BMS and cell balancing

[Daowd_2011, TI_bq76930, TI_slyp945, ltc3300-1]

BMS

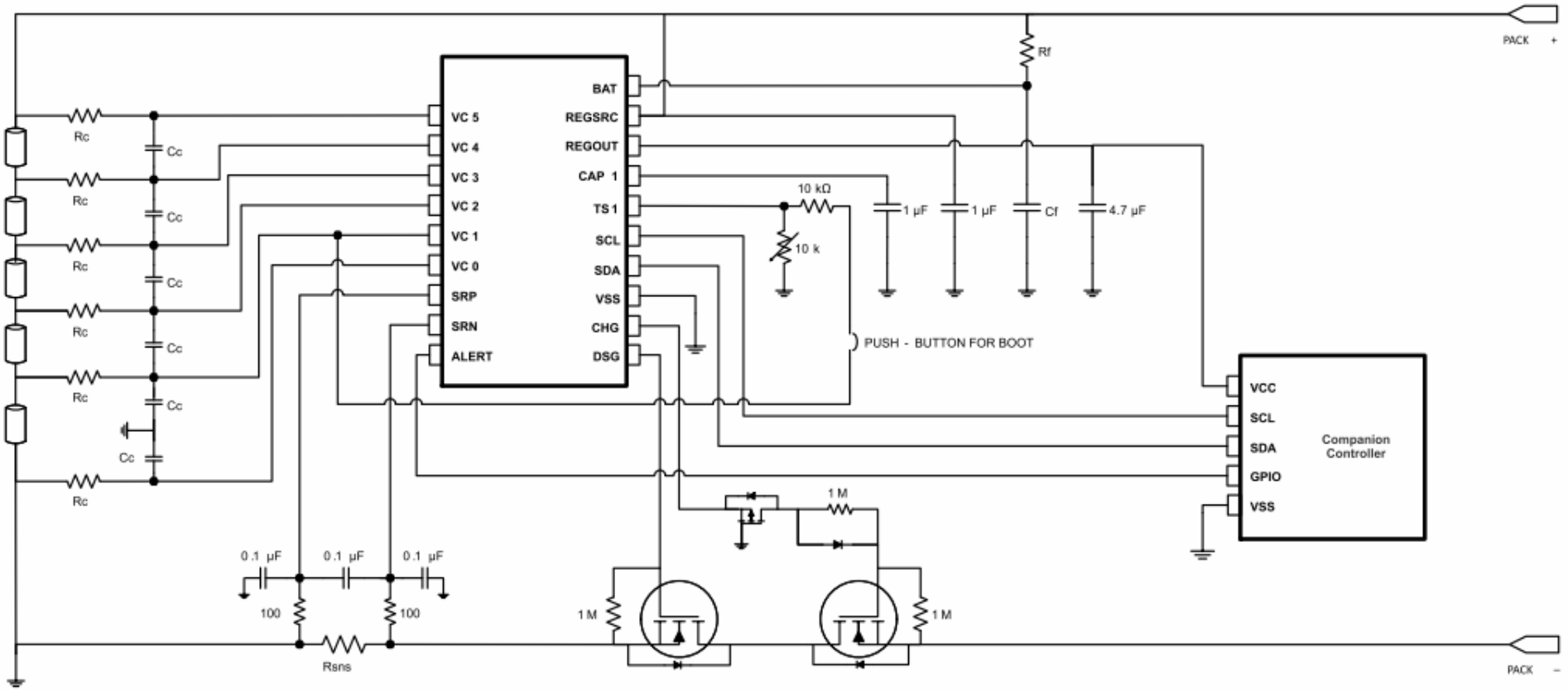
The BMS (battery management system) performs several tasks such as

- measuring the system voltage, current, temperature, cells' state of charge (SoC), state of health (SoH), remaining useful life (RUL)
- protecting the cells
- thermal management
- controlling the charge/discharge procedure
- data acquisition and communication with on-board and off-board modules
- storing historical data
- *cell balancing*

A lot of material on BMS is available via the document *slyp945.pdf*

Example of BMS: TI BQ76920

- *AFE (analog front end) monitoring*: cell voltage, die temperature, external thermistor, pack current
- *Hardware protection*: Overcurrent in Discharge (OCD), Short Circuit in Discharge (SCD), Overvoltage (OV), Undervoltage (UV)
- Integrated cell balancing FETs

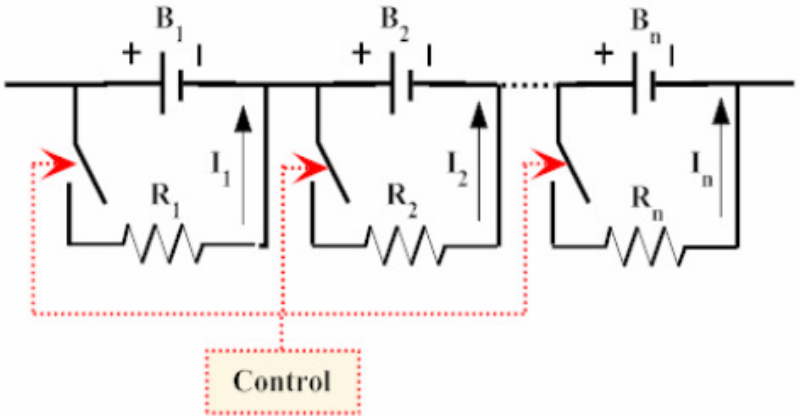


BMS: balancing

- Without the balancing system, the individual cell voltages will drift apart over
- The capacity of the total pack will also decrease more quickly during operation and the battery system will fail prematurely
- The cells imbalance is caused by
  - internal sources: manufacturing variance in charge storage volume, variations in internal impedance and differences in self-discharge rate
  - external sources: mainly, some multi-rank pack protection ICs may drain charge unequally from the different series ranks in the pack
  - thermal difference across the pack results in different self discharge rates of the cells

Balancing

- *Passive* balancing methods remove charge from the fully charged cell(s) through passive elements (resistors) until the charge matches those of the lower cells in the pack or charge reference



- *Active* cell balancing methods remove charge from higher energy cell(s) and deliver it to lower energy cell(s), using capacitors (similarly to charge pumps) or inductors/transformers (similarly to SMPSs)
  - many solutions do exist

LTC3300-1

The balancing architecture implemented by the LTC3300-1 is bidirectional synchronous flyback

- Each LTC3300-1 contains six independent synchronous flyback controllers that are capable of directly charging or discharging an individual cell
  - charge can be transferred from the cell being discharged to all the cells, and
  - a selected cell can be charged from the entire stack of cells