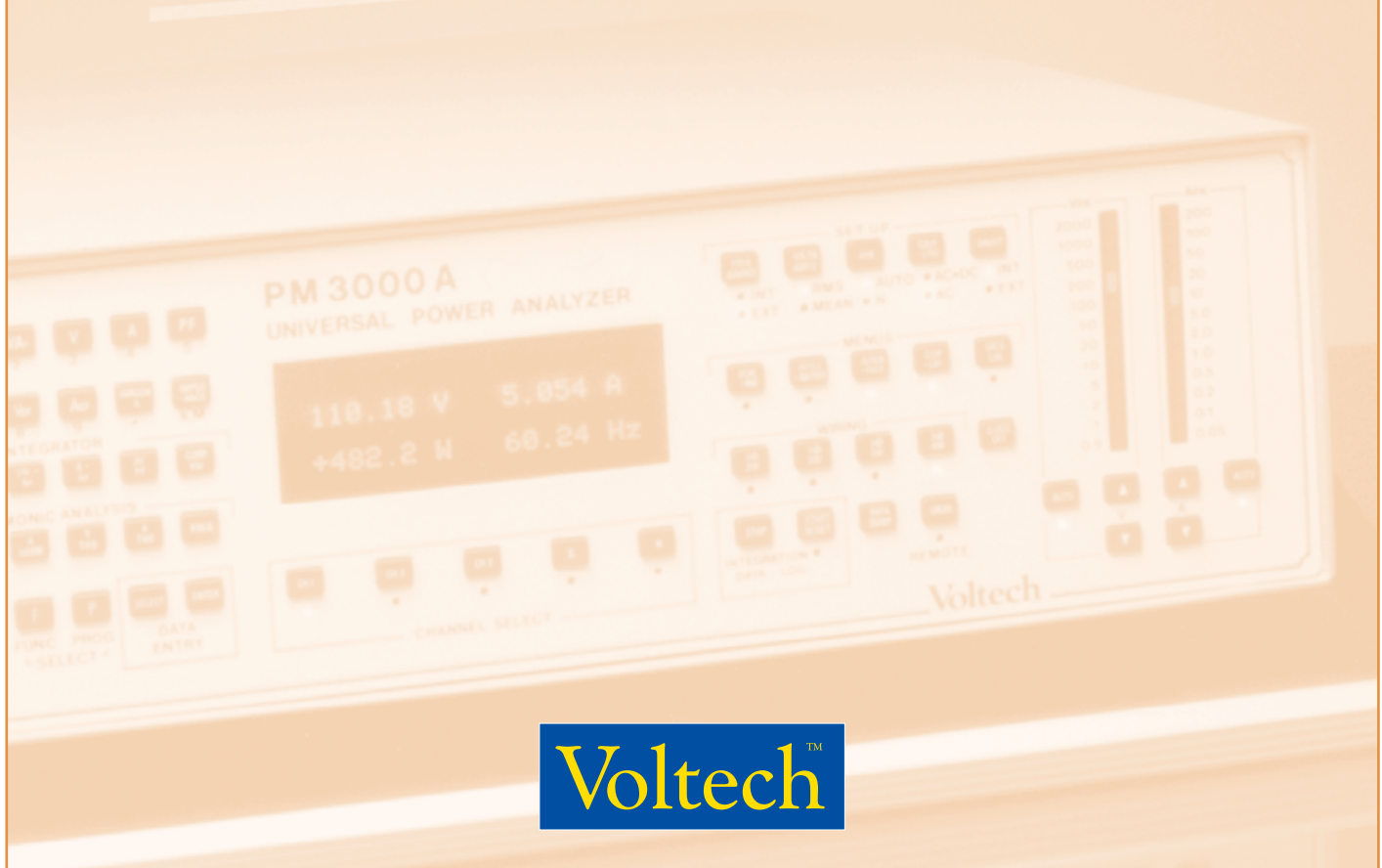


Standby and Low Power Measurements



Low Power Measurements

Introduction

Voltech power analyzers provide a comprehensive range of accurate measuring instruments for voltage, current, and all power parameters. Each instrument features fully isolated, floating inputs for the easy and safe connection of the ac power to be measured. Accuracy of the measurements is guaranteed over the following broad ranges:

Model	Current Range		Voltage Range	
	rms	peak	rms	peak
PM100CE	20mA to 20A	200A	2V to 700V	1000V
PM300CE				
PM3000ACE	50mA to 30A	200A	0.5V to 1000V	1500V

The measuring ranges of the analyzers may be extended both higher and lower using readily available transformers and other transducers. For high-power measurements, current transformers such as the Voltech CL100, CT1000, and CL3000 (100, 1000 and 3000A) are ideal for many applications.



Voltech high current transducers

This technical note discusses how Voltech power analyzers may be used to measure the relatively small current and power quantities found when ac line powered equipment is operating in a standby mode.

Technical Challenges

There is increasing legislative and consumer pressure to minimize the standby power consumption of common domestic and office electrical equipment. For example, USA Presidential Executive Order 13221 requests that government agencies shall “purchase products that use no more than one watt in their standby power consuming mode”.

It is, thus, important to product design and test engineers to have the ability to accurately measure ac power below one watt. This can be more difficult than it would first appear for two main reasons.

1. Dynamic Range

If the range and accuracy of the measuring instrument and its current transducers are not carefully considered, the measurement may be inaccurate or obscured by noise.

For example, a clamp-on power meter rated to 100A is used to measure 10mA. In this case, the reading is 1/10000 full scale of the meter. The current clamp, designed for 100A, will introduce very significant measurement errors and may not register a current at all.

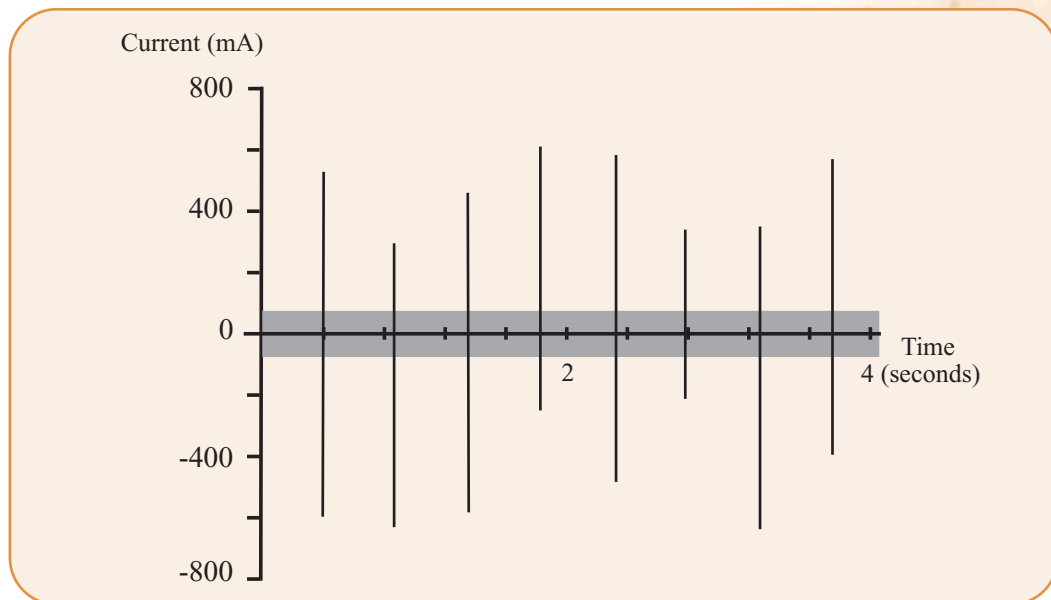
To make accurate low-power measurements, the current transducer should be appropriate to the level of current being measured and matched to the abilities of the power meter.

2. Burst Mode Standby

The switching power supplies found inside most domestic, office and industrial equipment will often draw greater than 1 Watt, just to supply their own control circuits. To minimize consumption at no load, various techniques are applied that shut down the power supply controller for intermittent periods. Terms used are

'burst mode' and 'skip cycle' amongst others.

The effect on the input is that intermittent bursts of current and power are drawn from the line. Significant current may still be drawn in the 'dead' period. The bursts are regular and repetitive but may vary with line voltage, load, etc. and are not crystal-controlled.



When current and power is drawn in bursts like this from the ac supply, power meters will attempt to track the variations and will often only provide a varying and inconsistent power measurement that is not definitive.

Voltech Solution

1. Dynamic Range

Voltech power analyzers are equipped with an external shunt input that may be connected to any suitable external shunt or current transducer. By entering a scale factor into the analyzer, the correct current and power quantities can then be displayed and transferred over the communication interfaces.

Notice that it is not necessary to purchase an expensive, special model power analyzer; the standard models are capable of measurements from micro-amps to mega-amps as long as an appropriate transducer is used.

Example:

An office laser printer is designed to have a standby mode where less than 1W of power is consumed. What value of external shunt should be used to make accurate measurements with a standard Voltech power analyzer?

Choosing an external shunt:

a) At 110V ac, the current will be:

$$1W / 110V = 9.09mA \quad (\text{at a power factor of } 1)$$

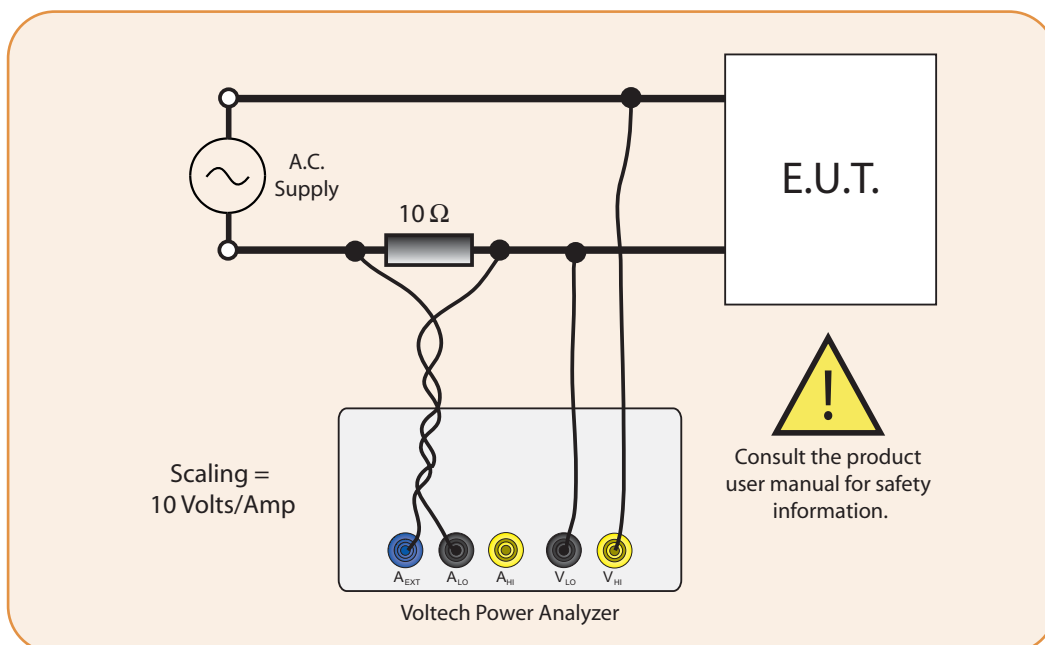
Let us say that the minimum current to be measured is 5mA, which allows some margin for other products and voltages.

b) The minimum recommended external shunt voltage input of the PM3000ACE is 6.25mV. Minimum resistive shunt value is:

$$6.25mV / 5mA = 1.25\Omega.$$

Choose a readily available 0.1% tolerance resistor: **10Ω**.

c) Connect the analyzer to the equipment under test (EUT) as shown below.



A Voltech breakout box may be used to simplify the power connections, if required.

d) Next, and on the front panel of the PM100 or PM3000ACE, select 'External Shunt' as the current input and enter the scale factor. A 10 ohm resistor scales at 10 Volts / Amp for the PM100 and 800 for the PM3000ACE. Consult the product user manual for details.

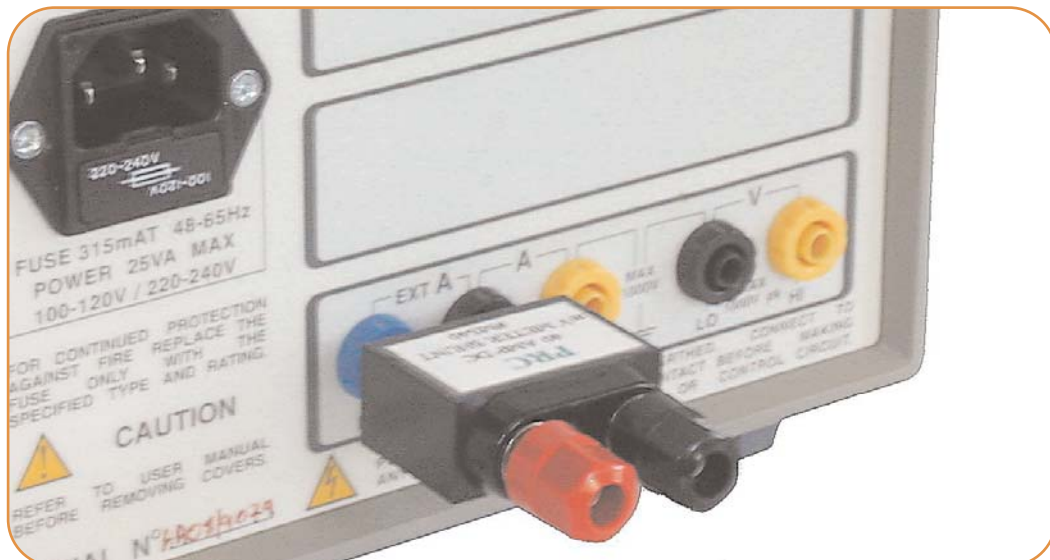
e) The power analyzer is now ready to make accurate low-current measurements.

A convenient way of connecting an external shunt resistor is to purchase a ready-made assembly such as that shown below. For improved accuracy and frequency response, non-inductive and four-terminal (Kelvin connection) shunts may be used.



Precision Resistor Co., Inc.

www.precisionresistor.com



PRC shunt shown fitted to a PM100. Special channels are not required.

Clamp-on probes designed specifically for low-current measurements are also available.



Chauvin-Arnoux E6N

- 5mA to 1.5A
- DC to 2kHz
- Scale factor: 1V / A

www.chauvin-arnoux.com

Note:

Consider also the maximum current that will be passed through the shunt or transducer. When a resistive shunt is used, consider its current and power rating (I^2R) and fitting a fuse in series with the shunt. This will protect the shunt from damage should an accidental over-current occur.

Voltech power analyzers are fitted with over-current devices which will protect them from damage in the majority of circumstances.

2. Burst-mode standby

To overcome the problems encountered in measuring the time-varying current and power in a stable fashion, the power analyzer must make continuous measurements at a high sample rate over an extended period of time and display the averaged results. Watt-hour integration features may be used to do this, but they are often processed at a lower sample rate and data (especially that related to the dead period in between bursts) may be lost. (This is not the case with the

Voltech PM3000ACE).

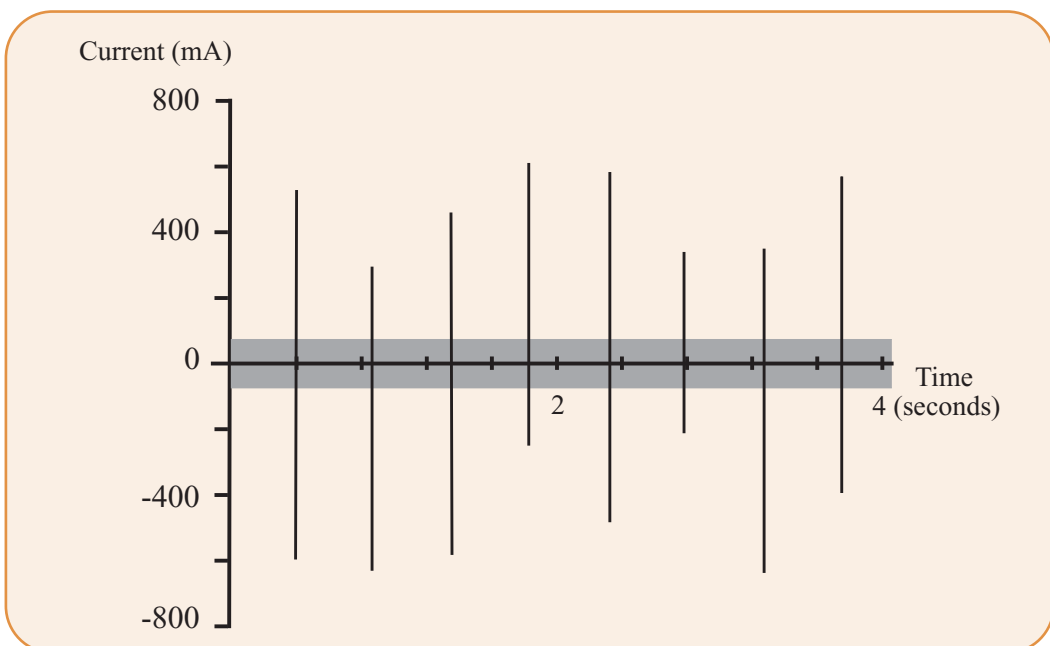
On the Voltech PM100, a special long averaging mode is available which:

- Samples at 200kHz to ensure no loss of data.
- Continuously averages all results together to constantly update and display the averaged measurements.
- Allows the user to select an appropriate averaging time.
- Displays all results, including volts, amps, watts and harmonics.

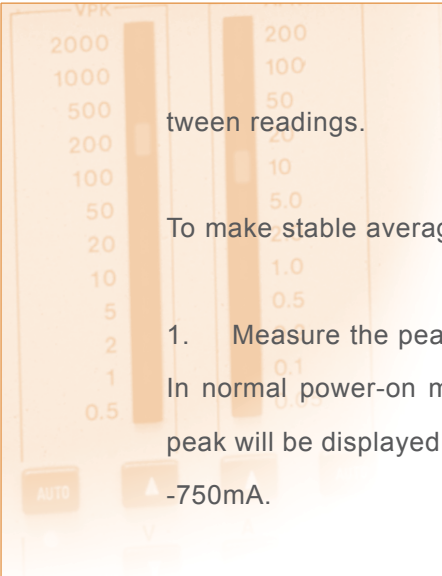
PM100 Example

An ac power supply is equipped with a low-power standby mode. In this mode, current is drawn from the supply in 'bursts' that occur every 300ms or so. The waveform is shown below.

A measurement of the average input power is required to check the rating of the



power supply. With default settings, the PM100 makes measurements at high speed and updates the display approximately every $\frac{1}{2}$ second. With the waveform above, the measurements are not stable, and the analyzer pauses while it auto-ranges inbe-



tween readings.

To make stable average measurements, follow this procedure:

1. Measure the peak current.

In normal power-on mode, press the **[A]** key and then the **[PEAK]** key. Amps peak will be displayed. In this example, the maximum reading was approximately -750mA.

2. Set up a fixed current range.

Press **[MENU]**, **[1]** and then **[←]** until you see:

```

MANUAL A RANGE
X  >√<
```

and then enter the nominal peak current, ignoring the (-) sign:

```

PEAK CURRENT
>0.750<
```

3. Now set up long averaging in **[MENU]**, **[2]**.

```

LONG AVERAGING
X  >√<
```

The averaging time should include several cycles of operation of the equipment.

Equipment Cycle Time	Example	Long Averaging Time
< 1 sec	Power supply in low power standby mode.	10 sec
1 - 10 sec	Signs, message boards, oscillating fan.	100 sec
10 - 60 sec	Soldering iron.	300 sec
> 60 sec	Washing machine.	300 sec + Integrator

In this case, the power supply current seems to vary over a two-second period. Choose 20 seconds for the averaging time. This can be increased later, if the measurements are not stable.

AVERAGING TIME

>20.0<

Press **[MENU]** again, and the analyzer will now begin to make measurements. The red PROG LED will flash to indicate that the PM100 is in long averaging mode.

All measurements are stable, reliable, accurate and continuously updated.

Conclusion

- 1) Accurate, stable and reliable measurements of electrical equipment that is operating in a standby mode differs from normal power measurements in two ways:
 - a) The low current of typically less than 10mA may be below the specified operating range of the analyzer. As a result, measurements will be inaccurate or even totally obscured by noise.
 - b) The current may be drawn in bursts, and that requires specific measurement techniques to provide reliable measurements.
- 2) The low current range of Voltech power analyzers may be extended by using an appropriate current transducer. It is not necessary to purchase special power analyzer models to measure low current and power.
- 3) The long averaging and integration techniques of Voltech power analyzers may be used to provide burst power measurements that are accurate, stable and repeatable.

References

1. Voltech Technical Note “Single Shunt Technology” (item number 104-114)
2. Voltech Technical Note “Kelvin Connections” (item number 104-104)
3. Voltech Technical Note “Back to Basics: AC Theory” (item number 104-109)
4. PM100/300 User Manual (item number 98-052)
5. EU Energy Efficiency Initiative (<http://energyefficiency.jrc.cec.eu.int/>)

All Voltech items are available free of charge from your Voltech supplier or from our website at www.voltech.com

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