Ample Power Company

# Instrumentation

An Amp–hour is the product of Amps times time. One Ampere for one hour is one Ah. Five Amps for two hours is 10 Ah. This apparent simplicity is mis–leading, since the amount of Amp–hours that a battery can provide is dependent on the rate of discharge. The faster the rate of discharge, the less total Amp–hours will be provided.

To account for rate of discharge, Peukert's exponential equation must be used. This is hard to do with a small microcomputer, and only Ample Power has been able to accomplish the task at this date. For more information about this critical subject consult the book *Wiring 12–Volts for Ample Power*.

## Amp–Hour Instruments

There are two different Ample Power instruments that measure Amp–hours consumed. One of these, the Energy Monitor/Controller also display Amp–hours remaining, which requires the use of Peukert's exponential equation that relates battery capacity to rate of discharge.

Not all instruments are created equally. There are many different ways to measure Volts, Amps, and Amp–hours, but there is only one right way . . . the Ample Power way. We take pride in offering the highest resolution and the highest accuracy of any meters presently available. Here's some of the techniques we use to assure that we provide correct readings, and they will remain correct over temperature variations and the many years we expect our instruments to survive.

- Extensive input filtering of the analog signals is done to avoid errors caused by electrically noisy power conductors, radios, flourescent lights, chargers, pumps, radars, and many other typical onboard devices.
- At least 256 measurements per channel are taken every second and digitally filtered to remove errors produced by slow sampling systems known as 'aliasing' errors.
- Digital to analog conversions are done with a resolution of better than 0.025% of full scale.
- A temperature compensated reference with guaranteed drift over time is used.
- Critical measurements, such as battery current are done with precision shunts which only lose 0.05 Volts at rated current. These shunts are connected in the negative side of the battery since there is no economical method to attain accurate measurements in the positive side of the battery.

Besides being the most accurate, the Ample Power instruments will remain that way far longer due to superior packaging techniques.

## About "Loops"

Current sensors are made with a magnetic loop which circles the wire and generates a signal proportional to the current flowing in that wire. The "loops" have the advantage that they are isolated from the current being measured, and as a result, are widely used to sense currents in AC/DC operated motor leads in the industrial environment.

Sensing current in motor leads is done to detect high currents that may damage the motor or the motor drive electronics. No great precision is required, and measurement of low currents isn't even of interest. In the battery system, measurement of low currents is of great interest, and precision a mandate.

Why would loops be introduced as mechanism for measuring battery currents? With a marginal isolation advantage, and so many inaccuracies and increased power consumption resulting from loop use, we can only conclude that marketing won the day over good engineering practices. The day that loops can do a better job of accurately measuring both low and high level currents than can shunts, will be the day that they will be part of the Ample Power product line.