WHITE PAPER

CAS DATALOGGERS

Measure Voltage and Current Using a Data Logger

Mastering AC and DC Current and Voltage Measurements

A common data logging application is measuring voltage or current flowing into or out of a piece of equipment, such as a user monitoring current in solar cells, inverters, or storage batteries. These measurements can be broadly classified into two groups: AC and DC. Depending on the levels involved, some data logger models can directly measure DC voltage and current. For example, the dataTaker DT80 family of data loggers can accept DC voltages up to +/-50 volts. Except for power/energy application-specific models, most data loggers cannot measure AC voltage or current directly and require external transducers to convert the parameter of interest into a signal that the data logger can measure and record. Here at CAS, we discuss these applications with customers daily and have put together this brief guide covering the basics of voltage and current measurement.

AC Voltage and Current Data Loggers:

For AC applications, there are several types of data loggers specifically designed to measure voltage and current. These include units supplied with current transformers or Rogowski coils supporting a specific current range.

If you need to monitor AC signals that don't match up to the range of these recorders or need to monitor a mix of AC and DC voltage and/or current inputs, you can use a Universal Input Data Logger. These can be outfitted with transducers to measure almost any type of input, from mV and uAmps to thousands of volts or amps.

AC Voltage Measurements:

- **AC Voltage Transducers** - If your application involves tracking incoming line voltage, several vendors provide standard AC voltage transducers for measuring typical AC line voltages from 110 to 480 VAC. There are also specialized models for either low voltages such as 12 VAC found in some control circuits or potential transformers that can step down very high voltages – 5000 to 14,440 VAC – to 120VAC than can be measured using a standard transducer. These are available in both single and multi-phase versions and with either DC voltage or 4-20mA current outputs scaled to output average or True RMS values.
- A**C Voltage signal conditioner modules** - If your application requires the measurement of small AC voltages or a large number of channels, 5B series signal conditioner modules are available with 100 mVAC to 700VAC inputs.
- **AC Voltage Isolators** – Some applications require recording the actual AC voltage waveform to look for anomalies that last less than one line cycle. Voltage isolators provide a scaled output voltage that is directly proportional to the input voltage, for example, 150VAC in to ± 5VDC out.

AC Current Measurements:

- **AC Current transducers** - A standard method of measuring AC current for a power line-connected device is to use an AC transducer which converts an AC to a DC voltage or 4-20 mA signal that can be measured with the data logger. As is the case with AC voltage sensors, current transducers are available in both single-phase and multi-phase models. The current transducers can utilize either an internal current-sensing element for small currents up to about 20 AAC, or an external current transformer or sensor for currents up to thousands of amps.

- **Clamp-on current sensors** – Clamp-on current sensors are available in a variety of models and current ranges with either DC or AC voltage outputs. Clamp-on sensors are easy to use: simply open the clamp and place it around one of the current-carrying

conductors. They are ideal for temporary installations and can easily be moved from site to site, although they are somewhat more expensive than fixed current transducers.

- **Split-core transformers** - Split-core transformers are very similar to clamp-on current sensors but are intended for semi-permanent installations. They consist of a transformer where one of the legs can be opened or removed to place around the conductor and then be secured with a latch or some other type of fastener. Some models provide an AC output that must be used with a current transducer to provide a signal for the data logger, while other models have built-in signal conditioning to provide a DC voltage or current that can be measured with the data logger.
- **Rogowski coils** - A Rogowski coil is a specially wound toroidal coil that can be opened up and placed around a conductor carrying an AC. The alternating magnetic field generated by the AC induces a voltage in the coil. This voltage is proportional to the rate of change of current in the conductor. This voltage is then electronically integrated to provide an output voltage that mimics the current waveform in the conductor. Rogowski coils are suitable for the measurement of currents up to thousands of amps.

DC Voltage and Current Data Loggers:

For DC applications, there are data loggers specifically designed to measure voltage and current using probes such as the Electrocorder DC3-VA that can be directly connected to the signal source. These models typically cost less and are easier to set up, but in turn, they offer less flexibility. If you think that

your range of measurements may change in the future, use a data logger with an external transducer which will allow you to change the input range by connecting a different transducer.
Again, if you need to log other signals in addition to voltage/current, or if you need to monitor a mix of DC and AC voltage/current, you can configure a general-purpose Universal Input Data Logger with appropriate transducers to enable the simultaneous measurement of multiple input signal types.

DC Voltage Measurements:

Attenuators - The simplest method of measuring a DC voltage that is outside the measurement range of the data logger is to use an attenuator. This is just a fancy name for a few resistors wired together to divide the incoming voltage to a range compatible with the data logger. If the voltage you need to measure is less than about 50 VDC they can provide a low-cost solution. However, the OSHA considers anything above the level as hazardous and we don't recommend them for these applications. Also, there are three issues to note when using attenuators:

- There is no isolation which can lead to cross-talk and measurement errors when using more than one attenuator.
- If the low side of the DC voltage is not at earth potential, the common mode voltage can cause errors and in the worst case damage to the data logger.
- The divider imposes some resistive loading which can affect the measurement accuracy, particularly in sensors with a high output impedance.

- **DC voltage transducers** - Several companies offer packaged DC voltage transducers that convert the incoming voltage to a range that is compatible with the data logger. These units offer the advantages of being able to measure very small (< 0.1) and very high (>1000) volt inputs, they have input to output isolation, and they only cause minimal loading effects. DC voltage transducers can also provide an output either as a voltage or as a 4-20 mA signal, which is beneficial if there is a long distance between your measurement point and the data logger.

- **Signal conditioner modules** - Standard signal conditioner modules such as the ubiquitous 5B series provide up to 1500 volts of isolation and amplification or attenuation in compact packages that are suitable for multi-channel systems. They are available in a wide range of input voltages and provide a DC voltage output. Because of their small size and their ability to mix and match input types and ranges, signal conditioner modules are very useful in systems with a high channel count.

DC Current Measurements:

- **Current Shunts** - A current shunt consists of a conductor with a very small (but known) resistance. The current flowing through the shunt creates a voltage drop that can be measured with the data logger. These are available in ranges to handle 5 to 1000 amps and provide an output from 0 – 0.100 volts. Like the attenuators for DC voltage measurements, you must pay attention to common mode voltage when using current shunts; we always recommend that they be used on the low side of the current path. The advantage of current shunts is their simplicity and low cost but they should not be used for an extended period at more than 2/3 of their rated current or the accuracy may be affected.

- **DC Current Transducers** - DC current transducers often utilize a Hall Effect sensor to allow current measurement without direct contact with the conductor. The disadvantage of these sensors is that they typically have limited resolution for lower currents; however, they work very well for higher currents.

For further information on how to measure voltage and current using a data logger, or to find the ideal solution for your application-specific needs, contact a CAS Data Logger Application Specialist at **(800) 956-4437** or www.DataLoggerInc.com.