

4s Battery Charger Solution For Vacuum Robot Reference Design



Description

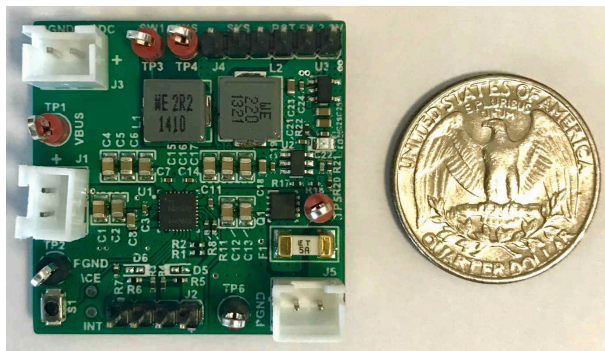
This reference design is for 4-cell battery charging applications, such as a vacuum robot or robotic lawn mower, and so forth. The design employs the BQ25672 buck battery charger with a wide input and output range for 1- to 4-cell battery charging. An external ship FET is introduced to minimize the battery leakage current by totally disconnecting all system load from batteries when in standby. This reference design uses two-layer board to optimize cost and achieve 35-mm × 35-mm board dimensions.

Features

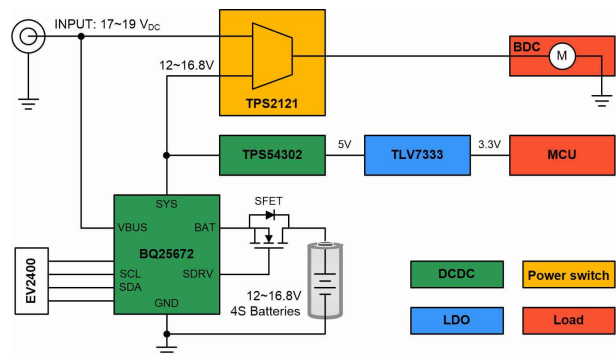
- Supports 4s battery with 16.8-V maximum regulation voltage, and 2.5-A charging current
- Robust ESD protection: passes 15-kV ESD test
- System power on and off without addition external components
- Small size solution (board dimensions 35 mm × 35 mm)
- Two-layer small form factor design for cost-optimized

Applications

- Vacuum robot
- Cordless vacuum cleaner
- Battery pack: vacuum cleaner, robot
- Cordless hair dryer
- Residential and living fan
- Portable printer
- POS printer



Top Photo



Block Diagram

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input Voltage	17 V–19 V
Maximum Input Current	3 A
Battery Voltage	12 V–16.8 V
Maximum Charging Current	2.5 A

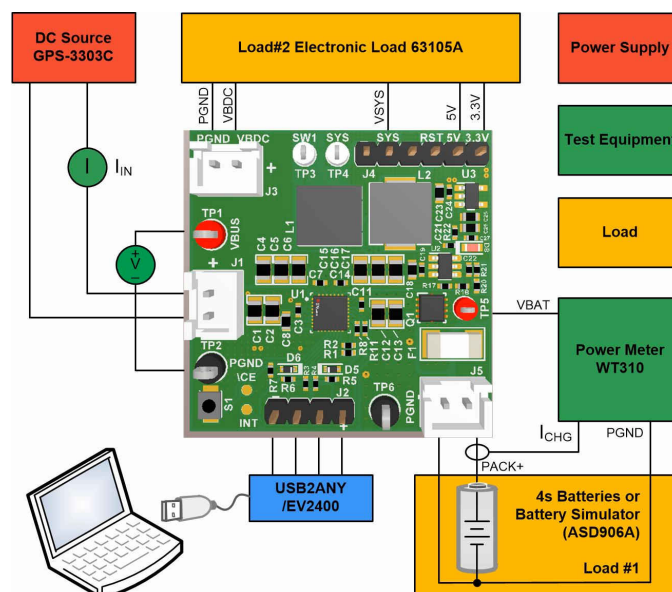
1.2 Required Equipment

- DC source: GWinstek, GPS-3303C
- Battery Simulator: ASunDar ASD906A
- Electronic Load: Chroma, 63105A
- Oscilloscope: Tektronix, DPO 3054
- Infrared Thermal Camera: Fluke, TiS65
- True-RMS-Multimeter: Fluke, 287C
- Digital Power Meter: Yokogawa WT310
- Computer Interface Adapter: [USB2ANY](#)

1.3 Test Setup

Use the following list to set up the PMP40937 test equipment:

1. Connect a DC source to J1, set the output voltage to 17-V and current limit to 3-A, and then turn off the supply.
2. Connect a voltage meter across TP1 (VBUS) and TP2 (PGND) to measure the input voltage.
3. Connect a current meter between the DC source and TP1 to measure the input current into the VBUS.
4. Connect Load #1 to J5, set Load #1 to constant voltage mode, set output voltage to 16.0-V, current limit to 3-A. A 470- μ F, 25-V capacitor is recommended to add to the output if using the battery simulator.
5. Connect a power meter between TP5 and J5 to measure the battery voltage and charging current.
6. Set Load #2 to constant current mode, and then disable the load. Connect Load #2 to J3 and J4.
7. Connect the USB2ANY between computer USB port and J2.
8. DC source and Load #1, measure and verify $V_{SYS-PGND}$ (TP4 and TP2) = 16.0-V \pm 0.2-V.
9. Launch the [TI-CHARGER-GUI](#) and select device BQ25672, connect the hardware if not connected.


Figure 1-1. Test Setup

2 Testing and Results

2.1 Efficiency Graphs

Efficiency is shown in the following figure.

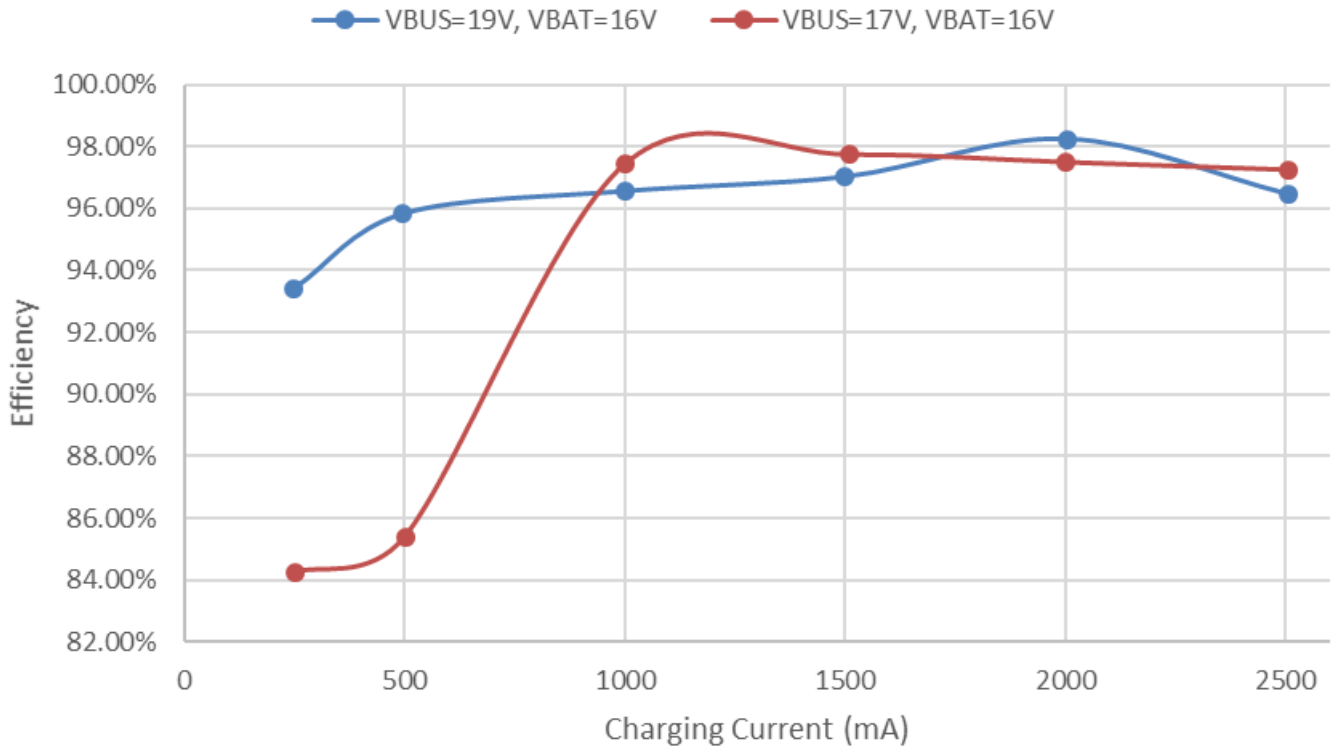


Figure 2-1. Efficiency Graph

2.2 Efficiency Data

Efficiency data is shown in the following table.

V _{BUS} (V)	I _{IN} (mA)	P _{IN} (W)	V _{BAT} (V)	I _{CHG} (mA)	P _{OUT} (W)	Efficiency
17.077	276.0	4.71	15.82	251	3.97	84.25%
17.067	545.0	9.30	15.85	501	7.94	85.39%
17.050	958.0	16.33	15.91	1000	15.91	97.42%
17.033	1447.0	24.65	15.97	1508	24.09	97.74%
17.013	1934.0	32.90	16.03	2001	32.08	97.49%
16.993	2440.0	41.46	16.10	2505	40.32	97.24%
19.080	221.0	4.22	15.82	249	3.94	93.42%
19.073	431.0	8.22	15.85	497	7.88	95.83%
19.056	865.0	16.48	15.92	1000	15.92	96.55%
19.039	1297.0	24.69	15.97	1500	23.96	97.02%
19.021	1743.0	33.15	16.26	2003	32.57	98.24%
19.003	2198.0	41.77	16.09	2504	40.29	96.46%

2.3 Thermal Images

The thermal image is shown in the following figure.

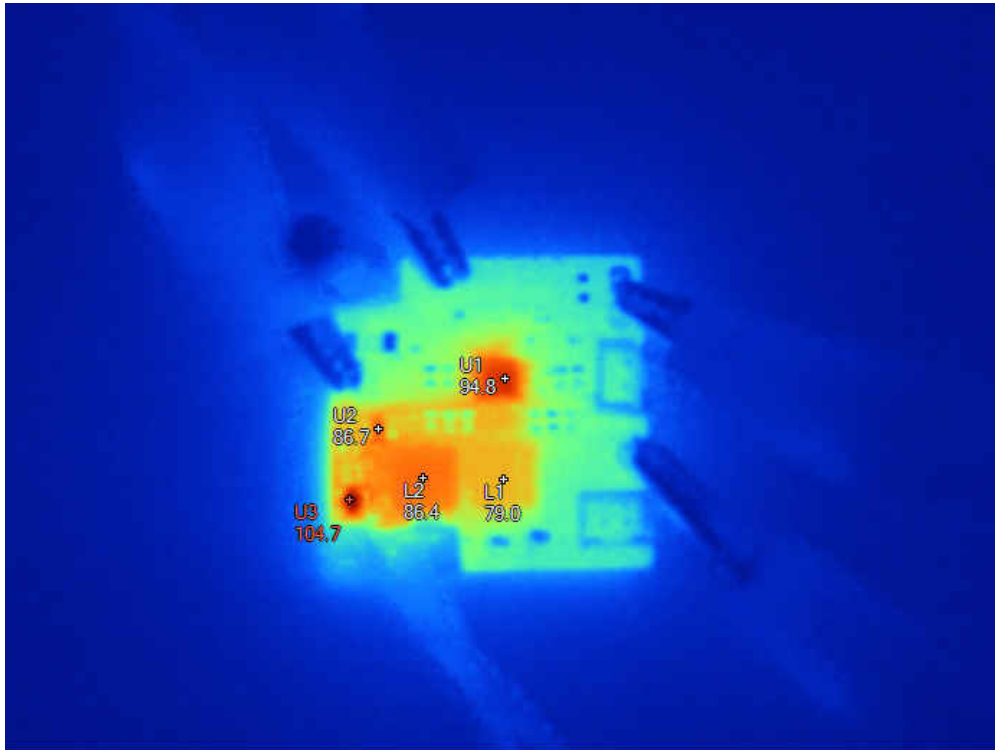


Figure 2-2. Thermal Image at $V_{BUS} = 17\text{-V}$ and $V_{BAT} = 16\text{-V}$, $I_{CHG} = 2.5\text{-A}$

3 Waveforms

3.1 Switching

Switching behavior is shown in the following figures at 17-V input and 16-V battery voltage, and $I_{CHG} = 2.5\text{-A}$. CH3 is the switch node (SW1) voltage. CH4 is the charging current (I_{CHG}).

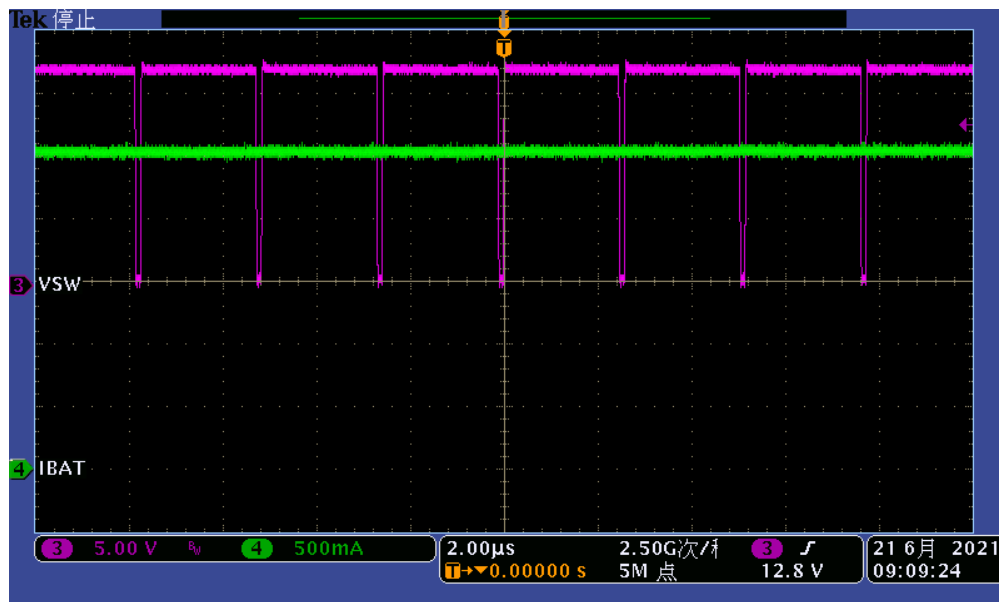


Figure 3-1. Switching 1

3.2 Output Voltage Ripple

Output voltage ripples are shown in the following figures at 17-V input and 16-V battery voltage and $I_{CHG} = 2.5\text{-A}$. CH1 is the VBAT voltage ripple; CH3 is the SYS voltage ripple; CH4 is the charging current ripple.

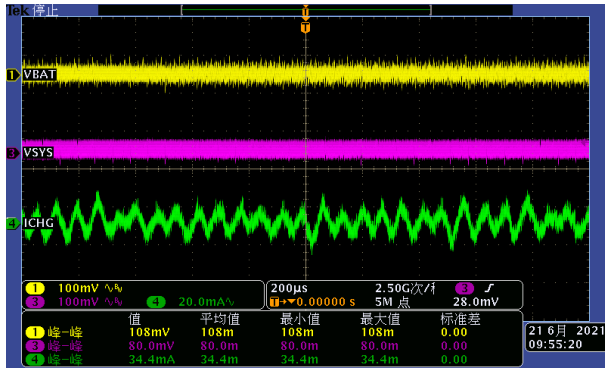


Figure 3-2. Output Voltage Ripple 1

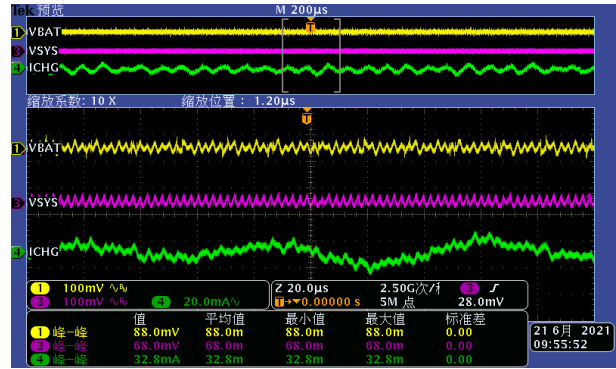


Figure 3-3. Output Voltage Ripple 2

3.3 Start-Up Sequence

Start-up behavior is shown in the following figures at 17-V input and 16-V battery voltage. CH1 is the VBUS, CH2 is the VBDC, CH3 is the VSYS, CH4 is the ICHG.

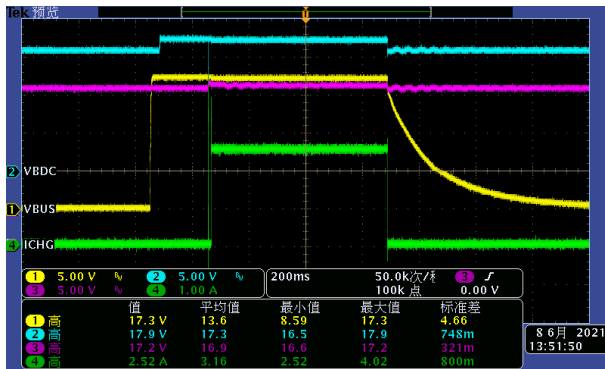


Figure 3-4. Start-Up 1

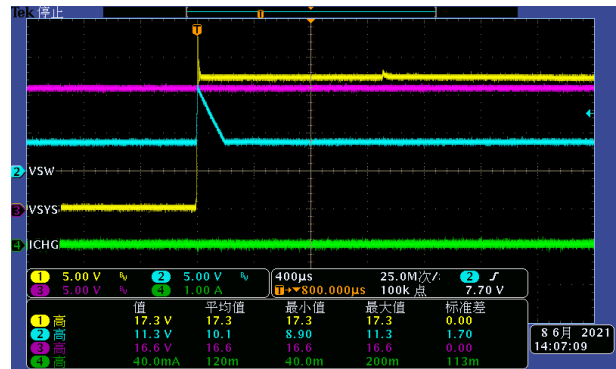


Figure 3-5. Start-Up 2

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