

PowerRESPONDER™ 2S balancing circuit applications note

The Paper Battery Company recognizes the need to place two or more PowerRESPONDER cells in series to increase total stored voltage for optimal converter efficiency in a variety of applications. Since $\text{Energy} = \frac{1}{2} * \text{Capacitance} * \text{Voltage}^2$, higher voltages will always provide more available energy than larger capacitences for a given capacitor arrangement.

Background:

When two or more batteries or super capacitors are placed in series to increase the available energy stored the possibility of cell voltages diverging happens owing to differences in the internal resistance or complex impedance of each cell.

There are a number of popular integrated circuits available to equalize one or more series cells of varying chemistries; however, the focus of this application note is the BQ29200 Series Two Cell balancer from Texas Instruments.

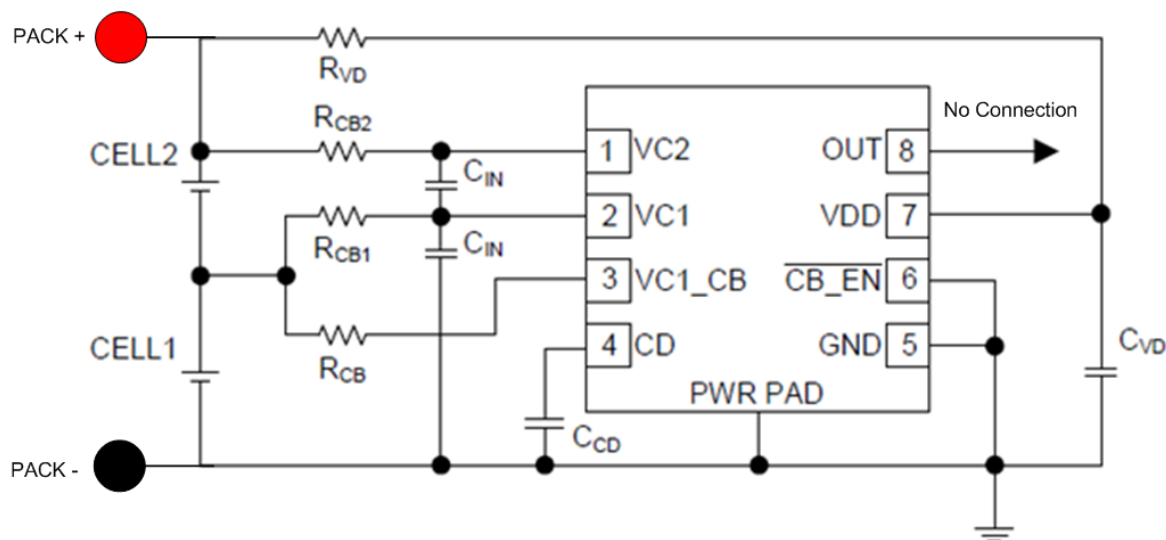


Figure 1: Typical BQ29200 Circuit Application

Theory of Operation:

The full details of how the BQ29200 operates can be found in the manufacturer's datasheet. This section focuses on operation specific to PowerRESPONDER use.

C_{CD} is the programmable external delay capacitor used for detecting overvoltage events.

While not entirely necessary for the PowerRESPONDER, it is a useful feature of the IC. The overvoltage delay for this pin is **approximately 1 second per microFarad. Observe capacitance tolerance to make sure that your desired timing restraints are met for the design.**

R_{vd} and C_{vd} are critical components to form an RC filter network on the Vdd pin of the control IC. During high transient current events the any voltage fluctuation on the Vdd pin can cause erratic operation. **These components should be placed as close as possible to the Vdd pin of the device.**

Selection of the balancing resistors themselves, R_{cb} , R_{cb1} , and R_{cb2} is to provide a suitable level of balancing current that will, at a minimum, counter act an increase in imbalance during normal operation of the battery. Care should be taken to ensure any connectivity resistance is also considered as this will also reduce the balancing current level.


DESIGN PARAMETER	EXAMPLE VALUE at TA = 25°C
Input voltage range	4 V to 10 V
Overvoltage Protection (OVT)	4.35 V
Overvoltage detection delay time	3s
Overvoltage detection delay timer capacitor	0.33 uF
Cell Balancing Enabled	Yes
Cell Balancing Current, ICB1 and ICB2	10 mA
Cell Balancing Resistors, RCB, RCB1, RCB2 and RVD	RCB = 100 Ω, RCB1 = 260 Ω, RCB2 = 160 Ω, RVD = 100 Ω


Figure 2: Table of values for design example above.

Layout considerations:

As with any power regulator or charging circuit, layout of the components surrounding this IC is critical for reliable and predictable operation of the battery pack. **The power pad under the device MUST be connected to a ground plane. It is required to open up the solder mask under the IC so that it may have adequate thermal conduction from the part.**

The BQ2920x applications note shows a pack connection inclusive of the R_{vd} resistor in series with it. This is not practical for high power applications.

 Additional circuitry required based on usage of the OUT pin

 Via connects between two layers

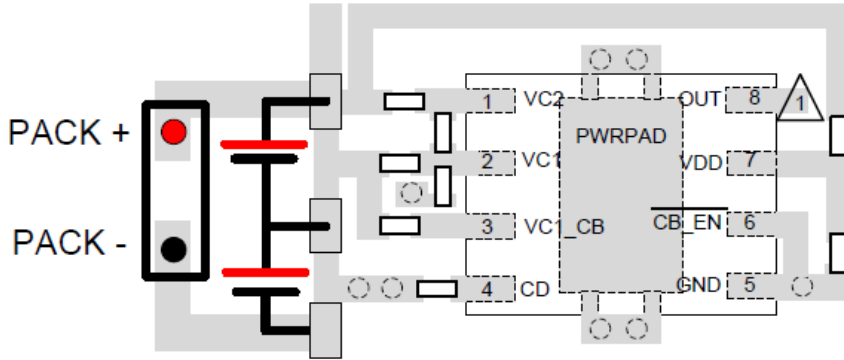


Figure 3: Example layout from BQ29200 datasheet

Ensure that the RC filtering components for VC1 and VC2 pins are placed as close to the IC as possible.