Glossary

Bidirectional - Ability of the device to measure current in both negative and positive directions.

Unidirectional - Unidirectional current sensing measures current in one direction only. The opposing direction is sensed as zero.

Output common mode - Shift of the output voltage by a certain value in order to allow bidirectional measurement. When using op amps, a small output common mode also prevents output from entering saturation and therefore provides better response to small currents.

Supply voltage - Common voltage which is applied to both inputs of the circuit. This voltage is not part of the useful signal and should not be amplified.

Common-mode rejection ratio (CMRR) - Measure of a device’s ability to filter out the common mode voltage. This is important for high-value or low-value current sensing.

Input offset voltage (Vio) - Difference between V+ and V- inputs in order to obtain the output at the mid-range of the supply voltage. It originates from the matching of internal transistors.

Input offset voltage drift (dVio/dT) - Drift of the input offset voltage with temperature. This might be important for motor control applications.

Input bias current (Iib) - Current flowing through device inputs. Due to device biasing requirements and normal operation leakage, a very small amount of current (pA or nA range, depending on the technology) flows through its inputs.

Current sensing - Ability of the device to measure current in both negative and positive directions.

Gain bandwidth product (GBP) - Product of the gain and maximum small signal frequency. A circuit able to amplify 10kHz with 40dB gain has the same GBP as a circuit amplifying 100kHz with 20dB gain. This parameter is specified in op amp datasheets.

Bandwidth (BW) - Signal frequency at which the amplitude drops by 3dB. This is specified in datasheets for current sense monitors.

For more information, visit us on http://www.st.com/current-sense-amplifiers and www.st.com/opamps
Current sensing is important in many industrial and automotive applications like motor control, battery management, power management, and many others. ST provides solutions for these applications based on operational amplifiers and integrated current monitors for shunt current sensing.

**HOLD IT WHERE IT MATTERS**

Our current sensing solution involves a shunt resistor and the straightforward application of Ohm’s law. An amplifier is placed on the current path and the linear voltage drop is amplified to derive a precise current measurement.

All resistors dissipate power in the form of heat, and this unwanted effect is also present to some extent in shunt resistors. As a lower shunt resistance value will increase the impact, the drawback is that higher amplification gain will be required, which lowers overall measurement precision.

**POSITION OF THE SHUNT**

Shunt resistors can be placed in several different locations to measure current through an application. Each of these has certain advantages and disadvantages.

- **High-side –** Shunt resistor is placed on the power rail. In this case, the current sensor is directly on the supply voltage, so its maximum input common mode voltage needs to be high enough to manage the supply voltage. High-side shunt resistors are used in applications where ground cannot be cut for mechanical reasons, RF disturbances, or other currents flowing to ground.

- **Low side –** This method can be costly if accuracy and speed are expected. Can be used in applications where ground disturbances are not a concern. For example, if the shunt is placed on the motor and some energy losses are allowable, this can be sacrificed for faster sensing.

- **In-line –** Also called phase current sensing. Shunt resistors can be placed inline with motors in motor control applications, but this requires bidirectional current sensing. While it offers the advantage of tracking current all the time, fast voltage transients will be present due to the switching activity of the H-bridge, and the device must be able to recover quickly after transients will be present due to the switching activity of the H-bridge, and the device must be able to recover quickly after

- **Bidirectional in-line or unidirectional**

  Battery management systems
  - Low voltage motor control
  - Wireless infrastructure

**INTEGRATED OVERCURRENT PROTECTION (OCP) VS OP AMPS**

One of the key points in preventing damage is an application in the ability to measure current variations very quickly and accurately. Current sensing with a comparator circuit is a method commonly used to detect an overcurrent. In many applications with input common mode voltage below 30V, the choice between a current sense monitor or operational amplifier is a matter of designer preference.

**SHUNT RESISTOR VALUE AND SIZE**

The final shunt value should always be smaller than the theoretical value to account for imperfections and errors. A smaller shunt value also gives some margin to measure overcurrent and prevent saturation. The maximum power dissipation of the shunt resistor must be higher than the calculated value.

**ST PRODUCT AND PORTFOLIO**

**APPLICATIONS**

- Battery management systems
- Low voltage motor control
- Wireless infrastructure

Current sensing is not required up to 48V. Can be adopted, isolated current sensing is not required up to 44V.