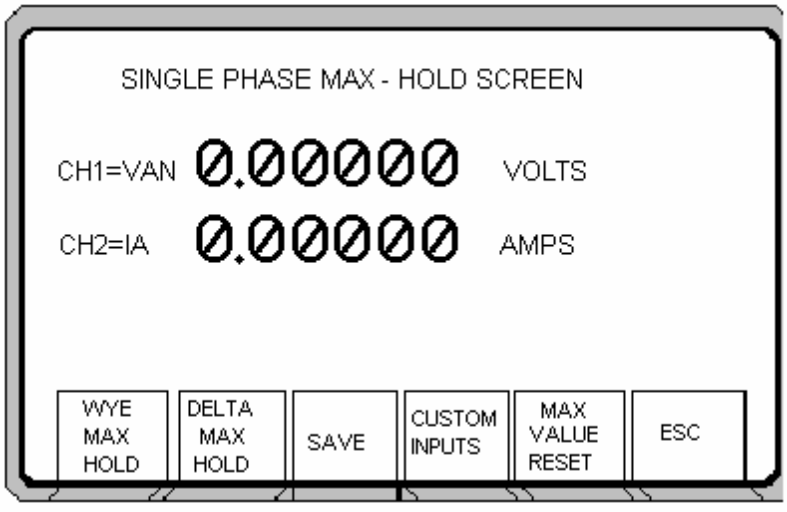
6. The instrument defaults to automatic ranging. If manual ranging is desired, the unit must be in High Speed Capture or Timer Mode. Proceed as follows:

   - Press **HIGH SPEED CAPR** function key. Select the **CHANGE I & V RANGE** function key.
   - Press **CHANGE I RNG** to set the current range desired.
   - Press **CHANGE V RNG** to set voltage range desired, after making the changes, press **OK** to enter the new configuration.

Please refer to section 4.7 if an external clamp-on current transformer is used.

7. Press the **ESC** function key, to return to the Single-Phase input selection screen.

4.5.3 THE MAX HOLD FEATURE



Pressing the MAX HOLD button in the Single-Phase Mode will result in the display of the selected single phase measuring screen. The PMM-1 will continuously monitor the selected inputs, and will display the highest value metered during the monitored period of time. It should be noted that the highest value must be present for at least 1 second, and only the highest value will be displayed. To save the value press SAVE, see section 4.10 to

VIEW SAVED DATA. Pressing WYE MAX HOLD or DELTA MAX HOLD will display the desired three-phase MAX HOLD screen. The same single-phase feature applies to the three phase MAX HOLD function.

4.6 THREE-PHASE OPERATION

NOTE: Due to the sensitivity of the Power Multimeter to very low levels of voltage and current, it is highly recommended that the protective ground terminal be connected to an earth ground and jumpered to the voltage input neutral post before making any measurements!!!! This is recommended even if the AC power cord is used.

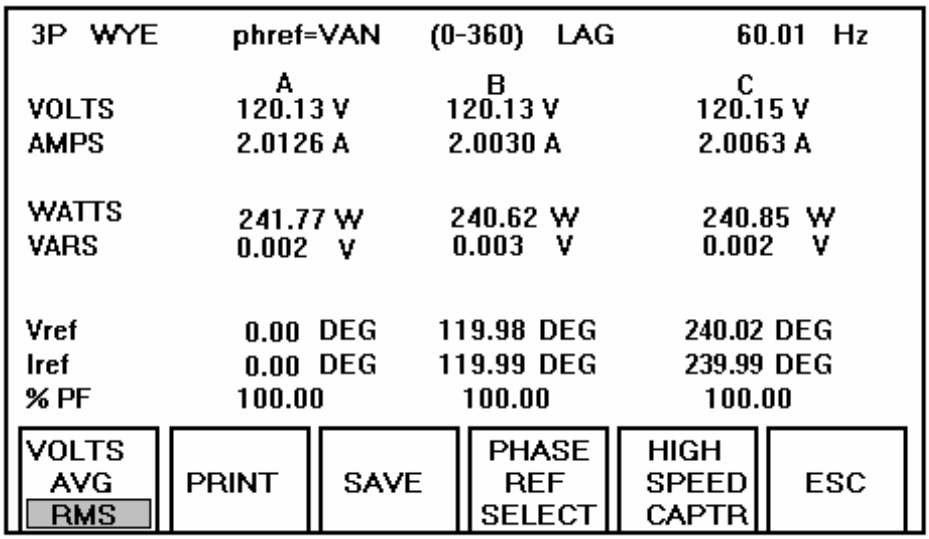
The three-phase operation mode is intended for measuring all 3-phase quantities in a wye or delta installation. Note: **Lag** ; displayed phase angles lags the reference in the Lag mode. **Lead** ;displayed phase angles leads the reference in the Lead mode.

NOTE: Instrument defaults to VAN as the phase reference. If current only is to be measured, the phase reference must be changed to IA, IB or IC.

Three phase watts are displayed in the three watt method.

4.6.1 SELECTING THE CONFIGURATION

From the Main Menu, select the **THREE PHASE WYE** or **THREE PHASE DELTA** configuration by pressing the corresponding function key. The instrument will immediately go into the measuring screen.



4.6.2 THE MEASURING FUNCTIONS

1. Anytime during the course of measurement, the serial and/or parallel (i.e., printer) transmission can be activated.

   In order to activate the transmission, make the appropriate connection to the PRINTER or RS232 device. Refer to section 4.13. for more details.

   Press the **PRINT** function key to initiate the transmission. If the instrument establishes proper communication with the external device (i.e., printer), **DATA** will be printed.

   Improper communication will prompt an error message!

2. If the timed data transmission has been activated, measured data will be sent to the external device at the set time interval. Please refer to section 4.11 for information on timed data transmission.

3. The **START** or **STOP** inputs respond to a change of state. This change may be a dry contact opening or closure, or the initial application of an AC or DC voltage. The input terminals are isolated from the chassis ground and are independent of signal polarity.

4. To save the measurements press the **SAVE** function key.

   Pressing this key will TAG NUMBER the sub-screen. This number is tagged to the saved data, for future reference. All saved data are time and date stamped.

5. The instrument automatically defaults to true **RMS** measurement. To change the measurement mode to **AVERAGE**, press the Volt function key to toggle from **RMS** to **AVG**.

   NOTE: When measuring DC volts, the instrument must be in the RMS measurement mode only and positive polarity connected to V_A, V_B, or V_C!

6. The instrument defaults to automatic ranging. If manual ranging is desired, the unit must be in High Speed Capture or Timer mode. Proceed as follows:

   - Press **HIGH SPEED CAPR** function key. Press the **CHANGE I & V RANGE** function key.
   - Press **CHANGE I RNG** to select the current range.
   - Press **CHANGE V RNG** to select the voltage range.

- After making the changes, press the **OK** key.

Please refer to section 4.7 if an external clamp-on current transformer is used.

7. Pressing **ESC** function key, will return the user to the three-phase measurement screen.

8. Phase A voltage input is taken as the reference for phase angle measurement. The operator may change the reference to either **VAN, VBN, VCN, IA, IB** or **IC**, by pressing the **Select Phase Ref** function key.

4.7 CLAMP-ON CURRENT AND POTENTIAL TRANSFORMER OPERATION

For application requiring direct measurement of primary current, five different optional clamp-on current transformers ratios are pre-set with this instrument. These ratios are **1000:1**, **1000:5**, **3000:1**, **3000:5** and **200:1**. If the clamp-on being used does not match any of the pre-set options, simply move the cursor to the **Customize** CT or PT.

There are two manners in which the clamp-ons can be utilized:

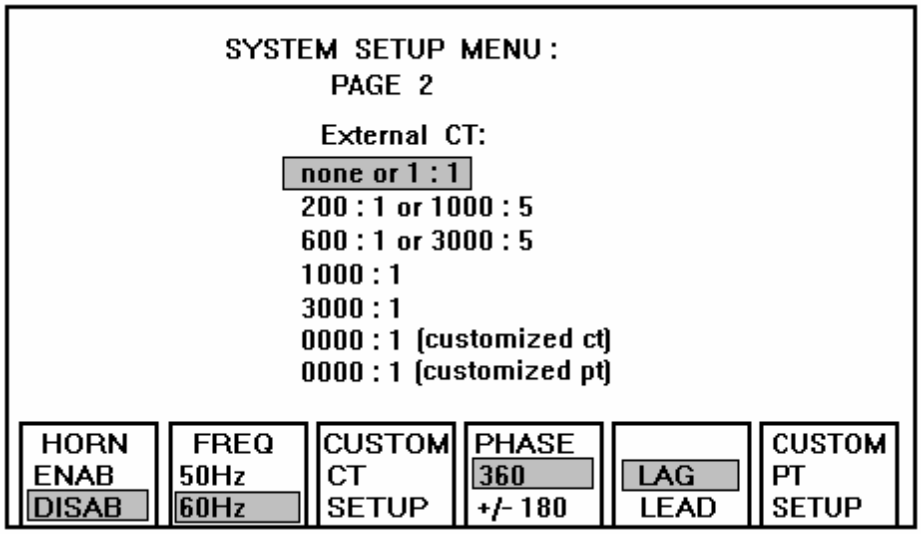
1. Measuring Primary current, watts and vars in a single- or three-phase installation.
2. Verifying the ratios of CTs, used in relaying and metering installations.

The following sections detail the operation for each of these applications.

4.7.1 MEASURING PRIMARY CURRENT

1. For this application, connect the clamp-on CT(s) directly to the current channel terminals on the front panel. Up to three clamp-ons can used for three-phase applications. Note that the CTs are only rated for 600 Volts class circuits.

2. To select the clamp-on ratio desired, proceed as follows:



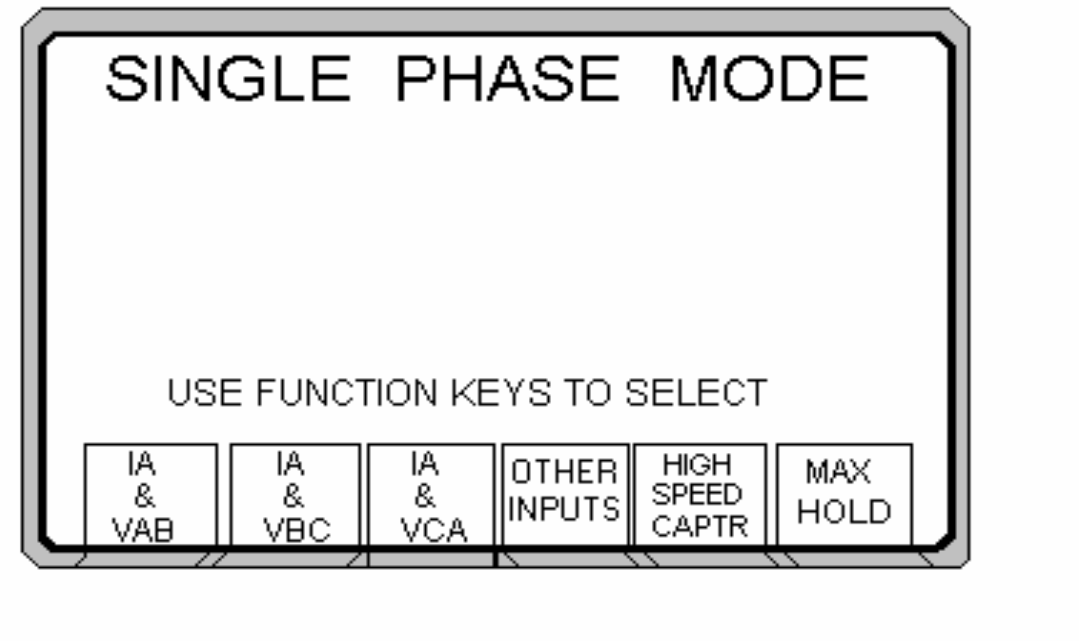
- From the Main Menu, press the More function key.
- From the More screen, press the SetUp Page2 function key.
- From the SetUp Menu screen, press the ⇑ or ⇓ Arrow keys to cursor to the preset CT ratios or the Customized Option.
- Preset ratioes are: **None** or **1:1, 1000:5 (200-1), 3000-5 (600-1), 1000:1, 3000:1,** Customized, CT and PT.
- In the Customized SetUp screen, the user can enter any ratio up to 9999:1 or 9999:5.
- Once the selection is entered, press the OK function key to return to the previous screen.
- Make the proper CT clamp connections to the unit and select the type of measurement (Single or Three Phase) desired.
- The Power MultiMeter will measure the current or currents by the selected ratio or **CUSTOMIZED** CT or PT ratio.
- After completion of the CT clamp on measurements, it is recommended that the unit be returned to its default setting: (None or 1:1).
- Return to the CT ratio screen by following the same steps as previously described or simply turn **OFF** the Power Multimeter.

3. All measuring functions are explained in sections 4.5. and 4.6.

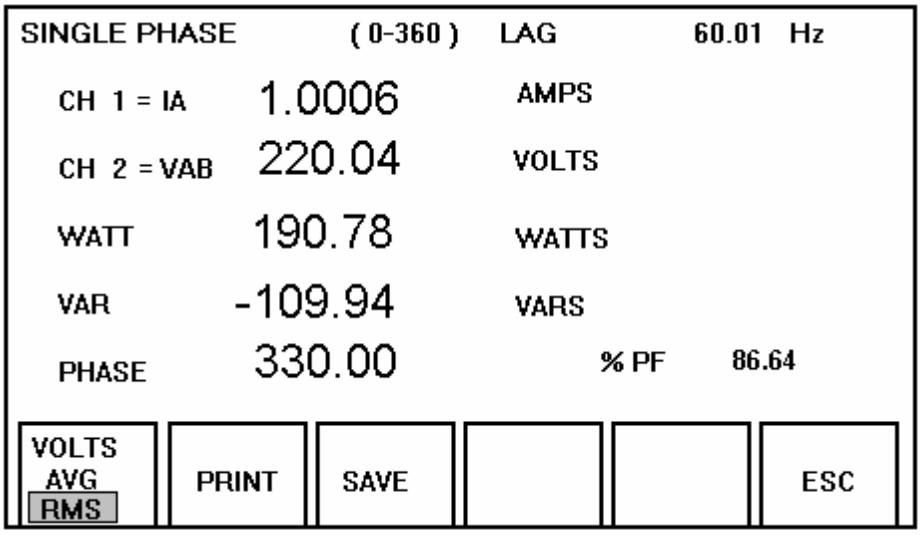
4.7.2 VERIFYING THE RATIOS OF CTS

1. For this application, connect the clamp-on CT directly to the phase A current channel terminals on the front panel. Connect the secondary of the CT under test to the phase B current channel terminals.

2. From the Main Menu, press the **SINGLE-PHASE** function key. The following should appear on the display.



3. From the single-phase screen, select **IA & VAB**, by pressing the corresponding function key. The measurement will be activated.



4. The instrument will default to automatic ranging. To change the measuring ranges proceed as follows:

   - Press **ESC** function key. The **SINGLE PHASE MODE** will be recalled.
   - Select **HIGH SPEED CAPTR** or go to **TIMER MODE** and follow the same procedures as previously described in the manual.

5. All measuring functions are as explained in sections 4.5.2.

4.8 HIGH-SPEED SINGLE-PHASE CAPTURE MODE

In the normal single-phase operating mode the instrument updates the readings twice every second. For applications requiring faster update rate, such as measuring currents and voltages of short duration, a high-speed capture mode is available. In this mode the update speed is 20 times every second. The high speed mode of operation works in conjunction with the START and STOP circuitry, allowing the user to capture up to a maximum 60 seconds of test results, in a controlled manner.

IMPORTANT Default ranges are 750 Volts and 100 Amps. This mode allows the user to select and set the voltage and current ranges before initalizing the measurement test. All ranges have a +20% of the selected range, if the amplitude exceeds the +20%, then it must be noted that the resultant values will be considerably off. It is highly recommended that the ranges selected be at least two ranges above the expected amplitude or simply just leave it in the defaulted ranges.

1. **CAPTURE MODES:** Two capture modes are available:

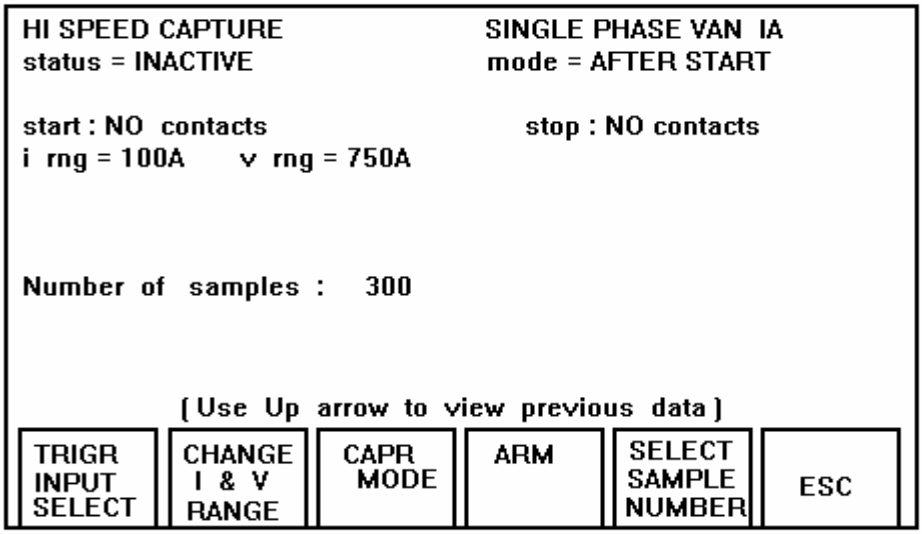
   - **AFTER-START:** in this mode a maximum of 60 seconds/1200 samples of data can be captured after the measurement is initiated. Use the START inputs to initiate the measurement. The measurement will automatically abort 60-seconds after it is started. Other measurement options are: 15 seconds/300 samples and 30 seconds/600 samples.
   - **NOTE:** Stop inputs can be used to terminate measurement.

   - B**EFORE-STOP**: in this mode a maximum of 60 seconds of data can be capture. Use the start inputs to initiate the measurement and the STOP inputs are used to terminate the test.

   4.8.1 THE MEASURING FUNCTIONS

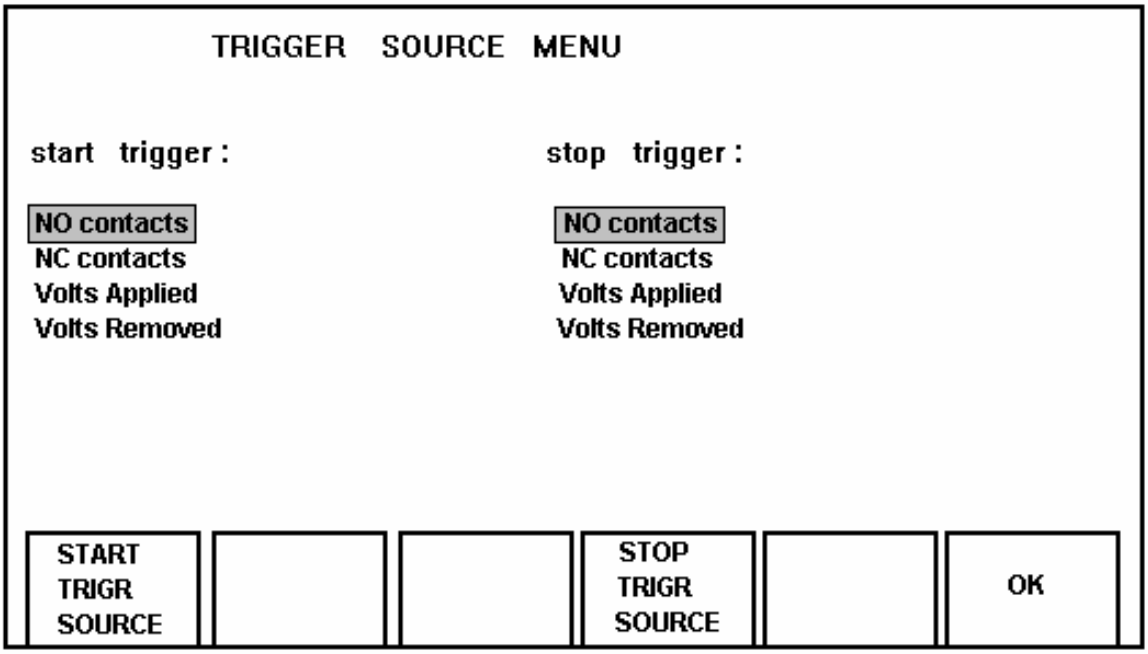
   1. From the Main Menu, press the **SINGLE-PHASE** function key.

   2. Select **HIGH SPEED CAPTR** from the Single Phase screen. The following will appear:



   Note that the information on top of the screen indicates the default conditions for this mode.

   3. To change the TRIGGER INPUT press the **TRIGR INPUT SELECT** function key. The following display will appear:

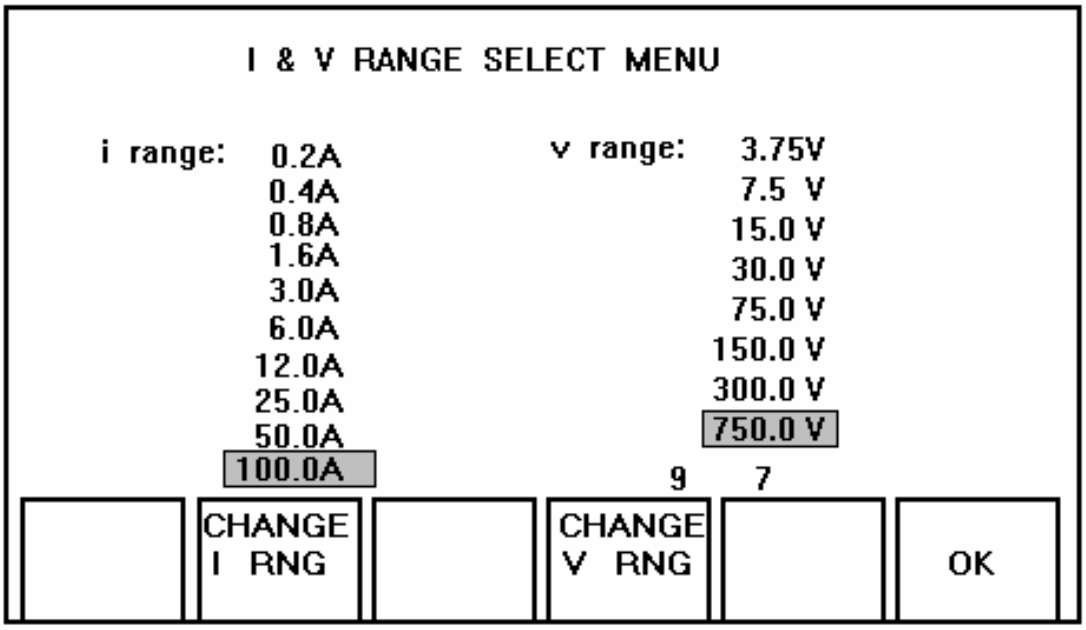


Press the **START** and **STOP TRIGR** function keys to highlight and select the configuration desired.

To enter the new configuration and return to the previous screen, press the OK function key.

4. Pressing the **CAPTR MODE** function key will change the capture mode from AFTER-START to BEFORE-STOP and vice versa, as previously explained. Note the capture mode is shown on the top right hand corner of the display.

5. Manual ranging is also available in this mode of operation. To set the desired voltage and current range prior to the measurement. Press the CHANGE I and V RANGE function key, and the following screen will appear.



- Select **CHANGE I & V RANGE**.
- Press **CHANGE I RNG** to set the current range desired.
- Press **CHANGE V RNG** to set the voltage range desired.

6. To enter the new configuration and return to the previous screen, press the OK function key.

7. Once **all** the connections to the instrument are made, press the **ARM** function key to arm the capture circuitry.
NOTE: Status will change from **INACTIVE** to **ARM**.

8. Use the **START** inputs to initiate the test. If a BEFORE STOP mode of operation is selected, a **STOP** signal is required to terminate the test. In a AFTER-START mode, the test is automatically terminated depending on selection: 15, 30 or 60 seconds after it is started (15 sec/300 samples, 30 sec/600 samples or 60 sec/1200 samples).

   The **START** or **STOP** inputs respond to a change of state. This change may be a dry contact opening or closure, initial application of an AC or DC voltage and . The input terminals are isolated from the chassis ground and are independent of signal polarity.

9. Once the measurement is completed and data has been captured, the data is automatically displayed. Use the **PAGE UP** or **PAGE DOWN** function keys to scroll through the pages of data. The total samples of readings and number of pages is dependent on selection; 15 sec/300 samples, 30 sec/600 samples or 60 sec/1200 samples.

10. In order to activate the transmission of the captured data to an external printer or PC, make the appropriate connection to the PRINTER and RS232 terminals. Refer to section 4.13. for more details.

    Press the **PRINT** function key to initiate the transmission. All pages of captured data will be transmitted.

11. To save the data press the **SAVE** function key.

    Pressing this key will TAG NUMBER the sub-screen. This number is tagged to the saved data, for future reference. All saved data are time and date stamped.

12. Press **ESC** to return to the previous screen.

4.9 TIMER/RELAY OPERATION

The POWER MULTIMETER is equipped with an internal timer, primarily intended for performing timing tests on protective relays and circuit breakers. The timer is equipped with a sensing circuitry that responds to a change of state. This change may be a contact opening or closing, or the initial application of an AC or DC voltage, or removal of an AC or DC voltage. The input terminals are isolated from the chassis ground and are independent of signal polarity.

NOTE: When using the Timer posts in parallel with another test set, it is very important that polarity be observed (red and black binding post). If the binding posts are cross connected the timer will not function correctly.

4.9.1 MODES OF OPERATION

There are two independent modes built into the TIMER/RELAY operation:

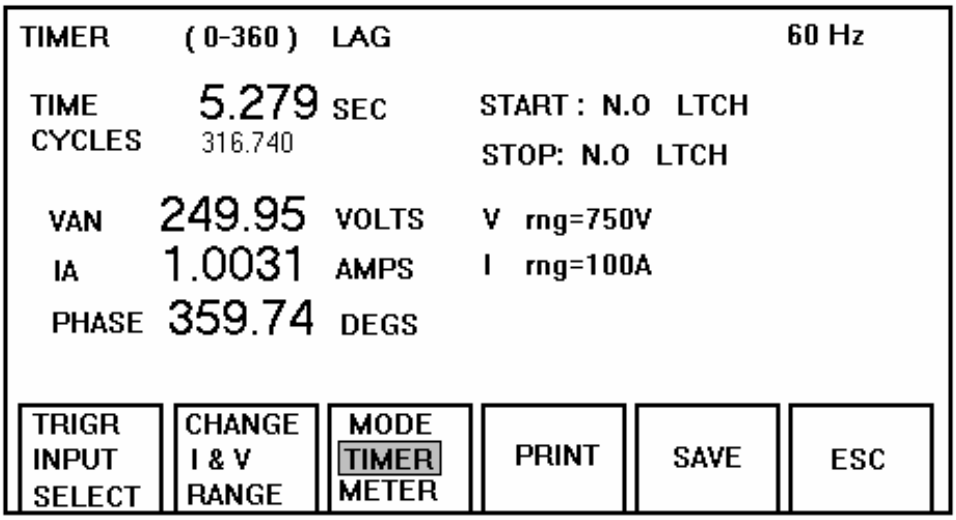
1. METER MODE: In this mode the timer is disabled, but the voltmeter and ammeter are operating continuously. This mode of operation, in conjunction with the **STOP** terminals, can be used to verify minimum pick-up on protective relays. Note that the **STOP** inputs act as a continuity detector in this mode.

2. TIMER MODE: In this mode the timer is armed and triggered using the **START** inputs. The ammeter and voltmeter are also running continuously. The timer can be stopped using the **STOP** terminals. The reading of the ammeter, voltmeter, seconds and phase angle freezes when the timer stops.

   This mode is useful for performing timing test on protective relays.

4.9.2 THE MEASURING FUNCTIONS

1. From the Main Menu, press the **TIMER** function key.



2. Select the mode of operation, as described in the previous section, using the appropriate function key. TIMER is the default mode.

3. The instrument defaults to **VAN** and **Ia**.

4. Manual ranging is also available for this mode of operation. To set the **TRIGGER INPUT**, **CURRENT** and **VOLTAGE RANGE** select each one individually and set the desired parameters as previously described in the manual.

5. In the METER MODE the timer is disabled, but the voltmeter and ammeter are operating continuously. The **STOP** inputs act as a continuity detector for testing minimum pick-up on protective relays. When a continuity is detected, a horn will sound. Use the SETUP PAGE2 screen to disable/enable the horn.

6. In the TIMER MODE the timer is armed and triggered using the **START** inputs. The ammeter and voltmeter are also running continuously. The timer can be stopped using the **STOP** terminals. The reading of the ammeter or voltmeter freezes when the timer stops.

   The **START** / **STOP** inputs are equipped with a sensing circuitry that responds to a change of state. This change may be a contact opening or closing, or the initial application/removal of an AC or DC

voltage. The input terminals are isolated from the chassis ground and are independent of signal polarity.

7. To reset the meter, press **RESET**.

8. Press the **SAVE** function key to save the content of the display. Pressing this key will TAG NUMBER the sub-screen. This information then will be saved in the **SAVED DATA DIRECTORY**.

9. From the Main Menu, press the **VIEW SAVED DATA** function key to view all stored data in the Saved Data Directory.

10. In the **SAVED DATA DIRECTORY**, use the **PAGE DOWN** or **PAGE UP** function keys to go through the data files. Press the **UP** or **DOWN** arrow keys to cursor to a desired file. Then press the View Item function key to view the selected file.

11. The **PRINT ITEM** or **XMIT ITEM** function keys can also be used to transmit the data to a printer or a PC. In order to activate the transmission of the data to an external printer or PC, make the appropriate connection to the PRINTER and RS232 terminals. Refer to section 4.13 for more details.

    Press the **PRINT ITEM** and/or **XMIT ITEM** function keys to initiate the transmission.

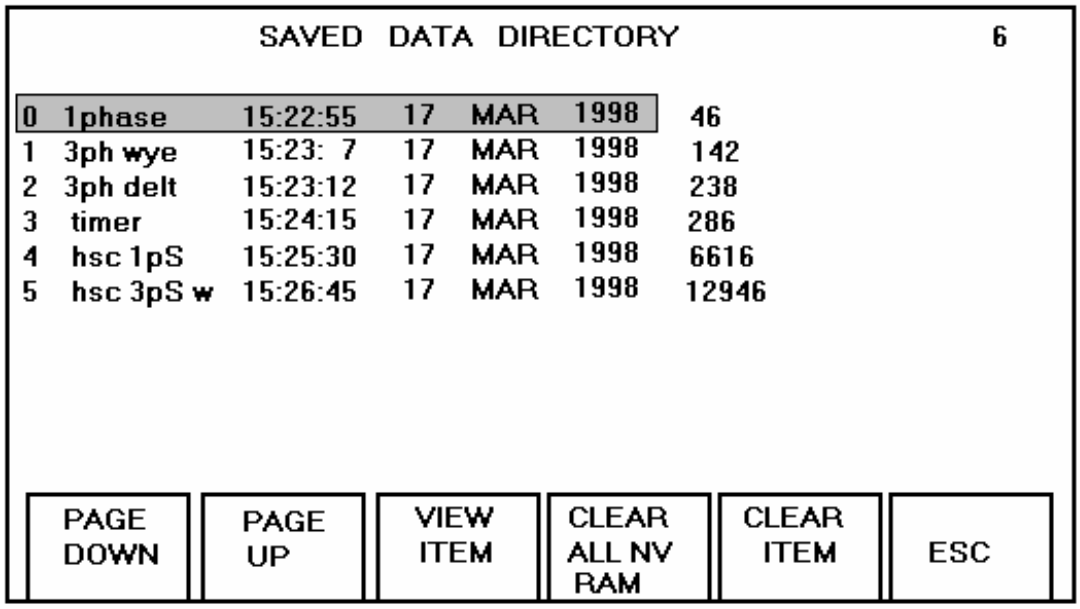
12. Press **ESC** to return to the previous screen.

4.10 VIEW SAVED DATA Directory

POWER MULTIMETER is equipped with a non-volatile internal memory (28,672 bytes) for saving the test data. The **VIEW SAVED DATA** features allows the user to retrieve the save data for download to an external device. The capacity of the internal memory and the type of measured data are as follows:

CONTENT		**CAPACITY**
Single Phase	(50 bytes)	573 sets
Three Phase Wye/Delta	(100 bytes)	286 sets
Timer	(52 bytes)	552 sets
Single Phase Max Hold	(26 bytes)	1102 sets
3-Phase Wye/Delta Max Hold	(40 bytes)	716 sets
HS CAPTURE		
HS Capture (15 sec/300)	(6330 bytes)	4 sets
HS Capture (30 sec/600)	(12630 bytes)	2 sets
HS Capture (60 sec/1200)	(25230 bytes)	1 set

1. From the Main Menu select **VIEW SAVED DATA**. The following screen will appear on the display:



A directory containing all saved data will be displayed.

2. To scroll through all files of the directory (if more than one) use the **DOWN** and **UP** arrow keys. To clear a single file in the directory, press the **CLEAR ITEM.**

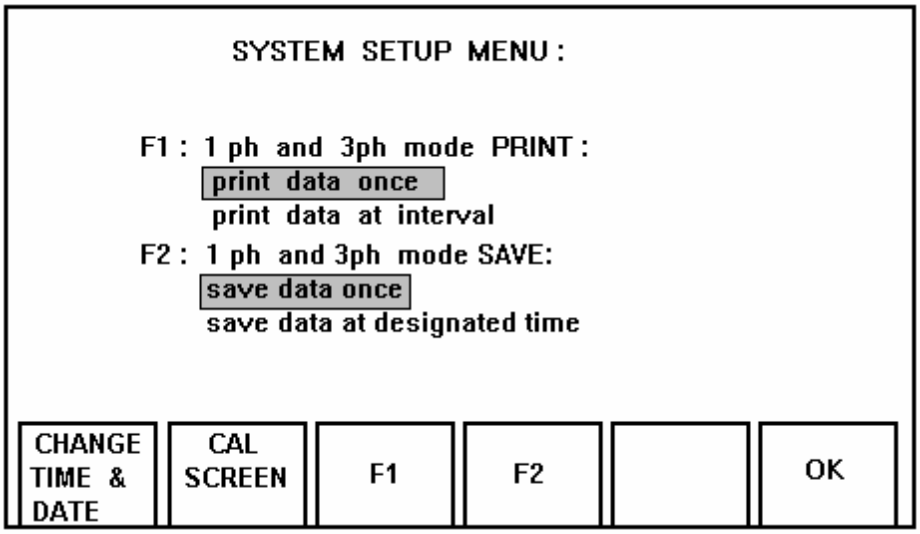
3. To view the content of the file highlighted press the **VIEW ITEM** function key.

   Each individual file can be printed or transmitted to an external device by selecting either the **PRINT ITEM** (printer) or **XMIT ITEM** (RS-232) function key.

4. To clear one or all saved files in the directory, press the appropriate **CLEAR** function key.

4.11. TIMED DATA TRANSMISSION

For normal single-phase or three-phase measurement the instrument can be configured so that the data is transmitted to an external PC or printer on a pre-programmed time interval. The interval is programmable from 1 to 60 minutes. For instance, if a 5 minute interval is selected, the operator can connect the PMM-1 to a printer, enable the print function and print the measured data every 5 minutes. The following example details the programming of this function:



To send data from the printer parallel port proceed as follows:

1. From the Main Menu screen select the **More** function key.

2. Then select the **SetUp Page1** function key to bring up the System SetUp Menu.

3. Use the **F1** function key to select either print data once or print data at interval.

4. If the print data once is selected, the user must press the Print function key once to initiate the data/measured readings out to a printer.

5. If the print data at interval is selected, the user must enter the minutes (1 to 60) at which the data is to be sent to the connected printer.

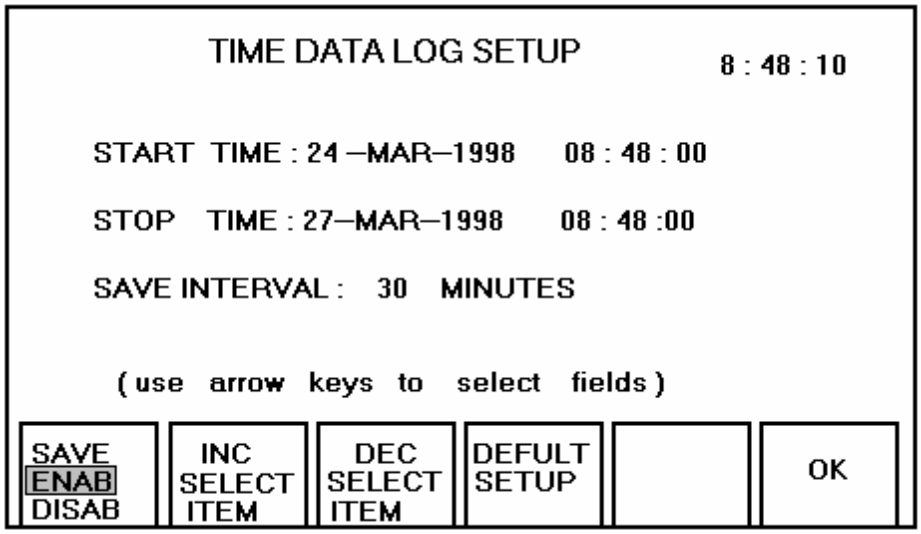
6. Return to the measuring screen desired and make the following changes.

7. Select the **Set Print Intrvl** function key, the Print Interval Select screen will be displayed. Use the up ⇑ and down ⇓ arrow keys to increase or decrease the time of interval transmission.

8. Next toggle the cursor from the Print Disable position to **Print Enable**.

9. After completion of the minutes setting, press the **OK** function key to initialize the changes.

10. The Power MultiMeter will begin to send the measured data to the external device at the set time of transmission.



To Save data directly to the **NOV** ram, at a set time interval proceed as follows:

1. It is highly recommended that the NOV ram be cleared of all data if possible, this is to allow maximum use of the unit's ram memory (28,672 BYTES). *Refer to page 30 of the instruction manual for number of bytes each test uses.*

2. From the Main Menu press the **More** key, then select the SetUp Page1 function key to bring up the System SetUp Menu. Press the **F2** function key once to toggle the selection to Save data at designated time. Press the OK key.

3. Select the measuring screen desired and make the following changes.

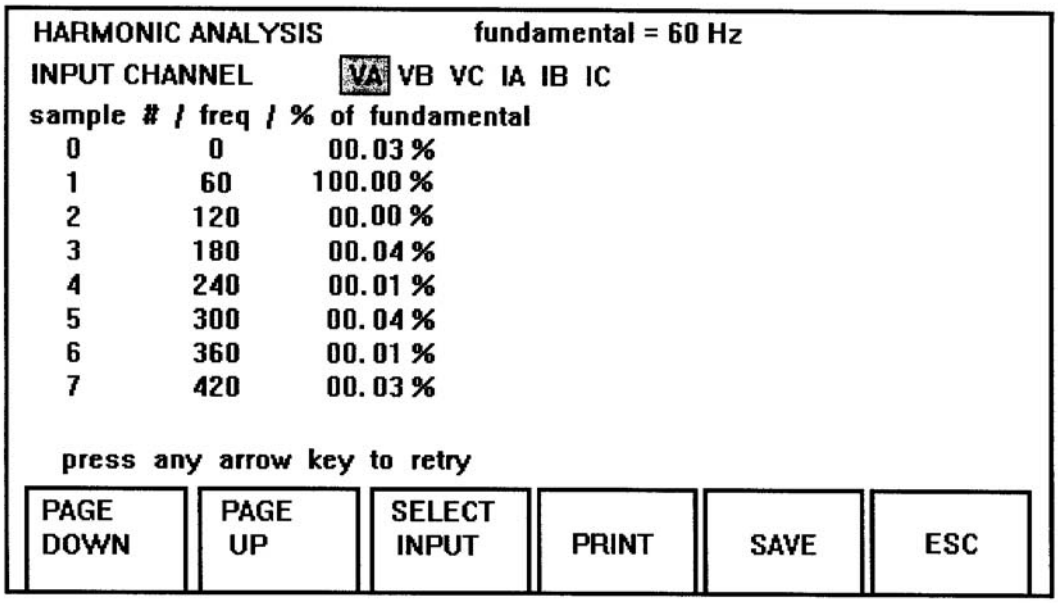
4. Press the Set Save Time function key. From the TIME DATA LOG SETUP screen use the arrow keys ⇑ ⇓ ⇐ ⇒ to move the cursor to the optional fields. Here the user can **Increase** or **Decrease** the Start/Stop time and the time interval between each reading.

5. Pressing the Default SetUp function key presets the Start Time to the current time and date, sets the Stop Time to terminate in 3 days and a Save time interval of 30 minutes between readings.

6. Once the settings have been completed, press the Save function key to toggle Disab to **Enab.** Press the OK function key to initialize the settings. The Power MultiMeter is now ready to begin saving the readings to the NOV ram memory.

7. To stop the recording to the NOV ram at any time, simply press the Esc or Menu key.

8. To view the saved data, return to the Main Menu and select the View Saved Data function key.



The figure above is the Harmonic Analysis screen, to call up the screen press the following function keys. From the Main Menu press the **More** key then select the **Harm** function key, the analysis screen will be displayed.

The Harmonic Screen measures the percentage (%) of fundamental for Va, Vb, Vc, IA, IB, IC. Each parameter can only be measured one at a time. The unit measures the harmonics up to the 49 th harmonic (2940 Hz). When making a harmonic measurement on a selection it is important that the user understand that the screen will not automatically measure and update the screen if a change in harmonics has occurred. The user **must** press any arrow key ⇑ ⇐ ⇓ ⇒ to measure or update the selected voltage or current.

The Harmonic Screen has numerous function keys that allows the user to select after making the harmonic measurement.

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- **Page Down**- this function key moves the data to the next page.
- **Page Up**- this function key returns the screen to the previous data page.
- **Select Input**- this function key allows the user to select the desired parameter for measurement.
- **Print**- this function key allows the user to send the measured data to a printer.
- **Save**- this function key saves each measurement to the Save Data Directory.
- **ESC**- recalls the previous screen.
- **Press any arrow key to retry**- press any arrow key ⇑ ⇐ ⇓ ⇒ to measure or update the selected voltage or current.

4.12. SETTING THE CLOCK AND DATE

The POWER MULTIMETER is equipped with an internal real-time clock and date, used to stamp the saved data. In order to change the clock and/or date settings proceed as follows:

1. From the Main Menu, press the **MORE** function key. Select **SETUP PAGE1** from the second menu.

2. Press the **CHANGE TIME** & **DATE** function key, the current date and time screen will be displayed. By pressing the **Date Select** function key the date field arrangement can be changed.

3. Use the left/right arrow keys to move to the appropriate field (i.e., year, day, hour, and minutes).

4. Use the up/down arrow keys to change the numbers, as required.

5. To save the new time and/or date press the **OK** or **MENU** keys.

4.13. PERIPHERAL OPERATION

4.13.1. PRINTER PORT

The printer port is located on the front panel of the instrument, and uses a 25-pin delta receptacle.

Printer SET-UP Procedures

To send data through the printer parallel port use the following steps:

1. From the Main Menu, press the **MORE** function key.
2. Select the SetUp Page1 function key to display the System SetUp Menu.
3. Use the **F1** function key to select either print data once or print data at interval.
4. If the print data once is selected, the user must press the Print function key from the measuring screen to initiate the data out to a printer.
5. If the print data at interval is selected, the user must enter the minutes at which the data is to be sent to the printer or RS-232 device.
6. Press **OK** to return to the Main Menu.
7. Select the measuring screen desired and proceed to make the following changes.
8. Press the **Set Print Intrvl** function key, from the Print Interval screen press the Print **ENAB/DISABLE** function key once to toggle to the ENAB positon.

9. Next, using the up ⇑ and down ⇓ arrow keys, increase or decrease the desired time of interval transmission (1 to 60 minutes).
10. After completion of the time interval setting, press the **OK** function key to initalize the changes.
11. The unit will begin to transmit the measured data to the external device at the set interval time.

Printer port connector pin-out is shown in TABLE 4-1.

TABLE 4-1. DOT MATRIX PRINTER PORT PIN-OUT

PIN NUMBER	DESIGNATION	SIGNAL DIRECTION
1	STROBE	OUTPUT
2	DATA BIT 0	OUTPUT
3	DATA BIT 1	OUTPUT
4	DATA BIT 2	OUTPUT
5	DATA BIT 3	OUTPUT
6	DATA BIT 4	OUTPUT
7	DATA BIT 5	OUTPUT
8	DATA BIT 6	OUTPUT
9	DATA BIT 7 (MSB)	OUTPUT
10	ACKNOWLEDGE	INPUT
11	BUSY	INPUT
19-25	SIGNAL GROUND	-----

Other pins are not used.

4.13.2. RS232 SERIAL DATA PORT

The serial port is located on the front panel of the instrument, and uses a 9-pin delta plug. The ASCII encoded characters are transmitted at the **19,200** baud rate, with **one start** bit, **8 data** bits, **1 stop** bit, and **no parity**.

The serial port can be directly interfaced to a terminal, a compatible serial data acquisition system or COM ports on any personal computer. Commonly used software programs such as Windows Terminal, Hyper Terminal or PROCOMM can be used to collect the data from the instrument.

The pin out of the 9-pin delta plug is shown in TABLE 4-2.. Please note the data transmission is unidirectional

TABLE 4-2. RS232 CONNECTOR PIN-OUT

PIN NUMBER	DESIGNATION	FUNCTION
2	TxD	Transmit Data
3	RxD	Receive Data
5	GND	Signal Ground
7	CTS	Clear To Send
8	RTS	Request To Send

Other pins are not used.

POWER MULTIMETER COMMAND SET

The Power MultiMeter incorporates an RS-232 Serial Communications Port for communications with a personal computer. This feature may be used to transport data from the measuring instrument to the computer for data analysis and report generation.

Computer Connection

A nine pin RS-232 cable is required to connect the instrument to a communications port on the personal computer. The connectors on the cable must be male type for the instrument and normally female type to connect to the computer (**Note:** The required cable is not null-modem).

Communications Port Settings

Communications through the RS-232 port require the following settings in the communications software being used on the personal computer:

- Bits per second **19200**
- Data bits **8**
- Parity **None**
- Stop bits **1**
- Flow Control **None**

To set up Hyper Terminal to communicate with the PMM-1 do the following:

- Locate Hyper Terminal and open the file.
- Open any **ht** file, A T & T mail ht, MCI mail ht, etc.
- Click on File, select **new connection**, message to disconnect will appear. Click on **Yes**.
- The Connection description box will appear, enter a new connection name.
- Click OK, the phone number dialog box will appear.
- Click on the **Connect using** option, select **Direct to Com 1** or appropriate communication port.
- Click OK, the Com 1 properties dialog box will appear.
- Make the following changes; change bits per second to **19,200** and Flow Control to **None**.
- Click OK, then select File and Properties to display the “XXX” Properties setting screen.
- Click Settings; select Window Keys and Set Emulation to **ANSI**.

- Click the ASCII Setup, select **Send** and **Echo**. Click OK to complete the setting changes

- Hyper terminal should now be ready to communicate to the PMM-1.

- Type in: **m1;** to change the PMM-1 screen from the main menu to the single-phase screen.
- **Note**: commands to the PMM-1 may require double entry before being accepted.

- If the single-phase command is successful, type **mpu;** to return to the main menu screen. If both commands are accepted, the communication to the PMM-1 has been successfully completed.

Power MultiMeter Commands

The following are commands available to control and retrieve data.

IMPORTANT: **ALL** COMMANDS MUST END WITH A SEMI-COLON **;**

Mode commands

Puts Power MultiMeter in a specified operating mode. All commands begin with "m" . All Mode commands respond with an "AOK!" string for a successful mode change and a "what?" string if command was invalid.

Measurement Type	**COMMAND**
Single Phase measure:	**m1;**
Three Phase Wye measure:	**m3y;**
Three Phase Delta measure:	**m3d;**
Power up Menu:	**mpu;**
Timer Mode:	**mtim;**
Hi Speed Capture single phase:	**mhsc1;**
Hi Speed Capture 3 phase wye:	**mhsc3y;**
Hi Speed Capture 3 phase delta:	**mhsc3d;**
Single Phase Max Hold:	**m1max;**
3 Phase Wye Max Hold:	**m3ymax;**
3 Phase Delta Max Hold	**m3dmax;**

Single Phase measure with automatic interval query reading feature: **m1i,K;**
K = interval in minutes. (**Note:** when any other command is executed in this mode the interval query operation is canceled.) m = mode, 1 = single, i = interval, K = minutes

3 Phase Wye measure with automatic interval query reading feature: **m3yi,K;**
K = interval in minutes. (**Note:** when any other command is executed in this mode the interval query operation is canceled.)

3 Phase Delta measure with automatic interval query reading feature: **m3di,K;**
K = interval in minutes. (**Note:** when any other command is executed in this mode the interval query operation is canceled.)

Setup commands

Single Phase custom input selection read: **slpcustomr;**
sends channel 1 and 2 input source selections (chan1=0, chan2=6) in 0-8 integer format.
0=Van, 1=Vbn, 2=Vcn, 3=Vab, 4=Vbc, 5=Vca, 6=Ia, 7=Ib, 8=Ic.
See Single Phase, pg 15.

Single Phase custom input selection write: **slpcustomw,m,n;**
Write channel 1 and channel 2 input source selections (same format as read) m=channel 1, n=channel 2. Note: Once input source settings are changed the change is not recognized until single phase mode is re-entered (i.e. 'ml' command is re-issued).

Three Phase mode phase angle reference source selection read: **s3pphrefr;**
sends (phref = 0) in 0-5 integer format. 0=Va, 1=Vb, 2=Vc, 3=Ia, 4=Ib, 5=Ic
See Three Phase, pg 20.

Three Phase mode phase angle reference source selection write: **s3pphrefw,1;**
writes in same format as s3pphrefr.
Note: once phase angle reference source setting is changed the change is not recognized until 3 phase mode is re-entered (i.e. 'm3y' or 'm3d' command is re-issued).

Hi-Speed capture mode:
sends status i.e., after start or before stop mode setting **shscbar;**
changes status, **K**=0 for after start, **K**=1 for before stop **shscbaw,K;**
See High Speed Capture, pg 25.

Sends voltage and current range in any mode: **sranger;**
format "vrng=K, irng=L".
K=voltage range (0-7):
0 =3.75, 1 =7.5, 2= 15.0, 3=30.0, 4= 75.0, 5= 150.0, 6=300.0, 7=750.0
L=current range (0-9):
0 =0.2, 1 =0.4, 2 =0.8, 3 =1.6, 4 =3.0, 5 =6.0, 6 =12.0, 7 =25.0, 8 =50.0, 9 =100.0
See High Speed Capture, pg 25.

Change voltage and current range: **srangew,K,L;**
Applies to timer and hi-speed capture mode ONLY. All other measurement modes are autoranging) Once these ranges are selected they are applied only on entry to timer mode.

Sends start and stop trigger sources for timer and hi-speed capture modes **striggerr;**
will work in any mode yet applies only to timer and hi-speed capture modes.

Change Start and Stop trigger sources for timer and hi-speed capture modes: **striggerw,K,L;**
works in any mode yet applies only to timer and hi-speed capture modes.
K=start setting, **L**=stop setting:

0 for normally open contacts, latch off*	100 for normally open contacts, latch on*
1 for normally closed contacts, latch off*	101 for normally closed contacts, latch on*
2 for voltage applied, latch off*	102 for voltage applied, latch on*
3 for voltage removed, latch off*	103 for voltage removed, latch on*

(* latch applies to timer mode only, for hi-speed capture a value of 100 is the same as 0).

Sends external CT ratio setting: **sextctr;**
format: " ratio =1 or =200 or =600 or =1000 or =3000"
Change (write) external CT ratio setting: **sextctw,K;**
K=1 or =200 or =600 or =1000 or =3000
Note: You must re-issue the 'm1, m3d, or m3y' for the change to be recognized.

Sends rms/average voltage setting: **srmsavgr;**
This setting affects voltage readings in single and three phase (wye and delta) measure modes only

Changes rms/average voltage setting: **srmsavgw,K;**
K= 0 for rms, K=1 for avg.

Hi-Speed Capture Specific: arm hi-speed capture function: **hscarm;**

Timer Specific: Timer reset: **treset;**

Query Command

Transmits **all** measurement data on display in a comma delimited string. Each string is terminated with a carriage return line feed.

Query readings: **qr;**
The query response string format depends on current operating mode. If current operating mode does not support a query "not in this mode you don't" string will be returned.

Modes supported:		1 phase, 3 phase (wye or delta), timer, and hi speed capture.)
response formats:	1phase:	chan1, chan2,watts, vars, phase (chan1 to chan2), freq

3phase: A_volts,B_volts,C_volts,A_amps,B_amps,C_amps
A_watts,B_watts,C_watts,A_vars,B_vars,C_vars
ph_Va_ref,ph_Vb_ref,ph_Vc_ref
ph_Ia_ref,ph_Ib_ref,ph_Ic_ref
A_pwrfact,B_pwrfact,C_pwrfact,freq

timer: status,time_count,A_volts,A_amps,freq
hi speed capture: (all modes) one line per sample
sample#,phase i.d.(A,B,C or S), chan1, chan2,phase (chan1 to chan2),watts,vars

query time: sends time **qt;**

query date: sends date **qd;**

Calibration

Correction Factors: correction factor read: **cfr,m;**
read one correction factor specified by m (0 <= m <=53)
cfrm=1 is returned where 1 is the integer value of the correction factor, or if m is out of the valid range 'invalid parameter' message is sent.
correction factor write: **cfw,m,n;**
write to one specified correction factor specified by m (as with cfr) 'n' is the 'AOK**!** is returned if change is accepted or 'invalid parameter' is returned if either m or n is out of range or string is not complete or improperly delimited.

send table showing all correction factors: **cfa;**
write bogus test correction factors: **cfb;**
update fudge float array: **cfu;**
Correction Factor x Power MultiMeter Indication = 100 % accuracy
Instrument Correction Factor = 1 + (Correction Factor / 1,000,000)
Correction Factor = (Instrument Correction Factor -1) * 1,000,000

Voltage Correction Factors:

Ranges	3.75V	7.5V	15.0V	30.0V	75.0V	150.0V	300.0V	750.0V
A phase:	cf0	cf1	cf2	cf3	cf4	cf5	cf6	cf7
B phase:	cf8	cf9	cf10	cf11	cf12	cf13	cf14	cf15
C phase:	cf16	cf17	cf18	cf19	cf20	cf21	cf22	cf23

Current Correction Factors:

Ranges	0.2A	0.4A	0.8A	1.6A	3.0A	6.0A	12.0A	25.0A	50.0A	100.0A
A phase:	cf24	cf25	cf26	cf27	cf28	cf29	cf30	cf31	cf32	cf33
B phase:	cf34	cf35	cf36	cf37	cf38	cf39	cf40	cf41	cf42	cf43
C phase:	cf44	cf45	cf46	cf47	cf48	cf49	cf50	cf51	cf52	cf53

POWER MULTIMETER
Calibration Procedures

To check or re-calibrate any range in the Power MultiMeter simply do the following:

1. Inject a source (voltage or current) into the phase or phases in question.

2. Record both readings from the Standard / Reference source and the Power Multimeter.

3. Use the % error formula to determine how much error the range in question is out of tolerance.

   Standard / Reference reading minus 1 X 100 = % error
   Power Multimeter reading

4. 3.00000 minus 1 X 100 = 0.0630 % error
   2.99811

5. When a range falls out of tolerance or needs to be re-calibrated, use Windows Terminal, Hyper Terminal or Procom to communicate to the Power Multimeter. *See communications port settings pg. 39 of the instruction manual.*

6. Once communications is established, use the Power Multimeter commands, *see pages 39-42 of the instruction manual* . Type in **sranger;** to inquire the present range of the voltage and current. Enter the command (**cfa;**) to retrieve all of the correction factors. Select the range in question and enter the command (**cfr,m;**) to retrieve the correction factors for the range in question. As an example, to retrieve A-Phase voltage in the 3.75 range the following commands would be used. **cfr,0;** this would bring back cfr 0 = xxxx

7. The xxxx's represent the correction number being used for that range. To enter a new correction factor in the selected range (cf0.....etc.), the old number must be zeroed out by sending the write command (cfw,m,n) to the range. **cfw,0,0;** this command writes over the existing correction factor, then type **cfu;** .

8. To verify the change re-send the read command, **cfr,0;** this should return cfr, 0 = 0 . Inject the source and record the readings of the Standard unit and the Power MultiMeter once more. Use the correction formula to calculate the new correction factor for the range in question.

9. Example:
Correction factor = [(Standard reading / Measured (PMM1) reading - 1] x 1,000,000

3.00000 / 2.99811 - 1 x 1,000,000 = 630.397, the new correction factor to be entered is a positive 630. Enter **cfw, 0, 630;** then update by typing **cfu;** . Inject the same source and verify that the correction factor has brought the range in question back into tolerance. Using the % error formula calculate the % error of the readings.

Keypad

lock keypad: **keylock;**
unlock keypad: **keyunlock;**
keypad test mode: **keytest;**
restore normal key operation after test mode: **keynormal;**
Note: A screen command (i.e. mpu, m1, m3y…) must be issued to restore normal key operation.

General

V25 and DSP firmware revision level query: **grev;**
returns revs in format: V25rev=K.k, DSPrev=L.1.

EXAMPLES

SINGLE PHASE:

Single Phase screen: **m1;**
query the readings: **qr;**

Single Phase custom input selection read; **s1pcustomr;**
sends channel 1 and 2 input source selections in 0-8 integer format.
(chan1=0 chan2=6)
0=Van, 1=Vbn, 2=Vcn, 3=Vab, 4=Vbc, 5=Vca, 6=Ia, 7=Ib, 8=Ic.

Single Phase custom input selection write: **s1pcustomw,m,n;**
Write channel 1 and channel 2 input source selections (same format as read)
m=channel 1, n=channel 2. **Note**: Once input source settings are changed the change is not recognized until single phase mode is re-entered (i.e. 'm1' command is re-issued).

Changes rms/average voltage setting: **srmsavgw,K;**
K= 0 for rms, K=1 for avg.

Lock keypad: **keylock;**

Single Phase screen and with automatic interval reading query: **m1i,K;**
(K = interval in minutes, 1 minute minimum, 60 minutes maximum).
(**Note**: when any other command is executed in this mode the interval query operation is canceled.)

THREE PHASE WYE:

Three Phase Wye screen: **m3y;**
query the readings: **qr;**

Three Phase mode phase angle reference source selection read: **s3pphrefr;**
sends (phref = 0) in 0-5 integer format. 0=Va, 1=Vb, 2=Vc, 3=Ia, 4=Ib, 5=Ic

Three Phase mode phase angle reference source selection write: **s3pphrefw,1;**
Note: once phase angle reference source setting is changed the change is not recognized until 3 phase mode is re-entered (i.e. 'm3y' or 'm3d' command is re-issued).

Changes rms/average voltage setting: **srmsavgw,K;**
K= 0 for rms, K=1 for avg.

Lock keypad: **keylock;**

Three Phase Wye screen and with automatic interval reading query: **m3yi,K;**
(K = interval in minutes, 1 minute minimum to 60 minutes maximum).
(**Note**: when any other command is executed in this mode the interval query operation is canceled.)

Unlock keypad: **keyunlock;**

THREE PHASE DELTA:

Three Phase Delta screen: **m3d;**
query the readings: **qr;**

Three Phase mode phase angle reference source selection write: **s3pphrefw,1;**
Note: once phase angle reference source setting is changed the change is not recognized until 3 phase mode is re-entered (i.e. 'm3y' or 'm3d' command is re-issued).

Changes rms/average voltage setting: **srmsavgw,K;**
K= 0 for rms, K=1 for avg.

Lock keypad: **keylock;**

Three Phase Delta screen and with automatic interval reading query: **m3di,K;**
(K = interval in minutes, 1 minute minimum to 60 minutes maximum).
(**Note**: when any other command is executed in this mode the interval query operation is canceled.)

PMM-1 QUICK TIPS

- If the PMM-1 has been in transient for more than a week, it is very important that the unit be given a **full** charge before being used in the battery operation mode.

- To adjust the screen contrast, press the **More** function key and use the Less or More contrast function keys to set the screen contrast.

- The PMM-1 is shipped with default settings: Timer Horn**-Disabled**, Measuring mode**-60 Hz**, and Phase Angles **0-360°** lag. To makes changes to these settings, press the More function key, then select **Setup Page2**. Complete the desired changes then press the OK or Menu key to initialize the changes.

- Make the proper connections to the voltage and /or current channel inputs. ***Connections should be established to the potential and current terminals of the PMM-1 before the measuring circuit is energized*****!!!!!!!!!!**

- When measuring DC volts, the instrument must be in **RMS** measurement mode **only** and positive polarity connected to VA, VB, or VC !!!

- PMM-1 defaults to VAN as the phase reference. If current **only** is measured, the phase reference must be changed to IA, IB or IC.

- To select a CT clamp-on ratio or the customized setup proceed as follows. From the Main Menu, press the More key, then select **SetUp Page2** key. Use the **up** ⇑ and ⇓ **down** arrow keys to move the cursor to any of the preset ratios or customized selection. After changes are completed, press the OK key to initialize the changes.

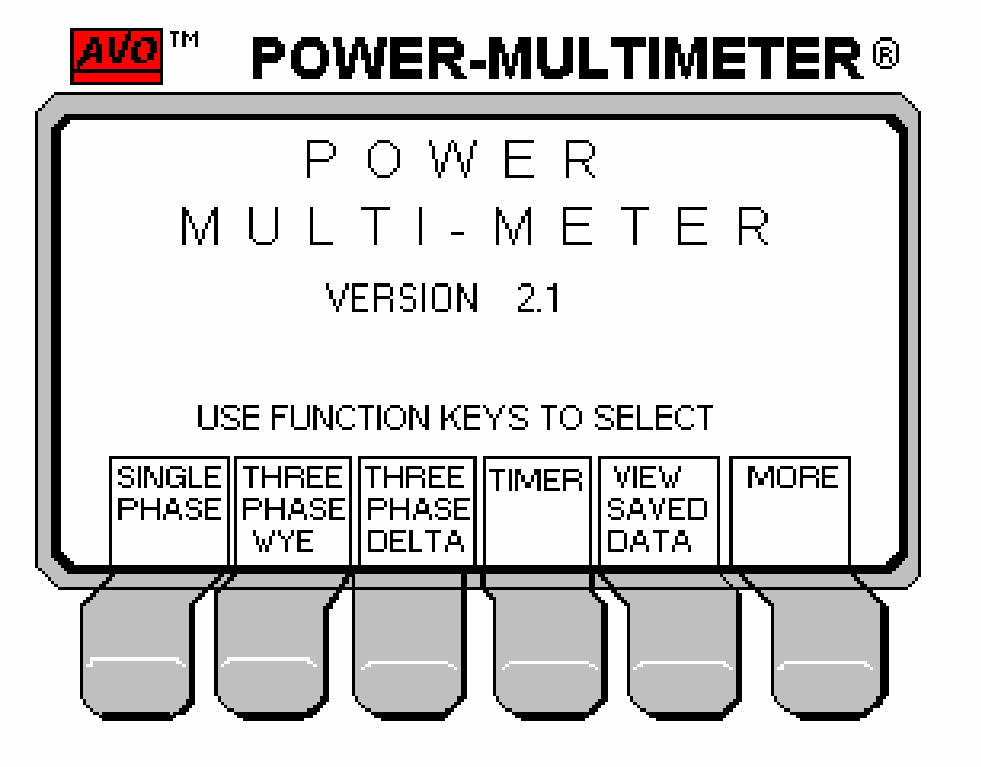
- High-speed capture samples data at a rate of 20 readings per second and can be used with single or three phase measurements. The PMM-1 has three sample selections: **15** sec / 300 samples, **30** sec / 600 samples and **60** sec / 1200 samples.

- Timer operation: When using the timer posts in parallel with another test set, it is very important that polarity be observed (red and black binding post). If the binding posts are cross-connected the timer will **not** function correctly.

- To set the PMM-1 for **Timed Data Logging** proceed as follows: From the Main Menu press the More key, select Setup Page1, press the **F2** function key to toggle the selection to **Save Data at designated time**. Press the OK key. From the Main Menu select a measurement mode then press the Set Save Time key. Using the ⇐ **left** and **right** ⇒ arrow keys cursor to the optional fields, press the **Inc select** or **Dec select item** function keys to increase or decrease each field. After making the changes press the **Save** function key once to toggle Disab to **Enab** then press the **OK** function key to initialize the changes.

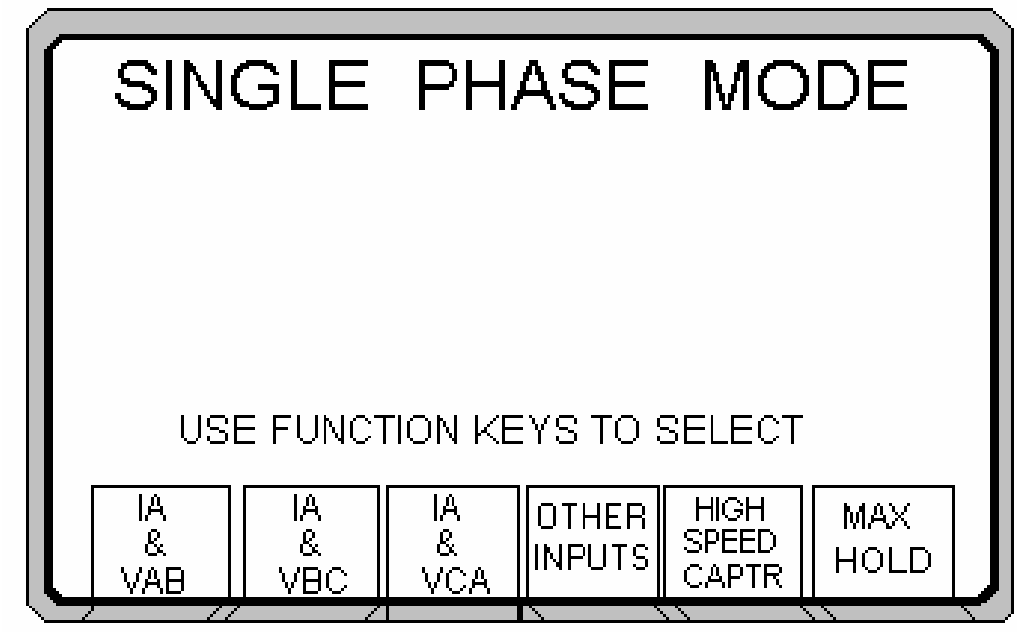
- To communicate through the RS-232 port using windows terminal, hyper terminal or ProComm the following settings are required: bits per second-**19,200**, data bits-**8**, parity-**none**, stop bits-**1**, and flow control-**none**.

EXAMPLES

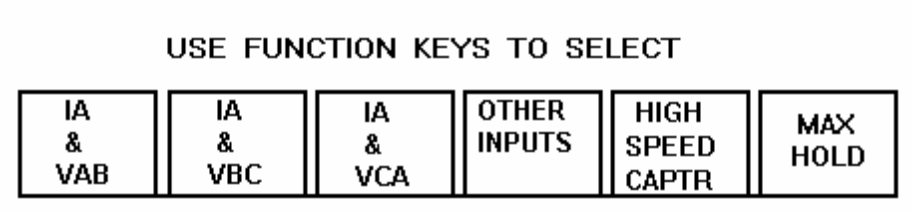


To make a Single Phase, IA and VAB measurement press the following function keys.

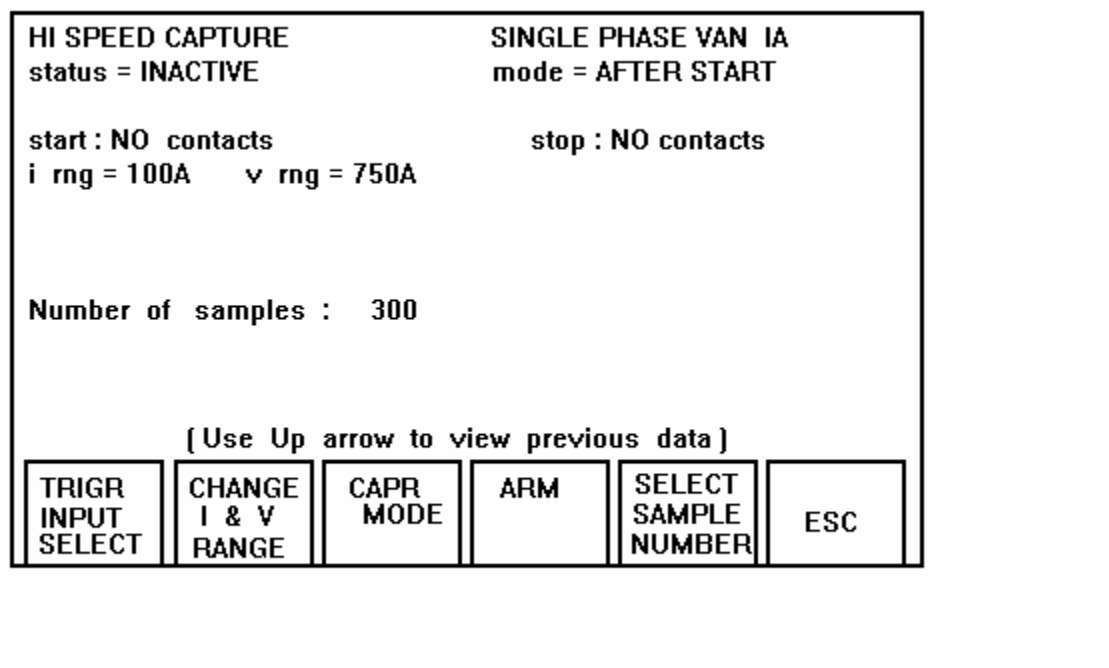
Single Phase and IA and VAB, the following screen will be displayed.



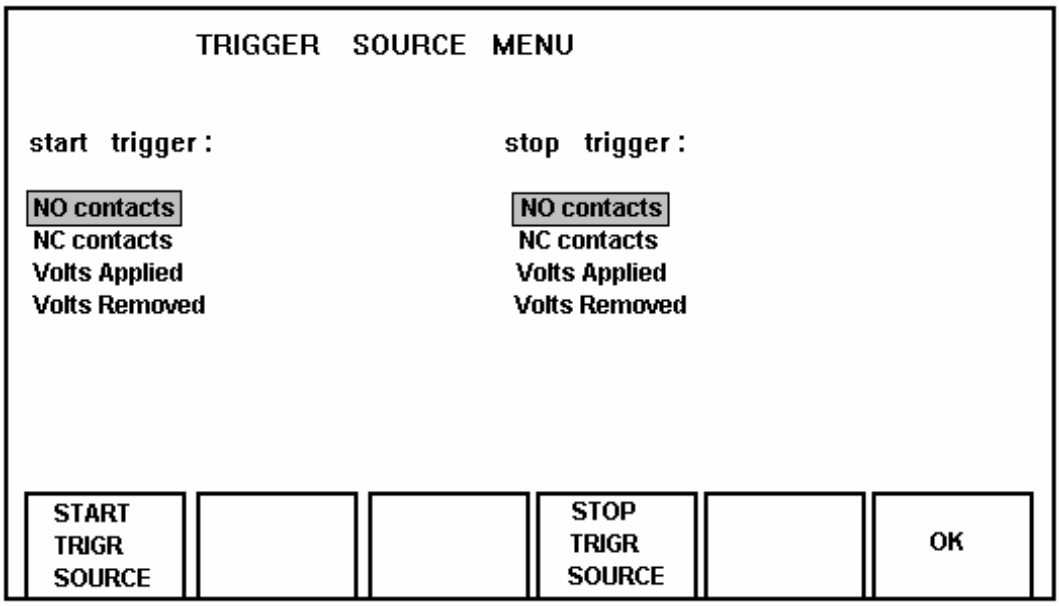
To select another Single Phase configuration press ESC to return to the Single Phase Menu. In this screen the user can use the Custom Inputs to set up the desired measurements. The Single Phase Menu also gives you the option of doing a High Speed Capture measurement on the selected inputs.



After selecting High Speed Capture the following screen will appear.

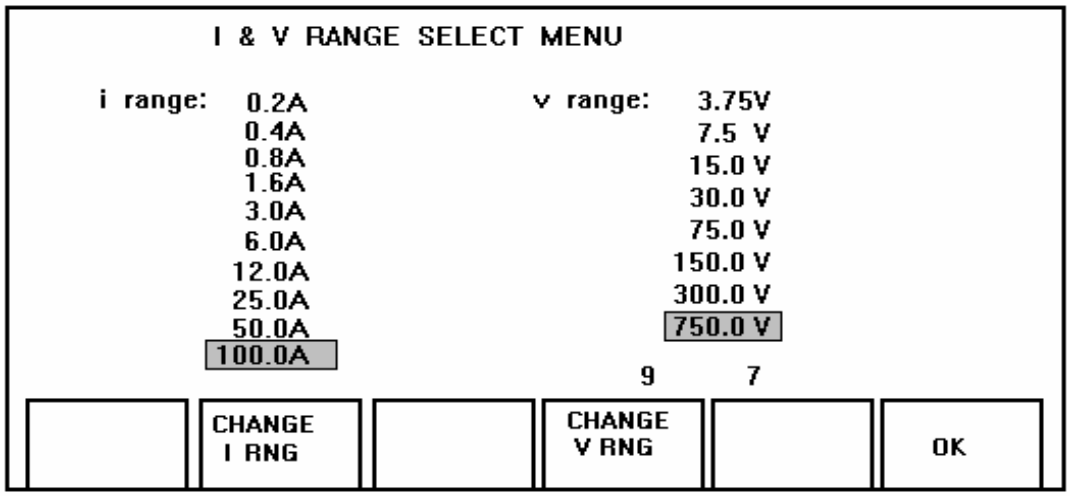


The High Speed Capture screen has several options the user can set before making the measurement. It allows the user to change the Trigger Input to the start and stop Timer binding posts.



The **Trigger Source Menu** allows the user the flexibility to set up the Start and Stop trigger to the desired configuration, that being NO contacts, NC contacts, Voltage Applied or Voltage Removed. After making the desired selections press the OK function key to initialize the new configuration and return to the High Speed Capture screen.

The Power MultiMeter is an auto ranging unit but if the user prefers to set up the Current and Voltage to the expected measurement range just simply press the **Change I & V Range** function key and the following screen will appear.



IMPORTANT Default ranges are 750 Volts and 100 Amps. This mode allows the user to select and set the voltage and current ranges before initalizing the measurement test. All ranges have a +20% of the selected range, if the amplitude exceeds the +20%,

then it must be noted that the resultant values will be considerably off. It is highly recommended that the ranges selected be at least two ranges above the expected amplitude or simply just leave it in the defaulted ranges.

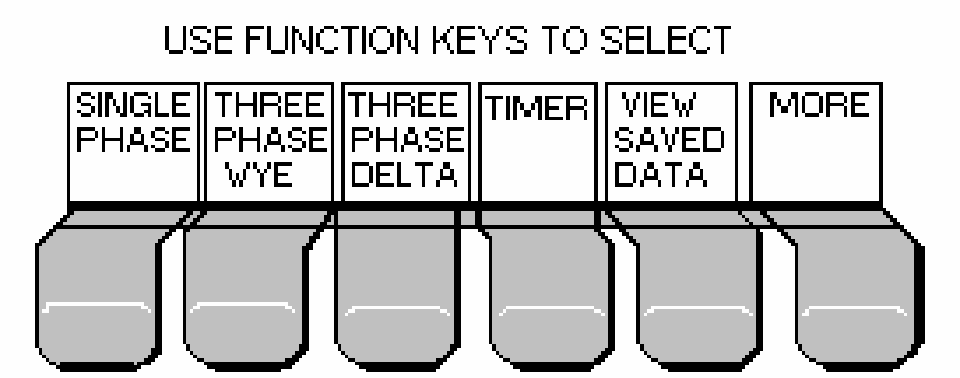
In this screen press the **Change I RNG or V RNG** function keys to move through the different ranges. Upon making the desired changes press the OK function key to initialize the new ranges and return to the High Speed Capture screen.

Upon setting the Trigger Input and I and V ranges, the user can then select the Capture Mode. There are only two options that being After Start and Before Stop.

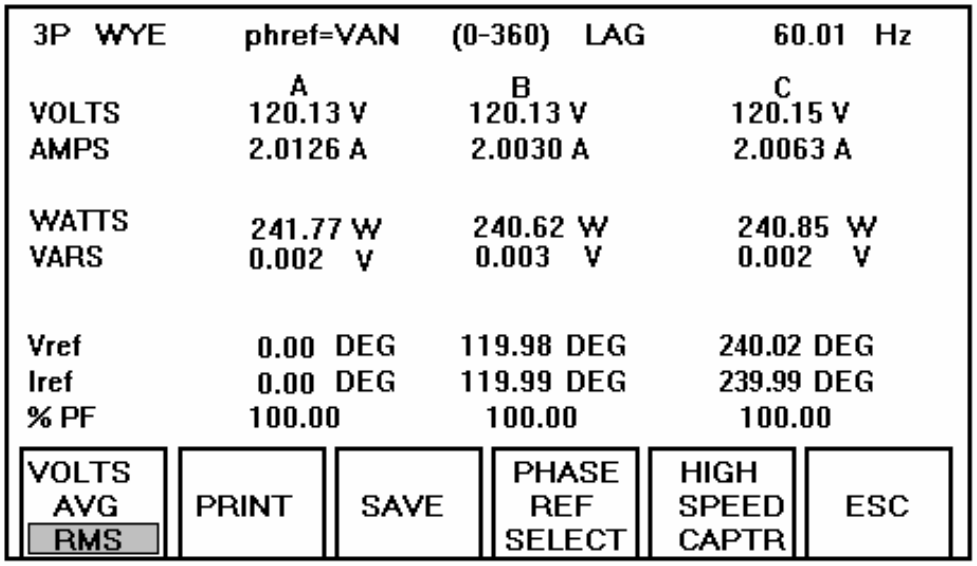
After Start: In this mode a maximum of 60 seconds of data can be captured after the measurement is initiated. Use the START inputs to initiate the measurement. The measurement will automatically abort (dependent on selection; 15, 30 or 60 SEC) after it is started.

Before Stop: In this mode a maximum of 60 seconds of data can be captured. The start inputs are used to initiate the test and the STOP inputs are used to terminate the test.

Once a High Speed Capture measurement is completed the data can be saved into the Saved Data Directory by just pressing the **Save** function key. This option allows the user to be able to save multiple measurements and later be extracted through the use of the RS-232 or Printer port.



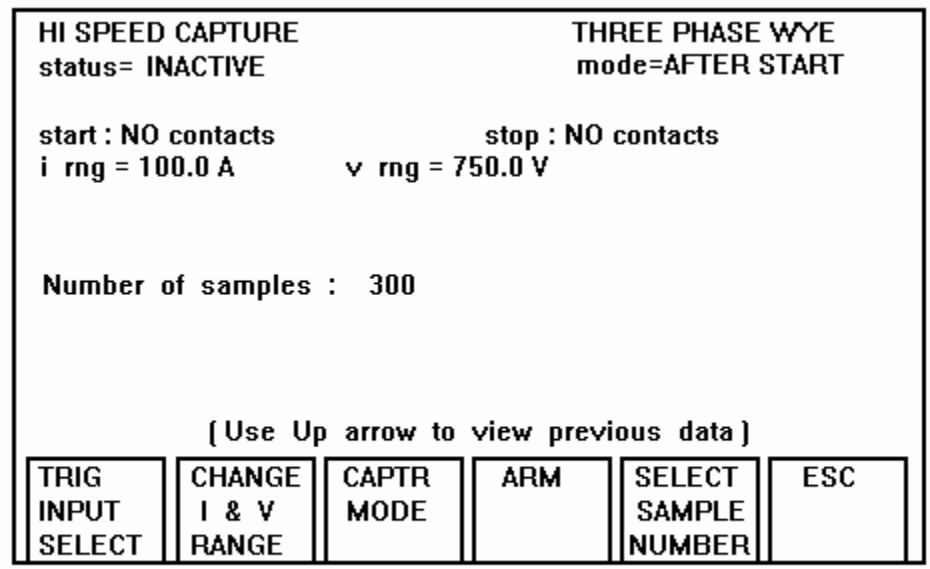
To conduct a Three Phase Wye measurement simply press the **Three Phase Wye** function key and the following screen will be displayed.



The **Three Phase Wye** screen has numerous function keys that allows the user to select for each particular measurement.

- **Volts**-selection of RMS or AVG mode measurement.
- **Print** -send measured data to a Parallel Printer.
- **Save** -save each measurement to the Saved Data Directory.
- **Phase Ref Select**-change reference point to; VAN, VBN, VCN, IA, IB, or IC.
- **High Speed Capture**-conduct a high speed test for each measurement.
- **ESC** - recalls the previous screen.

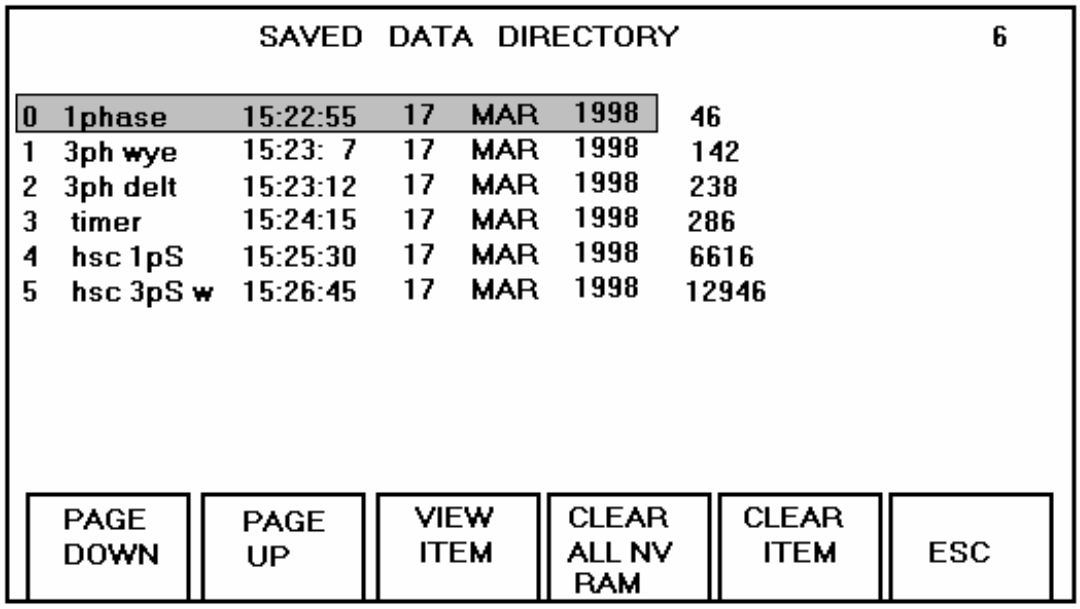
If a High Speed measurement is desired while in the Three Phase Wye or Three Phase Delta just simply press the **High Speed Capture** function key and the following screen will be displayed.



The **High Speed Capture** screen has numerous function key options that allows the user to make before conducting the high speed measurement.

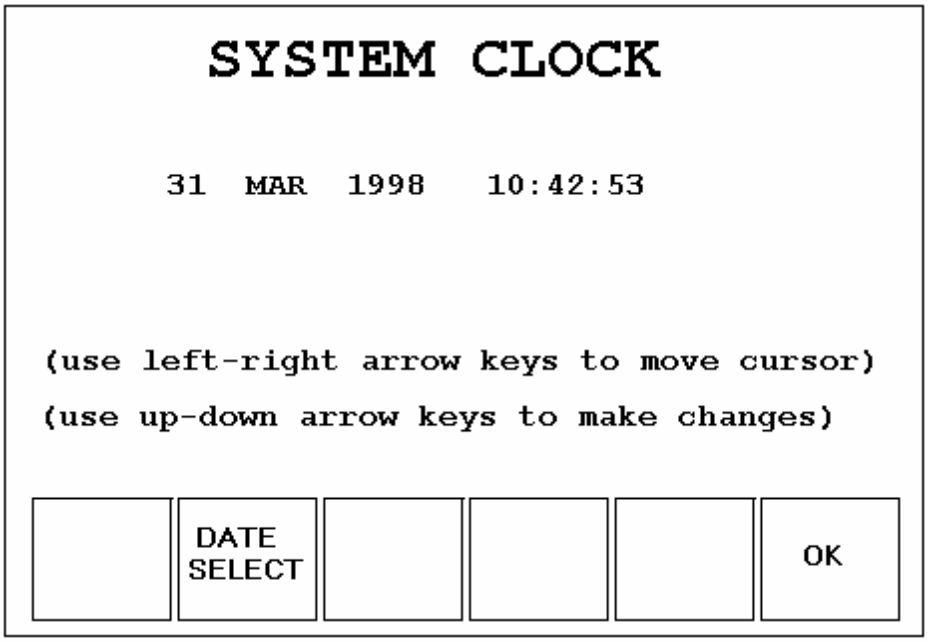
- **Trigger Input Select**-make changes to the Timer start and stop binding posts; NO or NC contacts, Voltage Applied and Voltage Removed.
- **Change I & V Range**- change the current and voltage range desired for each particular measurement.
- **Capture Mode**-After Start or Before Stop.
- **Arm**-arms the Power MultiMeter for immediate measurement.
- **Select Sample Number**-allows selection of; 15 sec/300 samples, 30 sec/600 samples, 60 sec/1200 samples.
- **ESC** - selection of this function key recalls the previous screen.

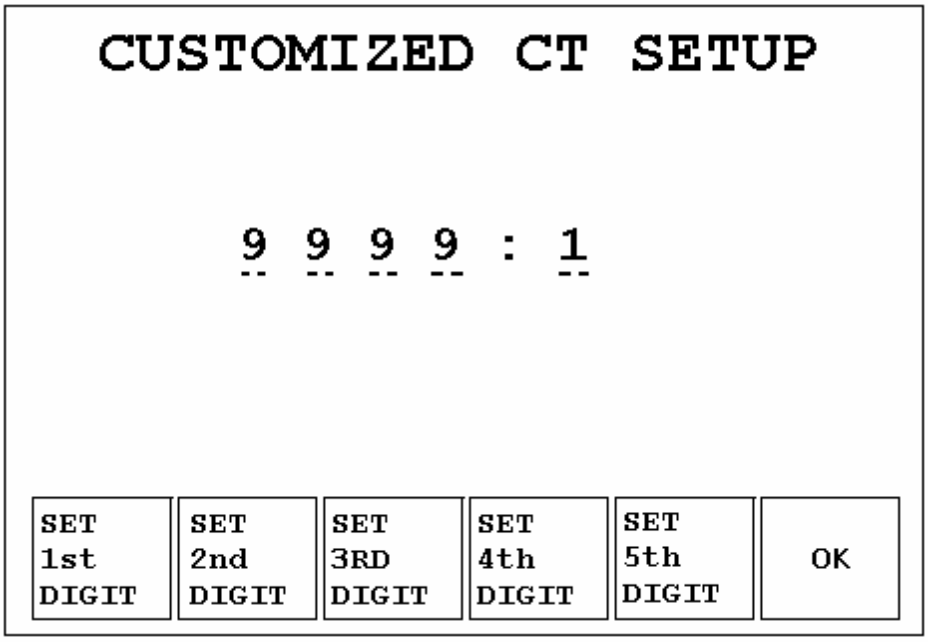
After numerous measurements have been saved and the data is needed for review or be extracted to a parallel printer or RS-232 device, simply return to the Main Menu and press the **View Saved Data** function key and the following screen will be displayed.



The **Save Data Screen** has numerous function key options.

- **Page Down**-selection of this function key moves the cursor down to the next page.
- **Page Up**-selection of this function key moves the cursor up to the previous page.
- **View Item**-selection of this function key displays the highlighted file for view.
- **Clear All NV Ram**-Clears every file saved in the NV Ram !!!!!!!!!
- **Clear Item**-Clears one file at a time. (File that is highlighted)
- **ESC**-selection of this function key recalls the previous screen.


SYSTEM CLOCK
31 MAR 1998 10:42:53
(use left-right arrow keys to move cursor)
(use up-down arrow keys to make changes)
DATE SELECT
OK


CUSTOMIZED CT SETUP
9 9 9 9 : 1
SET 1st DIGIT
SET 2nd DIGIT
SET 3RD DIGIT
SET 4th DIGIT
SET 5th DIGIT
OK

Power DB PROGRAM INSTRUCTIONS

Instructions for installing the Power DBLite program for use with the Megger Power Multimeter Model PMM-1.

Computer System Requirements:

Operating System: Microsoft® Windows 2000/XP; minimum 300 MHz PC; minimum 64 MB RAM; CD ROM drive; mouse

Installation from CD

1. Close all applications and insert the CD into the drive.

2. If Autorun is enabled, the CD Setup program will automatically load.

3. If Autorun is not enabled, choose **Run** from the Taskbar. Type **d:\setup.exe** and press the OK button. If CD is not in the D drive enter the appropriate letter.

4. Follow the Setup prompts.

5. After the program has loaded, remove the CD from the computer.

6. Restart / reboot the computer before executing the program.

Installation Via Internet

1. Close all applications. With your machine connected to the internet, Navigate to powerdb.com.

2. Click on ***Go To Download***

3. Click on ***Download Power DB Lite***

4. Follow the Setup prompts.

5. After the program has loaded, Restart / reboot the computer before executing the program.

6. Execute the program. Go to Help to view instructions on how to select Your Instrument Setup Screen, how to change the Logos on the test report, and other helpful information.

The following are brief explanations of the PMM-1 Power DB user screens and in no way is intended to be a tutorial on the Power DB Lite program. If more detail operating instructions is required please refer to the Power DB instruction manual. Some knowledge of Power DB is required to generate reports.

The following is a brief description of the Power DB Lite software with the PMM-1.

1. Upon opening the Power DB Lite software the user will be presented the Instrument Selection Screen.

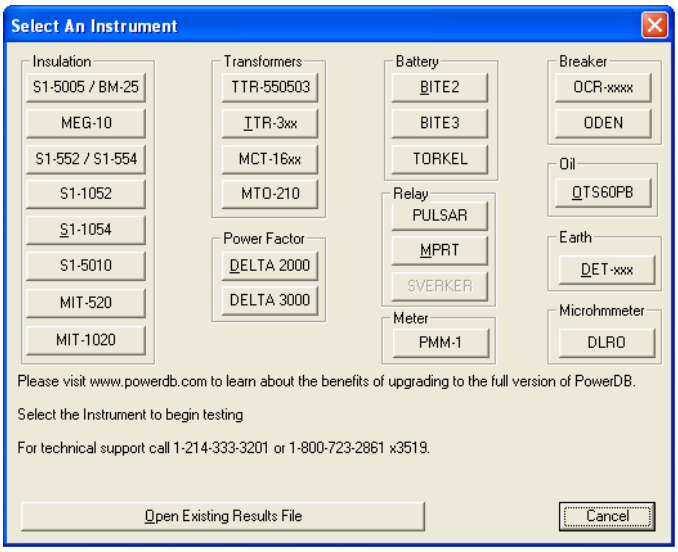


Figure 1 Select Instrument Screen

2. Click on the PMM-1 button. The user will then see the Instrument Configuration Screen.

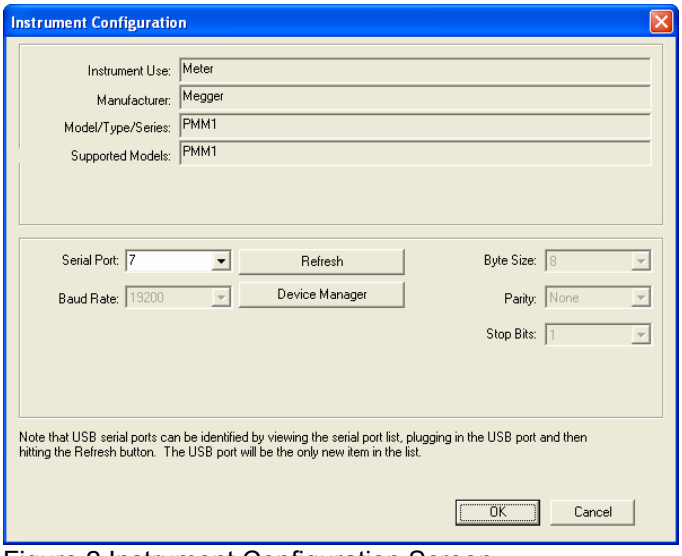


Figure 2 Instrument Configuration Screen

3. Click on the Serial Port selection button and select the appropriate communication port. If you are using a USB to serial adapter you may need to determine which

COM Port has been assigned to your USB adapter. To determine the COM Port assigned click on **Start**, **Control Panel, Performance and Maintenance, System, Hardware, Device Manager, Ports.** The COM Port for your USB to serial adapter will be displayed. Enter the COM port from the Pull Down window, click on OK.

1 PH Scan

1. Power DB Lite will automatically open the PMM-1 Single Phase test screen. Use the Zoom button  or select Tools, Zoom Out to reduce the form, see an example reduced form in the following figure.

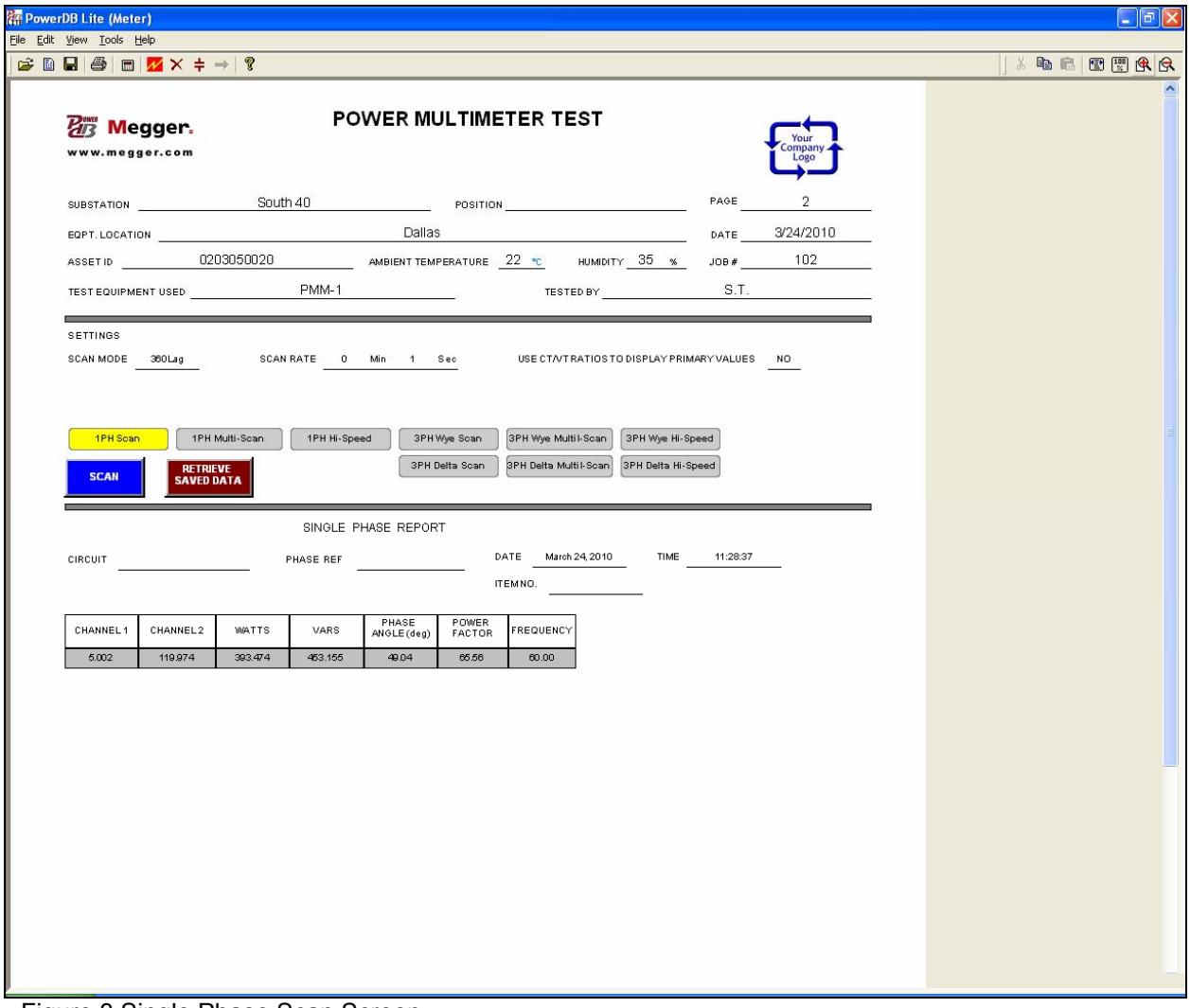


Figure 3 Single Phase Scan Screen

2. With the serial port properly connected to the PC, establish communications with the PMM-1 by clicking on the Initializing Instrument button  located in the tool bar.

3. Upon establishing communications Power DB will temporally display across the top of the screen that communication has been successfully established. You are now ready to use the software with the PMM-1.

4. Select the desired settings for the Scan Mode (360Lag, 360Lead and 180Lag) by clicking in the SCAN MODE window and use the pull down to select. See the following figure.

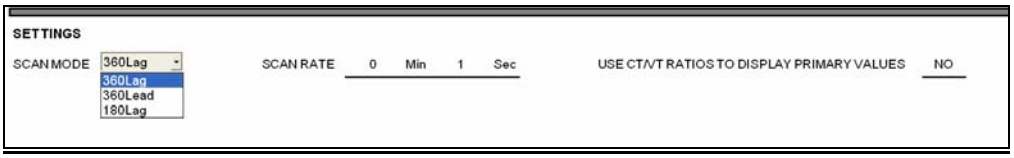


Figure 4 Single Phase Setting Screen

5. Scan Rate: The interval time between measurements. Scan rate can be entered in minutes and / or seconds. Using the default setting the display in Power DB will update every second.

6. Use CT/VT ratios to display primary values: (yes or no); Selection of no, sets the program to display the data in secondary values. Selection of yes, the data displayed will be in primary values based upon the CT/VT ratios.

You are now ready to use the Single Phase Scan Screen to record data from the PMM—1. The **1PH Scan** has two modes of operation; **SCAN** and **Retrieve Saved Data**. The display will automatically update based upon the SCAN RATE that you set until the STOP button is pressed. The **Retrieve Saved Data** mode retrieves a saved file from the PMM-1. To retrieve the desired file from the PMM-1, go to the PMM-1 **MAIN MENU**, press the **View Saved Data** function key. The **Saved Data Directory** screen will appear. Use the up ⇑ or ⇓ down arrow keys to move the cursor to the desired file. Press the **VIEW ITEM** function key to recall, display and verify the data on the PMM-1. To extract the data from the PMM-1 to the Power DB Lite software, mouse click on the **Retrieve Saved Data** hot key.

1 PH Mutli-Scan

Pressing the **1 PH Multi-Scan** button presents the user with additional settings requirements, see the following figure. The **1PH Multi-Scan** has three modes of operation; **SCAN**, **Retrieve Saved Data**, and **START / STOP DATE / TIME.** The Scan PMM mode reads and returns the measured data at the scan rate. To retrieve the data use the same procedure as outlined above.

Note: It is highly recommended that when making multiple Single Phase, Three Phase Y or Three Phase Delta Timed Data measurements that a different type of entry be saved between the Timed Data measurement. The singular saved entry separates the Timed Data.

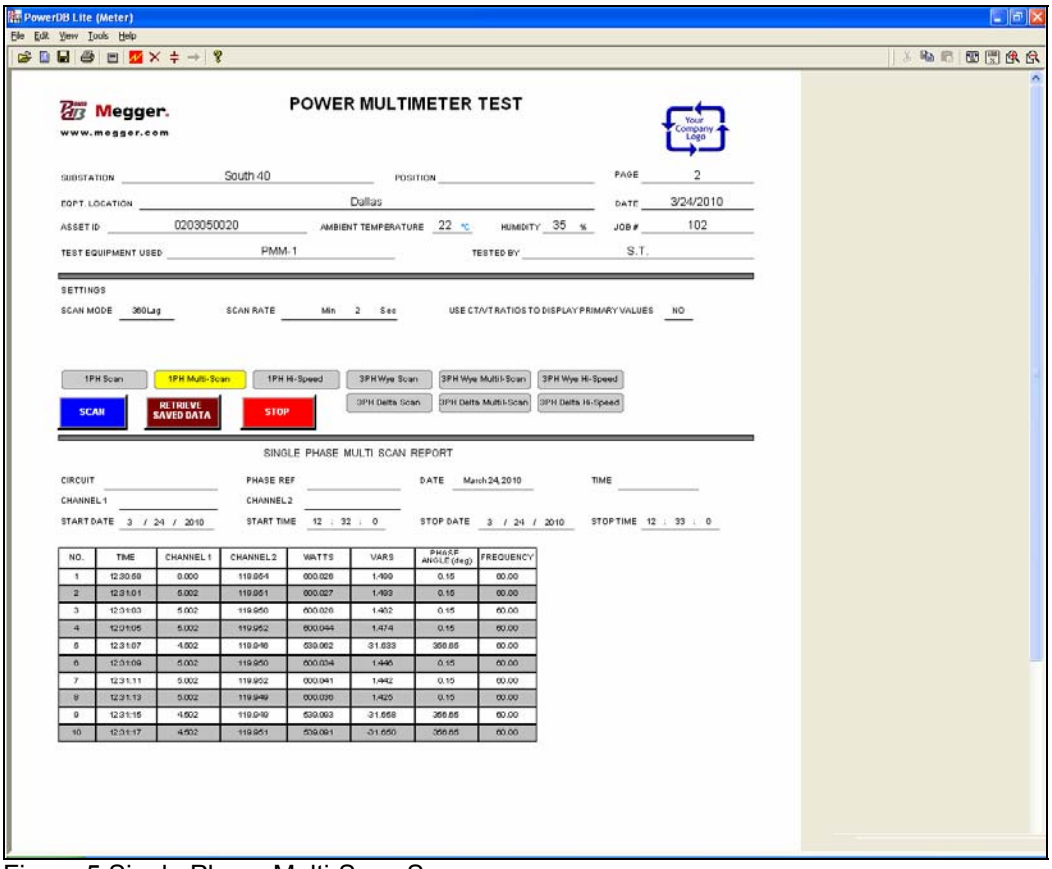
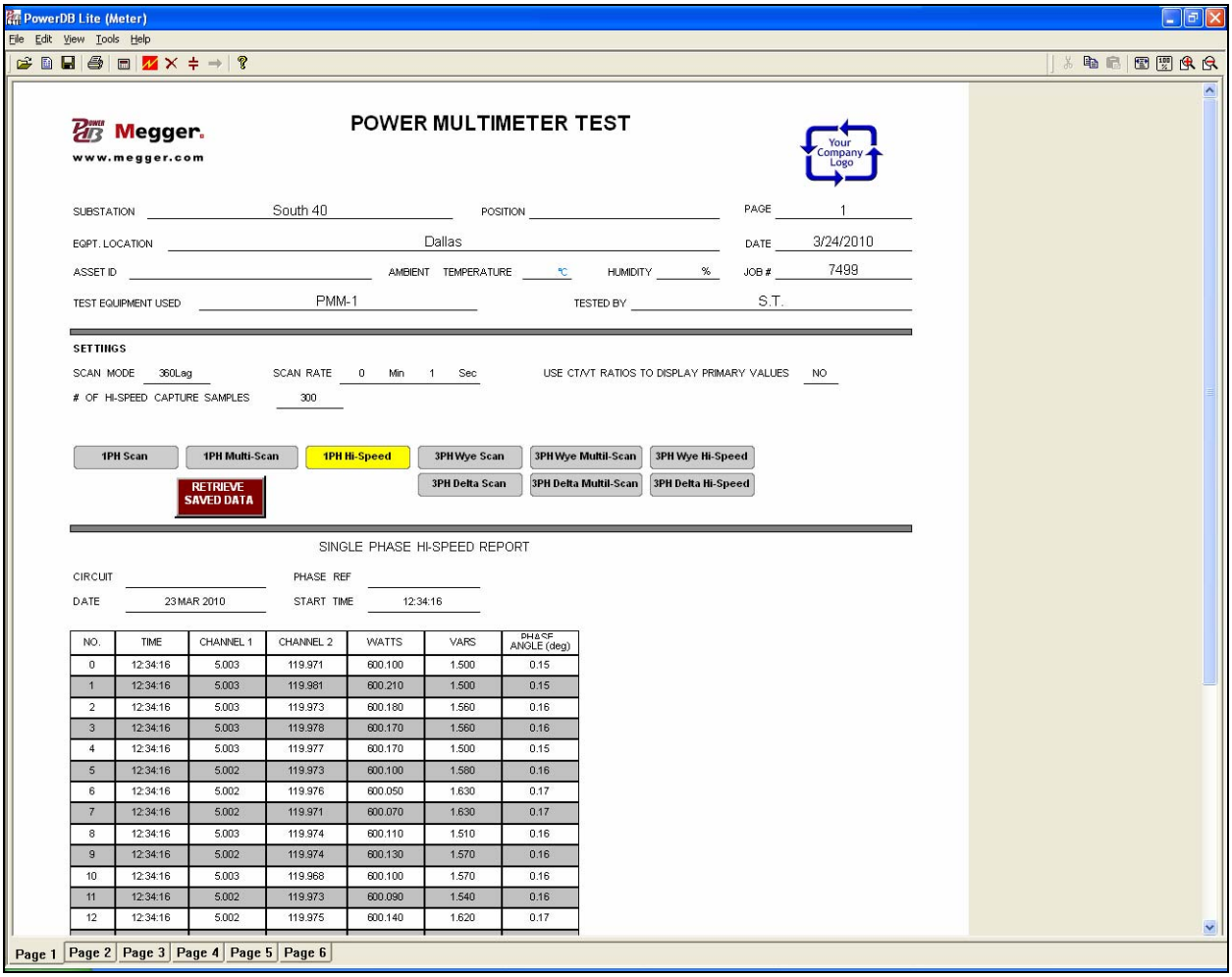


Figure 5 Single Phase Multi-Scan Screen

1. To run Multi-Scan the user will need to set the START DATE, START TIME, STOP DATE, and STOP TIME. The PMM-1 will start recording based upon the SCAN RATE at the START DATE and START TIME, and will stop recording at the STOP DATE and STOP TIME. Press the Scan button to start the process.
2. Either press the Stop button when desired or allow the software to continue to record data until the Stop Date and Time are reached.

1 PH Hi-Speed

Pressing the Single Phase High Speed button requires the user to input how many Samples are required (300, 600 or 1200). The sampling rate is taken at 20 readings per second, thus 300 = (15 seconds x 20 readings per second), 600 = (30 seconds x 20 readings per second), and 1200 = (60 seconds x 20 readings per second), see the following figure.



NO.	TIME	CHANNEL 1	CHANNEL 2	WATTS	VARS	PH&SF ANGLE (deg)
0	12:34:16	5.003	119.971	600.100	1.500	0.15
1	12:34:16	5.003	119.981	600.210	1.500	0.15
2	12:34:16	5.003	119.973	600.180	1.560	0.16
3	12:34:16	5.003	119.978	600.170	1.560	0.16
4	12:34:16	5.003	119.977	600.170	1.500	0.15
5	12:34:16	5.002	119.973	600.100	1.580	0.16
6	12:34:16	5.002	119.976	600.050	1.630	0.17
7	12:34:16	5.002	119.971	600.070	1.630	0.17
8	12:34:16	5.003	119.974	600.110	1.510	0.16
9	12:34:16	5.002	119.974	600.130	1.570	0.16
10	12:34:16	5.003	119.968	600.100	1.570	0.16
11	12:34:16	5.002	119.973	600.090	1.540	0.16
12	12:34:16	5.002	119.975	600.140	1.620	0.17

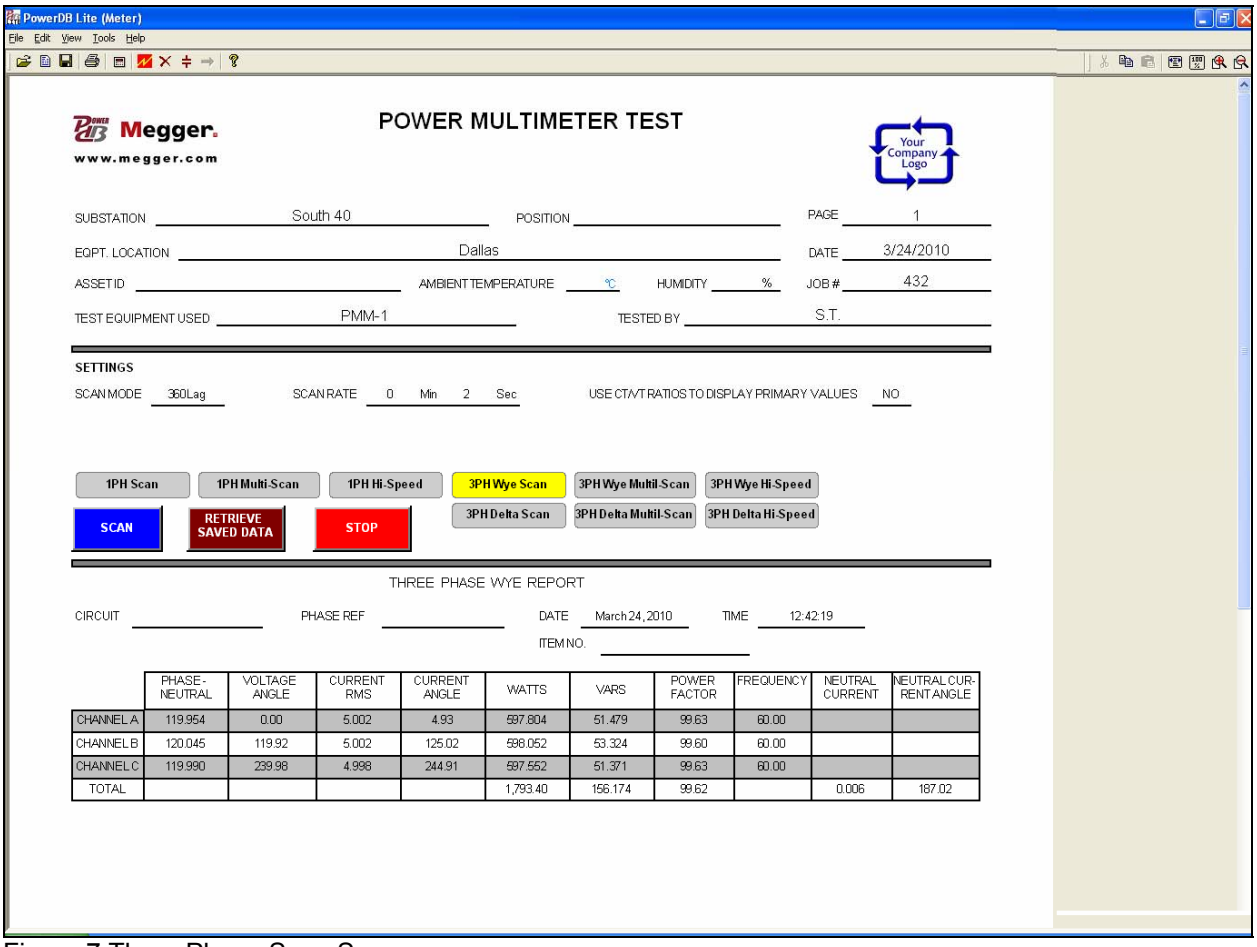
Figure 6 Single Phase High Speed capture Screen

1. The **1PH Hi-Speed** screen is used only when there is a need to retrieve a saved high speed capture file from the Power Multimeter. To retrieve the file, press the PMM-1 View Saved Data function key. Use the up ⇑ or down ⇓ arrow keys to locate the desired **hsc 1pS** file, then press the View Item function key to recall and display the data.

2. From the Power DB 1PH Hi-Speed screen mouse click the **Retrieve Saved Data** hot key to begin transmitting the data.

3 PH Wye Scan

The **3PH Wye Scan** has two modes of operation; **SCAN** and **Retrieve Saved Data**. The display will automatically update based upon the SCAN RATE that you set until the STOP button is pressed. The **Retrieve Saved Data** mode retrieves a saved file from the PMM-1, see the following figure.



	PHASE-NEUTRAL	VOLTAGE ANGLE	CURRENT RMS	CURRENT ANGLE	WATTS	VARS	POWER FACTOR	FREQUENCY	NEUTRAL CURRENT	NEUTRAL CURRENT ANGLE
CHANNEL A	119.954	0.00	5.002	4.93	597.804	51.479	99.63	60.00		
CHANNEL B	120.045	119.92	5.002	125.02	598.052	53.324	99.60	60.00		
CHANNEL C	119.990	239.98	4.998	244.91	597.552	51.371	99.63	60.00		
TOTAL					1,793.40	156.174	99.62		0.006	187.02

Figure 7 Three Phase Scan Screen

You are now ready to use the Three Phase Scan Screen to record data from the PMM—1. The **3PH Scan** has two modes of operation; **SCAN** and **Retrieve Saved Data**. The display will automatically update based upon the SCAN RATE that you set until the STOP button is pressed. The **Retrieve Saved Data** mode retrieves a saved file from the PMM-1. To retrieve the desired file from the PMM-1, go to the PMM-1 **MAIN MENU**, press the **View Saved Data** function key. The **Saved Data Directory** screen will appear. Use the up ⇑ or ⇓ down arrow keys to move the cursor to the desired file. Press the **VIEW ITEM** function key to recall, display and verify the data on the PMM-1. To extract the data from the PMM-1 to the Power DB Lite software, mouse click on the **Retrieve Saved Data** hot key.

3 PH Wye Mutli-Scan

Pressing the **3 PH Wye Multi-Scan** button presents the user with additional settings requirements, see the following figure. The **3 PH Wye Multi-Scan** has three modes of operation; **SCAN**, **Retrieve Saved Data**, and **START / STOP DATE / TIME.** The Scan PMM mode reads and returns the measured data at the scan rate. To retrieve the data use the same procedure as outlined above.

3 PH Wye Hi-Speed

Pressing the 3 PH Wye Hi-Speed button requires the user to input how many Samples are required (300, 600 or 1200). The sampling rate is taken at 20 readings per second, thus 300 = (15 seconds x 20 readings per second), 600 = (30 seconds x 20 readings per second), and 1200 = (60 seconds x 20 readings per second), see the following figure.

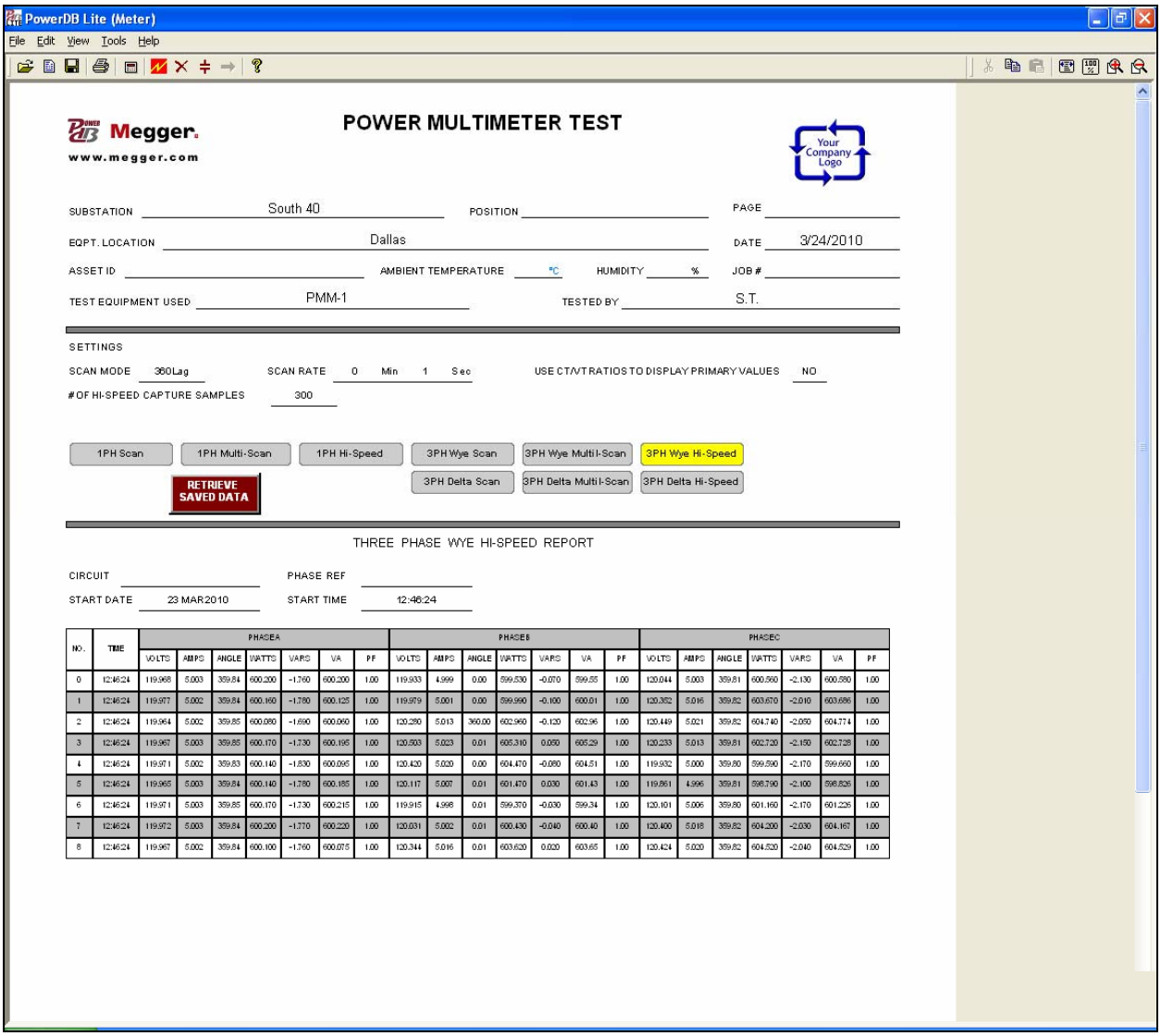


Figure 8 Three Phase High Speed capture Screen

1. The **3PH Wye Hi-Speed** screen is used only when there is a need to retrieve a saved high speed capture file from the Power Multimeter. To retrieve the file, press the PMM-1 View Saved Data function key. Use the up ⇑ or down ⇓ arrow keys to locate the desired **hsc 3pM** file, then press the View Item function key to recall and display the data.

2. From the Power DB 3PH Wye Hi-Speed screen mouse click the **Retrieve Saved Data** hot key to begin transmitting the data.

5. SERVICE AND MAINTENANCE

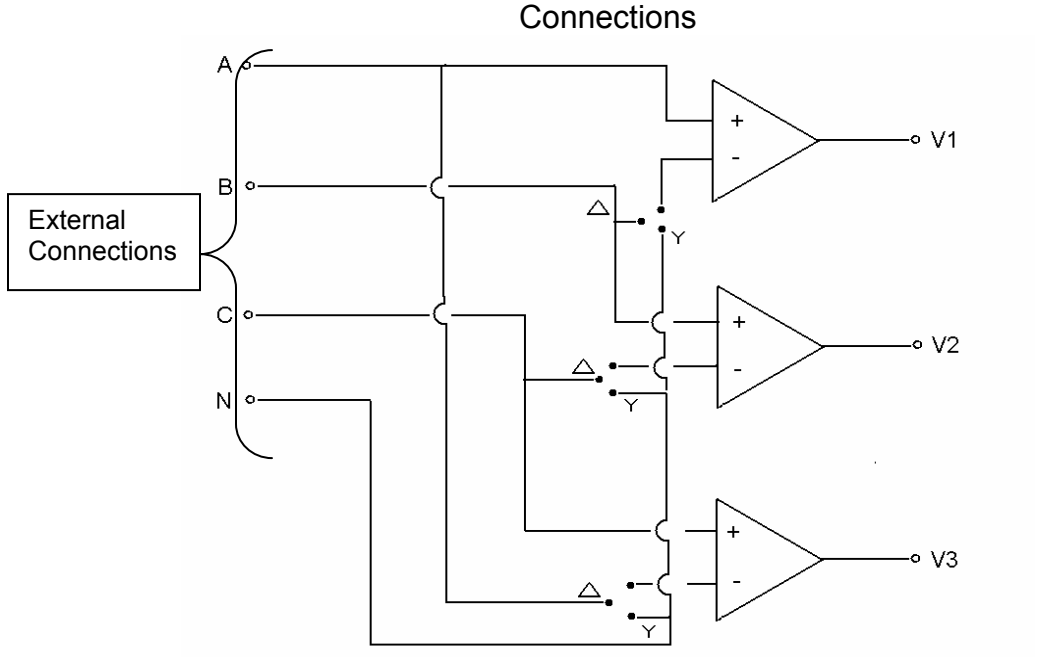
The components and techniques used by **Megger** are mostly standard and readily understood by competent, trained technicians. Some calibration and set-up procedures, however, are very difficult to perform in the field without the test jigs and accurate standards available to factory personnel. Customer repair and calibration are not recommended.Please contact your **Megger** representative should service or calibration be required.

6. ADDENDUM – Using PMM-1 for Delta Power Measurements

The North American Addendum Using the PMM-1 Power Multi-Meter For Delta Power Measurements

Electrical energy is the same regardless of the system configuration in which it is measured. In other words, 500 watts is 500 watts regardless of whether it is distributed throughout a 3 phase wye (Y) system or a delta (Δ) configured system. Blondel's Theorem suggests that the number of watt meters required to accurately measure energy within a circuit is one less than the number of conductors in that circuit. In keeping with Blondel's energy measurement philosophy, it becomes necessary to employ a minimum of two watt meters to measure energy in a delta system, whether it be an open or closed system. Due to the fact that the PMM-1 does not have a specific preset measurement mode for performing power measurements using a two watt meter method, the following procedure is set forth for that purpose.

Before going too far into an explanation of how these measurements are made, let's take a look at a diagram representing PMM-1 internal connections.



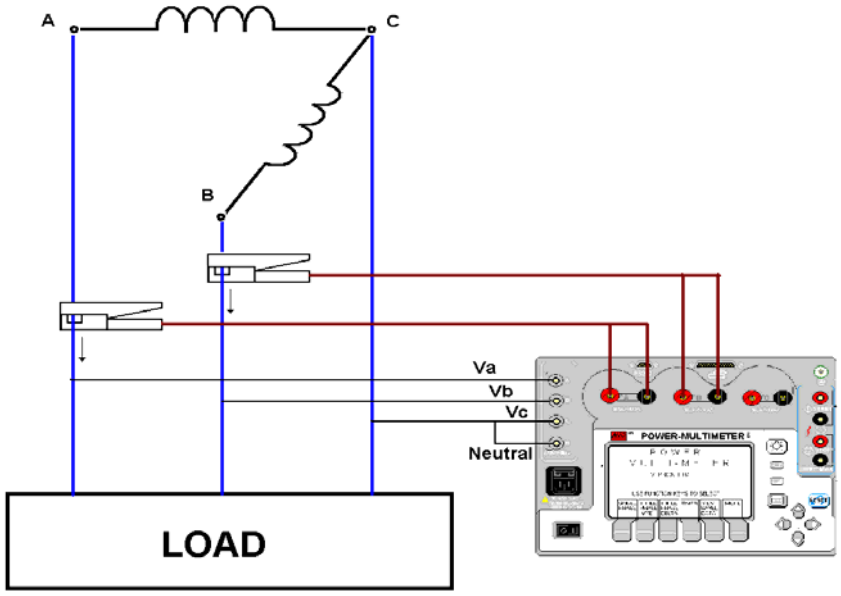
Y Configuration
$V_1 = V_{AN} = V_A - V_N$
$V_2 = V_{BN} = V_B - V_N$

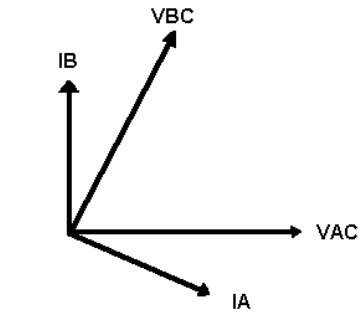
Δ Configuration
$V_1 = V_{AB} = V_A - V_B$
$V_2 = V_{BC} = V_B - V_C$

$V_3 = V_{CN} = V_C - V_N$ $V_3 = V_{CA} = V_C - V_A$

If we choose to use the 3 phase delta measurement mode on the PMM-1, we should assume that it will use three watt meters, 4 wire measurement process. Unfortunately, when quantities are limited such that only two watt meters are utilized, this measurement mode will display incorrect power quantities.

By selecting the C phase voltage as the reference, and tying it to the neutral binding post of the PMM-1, a 3 phase wye (ie. line to neutral) measurement mode can effectively be reconfigured for line to line measurements. Line to line voltage measurements can now be obtained using the 3 phase wye mode of measurement. The connection diagram in this case would be as follows.





Therefore the anticipated results of such a power measurement would be:

Phase A ⟹ $(V_A-V_C)\ I_A = V_{AC} \times I_A$
Phase B ⟹ $(V_B-V_C)\ I_B = V_{BC} \times I_B$
Phase C ⟹ $(V_C-V_A)\ 0 = 0$

The following mathematical exercises are for the purpose of coming to a better understanding of how we might accurately account for power measurements when monitoring a system of this sort.

Δ Configuration

If we were to assume a balanced load in a closed delta circuit, then we could also assume certain equalities within the circuit. For the sake of simplicity we will assume the following values and equalities to use in our calculations.

$E_{AB}=E_{BC}=E_{CA}=$ 100 Volts
$I_A=I_B=I_C=$ 1 Amps
θ=0˚, **Power Factor** = Cos θ = 1
Where θ represents the phase angle relationship between voltage and current

For this to be true, the voltage and current of each leg must be in phase with one another. Then single phase power could be calculated as follows.

Watts = Voltage x Current x Power Factor
= 100 x 1 x 1
= 100 watts

Total Load Power would equal to the single phase power multiplied by the number of phases.

Total Load Power = # of phases **x** phase voltage **x** phase current **x** Cos θ
= 3 **(**100**)**
= 300 watts

However, when using the two watt meter measurement method, Ø will become 30 degrees as a result of using the C phase voltage for our reference in making line to line measurements. Now there are only two legs that can have current flow in them, according to the above diagram. Power in a delta system will now have to be based on the voltages and currents in the remaining 2 legs. We will refer to these as P_{AC} and P_{BC}. The power in each of the two remaining legs can be calculated using the following formula.

$P_{AC} = P_{BC}$ = E x I x √3 x Power Factor
Where: θ = 30°, Power Factor = Cos 30° = √3/2 = .866

Total Power Measured **=** $P_{AC} + P_{BC}$ **=** $(E_{AC}$ **x** I_{AC} √3 **x** Cos θ**) + (**E_{BC} **x** I_{BC} √3 **x** Cos θ**)**
= 2 **x** 150
= 300 watts

Where we had previously used **Cos θ** to represent power factor, **θ** can now be represented in terms of it's components. When adding the power factor values for each of the two legs of the circuit being measured, the sum must be divided by √**3**. The PMM-1 only displays the individual power factor values for each individual voltage and current being measured. Therefore, a system power factor can be calculated by adding the power factors for each of the two legs in the system and then dividing their sum by √**3**

For example: If the power factor of each of the two legs were Cos 30˚**,** then:

$PF_{AC} = \sqrt{3}/2 = 0.866$
$PF_{BC} = \sqrt{3}/2 = 0.866$

Load Power Factor can now be represented in terms of these two components

$$\text{Load PF} = \frac{PF_{AC} + PF_{BC}}{\sqrt{3}} = \frac{0.866 + 0.866}{1.732} = 1 = \text{Cos } \theta \ (30^{\circ})$$

%PF = PF(100) = 100%

The following chart is provided as an example of the equality shown in the above equation. Power Factor may be represented in terms of Cos θ or in terms of the summed power factors from each leg of the circuit divided by the √**3.**

Ø	**Load Cos Ø**	**PF_{AC} Cos (30˚+Ø)**	**PF_{BC} Cos (30˚-Ø)**	**$\frac{PF_{AC} + PF_{BC}}{\sqrt{3}}$**	Total Power
-90˚	0	1/2	-1/2	0	0P
-60˚	½	√3/2	0	1/2	1/2P
-30˚	√3/2	1	1/2	√3/2	√3/2P
0˚	1	√3/2	√3/2	1	P
30˚	√3/2	1/2	1	√3/2	√3/2P
60˚	½	0	√3/2	1/2	1/2P
90˚	0	-1/2	1/2	0	0P

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