

Application Brief - Switching Inputs to Digital Meters Part II

Using a single 8200 Series AC Digital Meter to monitor multiple AC voltages and currents

Switching Inputs on AC Meters

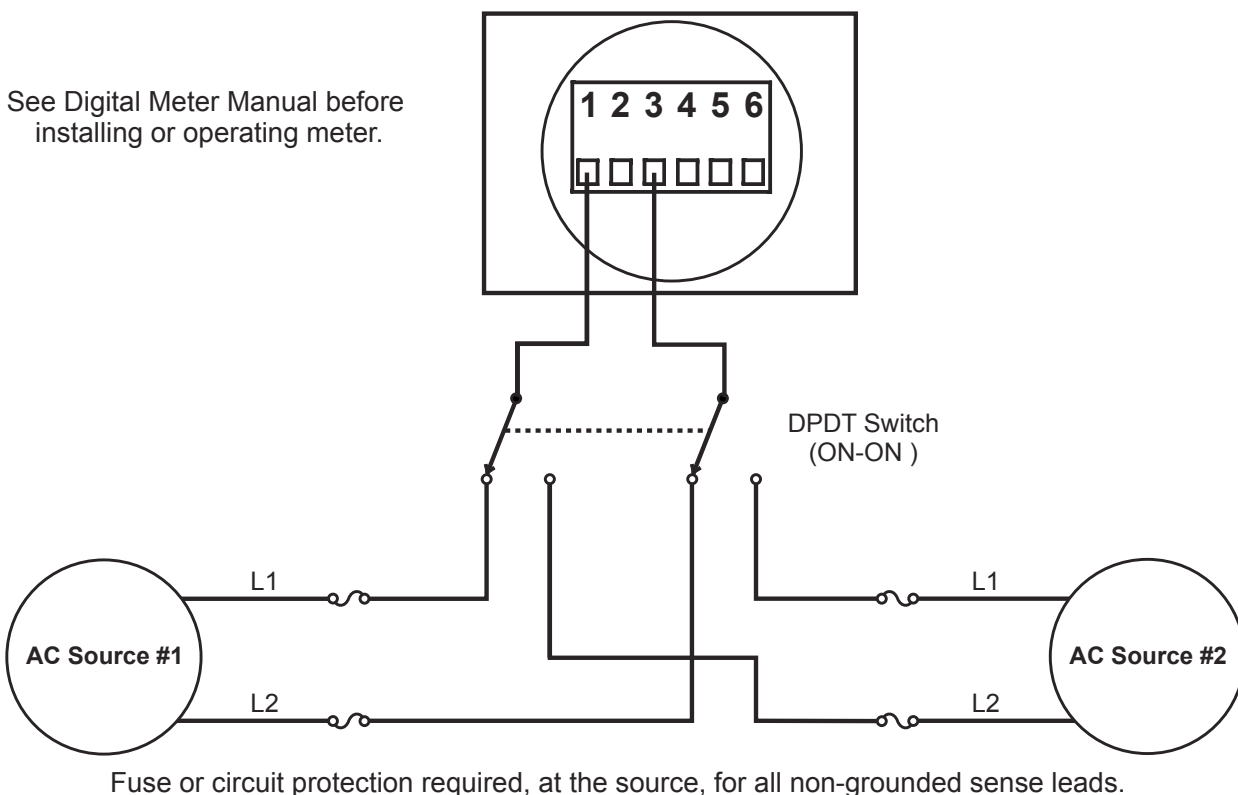
AC Digital Meters (Models 8237, 8238, 8239, and 8247) are powered by supplying 70-270VAC to terminals 1 and 3 on the back of the meter. These terminals provide power to the internal electronics and microprocessor and provide voltage sensing input for the meters that display voltage. The current transformer inputs are supplied on terminals 4 and 5 and may be switched between any number of current transformers, measuring any currents of interest. Care should be taken to not leave a completely open circuit across the unused current transformer terminals. A shorting switch may be used, a resistor may be wired across the terminals or zener diodes may be used to limit the terminal voltage. Excessive voltage can cause circuit damage. Switching voltage also requires some special precautions.

AC Voltage

There is no separate voltage sensing for the AC meters, this means that to measure multiple voltages the power to the meter is switched from one source to another. The meter's internal power supply can tolerate temporary transients but if the "off time" is too long the meter will go through its power up process. This does not damage the meter; it is simply a bit of an inconvenience. Choosing the correct switch can help eliminate this.

For example, to use an 8237 Digital Voltmeter to monitor two different AC voltage sources it would be best to use a Double Pole Double Throw (DPDT) switch that has an ON-ON operation as in Drawing 3. This type of switch has the minimum switching time. If a switch that has an ON-OFF-ON operation is used the transition through the center OFF position will likely cause the meter to de-power and re-power. However the center OFF position could be used to intentionally de-power the meter if that was desirable in the particular system design.

Switching Voltage Inputs To an 8237 Digital Meter



Drawing 3

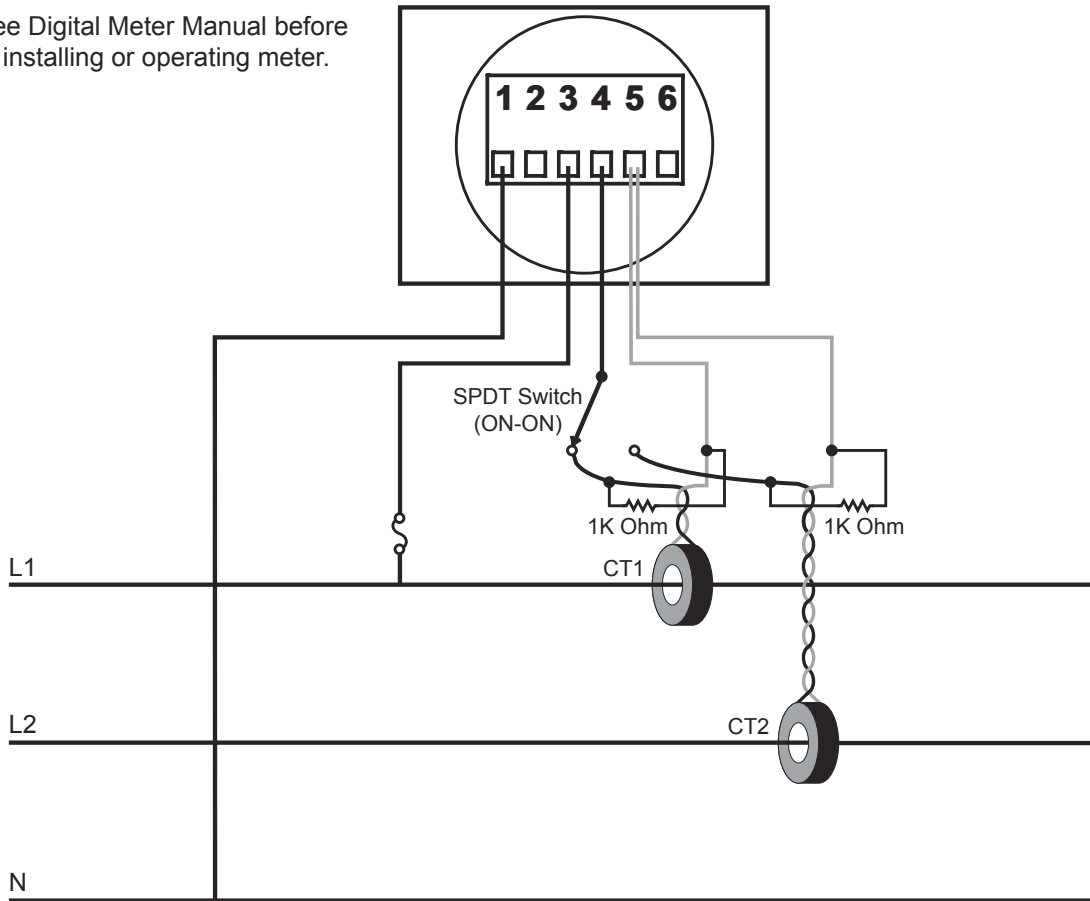
Note that both voltage sense leads are shown with circuit protection. Protecting the sense leads from faults is required for all ungrounded conductors. If one of the sense leads connects to a grounded neutral (i.e. a 120VAC system), then it does not require fusing. See the manual regarding fusing specifics.

AC Current

The current measurement input for Models 8247 and 8238 is supplied from a Current Transformer (CT). The CT generates an output of 50mA when a current of 150A is flowing in the conductor which is passed through the center of the CT (Please see the installation manual for more information on CTs.). It is possible to switch various CT inputs to the meter's input terminals 4 and 5. This very similar to switching shunt inputs, except a Single Pole Double throw switch may be used since one side of the CTs can be connected together in common, and to terminal 4 or 5. (Please review installation manual regarding determining the polarity of the CT when using Model 8247.) Drawing 4 illustrates this switching arrangement.

Using 8238 or 8247 Digital Meters to Measure Multiple Currents

See Digital Meter Manual before installing or operating meter.



Drawing 4

120/240V Systems: Switching Both AC Voltage and AC Current Inputs

Perhaps the most common application requiring the measurement of multiple voltages and currents is the typical single-phase 120/240VAC system. To fully instrument such a system requires measuring three voltages and three currents:

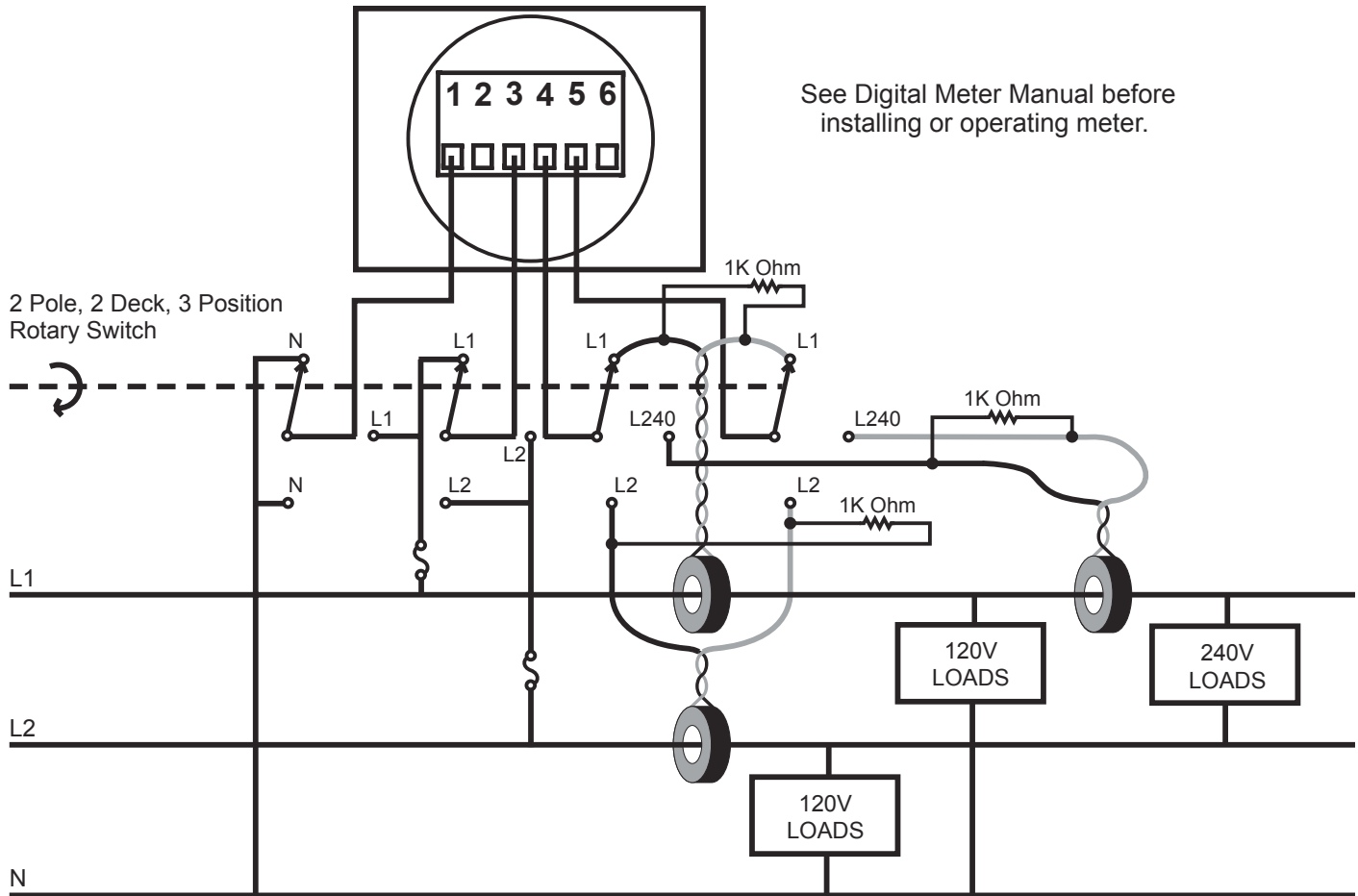
- 1) Line 1 to Neutral voltage
- 2) Line 2 to Neutral voltage
- 3) Line 1 to Line 2 voltage
- 4) Line 1 total current
- 5) Line 2 total current
- 6) Current flow in only the 240V loads

A review of the [Tech Brief in Newsletter 6](#) shows where to place the current transformers needed to monitor these current flows. This approach requires that the 240V loads on the system be "down stream" from the 120V loads. In other words, all of the 120V loads are connected to the bus ahead of the 240V loads. If the bus arrangement cannot be setup in this manner it may only be possible to monitor Line 1 and Line 2 current.

The AC Multimeter Model 8247 is an excellent choice for this type of system. Using a Double Pole, Two Deck, three-position rotary switch is the best way to switch the inputs to the meter. This switch configuration ensures that the voltage and current being measured are with respect to the same lines. When the switch is in the L1 or L2 position Line 1 or Line

2 voltage and current are monitored. When it is in the L1-L2 position, the voltage and the current monitored will be that of the 240V bus. Drawing 5 shows how to wire such a switch and meter arrangement for a 120/240V system. All current transformers are capable of delivering very high voltages if they have no load applied to the sense terminals. It is industry practice to use make-before-break switches to short the current transformer output before it is removed. These switches are relatively expensive and available in limited configurations. Because Blue Sea Systems current transformers generate relatively low levels of metering current (50mA full scale) it is possible to absorb the output current with resistors or zener diodes without seriously impacting the measurement accuracy. Connect the voltage limiting devices across the terminals of the current transformer as shown in the diagram. A suitable value of resistor for use with Blue Sea Systems meters is 1000 Ohms, which limits peak voltages to a theoretical maximum of 50 Volts at the full capacity of the current transformer. A 1000 Ohm resistor results in the meter reading 0.3% lower than the actual value, a generally negligible impact on accuracy. Because the current transformer core saturates, the power dissipation in the resistor is under ¼ Watt.

8247 Meter & Rotary Switch Wiring For 120/240 Volt AC



Drawing 5

It is critical that the loads be arranged as shown, otherwise the 120V and 240V load currents cannot be separated. Wired as shown, any current required can easily be calculated. For example: If Line 1 current was 10 Amps, Line 2 current was 20 Amps, and the 240V load current was 5 Amps, then the 120V loads on Line 1 total $10A - 5A = 5A$. Similarly, the 120V loads on Line 2 equal $20A - 5A = 15A$.

It is also possible to monitor the current flow to, or from, a particular load or source, by simply passing the circuit's hot or neutral wire through its own CT. As many CT's as desired may be installed by using a multiple position rotary switch.

Current transformers may be connected with their outputs in parallel to measure the sum of currents flowing in multiple conductors. This can be convenient when the wire size is so large that multiple conductors will not fit through a single current transformer or it is inconvenient to run the wires together. When connecting in parallel, be sure that the direction of current flow and the connection of the leads is in phase to produce addition and not subtraction. If subtraction is observed, reverse the output terminals of one transformer at a time until they are all adding when load is added to the system. If the Watt measurement function is active, the polarizations of each current transformer coil must be made to conform to the polarity that generates the appropriate Watt measurement.

A Product to Help

Blue Seas Systems 8410 panel incorporates a very high-quality switch, with knob in a stock 3.75" x 5.25" Blue Sea Systems panel into which an 8247 AC Digital Multimeter can be mounted. It includes 2 additional Current Transformers (PN 8256) allowing it to be wired as described by Drawing 5.

Closing Thoughts

Switching voltage and current sensing inputs to the 8200 Series Digital Meters can expand their capability and allow more complete system monitoring. Wiring complexity is naturally increased. Be careful not to accidentally switch the system voltage on to terminal 4 and 5, the current sensing inputs, particularly for the AC meter, as it will suffer serious damage. If during startup and testing there is a question about the values being displayed bypass the switch and feed the input directly to the appropriate terminals on the meter. In this way correct operation of the meter can be verified as a separate issue from the correct wiring of the switched inputs. Comments or questions regarding this technical brief can be sent to: conductor@blueseas.com or phoned to 360-738-8230. Additional information is also available at www.blueseas.com under the technical tab.