Adding Temperature Compensation to AASTO Battery Charger

Background.

Temperature compensation of lead acid battery chargers is important to maintain battery life and charge efficiency. A non-compensated charger will over charge the batteries at elevated temperature, resulting in reduced battery life, radically so if out gassing occurs. At lower temperatures a non compensated charger will undercharge the batteries resulting in a lower charge efficiency and of course lower battery power availability (if the low charge state of the battery results in deep discharge then this will also radically reduce battery life).

Lead Acid Gel Cells.

A 24V lead acid gel cell will typically float charge at 27.6V @25°C with a temp co of –50mV/°C. Boost charge will typically be at 29.4V @25°C.

Problems.

Adding temperature compensation to the AASTO battery charger raises a number of design problems.

The original facilities of current limit and boost charge should be retained.

Calex, the manufacturer of the DC DC converter, do not release details of the trim network. Hence it has unknown and unspecified characteristics.

The temperature sensing should faithfully reproduce the temperature of the batteries – this is especially important at very low temperatures where much of the initial charge results in battery heating rather than battery charging. In some situations charger PCB temperature maybe adequate (often used in commercial chargers), ambient is better (and used in better chargers), best is temperature sensing of the actual battery under charge. If a remote temperature sensor is used then, ideally, the circuit will still continue to function sensibly if the sensor is unplugged.

Power consumption of the temperature compensation network should be very low.

Circuit complexity should be low and the circuit must self start upon power up.

Proposed solution.

The proposed solution is based upon an Analog devices AD590 IC. This two terminal device gives 1µA of output current for each °K. As the device is a current source it can be operated with considerable lead impedance and hence can easily be used as a remote temperature sensor.

The proposed circuit is a modification of a remote sensing circuit given in Calex application note 410. It uses feedback to the trim pin to set the output voltage, detailed specification of the trim function is not required.

At low output voltages, when REF is less than 2.5V, IC1 (TL431I for extended temperature range) will be off, hence Q1 will be off and the Trim pin will be low forcing the output voltage up. Using this feedback mechanism IC1 will try and keep REF at 2.5V.

REF is formed by a potential divider of VR1 and R4, with the AD590 in parallel with VR1. Hence the current through R4 is the sum of the currents from the AD590 and from VR1.

But at REF of 2.5V I3 is 2.5/3K and at 25°C I1 will be 298µA from the AD590 Hence VR1 will be adjusted to about 46.9K to give an output of 27.6V
At 0°C, the output of the AD590 will have fallen to 273µA and the feedback loop will increase the output voltage to 28.8V to keep REF at 2.5V. Temp co −48mV/°C

The boost line switches into the potential divider network VR2. which tries to lower REF and hence the output increases.

At 25°C and with a VR1 of 46.9k, VR2 will need to be adjusted to about 65.1K to get an output voltage of 29.4V. At 0°C the output raises to 30.6V to keep REF at 2.5V, Temp co −48mV/°C.

Note that all devices in a circuit have individual Temp co’s which combine to give an overall Temp co. The Temp co of the Calex converter is removed by the feedback loop. The Temp co of VR1 should be as low as possible by choosing a high quality multi-turn pot. The Temp co of IC1 the TL431 is maximum 0.2mV/°C and typically 0.05mV/°C resulting in a Temp co at the output of maximum 3mV/°C and typically less than 1mV/°C, sign depends upon temperature but the value is small enough to be ignored.

The circuit can operate without the AD590 in place by adjusting VR1 to around 30K, and VR2 to about 42K. However, if the AD590 was removed without these adjustments then the output voltage would rise to the converters maximum of around 31.5V

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