Genetry Solar

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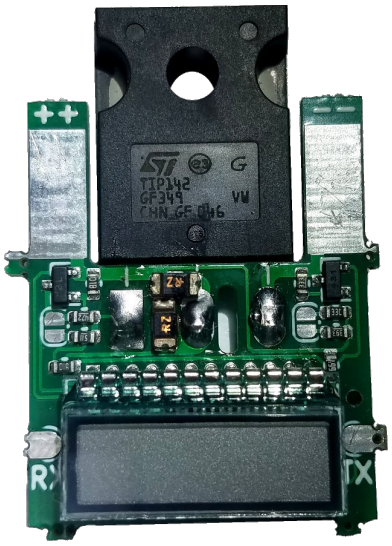

Lithium Balance Shunts

a highly scaleable top-balancing solution for any size Li-Ion or LiFePo4 battery bank

A product of Genetry Solar
www.genetrysolar.com
1-833-GENETRY

WARNING

These balance shunts convert excess power into heat. Sufficient heatsinking is required (and not included). At full load, they will get **VERY** hot, and as such must be located in a well-ventilated area, away from any potentially flammable materials.

NOTE: These balance shunts require **LARGE** HEATSINKS in order to reach full rated balance capacity. They are capable of generating upwards of 20 watts of heat **EACH**—more than a small soldering iron. For a 14S battery (with 14 balance shunts), this could potentially generate 280W of heat that must be dissipated in a safe manner for proper operation.

For any questions or support related to the Genetry Solar Lithium Balance Shunts, please contact Genetry Solar at:

1-833-GENETRY
or visit www.genetrysolar.com

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Introduction

Thank you for your purchase!

It has come to our attention that most off-grid battery systems are designed with a very large storage capacity in mind. Conversely, most low-cost BMS systems on the market have an extremely low balance current capability, which usually turns out to be completely inadequate for balancing a very large off-grid Lithium-based battery.

Our solution to the problem is a very high-current-capable balance shunt that can be used in Lithium battery strings from 1-200 cells. (Contact us if you need a higher string capability.) It is compact, with a built-in LCD to indicate the cell voltage, balancer status, and other info. This results in a very simple yet powerful balancing solution.

Features

- User-configurable balance voltage
  - 3.55v for LiFePo4
  - 4.15v for Li-Ion
- Current limit adjustment
  - ~2.5-3.0A
  - ~4.7-5.0A
- Thermally protected
- Automatic thermal reset
- Support up to 200 cells in series (limited only by serial comm function)
- RS-232 Battery Status string
  - Data output on the battery balancer closest to battery negative
  - No level shifting required for monitor system referenced to battery negative
  - Allows reading the voltage and balancer status of every cell in the string
  - Auto-cascading string with checksum
  - Update interval: ~4-5 seconds
  - 4800 baud, n, 1 (active high)

Theory of Operation

Each balance shunt constantly watches the cell voltage. If it reaches the setpoint, they will start to convert excess power into heat, “bypassing” the fully charged battery cell. This allows the other cells in the battery bank to finish charging, at which point the total pack voltage setpoint is reached, and the whole charge process tapers off to zero (full charge).

Note that the balance voltage of the balancers will directly determine the maximum possible voltage for the battery pack; exceeding this maximum value will cause all of the balancers to activate. The voltage setpoints have been chosen to give a bit of safety headroom, as well as increasing the battery longevity by being slightly under the maximum cell voltage.

The LCD display on the balance shunt itself offers a very simple and easy means to identify what is going on, as well as providing easy means to visually verify the battery voltages without any cumbersome and complicated equipment. Simple battery systems are thus fairly easy to put together, and can be very quickly visually checked on a regular basis.

In normal state, the LCD on the balance shunt will read the current battery voltage, as measured by the balancer itself.

If the measured battery voltage reaches the setpoint, the LCD will alternate between battery voltage and “bAL”.

If the balancer thermally overheats, the LCD will alternate battery voltage with “trIP”. It will remain in this state for approximately 60 seconds (balance current at ~0.2-0.4A in this state). Next, the LCD will switch to “Cool” (balance current: 0A) for approximately 90 seconds. Afterwards, it will resume normal balance operation. Please note that during this time, the battery cell voltage likely will continue going up unless charging is halted.

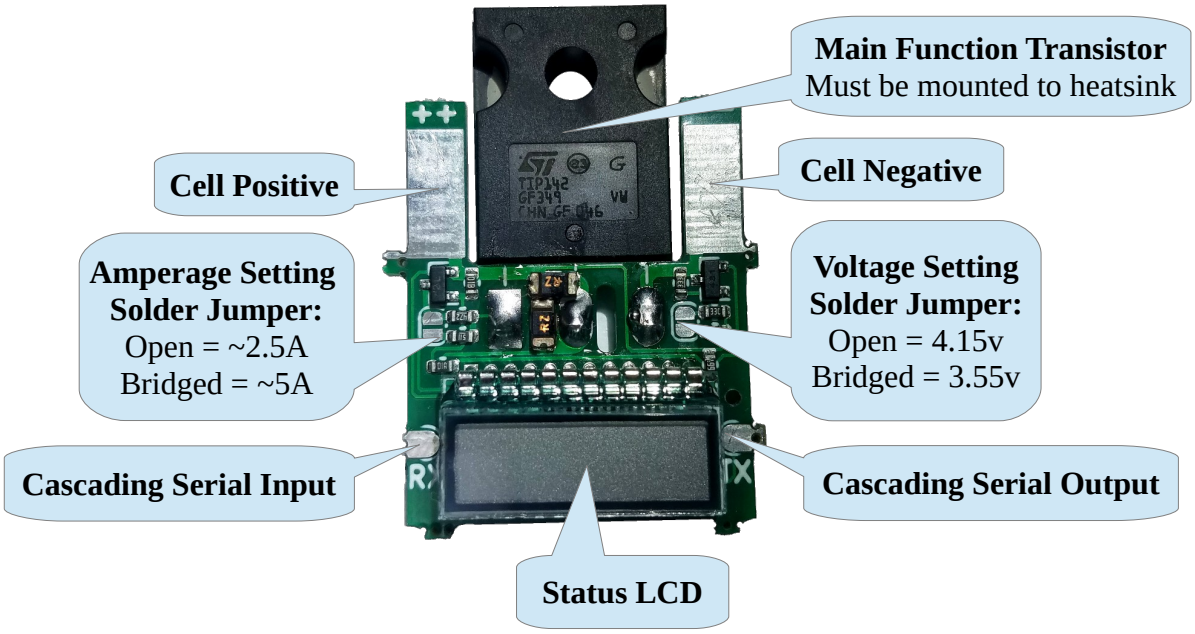
If the main transistor fails due to unregulated overheat, overvoltage, or other fault condition, balance current will remain at ~0.2-0.4A, and the LCD will alternate battery voltage with, “FAIL”. If this happens, the balancer must be disconnected from the battery, or it will drain the cell all the way to 0v.

PLEASE NOTE: If these balancers are being installed on a new unbalanced pack, it is highly recommended to do the initial charge cycle with a current limited power supply, or other means of limiting charge current as the batteries balance out to full charge. The maximum charge current should be limited by the balancers’ ability to dissipate the generated heat.

After the initial balance charge cycle is completed, you should be able to use the battery bank normally.

NOTE: If one particular balancer is fully active (i.e. generating a lot of heat) every time the battery reaches full charge, it may be indicative of a low-capacity/failing cell.

Unit Feature Identification



For those who may need to install the balancer in the dark, if held so the large transistor is on top (LCD on the bottom), the section of circuit board directly to the left of the transistor is a large copper plane (3/8” tall, 1/8” wide) for battery cell positive. On the right side of the transistor is a matching section of circuit board with large copper plane of the exact same size, for the battery cell negative. There are no through-hole connections on the board, due to the fact that it needs mounted to a metal heatsink, and any through-hole connections would run a serious risk of shorting out with the heatsink.

Note that there will be 2 little “nibs” (or “rough spots”) on the left and right sides of the balancer board. (There are also nibs on the bottom and top of the board, but these are not of value; all of these are the result of the PCB manufacturing process.). These four nibs (2 on the left, 2 on the right) correspond to the balancer connections as follows:

- Top left nib: bottom of the battery cell positive connection
- Top right nib: bottom of the battery cell negative connection
- Lower left nib: Serial RX
- Lower right nib: Serial TX

Please note when connecting the balancer serial RX and TX connections together, that the final cascaded TX output must be at the balancer on the battery negative cell. (This direction can’t be reversed.) In other words, the most positive balancer’s TX goes to the next-in-line’s RX, etc

Installation

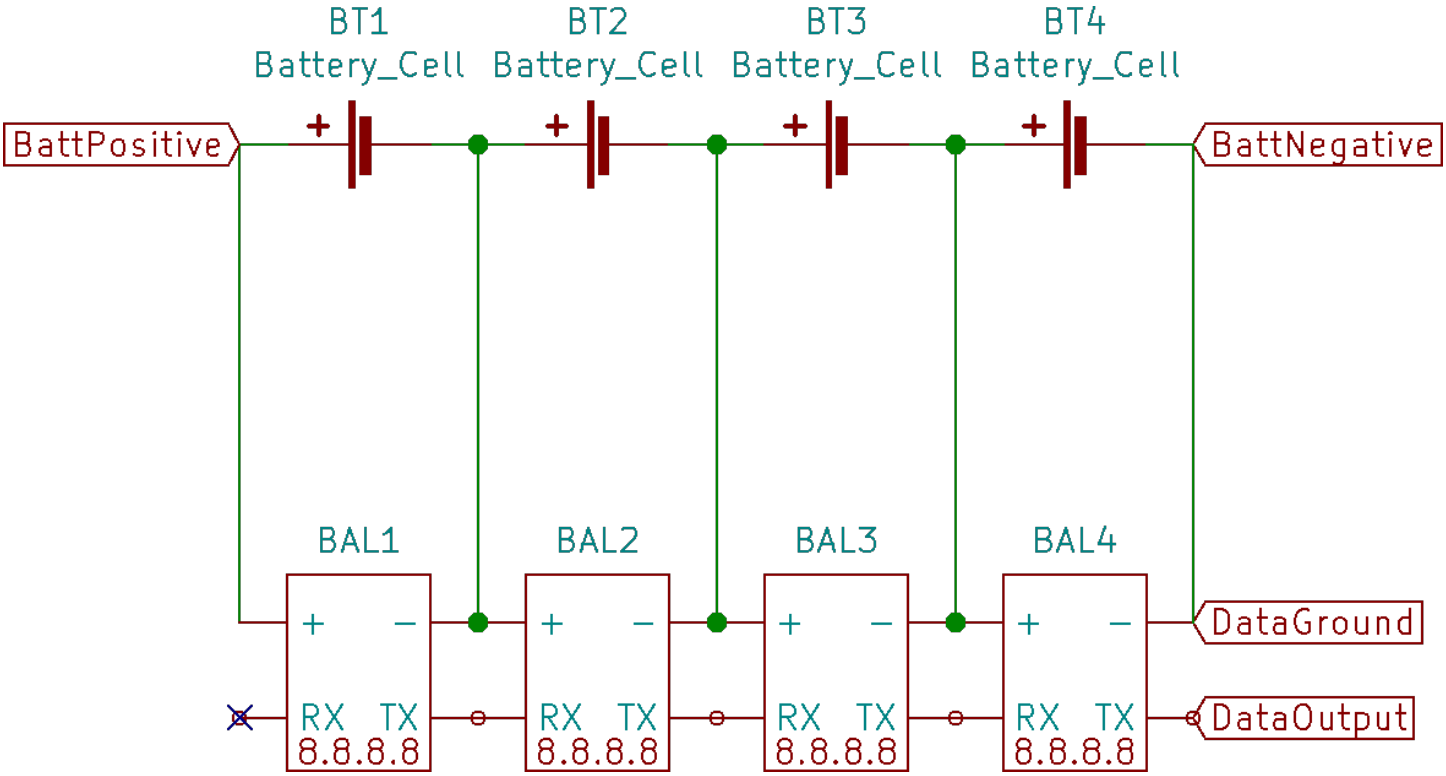
<u>WARNING: Improper installation can EASILY cause serious damage, injury and/or fire!</u> If you are <u>not</u> familiar with any of the required tools, or do <u>not</u> understand any of the steps, DO NOT BUY OR ATTEMPT TO USE THIS PRODUCT.

You will need (at least) the following tools and equipment:

- **Soldering iron** (and solder, etc.)
- **Multimeter**
- **16AWG wire** (or slightly larger) for connecting the balancers to the batteries
- **LARGE heatsinks** (These balancers get VERY hot!)
- **Screws (M3 / #6)** for mounting balancers to heatsinks
- **TO-247 thermal pads / mica insulators** (if more than one balancer per heatsink)

Before starting, check to make sure that the solder jumpers are set to the desired settings. If the balancers are wired up to a battery, they are electrically “hot”, and do not have a “power switch.”

A sample wiring schematic for a 4-cell Lithium battery system is as follows:



For higher voltage battery systems, simply continue the same connection method for as many cells as you have. The basic wiring premise is that you will want to connect one balance shunt directly across each series battery block in your system. (It is simplified in the above diagram to reduce the number of wires needed, but this may be rather confusing at first.)

Please note that the balancers are manufactured in blocks of 8, but you may need to "snap" the blocks apart into individual balancers for mounting. If this is the case, you will need to use lengths of wire to connect the appropriate terminals together for the desired functionality.

If you do not plan on using the serial data string, you do not need to connect any of the RX/TX leads together as pictured. NOTE: The RX/TX connections can ONLY be connected as pictured above; the data direction cannot be reversed to output at the battery positive side.

WARNING: The TX output from one battery bank **CANNOT** be connected to the RX input of another battery bank. Attempting this may damage the balancers' serial data function.

All wires between the balancers and the batteries should be kept as short as feasibly possible, and a minimum of 16AWG. Please be aware that if the wires are very long and/or very thin, the balancers will not be able to reach the rated balance current due to the voltage drop in the wires. (For example, 22AWG alligator clips will drop over 1v @ 4A current. With a voltage drop like this, a 4.15v Li-Ion battery would have to reach 5.15v in order for the balancers to attain 4A current—which of course, is terminal for the battery cell in question.)

Any necessary TX-RX connection wires can be 22AWG or smaller; these are extremely low power signals, and as such are not critical.

If the balancers are each mounted to separate electrically isolated heatsinks, you do not need any silicone thermal pads (or mica insulators).

However, if 2 or more balancers are mounted to the same heatsink (or to separate heatsinks with any electrical continuity together or with any electrical potential), they MUST be electrically isolated via a silicone thermal pad or mica insulator. (Back of the main transistor is internally connected to the battery positive lead, and will cause a serious short-circuit connection if the insulators are omitted.)

Serial Info String

The Genetry Solar Lithium Balance Shunts include support for a cascadable serial info string, where the data from an entire string of balancers can be read out at a regular interval (~4-5 seconds). Please note that the balancers are read-only, and cannot be controlled via serial.

A data stream consists of the following data, one byte per line (MSB first):

Start of transmission

1	0	1	0	0	1	1	1

0xA7 = start of transmission ("Master" character)

Data Packet

1	1	1	1	1	1	1	1

0xFF = packet start

0	0	0	0	0	0	0	1

0x01 = balancer version (future: may contain other info)

F	C	T	B	-	-	-	v

F = Fail. C = Cooldown. T = Tripped. B = Balancing.

v = 9-bit battery voltage number.

v	v	v	v	v	v	v	v

(The resulting 3-digit number is the calibrated battery voltage. For example, 342 = 3.42v)

0	0	0	0	0	0	0	0

(reserved for future: shunt throttle level)

0	0	0	0	0	0	0	0

(reserved for future: transistor temperature)

0	0	0	0	0	0	0	0

(reserved for future data)

Checksum

1	1	1	1	1	1	1	0

0xFE = checksum header

c	c	c	c	c	c	c	c

checksum byte. This is a very simple XOR checksum of all the transmitted data bytes. If the end result is 0, the data is likely intact.

Each balancer will start out in “master” mode, sending out a data packet (followed by a checksum packet) on TX every 4-5 seconds. If it detects a data packet on RX, it will switch to “repeater” mode, passing the data received packet on. When the balance unit receives a checksum packet, it will instead transmit it’s own data packet, followed by the updated checksum. (If the received checksum is invalid, it will abort the transmission.)

If balancers are connected together in a series string, the 7 bytes between the horizontal rulers will be repeated for each series-connected balancer; the checksum (0xFE) will only appear at the very end of the string. This makes it very easy to identify a valid serial string end.

This method of cascaded packet transfer is limited in size by the speed of the serial data rate, and the “master” packet interval. For the ~4-5 second “master” packet interval at 4800bps, the maximum system length is roughly estimated at nearly 400 units, which works out to a total system voltage in excess of 1200v.

Specifications

Electrical Specifications

Absolute Maximum Input Voltage Range:	-0.3v – +6.0v DC
Average Idle Power Usage (4.0v, Li-Ion mode):	0.7mA (0.0007A)
Maximum Balance Current:	5.0A (thermally limited)
LCD Voltage Tolerance:	+/- 0.01v
Balance Threshold Voltage Tolerance:	+/- 0.03v

Asynchronous Serial Data String Specifications

Serial Data Rate	4800 baud
Serial Data Format	active high; no parity, 1 stop bit
Serial Data Voltage	cell voltage of lowest balancer

Mechanical Specifications

30(W) × 40(H) × 10(D)mm (without heatsink)

1.125(W) × 1.625(H) × 0.375(D) inches (without heatsink)

A product of Genetry Solar
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This product and manual were designed and written with Ubuntu Linux, powered by an off-grid solar system

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