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### **Battery equalization circuit with ramp converter**

The University of Toledo is seeking a company interested in benefiting from technology relating to battery equalization circuits for use in series connected battery packs. This invention uses a current waveform in the shape of a ramp for providing zero current switching. The ramp converter power circuit has at least one semiconductor device and a transformer, coupled to the equalizing voltage supply source, with a primary winding circuit and at least one secondary winding circuit. The equalizing current is provided to the lowest voltage batteries in one half of the battery pack during one half of the charging cycle and then to the lowest voltage batteries in the other half of the pack during the other half of the cycle. This circuit also includes a feedback control loop or optically coupled switches to control the current from the equalizing source. Equalizing battery voltage increases battery life and vehicle range. This invention accomplishes this goal in a smaller and less expensive package than conventional battery equalization circuits.

#### **Application:**

This invention will be useful for increasing battery life and charge duration in any system utilizing packs made of several batteries in series. For example, packs of 12 V batteries connected in series provide the 300-400 V power sources used in electric vehicles and hybrid electric vehicles. This technology is especially beneficial to such applications because of its relatively small size and cost compared to other designs.

#### **Advantages:**

1. Prevents overheating and diminished acid levels of batteries connected in series by equalizing the voltages of the batteries, leading to improved battery life and charge duration
  2. Improves upon conventional battery equalization circuits by reducing the number of secondary windings by 50% and the number of diodes by 75%, thereby reducing cost and complexity
  3. Low loss design allows for high switching frequencies and small system size
- The use of optically coupled switches makes this battery equalization circuit more reliable and cost effective than other designs

This invention is protected by US Patent Nos. 5,666,041 and 5,982,143.

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