Correcting an out of balance cell

Contents

WARNING

All batteries store high current. Be careful not to short across the terminals with anything, including jewellery such as rings, wrist watches, and necklaces, tools etc. You can wrap insulation tape around a ring if you can't remove it, or around the exposed area of a spanner, socket etc.

When will you see an out of balance cell?

When the cells of your battery are sitting around their mid-point charge of 3.2V, the State of Charge (SOC) will be from 40% to 80%. If you don't fully charge your battery from time to time (say, once a month), you won't see if your individual cells are going out of balance.

You tend to only see cells out of balance when the battery is quite low or quite high. A word here: **NEVER try to balance cells when they are low**. Only balance cells when they are high, because it's only when the battery is full that you will see what the true out-of-balance situation is.

So roughly once a month you want to bring your battery up to fully charged. The Victron BMV may *say* you're at 100% SOC, but the cells are only fully charged when they reach about 3.45V to 3.5V. It doesn't matter whether you're charging from solar, DC to DC or mains, you need to get the cells up to 3.5V. In the summer, this is not often an issue if you have enough solar panels, but if you don't have enough solar panels, and you don't drive long distances, you may need to connect to a mains outlet

to bring the cells up to 3.5V. The Victron BMV will automatically reset to *true* 100% state of charge (SOC).

When your cells are up at 3.5V, if there is a problem with a low cell, this is when you will see it. If you get your cells to 3.5V and see that one or more cells is lower than the rest, you will notice that when you stop the charging source, the cells all seem to be in balance again. Don't ignore it – you do actually have a cell balance problem if the voltage difference (top right corner of the Junsi) is over 150mV. It the voltage difference reaches 100mV, check again next time you charge to a 100% SOC reset and see if it is the same or more. If it's the same or less, don't worry about it. If it's gone up, yes, you need to do a balance.

What causes a cell imbalance?

The most common cause of cell imbalance is leaving your battery charging from mains for long periods of time. What happens is that the control system stops the charger when a cell reaches 3.6V. It only takes one cell to reach 3.6V for the system to stop the mains charger. There may be other cells that haven't reached 3.6V yet and they progressively receive less and less charging due to the high cell turning off the charger.

If you put your battery on mains charging from time to time and leave it on for no more than a day or two, the cells settle down when charging stops and are less likely to get out of balance.

The imbalance may also be caused by having the float charge on your mains charger set too high. A good long-term float charge on your mains charger is 13.6V.

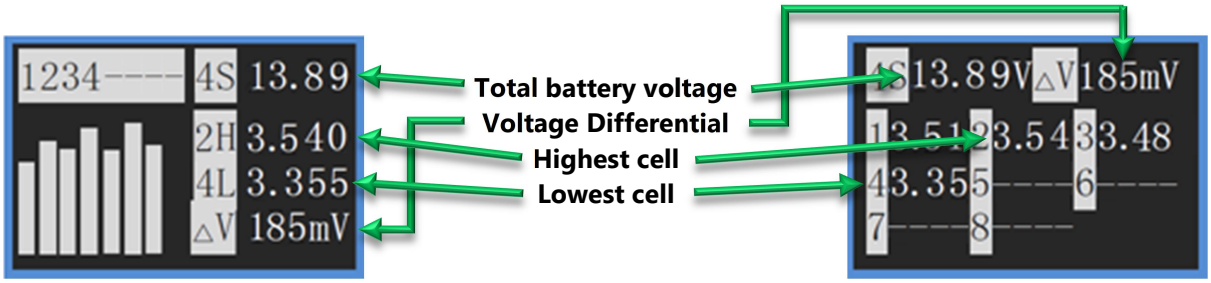
The Junsi cell logger

This is what the Junsi cell logger looks like.

Most systems we install will have one of these in the T1 Lithium control box. In older systems you may have one in your RV as well. In basic systems (where you're not drawing large amounts of power, usually because you don't have a large inverter), the Junsi sits on top of the small black basic control box.

Determining if a balance charge is needed

There are 4 screens that can be cycled through on the Junsi™ logger. Two of them show the voltage differential now, and one shows the highest voltage differential ever seen. A full explanation of all these screens is given in **T1 Lithium – About your T1 Lithium system**.



- Press any button to wake the Junsi.
- Press ▲ (1st button) or ▼ (2nd button) to cycle through the screens until you see one of the two example screens shown above. In all likelihood, your Junsi is already on the screen show to the right.
- The **Voltage differential** is the figure you're looking for. It's represented by the symbol **△V** and is measured in millivolts (**mV**).
- If the voltage differential is greater than **150mV**, note the highest cell and the lowest cell.
- In both examples above, cell 2 is the highest at 3.54 volts and cell 4 is the lowest at 3.35 volts.
- Write these readings down: the number of the highest cell, the number of the lowest cell, and the voltage differential. In the example above, this would be cell 2 is highest, cell 4 is lowest and the voltage differential is 185mV.
- Take another look at the Junsi the next day. If the voltage differential is again over 150mV, write these figures down again.
- Repeat this process on the third day.
- If the same cell has been low on all three occasions, this cell needs balance charging.
- It is quite possible that the voltage differential will be over 150mV on only one day and therefore nothing further needs to be done.

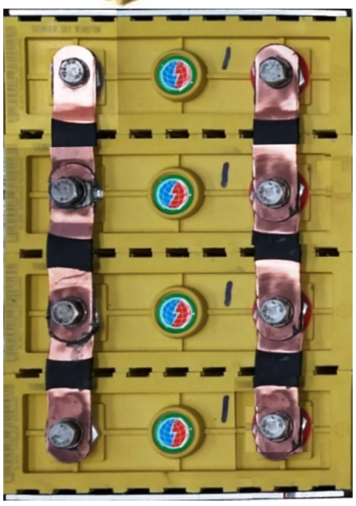
NOTE: The voltage differential tends to rise if the battery is *very* full (3.6V per cell) or *very* flat (under 2.8V per cell). If the battery is very full, use some power (in which case you'll see the voltage differential drop quite quickly) or if the battery is very flat, charge the whole battery (in which case the voltage differential will slowly decrease) before you worry about balancing cells.

Don't panic just because you see a voltage differential higher than 150mV. It is not a serious "better sort this problem now" issue unless it is greater than 500mV (half a volt).

Identifying the correct cell to charge

The term "cell" is a bit confusing here. It can refer to one cell that makes up a battery, like one of these:

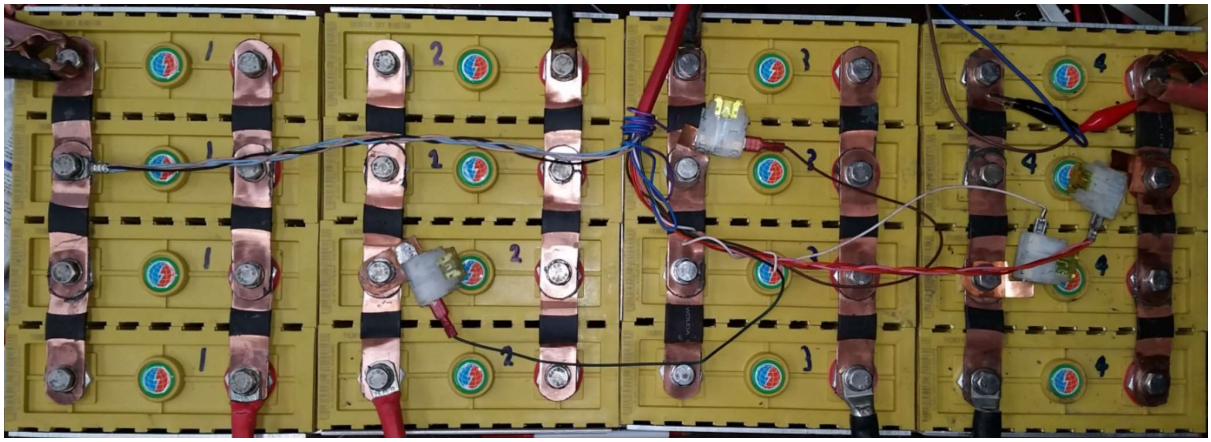
But it also refers to a group of cells connected in parallel (negative to negative and positive to positive) like this.



If you look closely, you'll see the red surround of the terminals on the right, which marks them as positive.

When we refer to a cell being out of balance, we're usually referring to a pack like this. Usually that pack consists of four individual cells, but sometimes it can consist of one, two, six or eight individual cells – it depends just how the battery pack is configured. We will have marked the individual cells in each pack with the same number.

The picture below shows a 400Ah battery made of four 100Ah cells like the one above to make 400Ah at 3.2V, and each of these packs of four cells are connected in series to make 400Ah at 12 volts. Cell number 1 is at the battery negative end and the cells are numbered sequentially from there. We've labelled the cells 1 to 4 in this picture.



Do not start the single cell charging routine unless the cell differential is greater than 150mV.

When to do your cell balancing

Cell balancing needs to be done when your battery is close to full and whilst your battery is still being charged, whether that's via a mains charger, a DC to DC charger while the engine is running, or via solar.

Never try to balance a cell when the battery is low – you'll only make the problem worse.

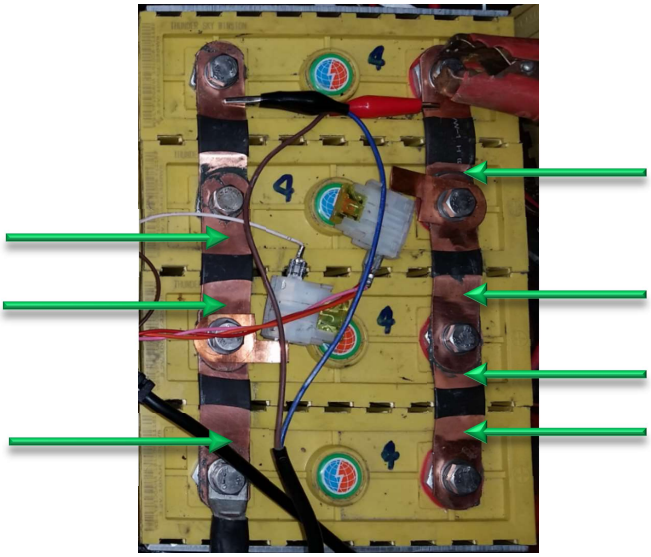
Stop the cell balancer by following the procedure below at the end of the day, regardless of what charging source you are using and regardless of whether the low cell has reached 3.6V. **Do not** continue trying to balance a cell overnight.

Connecting the single cell 3.7v charger

To avoid damaging the charger, do not turn on the single cell charger until you have connected the alligator clips to the correct copper cell links.

- While your battery is charging, connect the black alligator clip from the charger to a negative link on the cell you need to balance, in this case cell 4, and connect the red alligator clip from the charger to the positive link** on the same cell.

The black alligator clip can connect to any one of these negative links



The red alligator clip can connect to any one of these positive links

** A link is the copper strip that connects each terminal of the battery. Note that the alligator clip needs to clip onto this copper and not the bit in the middle of the copper strip that is covered in black heatshrink.

- There will be no light on the charger at this stage.
- When the alligator clips from the charger are connected, plug in the 3.7v single cell charger to either mains power or an inverter**. The indicator light on the charger will be off.
- Now disconnect the black alligator clip. The light on the charger will turn green. We need to do this step to turn the charger on, even though it is already turned on at the mains. The green light indicates that the cell is full, or the battery is no longer charging, or a wire is disconnected. In this case, the green light indicates that a wire is disconnected (because you've disconnected the black alligator clip).
- Reconnect the black alligator clip. The light on the charger will turn red. This means the single cell charger is now charging.

** If you're not connected to mains power, make sure your inverter is on. Plug the 3.7V charger into a power point in your RV that provides 240V power from the inverter. Some inverters have a power point built into them that you can plug directly into, but these power points are not usually available in larger inverters.

Disconnecting the single cell 3.7v charger

Always disconnect the single-cell charger is this order:

- Turn off the power to the single-cell charger.
- Disconnect the alligator clips from the cell links.

Turn the power to the single cell charger off before you disconnect the alligator clips from the cell lins.

How long does balance charging take?

Don't leave the single cell charger running overnight.

The single cell charger will take a number of hours to bring a cell up to 3.6 volts, maybe even a full day. If the balance isn't completed at the end of the charging day, disconnect the single cell charger and restart the process tomorrow. You might find the next day that the voltage differential is now under 150mV. In this case, there's nothing more needed to be done.

- Continue charging until the low cell (in this case cell 4) is the first to reach 3.6V. You'll know it has reached 3.6V because the Junsi logger will beep at you.
- When this is achieved, check the **Voltage differential** on the Junsi again.
- If it is less than 150mV, turn off the 3.7V charger, *then* disconnect the alligator clips. Job done.
- If it is not less than 150mV, turn off the 3.7V charger, *then* disconnect the alligator clips and repeat this process on the next lowest cell.

Is there any danger of over-charging a cell when balancing?

The single cell charger will not take the cell above 3.7 volts, and it takes a long time to bring a cell from 3.6 volts to 3.7 volts. To charge a cell already at 3.6 volts to 3.7 volts using this single-cell

charger could take all day, not that you really want to bring a cell from 3.6V to 3.7V anyway, as 3.6V is full. This is because the single cell charger slowly reduces its charging rate the closer the cell gets to 3.7V.

There is no harm in checking the Junsi from time to time whilst balancing is taking place and then disconnecting the single cell charger when the cells it's connected to reaches 3.6V.

The T1 Lithium battery management system will turn off the main charging source (which is charging the whole battery, not just a single cell), automatically when any cell reaches 3.6V (at this point, the Junsi logger will start beeping at you). The T1 Lithium battery management system does not turn off the single cell charger – it turns itself off when it reaches 3.7V. The low cell is constantly charging while it is connected and the red light is on. This actually speeds up the balancing process while the whole battery is in charging mode, whether the mains charging has been stopped by the T1 Lithium control box or not.

When you then disconnect the single cell charger, the Junsi will beep a few more times and then the cell will settle down to just under 3.6V. However, after the cell has reached 3.6V, if you don't disconnect the single cell charger at this point, the Junsi will keep beeping, and beeping and beeping… This means that the charging to the rest of the battery has stopped and won't restart until the Junsi stops alarming.

Also, if the battery is charging is by solar only, the single cell charger will send a cell out of balance if it is still charging after the sun has gone down, because the whole battery is not being charged. What was the low cell will become the high cell and you will now have 3 low cells and 1 high cell. You just made a bigger job for yourself.

GOLDEN RULE: only leave the single cell charger on while the low cell is reaching the 3.6V cut off and always disconnect the single-cell charger at sundown, whether the cell has reached 3.6V or not. You can always restart the process the next day, or you might find that you no longer have a balance problem the next day.

T1 Lithium

All documentation is available on our web site:
http://www.t1lithium.com.au/downloads.html