Date started: 4/17/2023

Lithionics DC-DC Converter Testing Rev C

Last update: 9/26/2023

Written by Nicholas Stoll

Contents

Figure 1: Lithionics DC-DC converter module

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1. Overview

The Lithionics bi-directional DC-DC converter is configurable for 51V to 12V buck or 12V to 51V boost. Applications include 12 chassis battery replacement to run 12V systems off the 51V battery in an RV, and charging a 51V battery off the chassis battery system.

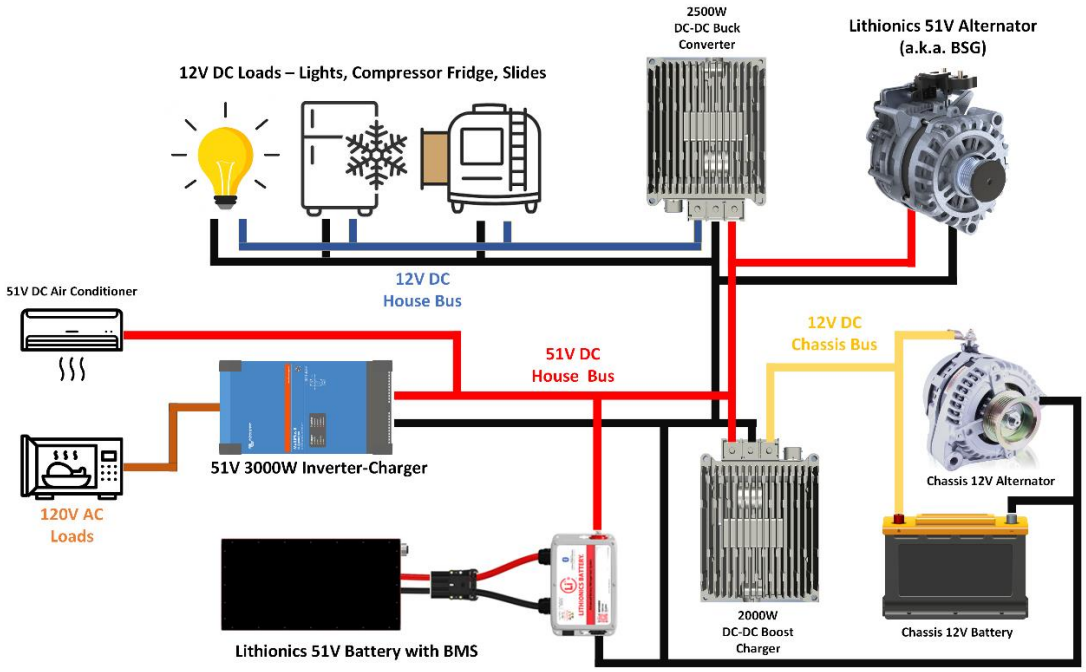

Figure 2: System diagram showing a Lithionics DC-DC converter configured for buck and one configured for boost. Typical customer installations will only require one converter

Max Buck output power	2.5 KW
Max Boost output power	2.0 KW
Low voltage input range	8 V – 16 V
High Voltage Input range	40 V – 60 V
Nominal efficiency	90% - 94%

2. Test Plan

- Experiment with configuration settings and document parameters and limitations
- Verify voltage limits
- Verify max output current/power
- Measure idle current
- Verify output voltage under low and high load
- Verify short circuit, over temperature, and overload behavior
- Calculate efficiency curve for 5,20,50 and 100% load

3. Test results

Test Graphs

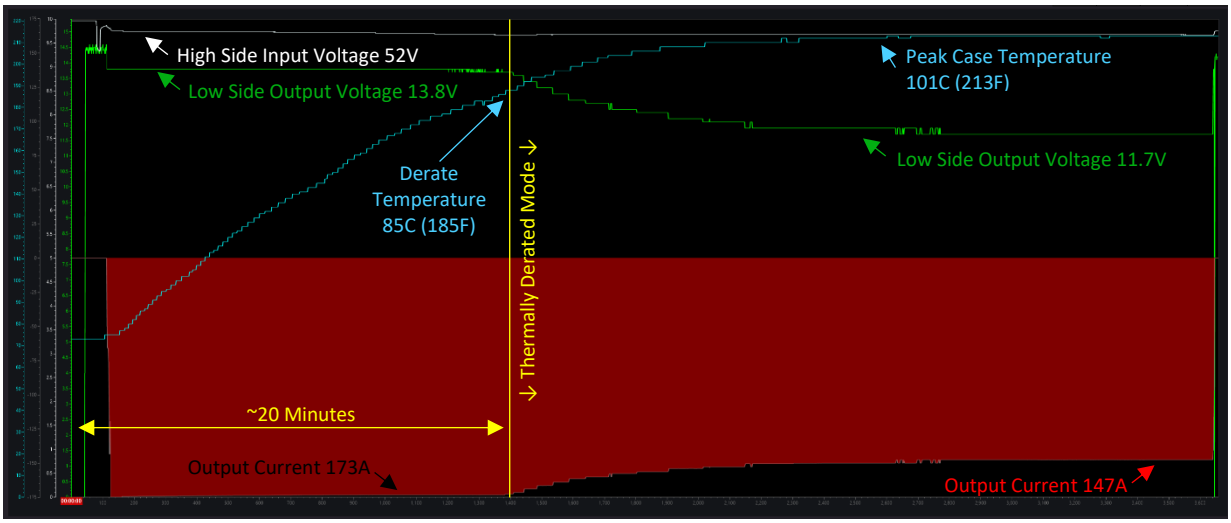

Figure 3: 2.5kw buck mode – 51V to 13.8V

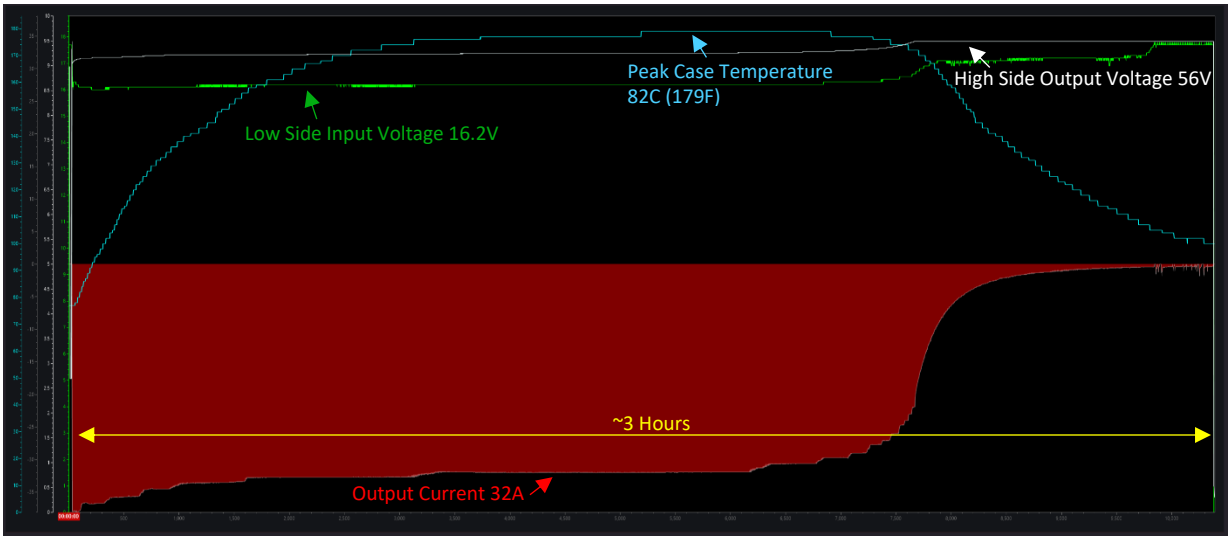

Figure 4: 2.0kW boost mode – 16V to 56V

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Measured Parameters

Buck mode – Load Based Efficiency					
Output Current	**Input Voltage**	**Amperage**	**Output Voltage**	**Amperage**	**Efficiency**
5% (8.9A)	53.09	2.7	13.81	10.3	99.2%
20% (35.6A)	52.95	8.9	13.81	33.8	99.0%
50% (89A)	52.67	24.2	13.8	90.6	98.1%
100% (178A)	52.12	49.3	13.78	179.6	96.3%

Boost mode – Load Based Efficiency					
Output Current	**Input Voltage**	**Amperage**	**Output Voltage**	**Amperage**	**Efficiency**
5% (2.05A)	13.77	11.8	53.17	2.8	91.6%
20% (8.2A)	13.61	32.9	53.3	8	95.2%
50% (20.5A)	13.32	82	52.14	20.1	96.0%
100% (41A)	14.78	141.2	52.7	37.7	95.2%

Output power derate temperature	85C (185F)
Max input voltage Boost	16V (programmable)
Min input voltage Boost	13.2V (hard coded)
Max input voltage Buck	59V (programmable)
Min input voltage Buck	40V (programmable)
Idle Current in boost mode	134ma
Idle Current in boost mode (Vin <13.4V)	67mA
Idle Current in Buck mode	43mA
Idle Current in Buck mode (Vin <40V)	26mA

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Discussion of Test Results

In buck mode the output voltage setpoint can be adjusted from 8V to 16V. The high side over (OVP) and under (UVP) voltage protection values can be configured to set the input voltage limits to protect the 51V battery. The max output current is configurable for up to 178A, when this current limit is reached the converter will enter a constant current derate mode where the voltage will progressively decrease with increased loads. In testing there isn't a minimum cutoff voltage, the converter will derate all the way down to 1V at full current.

In boost mode the output voltage setpoint can be adjusted from 40V to 60V, the low side UVP setting doesn't appear to work as there is a built in minimum voltage of 13.2V. In testing there seems to be about 0.2V of hysteresis in all values, 13.4V minimum turn on, 13.2V loaded cutoff. This isn't an issue as this is the expected lower voltage cutoff for a typical alternator charging system while it is running. Due to the constant idle current an ignition based option to fully turn off the converter may be investigated.

There also appears to be a bug with the low voltage side OVP in boost mode where if it is tripped it won't auto recover. The only way to reset it was to cycle the power or lower the voltage below the UVP point. This issue can be mitigated by raising the OVP setting to 18V which shouldn't be possible to reach by customer installs.

In buck and boost mode the converter will derate the output power if it exceeds a case temperature of 85C (185F). This can be seen in Figure 3, as the case temperature increases the output voltage and as such the current decrease steadily until equilibrium.

4. Conclusion

The converter has met expectations and is ready for customer testing and sales.