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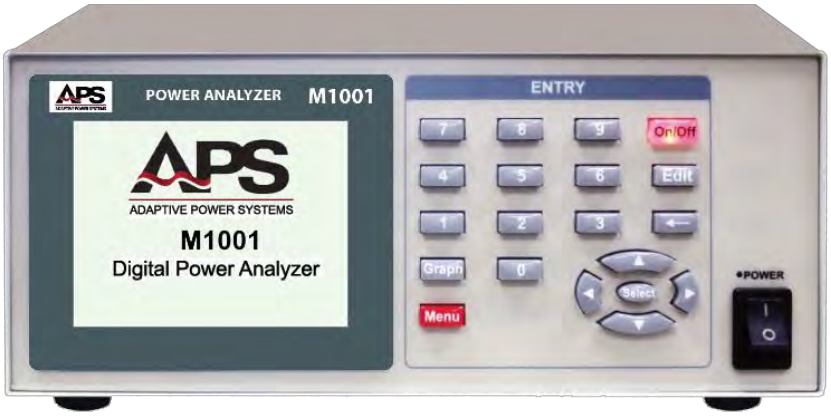
APPLICATION NOTE – M1001 AC Load Measurements

October 8, 2019



Contents

1 Introduction

This application note illustrates the use of the METER and HARMONICS measurement functions of the M1001 power analyzer.

2 AC Measurement Functions

2.1 Equipment Setup

Before any measurements can be made, it is imported to set up the equipment used. For this application, we will use a standard US 120Vac, 60Hz power outlet to provide power to the EUT.

The EUT for this example is a programmable AC load, APS model 3C037-37. The benefit of using a programmable AC load is the ability to set current level, crest factor and power factor to simulate a wide range EUT types. A simpler setup could be used with an actual EUT of interest or a resistive load if needed.

The general equipment setup is illustrated in the figure below.

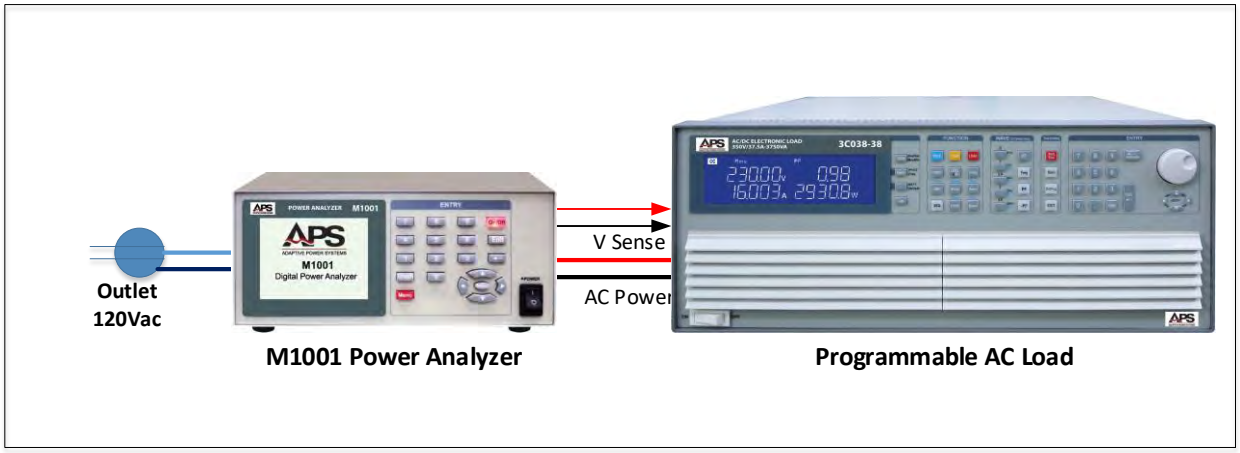


Figure 1: Equipment Setup

2.2 Measurement cable wiring

The connections between the power source (wall outlet), power analyzer and load are shown in the figure below.

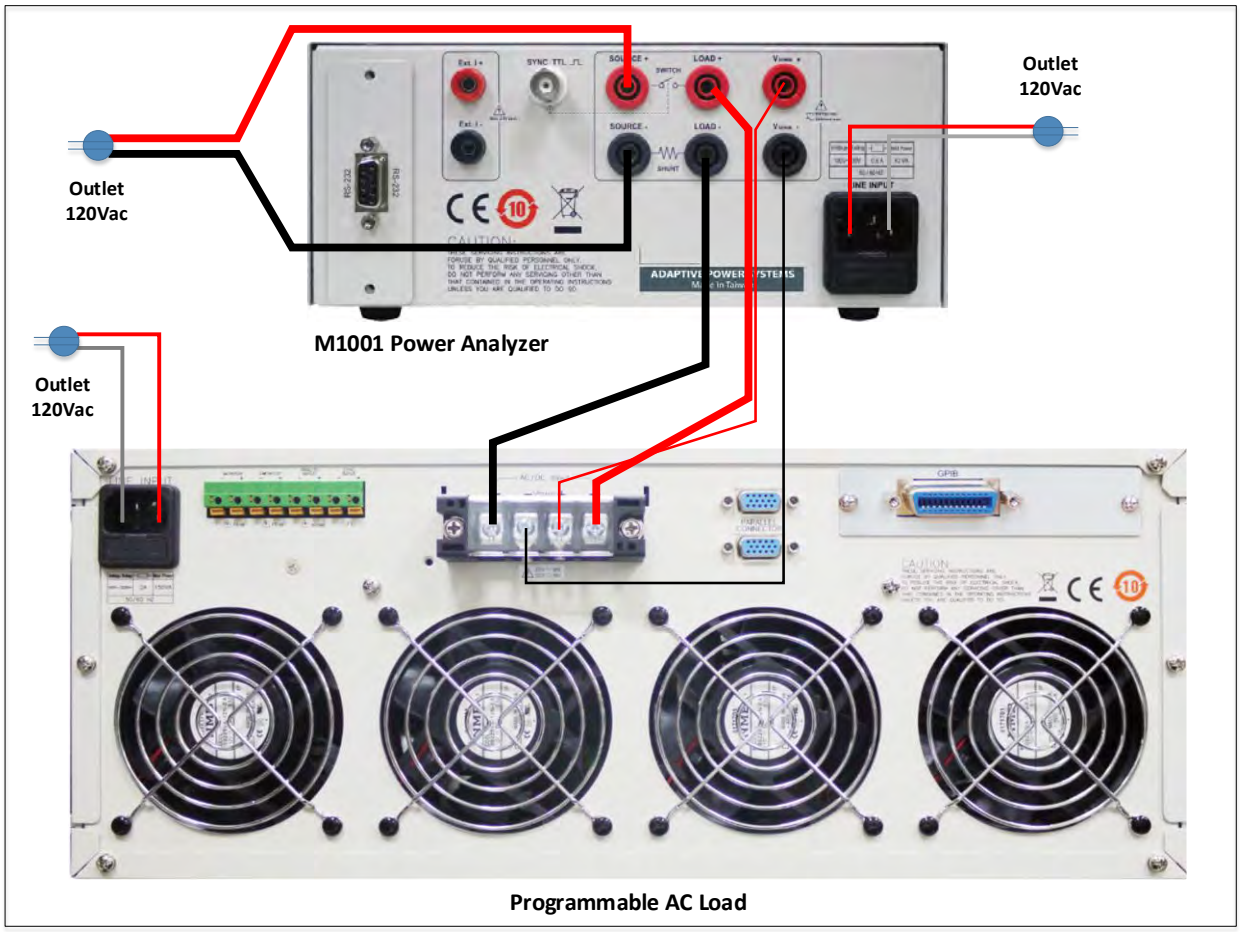


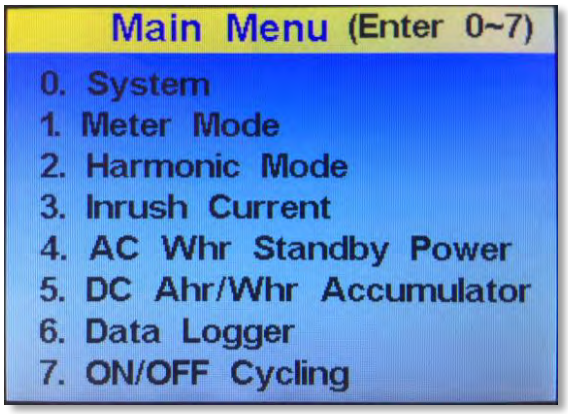
Figure 2: Equipment connections

Note the $\mathbf{V_{SENSE}}$ lines of the power analyzer must be connected to the load input to make sure any wire impedance voltage drops do not affect the measurement results.

2.3 Power Analyzer Setup

The power analyzer must be set up for the intended measurements. In this case, we are making AC measurements and will be using the internal current shunt of the M1001, as the expected current levels will be well below the 20Arms of the internal shunt.

Settings are made from the System Setting menu, available by pressing the **Menu** key followed by the number zero key **0**.

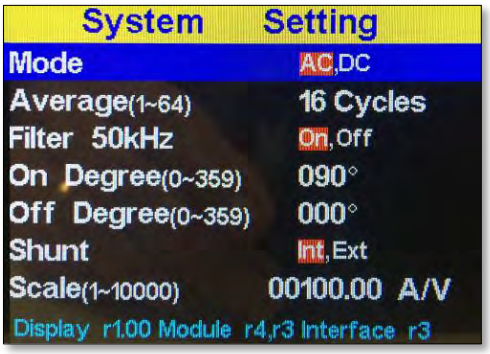


Once in the System Setting menu, press the **Edit** key and use the cursor keys to scroll through the available settings. To change a numeric setting, enter the new value and press the **Select** key inside the cursor keypad. To change alternate fields, use the left and right cursor keys to move between field settings and press **Select** when done.

Use the up down cursor keys to move to the next setting.

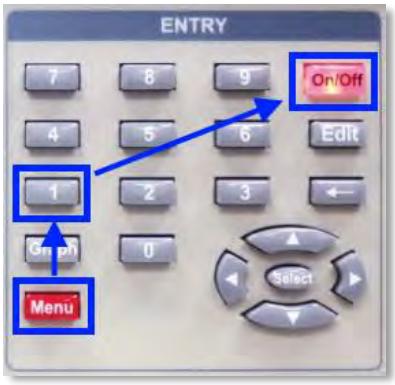
Since we are making AC measurements, we will make the following selections:

- Mode AC
- Average 16
- Filter 50 kHz On
- On Degree 090°
- Off Degree 000°
- Shunt Int



This is reflected in the System Setting screen shown here.
The average setting will results in more stable readings as systematic noise will be reduced as a result of averaging 16 readings. Lower averaging settings may be used for faster update rates as needed.

2.4 Connect load and start measurements



Before we can make any measurements, we need to select the Meter mode by pressing the **Menu** key followed by the number one key **1** (Meter Mode).

The Meter mode is now active but we must connect the load using the internal electronic switch of the power analyzer by pressing the **On/Off** key in the upper right corner of the keypad.

The power analyzer is now set but the programmable AC load must be set and enabled as well. For this example, we select CC mode and set the current to 2.0Arms. At the expected AC line voltage of 120Vac, we would expect a 240VA load. The load is also set to use a 2:1 crest factor for the current so the power factor will be less than 1.0 (unity).

2.5 AC Measurement Results

The resulting measurements are shown in the screens below. The left screen shows the M1001 Power analyzer metering screen. The right screen shows the AC Load's metering screen.

Figure 3: Power Analyzer Measurements versus AC Load Measurements

Difference in measurement between the two instruments are within their accuracy specifications.

Parameter	Power Analyzer	AC Load	Average	Delta	Rel. Delta (%)
Vrms	117.89	117.45	117.67	0.44	0.37%
Arms	2.005	2.000	2.0025	0.005	0.25%
Watt	195.66	193.5	194.58	2.16	1.1 %

Table 1: Measurement Differences between instruments

Note that the power analyzer typically has more measurement ranges than an AC or DC electronic load. Thus, measurement range related error contributions on the power analyzer tend to smaller than those for the AC load in this situation.

While the Meter displays shows only four measurements per screen, there are many other measurements taken by the power analyzer. Additional readouts can be viewed by scrolling up or down using the up and down cursor keys.

Figure 4: Additional Metering Screens obtained by scrolling up or down

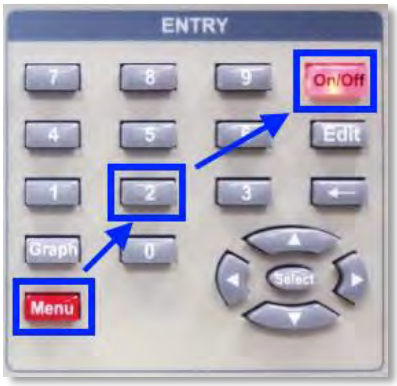
Note the 2:1 Crest factor for the current and the associated high level of current distortion of 65% typical for a full wave rectified AC input circuit. The AC grid voltage also shows a certain amount of voltage distortion at 3.2% as the result of some flat topping under this high crest factor current load condition.

2.6 Meter Graph Mode

The Graph mode for the Meter results shows the voltage and current waveform as shown in the figure below. The current cress factor of 2:1 is evident from the current waveform (red). To display the graph meter data, press the **Graph** key located directly above the **Menu** key.

Note that the Graph or Scope mode is not that relevant for taking actual measurements but rather serves to be able to identify any anomalies in either voltage or current waveforms. In this example, it is immediately obvious that the load current represents a rectified AC current or a non-linear load, which explains the high level for current distortion. To toggle back to the numeric meter display, press the **Graph** key again.

2.7 Harmonic Measurements



While we are on the topic of current distortion, let us take a closer look at this by selecting the Harmonic Measurement mode. This mode is selected from the Main Menu by pressing the **Menu** key followed by the number two key **2** (Harmonic Mode).

Note that pressing the **Menu** key automatically turns the power analyzer measurements off. This is reflected by the **On/Off** key toggling from green (On) to red (Off).

The start the harmonic measurement function, press the **On/Off** key until it turns green.

The first Harmonic screen that appears will be the Voltage Harmonic data. Since we are interested in the Current Harmonic data, use the left cursor key to switch to the Current Harmonic screen as shown below.

IH01	1.676	A	IH02	3	mA
IH03	1.040	A	IH04	2	mA
IH05	280	mA	IH06	0	mA
IH07	119	mA	IH08	1	mA
IH09	98	mA	IH10	0	mA
IH11	46	mA	IH12	0	mA
IH13	58	mA	IH14	0	mA
IH15	25	mA	IH16	0	mA

Figure 5: Current Harmonic Table

Figure 6: Current Harmonic Graph w/cursor on IH3

The left screen shows the individual current harmonic values. The odd harmonics are significant with the 3rd harmonic (180Hz) being almost as high as the fundamental current (60Hz). This can be seen in the bar chart display on the right as well. This display is shown when the **Graph** key is pressed.

The left and right cursor keys can be used to move from one harmonic no. to the next or back. In the example screen shown above, the cursor is positioned on the 3rd current harmonics (IH3).

3 Other M1001 Measurement Functions

Additional measurement functions of the M1001 are covered in other application notes. Contact Adaptive Power Systems or its representative for copies of other power analyzer application notes.

- Inrush Current measurement
- Standby Power Whr measurement
- Measurement Data Logging
- ON/OFF Power Cycling

4 Summary

Gathering key measurements and harmonics content for an AC load is quick and easy when using a dedicated power analyzer.

5 Contact Information

For product information or technical support by region, contact our exclusive equipment representative shown below.

NORTH AMERICA	EUROPE	ASIA
PPST Solutions	**Caltest Instruments GmbH.**	**PPST Shanghai Co. Ltd.**
Irvine, USA	Kappelrodeck, Germany	Shanghai, China
Phone: +1(888) 239-1619	Phone: + 49(0)7842-99722-00	Phone: +86-21-6763-9223
Fax: +1 (949) 756-0838	Fax: + 49(0)7842-99722-29	Fax: +86-21-5763-8240
Email: info@ppstsolutions.com	Email: support@adaptivepower.com	Email: support@adaptivepower.com

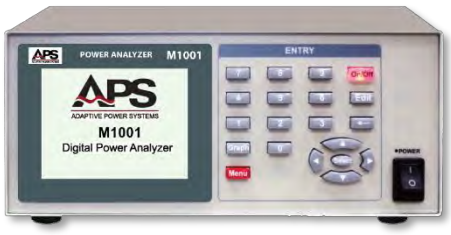


Figure 7: M1001 Series Power Analyzers

Figure 8: M2000 Series Power Analyzers

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