

Introduction to BMS for HEV and EV

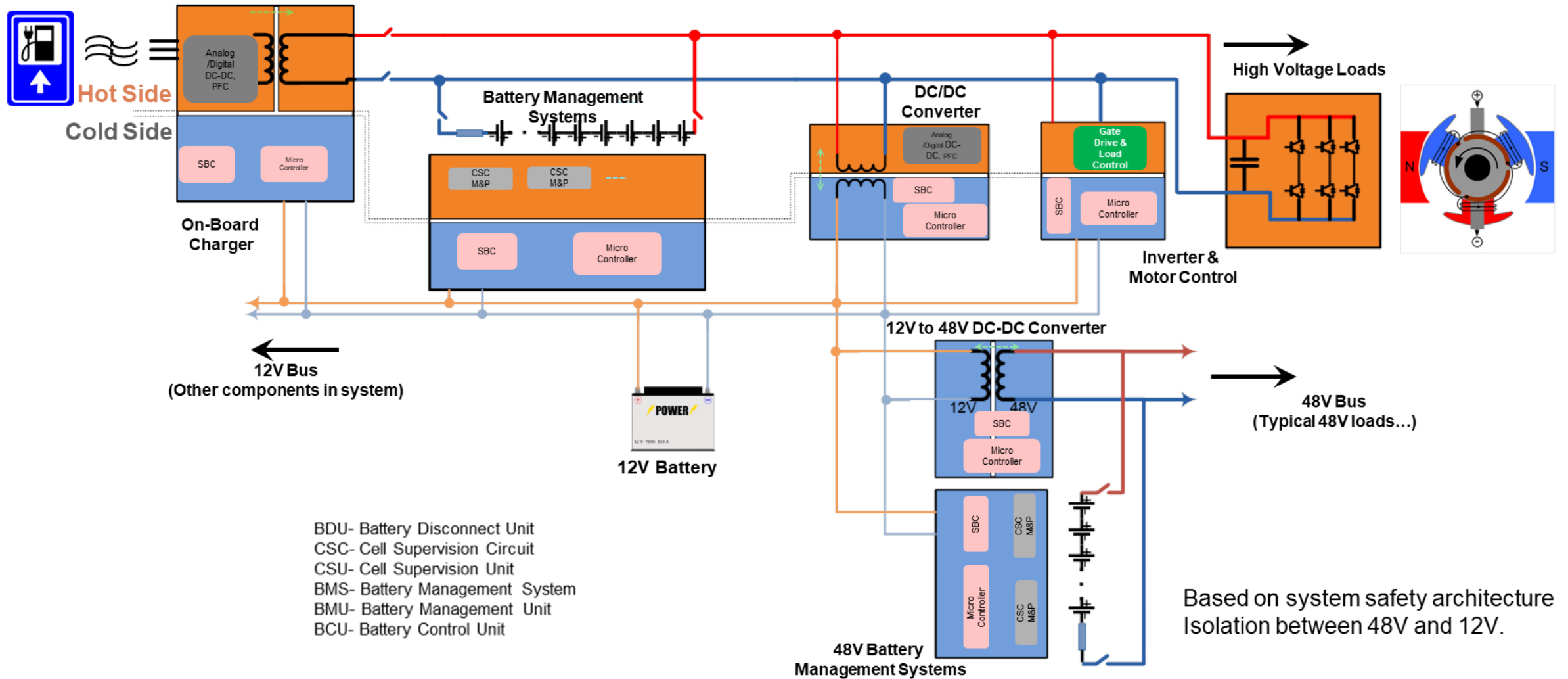
From a current sensing perspective

Guang Zhou
Applications Engineer
Current and Magnetic Sensing

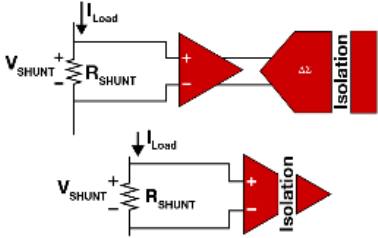
Topics

- BMS overview
- TI current sensing amplifier portfolio
- Current sensing amplifiers for high and low voltage BMS
- Nonisolated shunt based current shunt monitors for BMS.

HEV/EV BMS System Overview – Where Does CSA Fit?



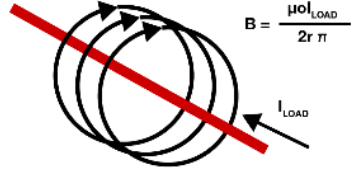
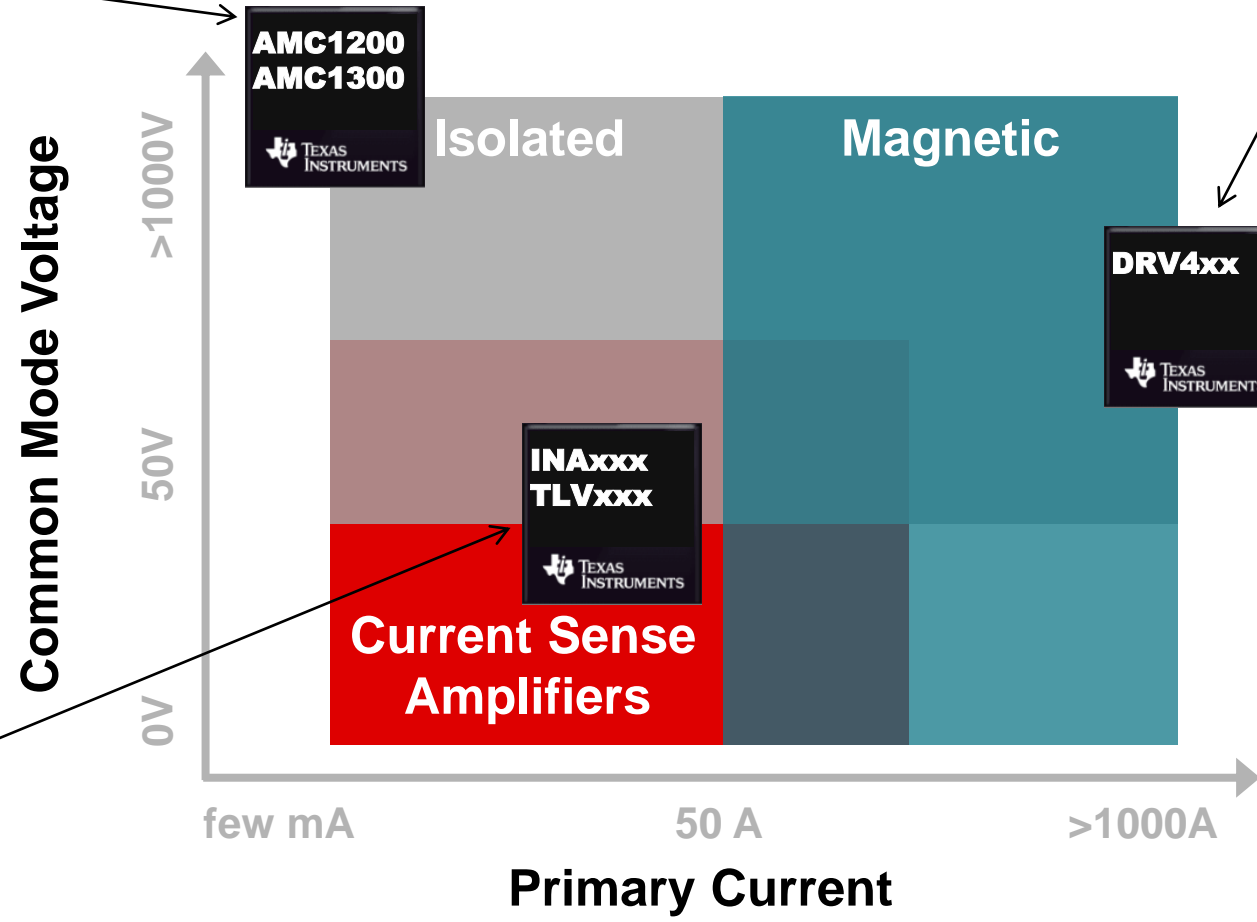
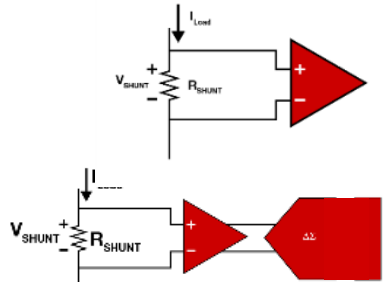
TI Current Sensing Solutions



Isolated Options

Directly measures the current through a relatively small ohmic valued (shunt) resistor.

Non-Isolated Options

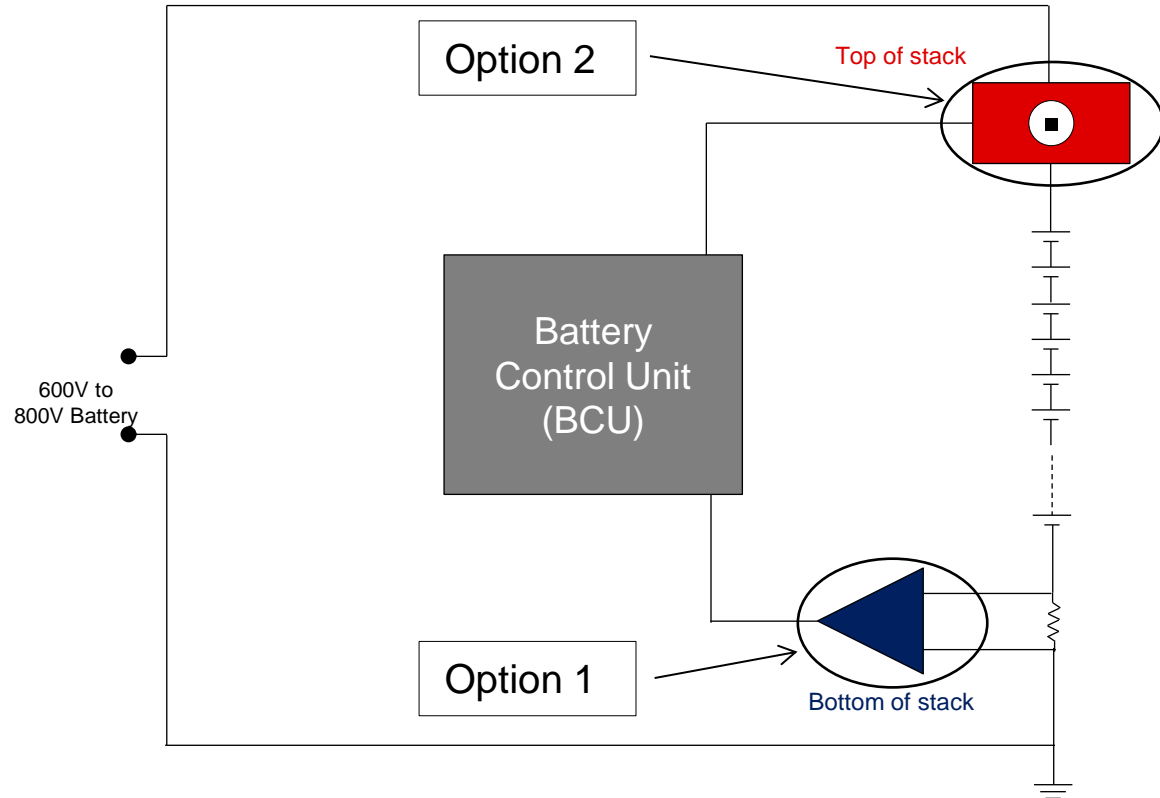


Non-invasive & Isolated

Magnetic sensing indirectly measures the load current by measuring the magnetic field produced by a current running through a conductor.

TI Current Sensing Solutions for EV Battery Management Systems

Current measurement options for EV Battery Management Systems (BMS)



TI EV Battery Management System Current Sensing Solutions

Top of Stack Current Monitoring Option 2

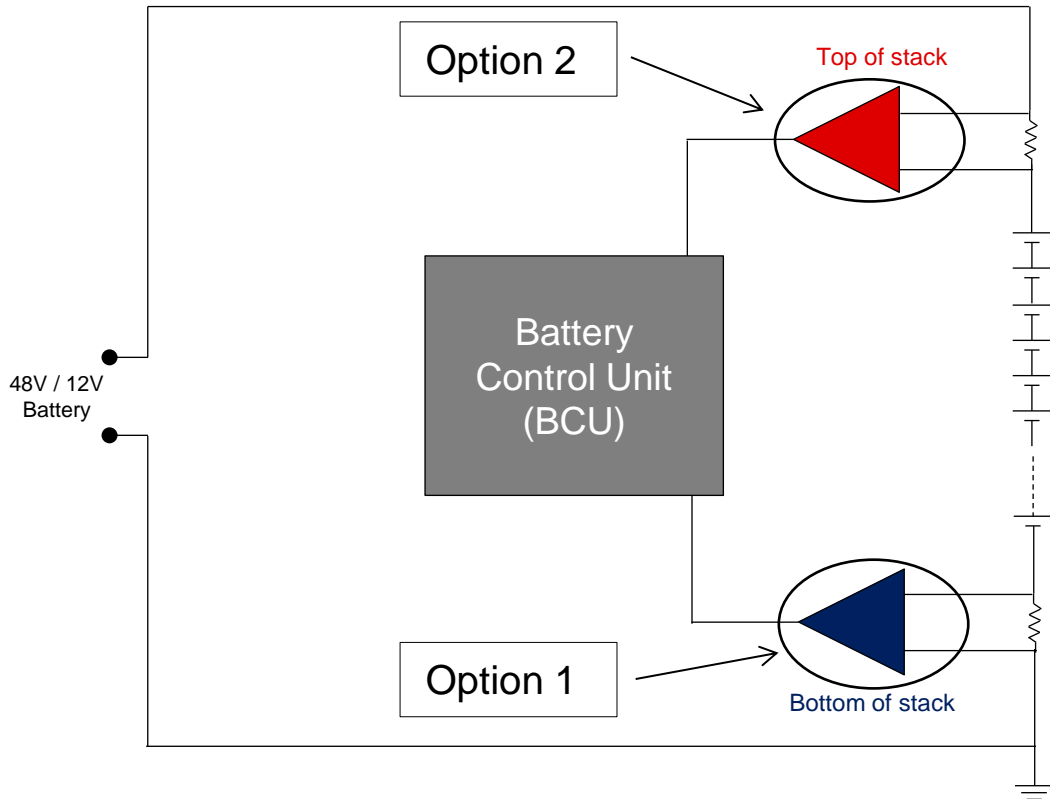
Device	Offset	Drift	Sensor Range	Gain Error	Gain Error Drift	Comment
DRV425	$\pm 8\mu\text{T}$	$\pm 5\text{nT}/^\circ\text{C}$	$\pm 2\text{mT}$	$\pm 0.3\%$	$\pm 5\text{ppm}/^\circ\text{C}$	Isolated

Bottom of Stack Current Monitoring Option 1

Device	V_{CM} Range	$V_{\text{OS}} / A_{\text{OS}}$	V_{OS} Drift	Gain	Gain Error	Gain Error Drift	Comment
INA181	-0.2V to +26V	500 μV	1.0 $\mu\text{V}/^\circ\text{C}$	20, 50, 100, 200	1.0%	20ppm/ $^\circ\text{C}$	Low cost
INA381	-0.2V to +26V	500 μV	1.0 $\mu\text{V}/^\circ\text{C}$	20, 50, 100, 200	1.0%	20ppm/ $^\circ\text{C}$	Integrated Comparator
INA226-Q1	0V to +26V	10 μV	0.1 $\mu\text{V}/^\circ\text{C}$	1	0.1%	50ppm/ $^\circ\text{C}$	I ² C Compatible Current/Power
INA28x-Q1	-14V to +80V	70 μV	1.5 $\mu\text{V}/^\circ\text{C}$	50, 100, 200, 500, 1000	1.4% 1.6%	50ppm/ $^\circ\text{C}$	Wide CMV
INA19x-Q1	-16V to +80V	3mV	2.5 $\mu\text{V}/^\circ\text{C}$	20, 50, 100	1.0%	100ppm/ $^\circ\text{C}$	Wide CMV
INA240-Q1	-4V to +80V	25 μV	0.25 $\mu\text{V}/^\circ\text{C}$	20, 50, 100, 200	0.2%	2.5ppm/ $^\circ\text{C}$	Ultra-high Precision

TI Current Sensing Solutions for 48V/12V Battery Management Systems

Current measurement options for 48V/12V Battery Management Systems (BMS)



TI 48V/12V Battery Management System Solutions

Top of Stack Current Monitoring Option 2

Device	V_{CM} Range	V_{OS}/A_{OS}	V_{OS}/A_{OS} Drift	Gain	Gain Error	Gain Error Drift	Comment
INA240-Q1	-4V to +80V	25 μ V	0.25 μ V/ $^{\circ}$ C	20, 50, 100, 200	0.2%	2.5ppm/ $^{\circ}$ C	Ultra-high Precision
INA28x-Q1	-14V to +80V	70 μ V	1.5 μ V/ $^{\circ}$ C	50, 100, 200, 500, 1000	1.4% 1.6%	50ppm/ $^{\circ}$ C	Wide CMV
INA19x-Q1	-16V to +80V	3mV	2.5 μ V/ $^{\circ}$ C	20, 50, 100	1.0%	100ppm/ $^{\circ}$ C	Wide CMV

Bottom of Stack Current Monitoring Option 1

Device	V_{CM} Range	V_{OS} / A_{OS}	V_{OS} Drift	Gain	Gain Error	Gain Error Drift	Comment
INA181	-0.2V to +26V	500 μ V	1.0 μ V/ $^{\circ}$ C	20, 50, 100, 200	1.0%	20ppm/ $^{\circ}$ C	Low cost
INA381	-0.2V to +26V	500 μ V	1.0 μ V/ $^{\circ}$ C	20, 50, 100, 200	1.0%	20ppm/ $^{\circ}$ C	Integrated Comparator
INA226-Q1	0V to +26V	10 μ V	0.1 μ V/ $^{\circ}$ C	1	0.1%	50ppm/ $^{\circ}$ C	I ² C Compatible Current/Power

Current-Sensing for BMS Applications in HEVs and EVs

- Literature number [SBAA324](#)
- Shunt based current sensing in low voltage (12V – 48V) BMS

INA226-Q1 for Low Voltage BMS

- Literature number [SBAA325](#)
- INA226 features
- How to optimize speed and accuracy with INA226

For more info www.ti.com/currentsense

Application

- $\pm 100\text{A}$ Bus Bar Current Sensing EVM
- Isolated / Lossless Current Measurement

