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Making watt-hour measurements with Fluke power quality analyzers

Application Note

Introduction

The need to manage power is never more critical than when power prices skyrocket and power quality becomes suspect. Electrical technicians today are more aware of power consumption and are on the watch for consumption that's higher than anticipated. Once that occurs, technicians must become detectives and try to trace the power consumption back to its source.

Fluke power quality analyzers (PQA), like the 43B, are excellent tools for conducting the portable energy audits necessary to track down energy draining devices.

This application note details the procedures for using Fluke power quality analyzers for average watt measurements and converting those to watt-hours.

Average wattage to watt-hours conversion

Fluke power quality analyzers can provide a reading of average wattage over time, a value that can be easily used to determine watt-hours. To convert average watts to watt-hours, simply multiply the average watts reading by the amount of time over which the average was measured.

For example, the following calculations are for continuous loads (for cycling loads, see *load cycle considerations*):

- A one-watt averaged load measured for one hour is equal to one watt-hour; a 1000-watt averaged load measured for one hour is equal to one kilo-watt-hour.
- A 60-watt averaged load measured for two hours is equal to 120 watt-hours.
- A 60-watt averaged load measured for 15 minutes (one-quarter hour) is equal to 15 watt-hours.

This technique for measuring real power consumption (kWh) can also be applied to apparent power (kVA) and reactive power (kVAR). Simply set the power quality analyzer to calculate the running average kVA or kVAR, then multiply by the recording time to get kVAh or kVARh used by the load.

Using the Fluke 43B for average watt measurements

When using the 43 or 43B to measure the average watts, you will use the *record mode* in the *power mode* section of the meter. To make watt-hour measurements with the 43B:

1. Connect the 43B to ac power using the PM8907 battery eliminator/charger.
2. Be sure the voltage leads and the current clamp are connected before starting the record mode (see the Application Guide included with the instrument for hookup diagrams).
3. Select the *power mode* and make sure the wattage readings are correct.
4. Press the *record* button and select watts for reading #1. Reading #2 is not required, so you may select any of the other items — VA (volt amperes) would be a good choice for reading #2 unless you have some other need.
5. Selecting *record* time:
   - If you do not know how long you are going to be making the watt average measurements, then use *endless* which has a 16-day maximum. Be sure to keep an accurate record of how long the measurement was made; longer is better to keep timing errors to a minimum.
   - If you know how long you want to measure, then select one of the preset times (four minutes to eight days). Use that time value to calculate the watt-hours unless you stop 43B record mode before it stops itself. In that case, record the measurement time at which you stopped the recording.

Fluke 43B recording mode with record time selections from four min to endless (16 days).

6. Start the recording.
7. Press the *hold* button to stop recording unless you are going to let it automatically stop on one of its preset values.
8. Before turning off the 43B or disconnecting the voltage leads and the current clamp, write down the average watt values or save the screen information in one of the save memories.
9. Perform the math as shown earlier in this application note.

Note: On the 43B, you can log watts, but not watt-hours directly to a PC (at one reading every second or slower). The PC software can output a .csv data file so that you can use Microsoft® Excel or other data analysis PC software to do the watt-hour calculations after the test is over.

Using the Fluke 39 Power Meter or 41B Power Harmonics Analyzer

When using a Fluke 39 or a 41B (or the older 40 or 41) to measure the average watts, use the *record mode*. To make watt-hour measurements with these meters:

1. Be sure to start with fresh batteries (three days is the maximum time between changes with alkaline batteries).
2. Be sure the voltage leads and the current clamp are connected before starting the record mode (see pages 10 through 13 of the manual for hookup diagrams).
3. Make sure the wattage readings are correct before starting the *record mode*. Also, it is best to leave the meter in the *auto mode* (via the range button) so that the meter does not overload when the voltage or current increases.
4. Keep an accurate record of how long the measurement was made. A longer period of time is better. Save your readings and jot down the average watt values before turning off the *record mode*. Turn off the meter before its batteries run down, or before you disconnect the voltage leads and the current clamp.
5. Perform the math as shown earlier in this application note.

Note: With the 41B with version 3.0 or higher PC software, you can log watt-hours directly to a PC (at one reading every ten seconds or slower).

Load cycle considerations

When making average watt measurements, be sure to take into consideration the load cycles you're working with.

Long cycle loads: If the load creating the watt draw has a long on/off cycle, like a refrigerator, be sure to measure long enough to include several on/off cycles to get a good representation of the average watts. If possible, try to stop the measurement at an even number of on/off cycles to reduce measurement errors.

Short cycle loads: It is not advisable to use these models for situations where loads can cycle on and off or make large changes faster than one per second (ten per second when using a PC to log watts from a 41B). Wattage values may be not measured completely.

Glossary

Apparent Power (kVA)	In an ac circuit, the power value obtained by multiplying the current by voltage (P equals IE), with no consideration of the effects of phase angle.
Kilowatt	1,000 watts
Reactance (X)	The opposition offered to the flow of alternating current by pure capacitance, inductance, or a combination of the two.
Reactive Power (kVAR)	The product of kilovolts and amperes in a reactive component of a circuit.
Real Power (kWh)	The apparent power multiplied by the power factor in an alternating-current circuit containing reactance. Real power is the difference between the apparent power and the reactive power. Actual radiated or dissipated power cannot exceed real power.
Watt-hour (WH)	A unit of electrical energy or work. It is defined as one watt of power sustained for one hour. A 13-watt lamp operating for 6 hours would consume (13 W) x (6 hrs) = 78 WH. A larger unit of measurement is the kilowatt-hour (kwh), which is 1000 WH.

For accurate measurement of short cycle loads, use a power recorder with high resolution capabilities, such as the Model 1650 from Reliable Power Meters, A Fluke company.

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